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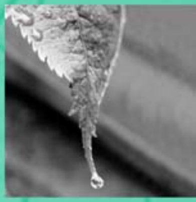

healthy aquatic ecosystems

# Review of Benthic Invertebrates and Epilithic Algae at Long-term Monitoring Sites in the Bow River


> Alberta Environment
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> March 2009


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# Review of Benthic Invertebrates and Epilithic Algae at Long-term Monitoring Sites in the Bow River

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March 2009

# EXECUTIVE SUMMARY

Water for Life: Alberta's Strategy for Sustainability (Government of Alberta 2003) requires regular monitoring, evaluation, and reporting of aquatic ecosystem health. Although comprehensive water quality information is generated annually as part of Alberta Environment's Long-term River Network (LTRN), comparable, current information on sediment quality and biological communities is not available.

In 2006 benthic invertebrates and epilithic algae were collected from the Bow River in order to:

1. Fill knowledge and information gaps identified by North South Consulting Inc. *et al*. (2007) with current data for Bow River LTRN sites.
2. Compare various benthic invertebrate sampling techniques for long-term river monitoring sites in Alberta and provide recommendations for future monitoring at these sites.
3. Evaluate temporal changes and longitudinal trends in benthic invertebrate and epilithic algal communities, particularly as they relate to nutrient management in the Bow River.

After comparing the relative merits of data collected with a Neill cylinder sampler and kick nets of varying mesh sizes, the former was selected for further monitoring at LTRN sites. This decision was based on several considerations. Maintaining continuity with Alberta Environment's historical database was viewed as important. Neill cylinder samples are quantitative and replicated, and hence lend themselves easily to statistical difference testing of population densities. Furthermore, Neill cylinder samples reflect a greater taxonomic diversity than kick samples. Nevertheless, kick samples could be appropriate in other contexts even though they only provide qualitative information.

Benthic invertebrate data from 2006 show evidence of perturbation at Cochrane, most likely due to sharp diurnal fluctuations in discharge (and stage) caused by the operation of an upstream hydro-electric dam. As well, *Didymosphenia geminata*, a colonial diatom which forms dense cotton-like mats on the rocks contributes further to the inhospitable nature of the physical habitat at this site. Zoobenthic and epilithic algal communities provide clear evidence of nutrient enrichment at Stier's Ranch and Carseland downstream of Calgary. Algal and invertebrate abundances are lower at Cluny, but a diverse community including sensitive taxa is supported. The fauna at Ronalane, near the mouth of the Bow River, is characteristic of a depositional area with a sediment bottom, macrophytes, and potentially lower dissolved oxygen levels. Longitudinal changes in benthic invertebrate communities are similar in erosional and depositional areas, although signs of stress, such as lower diversity indices, are apparent in depositional areas of Stier's Ranch and Carseland.

There is a gap of thirteen years between the current data and the last zoobenthic samples collected from the Bow River. Based on this limited record, it appears that while the City of Calgary's nutrient removal program led to some improvements reflected in the river's benthic invertebrate and epilithic algal communities, the degree of impairment may again be increasing. These conclusions may be biased by differing annual flow regimes; in the future, a more consistent sampling schedule should be adhered to so that such variation can be better accounted for.

Evaluating these biomonitoring data along with sediment and water quality chemistry will help to further define current conditions and past changes in the Bow River. The development of indicators and perhaps even a predictive model for aquatic ecosystem health should follow. Again, this work would be of most value if supported by a regular and consistent sampling schedule.

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# ACKNOWLEDGEMENTS

This report was prepared under contract with Alberta Environment and with funding from Water for Life, Aquatic Ecosystem Health working group.

Several staff members from Alberta Environment, including John Willis, Ray Walker, Randy Sweeny, Christie Bonham, Richard Casey and Anne-Marie Anderson, collected samples from the Bow River in 2006.

Epilithic chlorophyll-*a* was analyzed at the Analytical Chemistry Laboratory of the Alberta Research Council in Vegreville under supervision of Frank Skinner. Michael Agbeti (Bio-Limno Research & Consulting Inc.) Halifax, Nova Scotia identified and enumerated epilithic algae. Benthic invertebrates collected in 2006 were sorted, identified, and enumerated by Bob Saunders, Calgary, while most of the historical samples were processed by Bill Anderson, Spruce Grove.

Bridgett Halbig, Westbank, British Columbia, helped to format the historical invertebrate data for analysis.

Statistical analyses were performed by Dr. Zack Florence, Vancouver, British Columbia.

Mary Raven, Alberta Environment, finalized figures and tables and formatted the report.

Valuable review comments provided by Leigh Noton, Richard Casey and Al Sosiak (Alberta Environment) were incorporated in the final draft.

# 1.0 INTRODUCTION

Regular monitoring, evaluation, and reporting of aquatic ecosystem health are requirements highlighted under Water for Life, Alberta's Strategy for Sustainability (Government of Alberta 2003). A recent report by North South Consulting Inc. *et al.* (2007) reviewed available information on aquatic ecosystem health in Alberta. Although comprehensive water quality information is generated on a regular basis as part of reporting on Alberta Environment's long-term river network (LTRN), data for sediment quality and biological communities at the network sites was not available.

The use of benthic invertebrate and epilithic algal communities in biomonitoring programs is widespread and well documented (*e.g.*, Davis and Simon 1995, Barbour *et al.* 1999). Although recent biomonitoring data are lacking in Alberta, there is a substantial historical database for benthic invertebrates as well as some epilithic algae data dating back to the 1980s (*e.g.*, Charlton 1986, Charlton *et al.* 1986, Anderson 1991, Sosiak 2002).

Alberta Environment established a long-term zoobenthos monitoring network in the 1970s and 80s at about 20 sites on major provincial rivers. The network was designed with spring and fall collections over 5 consecutive years alternating with 5 years with no collections. The expectation was that, over time, it would be possible to relate changes in community composition to changes in aquatic ecosystem quality (Anderson 1991). Sampling was not resumed as scheduled in 1993 because of fiscal constraints and evolving provincial monitoring priorities. However, benthic invertebrate monitoring continued in some rivers as part of other projects (*e.g.*, longitudinal surveys in the Bow River in 1993, following some major upgrades to municipal wastewater treatment in Calgary).

The Bow River is an interesting system in which to study responses of biological communities to improvements in municipal wastewater treatment. Phosphorus removal technology was implemented at Calgary's two wastewater treatment plants in 1982-83. This was followed by improvements to nitrogen removal between 1987 and 1990. However, between 1983 and 2006, Calgary's metropolitan area population grew from 620,692 to 991,759 (City of Calgary 2007) and is now over 1,000,000. Despite reductions in nutrient concentrations due to improved municipal treatment, increasing population density will lead to increased wastewater production which could increase nutrient loadings to the Bow River.

In the Bow River, chlorophyll-*a* and taxonomic composition of epilithic algal communities as well as biomass and macrophytes species composition have been monitored regularly since the early 1980s. These data were used to document biological responses to the management of municipal effluent loading from Calgary (Charlton *et al.* 1986, Sosiak 2002). According to Sosiak (2002), changes to nutrient loading from the City of Calgary resulted in a reduction of macrophyte biomass but did not significantly influence epilithic algal growth in the period studied (up to 1996). Both the continued phosphorus removal (alum) and the scouring action of the 2005 flood have resulted in an aquatic plant community that is mostly periphyton and which now may be responding to much lower levels of phosphorus (Al Sosiak, pers. communication, 2008).

Benthic invertebrate monitoring was part of surveys conducted in 1989 and 1992. Initial benthic invertebrate responses to phosphorus removal from Calgary's municipal discharges were documented in Anderson (1991), but benthic data have not been evaluated since.

In 2006 a pilot sampling program for both benthic invertebrates and epilithic algae was implemented on the Bow River. Objectives of the study were to:

1. Start filling knowledge and information gaps identified by North South Consulting Inc. *et al.* (2006) with current data for Bow River LTRN sites.
2. Compare the relative merits of various benthic invertebrate sampling techniques for long-term river monitoring sites in Alberta and provide recommendations for future monitoring at these sites. Although Neill cylinder samples have been the standard sampling technique by AENV, rapid assessment sampling techniques are gaining popularity and needed investigation.
3. Evaluate temporal changes and longitudinal trends (both current and historical) in benthic invertebrate and epilithic algal communities, particularly as they relate to nutrient management in the Bow River.

# 2.0 METHODS

## 2.1 Sampling Program

### *2.1.1 Introduction*

Alberta Environment (AENV) collected benthic invertebrate and epilithic algal community samples from five long-term monitoring sites on the Bow River (Cochrane, Stier's Ranch, Carseland, Cluny, and Ronalane - Figure 1) in October 2006. Method comparison was one of the objectives of this project; therefore, care was taken to alternate the collection of sample types to account for habitat variability and to augment the comparability of data sets. For example, in erosional areas, six rocks for epilithic algal sampling would be collected first, followed by one Neill cylinder sample, a '90 second' kick sample with a 210µm net, and finally a '90 second' kick sample with a 400µm mesh. This cycle would be repeated until all samples were collected. Sampling proceeded in an upstream direction, taking care not to disturb areas yet to be sampled.

In addition to biological sampling described below, flow velocity, depth, and a visual assessment of substrate type were recorded from the reach sampled at each site (Appendix 1).

### *2.1.2 Benthic Invertebrates*

Alberta Environment has used a Neill cylinder to collect lotic benthic invertebrates for over 30 years (*e.g.,* Anderson 1991). This method is quantitative as the cylinder covers a known area ($0.1m^2$) which allows estimates of invertebrate population density. The cylinder is inserted securely in the substrate so that a seal is established. Rocks enclosed in the cylinder are cleaned by hand and the substrate is then agitated with a pointed shovel until water flows clear into the collecting net. Debris and invertebrates are washed into a net (mesh aperture of 0.210 µm) attached to the downstream portion of the cylinder, and from there into a collection bottle. In accordance with AENV protocol (AENV 2006), five replicate samples are collected at each site.

Semi-quantitative kick net sampling methods are favoured by many organisations (United States Geological Survey, USGS, Cuffney *et al*. 1993; United States Environmental Protection Agency, USEPA, Barbour *et al*. 1999; Ontario Benthic Biomonitoring Network OBBN, Jones *et al.* 2005). These methods are primarily used in conjunction with "rapid assessment" and "reference condition" approaches which usually involve only one sample per site. However, the reference condition approach requires individual samples from numerous sites to provide sufficient sample size to define the characteristics of reference sites. These samples may be standardized based on sample area, and/or the length of time spent agitating the substrate upstream of the net. The mesh size of the net tends to vary. USEPA (Barbour *et al*. 1999) and OBBN (Jones *et al*. 2005) protocols specify 500µm openings; Waterwatch Australia (2004) and others (Taylor 1997) recommend a 250 µm mesh size.

Three methods were used to collect benthic invertebrates from erosional areas in the Bow River:

1. Neill cylinders with a 210µm mesh size and a 0.1 $m^2$ sampling area. Five (5) replicate samples per site as per Alberta Environment (2006).
2. Kick samples taken with a 400µm mesh size, total time of 3 minutes. A single sample per site with two extra samples at 2 sites for QA/QC purposes.
3. Kick samples taken with a 210µm mesh size, total time of 3 minutes. A single sample per site with two extra samples at 2 sites for QA/QC purposes.

Each kick sample was usually made up of two subsamples timed at 90 seconds and pooled together to form a composite. The net was emptied more often if fines were clogging it, but the total sampling time was always 3 minutes. All invertebrate samples were preserved shortly after collection with 4% formaldehyde.

In depositional areas a kick sample taken with a 210µm mesh size was collected over 90 sec.

### *2.1.3 Epilithic Algae*

Epilithic algae samples for chlorophyll-*a* analysis, as well as samples for taxonomic analysis were collected from erosional areas. Epilithic algae for chlorophyll-*a* determination were scraped from rocks using the template method (Alberta Environment 2006). Scrapings from a 4 $cm^2$ template were taken from each of 3 rocks to form a composite sample. Algal material was placed on a GF/C filter, sprinkled with $MgCO_3$, and then wrapped in aluminum foil and frozen. Three replicate composite samples were collected at each site, and up to 6 additional samples were taken at some sites for QA/QC.

Epilithic algae for taxonomic analysis were also obtained using the template method, but in this case scrapings from 9 rocks (4 $cm^2$ scraping each) were combined to form one composite sample. The sample was preserved shortly after collection with Lugol's solution and 5 drops of formaldehyde.

## 2.2 Laboratory Analyses

### *2.2.1 Benthic Invertebrates*

The zoobenthic samples were stained with Rose Bengal (Mason and Yevich 1967) then sorted through three sieves with mesh apertures of 2, 1, and 0.2 mm. The coarse fraction and fine fractions were sorted under a dissecting microscope (magnification range 6 to 50X). It was necessary to sub-sample the fine fractions (residue on the 1 and 0.2 mm screens) of some samples that contained large numbers of organisms. Sub-sampling was performed using the Imhoff cone method described by Wrona *et al.* (1982).

Specimens were identified to genus or species where possible, according to Edmunds *et al*. (1976), Baumann *et al*. (1977), Wiggins (1977), Pennak (1978), Merritt and Cummins

(1984, 1996), Clifford (1991), Thorp and Covich (2001), and others using the most current taxonomic designations available.

Raw benthic invertebrate data are presented in Appendix 2

### 2.2.2 Epilithic Algae

Chlorophyll-*a* and phaeophytin-*a*, a degradation product of chlorophyll, were determined fluorometrically after acetone extraction at Alberta Research Council, Vegreville. Results are reported as $mg/m^2$.

Non-diatoms (soft algae) and diatoms were analyzed separately. Depending on their concentration, non-diatom samples were diluted first. To determine the appropriate dilution, the original samples were screened to assess the densities of algae and non-algal matter (debris and particulate matter). Aliquots of the appropriately diluted samples were allowed to settle overnight in sedimentation chambers following Utermöhl's procedure described in Lund *et al*. (1958). Algal units were counted from a minimum of four transects on a Zeiss Axiovert 40 CFL inverted microscope. Counting units were individual cells, filaments, or colonies depending on the organization of the algae. Both diatoms and non-diatoms were counted. For soft algae, between 250 and 300 units were counted at 500X magnification; a number of transects were scanned at 250X for larger algae. For diatoms, a minimum of 250 was set as the target. At this stage, diatoms were not identified to species or genus, but recorded as "diatoms", and were later identified to species from prepared slides.

Preparation of diatom slides consisted of digesting sub-samples using concentrated nitric acid and hydrogen peroxide and washing several times (by centrifuging) with distilled water. A few drops of the diatom slurry were placed on a cover slip and allowed to evaporate overnight. Once dry, the diatoms were mounted in Naphrax and identified using 1000 to 1500 X magnifications (under oil immersion) on a Zeiss Axioskop 40 compound microscope. A minimum of 500 diatom frustules were counted on each slide. The diatom counts on the slides were converted to density based on the number of transects covered during the fresh (Utermöhl) counts.

Biomass was calculated from recorded abundance and specific biovolume estimates, based on geometric solids (Rott 1981), assuming unit specific gravity. The biovolume of each species was estimated from the average dimensions of 10 to 15 individuals. The biovolume of colonial taxa was based on the number of individuals in a colony. All calculations for cell concentration ($units/cm^2$) and biomass ($\mu g/cm^2$) were performed with Hamilton's (1990) computer program.

Taxonomic identifications of soft algae were based primarily on Anton and Duthie (1981), Entwisle *et al.,* (2007), Findlay and Kling (1976), Huber-Pestalozzi (1961, 1972, 1982, 1983), Tikkanen (1986), Prescott (1982), Whitford and Schumacher (1984), Starmach (1985), Komarek & Anagnostidis (1998, 2005), and Wehr and Sheath (2003). Diatom identifications were based primarily on the following texts and supplemented with other publications: Krammer and Lange-Bertalot (1986, 1988, 1991a,b), Reavie and

Smol (1998), Cumming *et al.* (1995), Bahls (2004), Camburn and Charles (2000), Fallu *et al*. (2000), Patrick and Reimer (1966, 1975), Siver and Kling (1997), and Siver *et al.* (2005).

Raw epilithic algal data are presented in Appendix 3.

## 2.3 Data Analyses

### *2.3.1 Benthic Invertebrate Data*

#### *2.3.1.1 Metrics*

The use of benthic invertebrates as indicators of aquatic ecosystem health is well established. Characteristics such as feeding method, habit, habitat preference, pollution tolerance (primarily tolerance to organic pollution) and environmental sensitivity can account for the distribution of benthic invertebrates and can be used to illustrate changes due to both natural and man-made factors. Many metrics, based on invertebrate counts (individuals and taxa), proportions, or more complex indices have been derived to summarize invertebrate data in order assess river conditions (Merritt and Cummins 1996, Barbour *et al*. 1999, Mandaville 2002). Several such metrics were computed from raw data for this report. These metrics, along with their rational and formulae, if appropriate, are listed here.

***Abundance*** – The total count of individuals in a sample.

***Richness*** – The number of unique taxa in a sample. Richness was calculated at the species, genus, and family level for this report. A greater the number of taxa usually suggests a healthier aquatic community.

***Diversity*** – Diversity combines the concepts of abundance and richness. Two common diversity indices were calculated for this report (Beals, Gross, and Harrell 1999, 2000):

*Simpson Diversity Index (D)* -

$$D = \frac{\sum_{i=1}^{S} n_i(n_i - 1)}{N(N-1)}$$

…where *S* is the number of taxa (species), *N* is the number of organisms, and *n* is the number of organisms in the "$i^{th}$" taxon. This index is usually presented as 1-D so that the results are more intuitive (*i.e*. the lower the number, the lower the diversity).

*Shannon Diversity Index (H)* –

$$H = -\sum_{i=1}^{S} p_i \ln p_i$$

…where *S* is the number of taxa in the community, and $p_i$ is the proportion of individuals in the "$i^{th}$" taxon. H increases with increasing diversity.

***"Number of unique zoobenthos groups"*** - The number of species, genera or families within a particular group of invertebrates, whether defined taxonomically, by functional feeding group, habit/behaviour, habitat preference, or pollution tolerance/sensitivity. Useful measures within this category include:

*Number of EPT taxa* – Members of the orders Ephemeroptera, Plecoptera, and Trichoptera are generally considered to be sensitive to pollution, preferring oxygen-rich habitats. Richness in these groups should be higher when water quality conditions are better.

*Number of ETO taxa* – This is similar to the previous measure, but includes Odonata, instead of Plecoptera, which are also considered to be sensitive.

*Number of Clinger taxa* – These organisms hold their position on the bottom substrate in flowing water. Their numbers are lower in the presence of excessive algal growth or sedimentation.

*Number of Pollution-Intolerant Taxa* – 'Pollution' refers primarily to nutrient or organic enrichment. Organisms were assigned a value between 0 (very intolerant) to 10 (very tolerant) based on the concept of Hilsenhoff (1987, 1988) as compiled by Mandaville (2002). For this report, a conservative approach was used where species with rankings from 0 through 2 were counted as intolerant.

***Proportional Abundance*** – The number of a particular group of invertebrates in comparison to the total number of individuals in a sample. Examples of metrics in this category include:

*Proportion of Chironomidae* – Higher proportions of midge larvae are expected at more impacted sites.

*Proportion of EPT* – Higher proportions of these organisms are expected at less impacted sites.

*Proportion of Filtering Collectors* – These organisms will be found in greater proportions at sites with more fine particulate organic matter in the water column.

*Proportion of Burrowers* – These organisms will be found in greater numbers where the riverbed is covered with sediment.

*Proportion with Erosional Preference* – These invertebrates should occur in greater proportions in erosional (riffle) areas (rather than in depositional or sediment habitats).

***Percent Contribution by Dominant Taxon*** – A large prevalence of a single type of organism in a sample suggests an impacted site. In this report, the dominant order of insects was compared to total insects.

***Ratio of EPT to Chironomidae*** – An indication of community balance, this ratio is lower under conditions of environmental stress.

***Ratio of Hydropsychidae to Trichoptera*** – Hydropsychids are considered to be less sensitive than most caddisflies.

***Ratio of Scrapers to Filterers*** – This ratio compares two different feeding strategies to reflect different environmental conditions. Scrapers prefer areas with lots of algae and plant material, while filters require fine particulate material in the water column. Filterers may also be used to assess pollutants adsorbed to particulates, although they are not necessarily sensitive to such pollutants. This ratio did not provide much information for the Bow River sites.

***Biotic Index (BI, Species) and Family Biotic Index (FBI)*** - (Modified from Hilsenhoff 1987, 1988). Pollution tolerance values from 0 to 10 were assigned at the species or family level according to tables compiled by Mandaville (2002). The indices were then calculated according to the following formula:

$$BI \text{ or } FBI = \Sigma(n_i * t_i)/(N)$$

…where $n_i$ the number of individuals in the "$i^{th}$" taxon, $t_i$ is the tolerance value of the $i^{th}$ taxon, and $N$ is the total number of organisms in the sample. A lower index value implies better water quality.

***Biological Monitoring Working Party (BMWP)*** – (Modified for North America by Mackie 2004). This procedure assigns scores, primarily at the family level, between 1 and 10, where 1 is least sensitive to pollution and 10 indicates a high sensitivity. The scores for all families are then added together. A higher number indicates better aquatic conditions. Scores for this index were obtained from Mandaville (2002).

***Average Score Per Taxon (ASPT)*** - The BMWP (sensitivity) for a sample is divided by the number of taxa used to calculate the BMWP. This eliminates the effect of family richness, yielding a number between 1 and 10; the higher the ASPT, the better the conditions.

#### *2.2.3.2 Sampling Method Comparison*

The raw numbers and 20 metrics selected from Section 2.2.3.1 were used to compare the three sampling methods based on two broad criteria: whether similar patterns were exhibited among sites and whether the kick samples fell within the variability exhibited by the replicate Neill cylinder samples. The latter is particularly important if valid historical comparisons are to be made should the Neill cylinder method eventually be replaced by kick samples.

Method comparisons were accomplished both statistically (11 metrics) and/or graphically (20 metrics). Because five replicates are available for the Neill cylinder, the data can be treated in two ways, either using the mean (or other measure of central tendency) of a metric calculated for each of the five samples, or by calculating the metric on the averaged (or summed) data. The results can be very different for metrics dealing with counts (of species or other taxonomic levels) but are more similar for proportional data (ratios, percentages). The two ways of dealing with the data, as described above, are designated as "Average Neill" and "Total Neill" in the Figure 2 and Appendix 4.

The Neill replicates were compared statistically to the individual kick and total Neill (*a.k.a*. Neill mean metric) by using the "bootstrap" method, which estimated the mean difference and 95% confidence bounds over a course of 1000 iterations for each metric. The bootstrap offers a well-established method for estimating parameters and their standard errors when larger samples are not available (Manly 1991, 2001; Efron and Tibshirani 1986, 1993).

The protocol was as follows:

1. Sample 5 values from field data (replicates), with replacement.
2. Calculate the mean.
3. Subtract the reference value (210 kick, 400 kick, Neill) from the mean (#2).
4. Store the resulting difference.
5. Repeat the above 1000 times.
6. Calculate the upper and lower 95% percentiles around the 1000 differences.
7. Decision: do the 95% bounds contain "0" (zero)? If so, this is good evidence that the respective sample method (210 kick, 400 kick, or Neill Mean) is a good fit, with 95% confidence, to the Neill replicates.

The total number of factorial combinations in this exercise was: 3 methods x 5 locations x 21 metric = 315.

All bootstrapping was done using: Resampling Stats, version 5.0.2, Resampling Stats, Inc., Arlington, VA, USA, 22201. The reasoning for performing 1000 iterations is contained in Manly (1991).

#### *2.2.3.3 Assessment of Longitudinal and Temporal Trends*

In order to compare the Bow River zoobenthos data collected in autumn 2006 to other data also collected in autumn at the same sites (i.e., 1983, 1984, 1985, 1986, 1987, 1989, and 1993), some changes to taxonomic groupings had to be made. Identifications in the two previous decades were often not as detailed as those done for the 2006 samples; occasionally, identifications were at relatively high levels, family or order. This difference in level of detail had the greatest impact on results for the family Chironomidae. These organisms were almost always identified to genus for the 2006 samples but were left at tribe or sub-family in the earlier samples. Changes to taxonomic conventions in the 13 years between 1993 and 2006 also led to differences between the recent and earlier data sets. In particular, mayflies included historically in the genus *Baetis* have been split into the following: *Acerpenna*, *Diphentor*, *Fallceon*, *Procleon*, *Plauditus*, *Acentrella*, and *Baetis*, while the historical genus *Psuedocoleon* was included with *Baetis* (W.J. Anderson, pers. comm. 2007, Merritt and Cummins, 2$^{nd}$ and 3$^{rd}$ Editions). Therefore, the data had to be altered to achieve taxonomic consistency among years.

The raw data and the derived metrics can be found in Appendix 5.

Statistical analyses, usually performed on transformed data (*e.g*., log(x+1), arcsin(x)), consisted of principal components analysis (PCA) and step-wise discriminant analysis for all sites and years; analysis of variance (ANOVA) for changes in mean values over sites for each year (*longitudinal differences*), changes in mean values over years for each site (*temporal differences*), and changes in PC scores and discriminant function (DF) scores for the five sites over time; and Bonferroni pair-wise comparisons among years and sites for all scores and means.

### 2.3.2 Epilithic Algal Data

Longitudinal trends for chlorophyll-*a* data and various metrics based on the taxonomic data were examined graphically. Metrics included biomass, density, number of species and genera, and % biomass distributed over the various algal groups for each site, as well as the Shannon diversity index. In addition, diatom species were classified as preferring low or high total phosphorus concentrations, and low or high total nitrogen concentrations, according to the work of Potapova and Charles (2007).

Pearson correlations were performed to examine the relationship between various invertebrate and epilithic algal metrics. A limited amount of historical epilithic community and chlorophyll-*a* data were also available for comparison.

# 3.0 RESULTS AND DISCUSSION

## 3.1 Comparison of Benthic Invertebrate Sampling Methods

### *3.1.1 Numbers of Organisms and Taxa*

Because the Neill cylinder samples are quantitative and the kick samples are not, the actual number of organisms counted cannot be directly compared. However, the number of organisms collected can be important in that too small a sample may not adequately show the diversity of the benthic community, and too large a sample presents enumeration difficulties. If the collection methods are equivalent, however, the proportions of the various groups of organisms collected should be similar, even if the numbers are not comparable. The Neill average had the lowest abundances, while the total Neill and 210 kicks had the highest abundance. The fewest organisms were collected at Cochrane in all cases. The site with the most organisms varied with method; the largest number of organisms, 73675, was collected in the 210 kick at Stier's Ranch (Figure 2.1). Counts in the Neills were statistically different from those in the corresponding kick samples at all sites (Appendix 6).

An important indicator of aquatic ecosystem health is the number of unique taxa collected. Samples, therefore, must accurately reflect the variety of organisms present. For all methods, the lowest number of taxa was collected at Cochrane. The highest number of taxa was collected at Carseland for all methods except for the 400 kick. The individual Neill samples, which tend to collect fewer organisms than the kicks, had the least number of taxa. When the results of the replicates were summed, however, the Neills had the highest number of taxa – between 22 and 30 more per site than the individual samples. The second highest number of taxa was usually collected by the 210 kicks (Figure 2.2). The richness of the kicks and of the summed Neills could almost always be considered to be different than that of the individual Neills, with a few exceptions at Stier's Ranch and Cluny for the 210 kicks.

The different collection methods produced similar longitudinal patterns for many sub-sets of organisms, such as number of chironomid genera. The greatest numbers of chironomid genera were found at Carseland by all methods. As for overall taxon richness, the lowest numbers were from the average Neills and highest were from the total Neills (Figure 2.3). For Ephemeroptera, Plecoptera, and Trichoptera (EPT) genera, all methods found the number of unique genera to be highest at Cluny. While the total Neills tended to have the highest counts overall, the 400 kick samples had higher counts than the 210 samples and the average Neills had the lowest (Figure 2.4).

It is possible that the behaviour of the benthic invertebrates (*i.e.*, whether they burrow, climb, cling, swim, *etc*.) might affect their capture by the Neill cylinder compared to kick nets. For clinger taxa, a similar longitudinal pattern was seen for all methods, with more clinger taxa being found at Carseland than anywhere else (Figure 2.5). For taxa classified primarily as swimmers, however, similarities among the methods were not apparent (Figure 2.6). These results may reflect a sampler-type bias, an overall challenge associated with collecting swimmers, or the fact that the number of taxa in this habit category was low.

The benthic invertebrates were also categorised by functional feeding group. Unlike some of the previous examples, the numbers of collector-gatherer taxa for both averaged and total Neill samples were higher than for the kick net samples. Lowest counts overall were found at Cochrane; for the Neills, the highest number of gatherers were found at Carseland, while for the kicks, numbers were highest at Ronalane (Figure 2.7). Relatively low counts in the individual Neill samples occurred for the predator taxa; as in the previous case, however, the kick samples were much more similar to each other than they were to either the averaged or total Neills (Figure 2.8).

Both kicks and Neills showed similar site-to-site patterns for taxa classified by habitat preference (erosional, depositional, *etc*.). The most taxa with an erosional preference were found at Carseland and the least were found at Cochrane, independent of the method used. Overall, the greatest variety of erosional taxa was present in the total Neill samples (Figure 2.9).

All sampling methods showed similar patterns among sites for taxa intolerant to pollution (*i.e.,* those rated as 0, 1, or 2 on a scale from 0 to 10). This occurred even though relatively small numbers of these taxa were found (Figure 2.10). The number of intolerant taxa in the 400 kick samples was consistently higher than that in the 210 kick samples, despite the fact that the 210 kicks collected more invertebrates in total.

### *3.1.2 Relative Proportions of Organisms*

Calculating the proportion of various organisms to the total collected or to a sub-set of the collection should reduce some of the difference among methods that is due to sample size. For the Oligochaeta, longitudinal patterns and percent contributions were similar for the average and total Neill samples and the 400 kick samples at all sites. At Carseland and Cluny, the percentages of the 210 kick samples made up of aquatic worms were double the percentages collected by the other methods (Figure 2.11). This finding may reflect the fact that a smaller mesh size is more effective at collecting smaller organisms; at these sites, the oligochaetes were almost exclusively from the family Naididae, which tend to be quite small. The Neill and 400 kick also tracked each other more closely than the 210 kick samples for the percentage of Diptera (including the Chironomidae), although the overall trend was similar for all samples (Figure 2.12).

The dominance of one type of organisms in a sample can be an indication of an impacted, or a less complex, benthic environment. The contribution by the dominant insect order at each site (as a percentage of total insects) showed closer correspondence between the Neill samples and the 210 kick samples than the 400 kick samples (Figure 2.13). The percentage contribution was always lower in the 400 kicks than the individual Neill samples, and significantly so at four of the five sites (Appendix 6). In most samples, dipterans dominated, primarily as a function of number of Chironomidae. The only exceptions were for both Cochrane kicks, in which Hemiptera (Corixidae) were most plentiful and for the 400 kick at Cochrane for which the high Diptera counts were due to Simuliidae.

The ratio of EPT to Chironomidae can be used to indicate environmental stress, with higher ratios (relatively more EPT) indicating less stress. In this case, the 400 kick samples gave much higher EPT/Chironomidae ratios, particularly at Stier's Ranch and Cluny (Figure 2.14). Not only were fewer small and/or filiform organisms, such as chironomids, collected by the 400 mesh nets, but it appears that more EPT organisms were collected as well (see Figure 2.4). This finding was confirmed by the statistical exercise. With the exception of Ronalane, either one or both of the proportion of EPT and the EPT/Chironomidae ratio were significantly higher for the 400 mesh kick samples than for the individual Neills (Appendix 6). Perhaps greater flow through the wider mesh offers less resistance to larger and mobile insects. Slower flow through the finer mesh, slowed further by a greater chance of the mesh being obstructed by debris, may allow more active animals a chance to escape capture.

The longitudinal patterns for the percentage of organisms that cling to the substrate were similar for all the collection methods, with the percentage of clinger taxa highest for all samples at Stier's Ranch and lowest at Ronalane. At each site, the percentage of clingers tended to be lower for the 210 kicks than the other methods (Figure 2.15). As suggested previously, increased resistance to flow through the 210 mesh net may have made capture of clinger taxa slightly more difficult. Swimming taxa, the actual numbers of which were difficult to interpret, clearly made up a larger percentage of all samples taken at Cochrane than elsewhere. The percentage of swimmers was much higher in the 210 kick than in other samples at this site. Over all sites, however, the proportion of swimmers was slightly higher in the 400 kicks (Figure 2.16).

The percentage of predator taxa was higher for both types of kick samples than for the Neill samples at Cochrane and Stier's Ranch. Sample results were not as different at the three downstream sites (Figure 2.17). The ratio of scraper taxa to filtering collectors, however, was similar for all sample types at the first three sites. At Cluny, both kicks differed from the Neills (210 lower, 400 higher) and at Ronalane the 400 kick had a higher scraper to filterer ratio than the Neills (Appendix 6).

The 210 kick samples at Cochrane and Stier's Ranch appeared to be different from both the Neills and the 400 kicks for taxa preferring depositional habitats. At Cochrane, the 210 sample had the highest percentage of depositional taxa compared with the other sampling methods, while at Stier's Ranch the 210 sample had the lowest percentage (Figure 2.18). Statistically, the 210 kick samples at Cluny and Ronalane were also different than the Neills (Appendix 6). For taxa with a preference for an erosional habitat, the proportion found in the 400 kicks was different than that of the individual Neills at four of the five sites (lower on 3 of these occasions), while the proportion found in the 210 kicks was higher than the Neills at Cluny and Ronalane, and lower at Cochrane.

### *3.1.3 Indices*

The Biotic Index is calculated by assigning pollution tolerance values from 0 (intolerant) to 10 (tolerant) to all taxa (species in this case) to determine an average tolerance for the community. Longitudinal patterns were generally similar, with the highest or second highest scores for each method occurring at Cochrane and Ronalane, and the lowest scores (more favourable conditions for invertebrates) for each method occurring at Stier's Ranch. However, the kick samples gave index values that were quite different from the Neill samples and often very different from each other (Figure 2.19 and Appendix 6). It is apparent that the meaning of the index values must be calibrated for each method, and need to be reviewed in the context of actual rather than assigned taxa tolerances, and actual river conditions. For example, despite pronounced diurnal fluctuations and critically low DO in summer at Stier's Ranch, the abundant food supply resulting from enrichment at this site still allows the establishment of large invertebrate populations.

The Shannon Index uses the number of individuals in each taxon present in a community to give an indication of diversity. A higher value represents higher biotic diversity. The index values differed for each collection method, giving different impressions of the pattern of diversity at each site. The highest index scores for the kick methods were achieved at Cochrane, while the Neill methods produced the lowest scores at this site (Figure 2.20). As for the biotic index, the diversity index values should not be compared among different collection methods and need to be evaluated in the context of other data (Appendix 6).

### *3.1.4 Other Considerations*

As well as being able to capture a representative sample of benthic invertebrates, an ideal collection method should be easy to use and be both time- and cost-effective. Kick nets and Neill cylinders are both fairly easy to use. The nets tend to allow more variability in the way they can be used. Neill cylinder use may be more easily reproduced, which is particularly important if many field technicians are involved in the collections. The time taken to obtain five Neill samples is slightly more than the time required to collect a single kick sample, but not significantly so.

Sample processing time and cost are also a consideration. Even if the cost for processing Neill and Kick samples are similar, processing Neill samples would be costlier because collection of replicates is the norm. Kick samples are larger than individual Neill samples and contain more debris so require more time to process unless severe sub-sampling measures are taken. Although the total number of organisms in five replicate Neills can be fairly close to the total found in a 210 µm kick sample, more of the material tends to get sorted. In the current study, even the coarse 2.0 mm fraction of the 210 and 400 kicks from Stier's Ranch had to be quartered to make sorting and identifying manageable. For the 1.0 mm fraction, most of the Neill replicates were sorted in their entirety, while on average half of the fraction was sorted for the 210 kicks and a third of the fraction was sorted for the 400 kicks. For the finest fraction (0.2 mm), a little more than a tenth of the Neill material and a quarter of the 400 kick sample was used on average. For all the 210 kicks except from Cochrane, only one fortieth of the fine fraction was evaluated. The smaller the sample fraction sorted the larger the uncertainty surrounding the estimated abundance and richness of that sample.

### *3.1.5 Conclusions*

Although there is a higher cost associated with processing Neill cylinder samples, this method appears to be the most appropriate for continuing to monitor longitudinal and temporal trends in the benthos of Alberta's major rivers. The method is repeatable and relatively simple. The replicates collected at each site provide smaller, more manageable samples that provide greater statistical power than a single kick sample. Considered together, the Neill replicates have the ability to reflect greater taxonomic diversity than either the 210 or 400 kick samples. The quantitative nature of the Neill cylinder allows population density estimates that are not possible with kick samples. Furthermore, given that Neill cylinder samples have historically been used in Alberta rivers by AENV, the results will be directly comparable with 20 years of previous data.

Many of the site-to-site differences that were observed in the Neill samples were reflected in the kick samples as well. Kick samples may very well be appropriate in other contexts, such as in a regional survey of smaller streams where many locations are being examined. In a case where kick nets are preferred, the choice of mesh size will be important. Although a smaller mesh allows the capture of more organisms, the potential for very large samples that may be biased towards smaller organisms must be considered.

## 3.2 Assessment Of Longitudinal And Temporal Trends In Benthic Invertebrate Data

### *3.2.1 Longitudinal Trends in Erosional Habitat (2006) – Neill Cylinder Samples*

#### *3.2.1.1 Abundance, Richness, and Diversity*

Differences in the numbers and types of invertebrates found at each of the five Bow River sites show longitudinal patterns consistent with natural and anthropogenic changes along the length of the river. The lowest abundance of organisms (total number of organisms) was found at Cochrane, while the highest was found at Stier's Ranch (Figure 3.1). Abundance at Cochrane was significantly lower than at all other sites; the only other significant difference was between Stier's and Cluny (Appendix 7). The Cochrane site is upstream of most major point-sources of nutrient enrichment on the Bow River (except for some municipal and industrial discharge from the Bow Valley Corridor). In contrast, Stier's Ranch is directly below the City of Calgary and its two wastewater treatment facilities, which provide nutrients to maintain substantial populations of algae, macrophytes, and invertebrates.

The number of unique taxa (richness) provides information about the "health" or degree of perturbation at a site, with fewer taxa suggesting a more impacted site. In the Bow River, the lowest richness occurred at Cochrane (Figure 3.2), where the number of taxa was significantly lower than at all other sites (Appendix 7). Given Cochrane's foothills location and heterogeneous substrate, the site would be expected to support a larger variety of taxa. However, as suggested by Anderson (1991), manipulation of flow as a result of the operation of the Ghost River hydroelectric dam upstream of the site causes significant diurnal disturbance to the benthic fauna at this site. Benthic communities in this reach of the river may be submerged and exposed within a 24 hour period, depending on their location in the channel. This situation would not be tolerated by many sensitive organisms and would affect the distribution of other organisms. Collecting a representative sample at such a site is difficult, as samplers may not be aware that they are accessing an area that has been recently exposed to air (Anderson 1991). Furthermore, during periods of high flows, flow velocity and steep slopes make it difficult to penetrate deep enough in the river. *Didymosphenia geminata,* a colonial diatom, was encountered regularly when collecting invertebrates in the 1980's and 1990's; it was present in 2006 although perhaps not to the same degree. The diatom can cover rocks with cotton wad-like material and contributes further to a rather inhospitable habitat for invertebrates. The distribution of *Didymosphenia geminata* in Alberta Rivers is believed to be linked to flow regulation (Kirkwood *et al*. 2007).

For richness, as for all metrics involving counts of taxa, the Neill cylinder data can be summarized as either the mean number of taxa per site (based on 5 replicates) or as the total number of unique taxa at a site, the latter better reflecting the site's true complement of taxa, including rare organisms. In this case, while the highest mean number of taxa occurred at Stier's Ranch, the highest total number of unique taxa occurred at Ronalane (Figure 3.2, Appendix 7). Note also most of the analyses for the 2006 data are based on a "truncated" data set, reflecting taxonomic levels and names used in the historical data sets. Using the original taxon list for the 2006 data, total richness is higher at each site by between 12 and 23 taxa (Figure 3.3). The overall pattern is similar to that based on higher taxonomic levels; however, the highest mean and total numbers of taxa occur at Carseland, mainly due to a large variety of chironomids at this site.

Because they summarize the relative abundance of various taxa, it is expected that diversity indices provide more succinct information about benthic communities than abundance or richness alone. Two such common indices, Simpson's (*D*) and Shannon's (*H*) were calculated for the 2006 data. The Simpson Index showed the lowest diversity at Cochrane and Ronalane, with Cochrane differing significantly only from Stier's Ranch, the most diverse site (Figure 3.4, Appendix 7). This index de-emphasizes rare taxa, while highlighting common taxa and evenness or equability among taxa (Mandaville 2002; Beals, Gross, and Harrell 1999). The Shannon Index also considers abundance and evenness of taxa, but is more affected by rare taxa (Mandaville 2002; Beals, Gross, and Harrell 2000). This index again showed Stier's Ranch to have the highest diversity, and Cochrane the lowest, although the results did not differ significantly (Figure 3.5, Appendix 7).

#### *3.2.1.2 Counts and Proportions of Taxa*

The previous measures suggest that Cochrane experiences some disturbance which limits benthic invertebrate abundance and richness, while enrichment downstream of Calgary supports a larger and more diverse population. More specific information about the taxa at each site is necessary to describe further differences in the benthic communities along the length of the Bow River. The presence of a variety of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa is generally indicative of desirable lotic conditions. The number of EPT genera was significantly lower at Cochrane than at the other sites, and was also significantly lower at Ronalane, near the mouth of the Bow River, than at the previous three sites (Figure 3.6, Appendix 7). Stoneflies (Plecoptera) were completely absent from both Cochrane and Ronalane. While flow fluctuations likely limit the number of EPT taxa at Cochrane, it is probable that many of these taxa are excluded from Ronalane by the slower flow and more homogeneous substrate typical of a depositional (as opposed to erosional) environment. Lower dissolved oxygen levels may limit sensitive taxa at Ronalane as well.

In erosional habitats, the balance between the abundance of EPT organisms and the generally more pollution-tolerant Chironomidae should be relatively even in a community in good biotic condition (Mackie 2004). The EPT to Chironomidae ratio tended to be highest at Stier's Ranch (mean 0.59), although replicates varied widely, while the lowest was at Ronalane (mean 0.02) (Figure 3.7). The mean ratio at Stier's Ranch was significantly higher than that at the Cochrane, Carseland, or Ronalane sites (Appendix 7).

Chironomids, nematodes and oligochaetes, as major groups, are often described as being tolerant to adverse conditions, especially nutrient enrichment and low DO. However, many taxa belong to these groups and the perceived tolerance may be attributable to only a few taxa. Unfortunately this is seldom recognized because species or genus identifications are rarely performed on nematodes and oligochaetes. The highest proportions of chironomids were in samples taken from Carseland, while the lowest proportions were found at Cochrane (Figure 3.8). Cochrane, however, had the highest proportion of Nematoda (Figure 3.9). Oligochaetes were present in the greatest proportion at Ronalane followed by Cochrane (Figure 3.10).

The relative contribution to abundance by different taxa is another measure of environmental condition. In a less complex, potentially more impacted site, the percent contribution of the dominant group would be expected to be higher than at a less impacted site. In terms of insects, members of the order Diptera were most abundant at all 5 sites. The percent dominance of this order was higher at Ronalane (mean 98%) than at all other sites, and significantly so for all but Carseland (Figure 3.11, Appendix 7).

#### *3.2.1.3 Functional Feeding Groups*

Aquatic invertebrates can be classified into functional feeding groups by the type and size of food particles they eat and by the method that food is obtained (Merritt and Cummins 1996). The feeding group concept is useful for describing the ecological role of aquatic organisms. The numbers of invertebrates with various feeding strategies can then be used to make inferences about river conditions.

Filtering collectors, or suspension feeders, feed on fine particulate organic matter. Ronalane had the highest number of filter-feeding taxa (Figure 3.12, Appendix 7). However, the proportion of filters was significantly higher at Stier's Ranch than at all other sites (Figure 3.13, Appendix 7), likely as a result of organic enrichment from the City of Calgary. In contrast, gathering collectors, which consume coarser particulate organic matter, occurred in the highest proportion at Ronalane (Figure 3.14, Appendix 7). Both Cochrane and Stier's Ranch had much lower proportions of gatherers than did the downstream sites.

Shredder organisms, which "shred" coarse organic matter such as leaf litter, were found in the highest proportion at Cochrane (Figure 3.15). Shredder proportions were relatively low at all sites, however, and the differences between the sites were not significant

(Appendix 7). Scraper organisms, which feed directly on periphyton, were found in much lower proportions at Cochrane and Ronalane than at the other sites (Figure 3.16, Appendix 7), reflecting lower amounts of epilithic algae at these sites.

Predators, which feed on other invertebrates, were found in the highest proportion at Stier's Ranch (mean 0.10), the site with the highest invertebrate abundance. Predator proportions were the lowest at Ronalane (mean 0.03) (Figure 3.17, Appendix 7).

#### *3.2.1.4 Habits and Habitat Preference*

Differences in the behaviour or habit of benthic invertebrates, defined as the way they move or maintain position in flowing water, were examined for the Bow River sites. The proportion of swimmers was significantly higher at Cochrane than anywhere else (Figure 3.18, Appendix 7). Swimming taxa have the greatest motility, and thus would be best able to deal with the dynamic flow and water level fluctuations at this site.

Clinger organisms hold their position on the bottom substrate in flowing water. Greater numbers and proportions of clinger taxa are expected under conditions subject to less impact from physical disturbance or pollution. Cochrane and Ronalane had significantly fewer clinger taxa than the other sites (Figure 3.19, Appendix 7). In terms of proportion, Stier's Ranch had significantly more clingers and Ronalane significantly less, than the other sites (Figure 3.20, Appendix7). Sprawler taxa, which hold on to both the substrate and submerged vegetation, showed a similar pattern, with the highest mean proportion found at Stier's and the lowest at Ronalane (Figure 3.21, Appendix 7). In contrast, the greatest number of burrowing taxa, which live in the sediment, occurred at Ronalane (Figure 3.22). The proportion of burrowers was lowest at Stier's Ranch, and highest at Ronalane, where on average 95% of the organisms present were burrowers (Figure 3.23, Appendix 7).

Given the pattern shown for benthic invertebrate habits, it would be expected that habitat preference (whether erosional or depositional) would also be a useful metric for describing longitudinal patterns in the Bow River. However, based on the taxonomic units used for comparison with the historical data, habitat preference was misleading. There were no interpretable differences among sites based on the mean proportion of organisms preferring depositional habitats; Ronalane, which is clearly a slower-flowing depositional site, showed the lowest proportion of depositional organisms (Figure 3.24, Appendix 7). However, when taxonomic detail was added back in, Ronalane stood out from the other sites as the location where the greatest proportion of the benthos preferred depositional habitats, consistent with the nature of this site (Figure 3. 25). This difference was driven by the specific preferences of various chironomid genera.

#### *3.2.1.5 Tolerance*

The tolerance or sensitivity of many benthic invertebrates to pollution and other perturbation is fairly well known. For this report, pollution tolerance and pollution sensitivity grades were assigned to taxa based on tables in Mandaville (2002), which were drawn from a number of original sources. Tolerance values, whether at the species/genus level or the family level, range from 0 (very intolerant) to 10 (very tolerant) and are based primarily on response to organic pollution. These values can be combined into a biotic index (BI) or a family biotic index (FBI) to give a range of values between 0 and 10, where 0 represents excellent water quality and 10 represents very poor water quality. Pollution sensitivity grades are assigned on a family basis or higher. These values range from 1 to 10, where 1 is least sensitive and 10 is most sensitive. The sensitivity grades can be examined as the cumulative score of all taxa (referred to as the Biological Monitoring Working Party number, BMWP) or can be divided by the number of taxa to yield an average score per taxon (ASPT).

The number of pollution intolerant taxa (score of 0, 1, or 2) was lowest at Ronalane, followed by Cochrane (Figure 3.26, Appendix 7). There were no significant differences between the other three sites, although Carseland had the highest mean number of intolerant taxa, and was tied with Cluny for the highest total number of intolerant taxa.

The mean Family Biotic Index (FBI) scores for the 5 Bow River sites ranged from 7.8 (Cochrane) to 5.8 (Stier's Ranch). Scores at Cochrane and Ronalane were significantly higher than at the other three sites indicating that these two sites sustained the most negative impact (Figure 3.27, Appendix 7). Although schemes exist for translating BI and FBI scores into water quality ratings (*e.g.* Hilsenhoff 1987, 1988), the values calculated for the Bow sites should be interpreted as relative rankings only. Attributing the scores to specific water quality ratings can only be done after extensive calibration for the region in which they are to be used.

Mean cumulative sensitivity (BMWP) scores were significantly lower at Cochrane than all other sites except for Ronalane (Figure 3.28, Appendix 7). The general paucity of fauna at the Cochrane site had some bearing on this result. Once the effect of the number of taxa was eliminated by calculating the average sensitivity score per taxon, the gap between Cochrane and the other sites was narrowed, and the significance of the difference between Cochrane and Stier's Ranch was eliminated. Both Cochrane and Ronalane had significantly lower ASPT than Cluny and Carseland (Figure 3.29, Appendix 7). These results suggest that although nutrient enrichment at Stier's Ranch resulted in a rich and abundant benthic community, there may be a slight tendency for those organisms to be less sensitive to organic pollution than those in adjacent downstream communities, farther from Calgary's direct influence.

### *3.2.2 Longitudinal trends in Depositional Habitat (2006) – 210 µm Kick Net Samples*

Most of the benthic invertebrate monitoring programs by Alberta Environment have focused on erosional habitat and the benthic data collected from depositional areas at Bow River LTRN sites are among the first for such habitat.

In many ways the longitudinal patterns exhibited by benthic invertebrate metrics in depositional areas mirror those observed in erosional areas. For example, the number of invertebrates collected downstream of Calgary was considerably higher than upstream (Figure 4.1), indicating that responses to enrichment are also measurable in depositional areas.

The number of taxonomic groups collected in depositional areas tended to be lower than in erosional areas sampled with the same mesh size (Figure 4.2). This is particularly noticeable for some taxa such as mayflies, stoneflies, and caddisflies which were considerably less diverse and less abundant in depositional areas (Figures 4.3 and 4.4). As expected, the proportion of taxa which are known to prefer depositional habitats was greater in depositional samples than in erosional samples (Figure 5) and taxa which burrow in sediments were more prevalent in this habitat (Figure 6). Swimmers, which are quite mobile (over the sediment and in the water column), also tended to be relatively more abundant in depositional areas.

Unlike erosional habitats where diversity indices change relatively little along the length of the Bow River, there was a fairly sharp longitudinal decline in index values in depositional habitats downstream of Calgary and recovery was only apparent at the most downstream site (Figure 4.5 and 4.6). By nature, depositional areas have slower flow velocities. Dissolved oxygen fluctuations may be more pronounced than in faster flowing waters, particularly in areas that are very rich in nutrients, and/or have high algal and macrophyte biomass. Subsequent decomposition of primary producers may lead to excessive oxygen consumption from the water column. The decline in diversity indices may be an indication of more stressful conditions in depositional than erosional areas. If this can be verified, it may be judicious to continue monitoring such depositional areas to assess responses to nutrient management in the basin.

### 3.2.3 Historical Longitudinal and Temporal Trends for Invertebrates in Erosional Habitat

Many of the patterns described from the 2006 data, including evidence of perturbation at Cochrane, organic enrichment at Carseland, and depositional conditions at Ronalane are consistent with the longitudinal differences in the Bow River benthic community discussed in Anderson (1991). This historical work was based on data collected between 1983 and 1987 at Cochrane, Carseland and Ronalane. For the current report, these data were combined with occasional data from Stier's Ranch and Cluny and data collected in 1989, 1993, and 2006 in order to examine overall differences among sites and over time using a number of different techniques, including multivariate analyses.

#### 3.2.3.1 Stepwise Discriminant Analysis – All sites and Years

Stepwise discriminant analysis was performed using counts of the top 25 taxa (out of a total of 64). Four canonical discriminant functions were used in the analysis, the first three of which accounted for about 96% of the variance among samples. The correlations for these functions are shown in Appendix 8. Of the 25 taxa used in the discriminant analysis, 14 were associated with the first 3 functions.

Samples from Cochrane were clearly separated from the rest of the Bow River sites along function 1, based primarily on fewer Chironomini, Tubificidae, and Simulidae at this site than others (Figure 7). All sites showed more separation along function 2, which was positively correlated with the mayflies *Stenonema* and *Tricorythodes*, and negatively with

*Hydra* and Ephemerellidae. Cochrane and Stier's Ranch held a neutral position along this axis, while Carseland had a negative score and both Ronalane and Cluny had positive scores for this function (Figure 7). Discriminant function 3 was positively correlated with the caddis fly family Helicopsychidae and to a lesser extent with the chironomid tribe Tanytarsini. Carseland, Cluny, and Ronalane scored higher on this function and Cochrane occasionally scored lower, while Stier's Ranch samples scored negatively (Figure 7). Considering all three functions, Ronalane and Cluny were the most similar, showing the most overlap, and the other three sites each formed distinct separate groups (Figure 7).

The fairly good separation of the five sites based on this analysis suggests that many of the basic longitudinal differences in the zoobenthic community of the Bow River remained consistent over the 23 year period of study. However, to better detect significant trends over time within sites, analysis of variance (ANOVA) was performed using the discriminant function scores. The hypothesis was that no change had occurred in the taxa influencing the function in question, while the alternate hypothesis was that significant change had occurred. For DF-1, only Stier's Ranch showed a significant increasing change over time (Figure 8). The taxa most strongly associated with this function tend to be pollution tolerant, suggesting a trend towards more tolerant organisms at this site. For DF-2, scores at Ronalane decreased significantly over time. Taxa associated with this function were less tolerant to pollution than those for DF-1, suggesting a trend towards fewer sensitive organisms at this site. For DF-3, Carseland's scores significantly decreased over time, while Cluny's scores increased significantly. DF-3 was most strongly associated with the presence of helicopsychid caddisflies which prefer erosional habitats. Overall, these analyses suggest some change over time at all sites except for Cochrane. At all sites, it appears that conditions may have been more favourable to pollution-sensitive organisms in the middle of the period studied than in the early eighties or at present, with some minor exceptions.

#### *3.2.3.2 Comparison: 1985, 1993 and 2006*

There are only three years with data at all five sites: 1985, 1993, and 2006. These three years represent fairly well-spaced time periods: post-phosphorus removal (1980s), post-nitrogen removal (1990s), and present (2000s).

Reductions in nutrient loading would be expected to result in less primary production and improved dissolved oxygen conditions. Depending on the degree of these changes, benthic invertebrate communities would be expected to show increased taxonomic richness, particularly for 'sensitive' taxa. If nutrient reductions were sufficient to result in a decline of invertebrate food resources, a decline in overall population densities might also be seen.

The flow history that precedes invertebrate sampling can have a determining influence on benthic invertebrate distribution and, in this context, an evaluation of flows has been included in Appendix 9. Flow conditions were quite different in the three years. Flows preceding the sampling in 1985 were generally low, but a sharp peak occurred a month earlier in September. Flows for the 2006 sampling were higher, but had remained fairly stable for much of the summer and fall; very high flows occurred in June 2006. The

September 1993 samples represent the highest monthly and daily flows of all years and numerous high flow events occurred during the summer. The higher flows experienced in 1993, in many ways could have favoured 'sensitive' taxa.

A graphical comparison of benthic invertebrate metrics for 1985, 1993 and 2006 follows. This comparison is supported by a series of ANOVAs, examples of which are provided in Appendix 10).

#### *3.2.3.3 Counts and Indices*

In spite of some site-to-site differences, overall abundance (measured as the mean of the five sites) was similar for 1993 and 2006, while it was much lower in 1985 (Figure 9-1). It is possible that high flows prior to sampling resulted in lower benthos numbers in that year. However, in terms of richness (shown for number of families), 1985 and 2006 were similar, while the number of taxa was generally higher in 1993, which could be an indication of more favourable conditions (Figure 9-2). Both abundance and richness were significantly lower at Cochrane in 2006 than in the previous years. At Stier's Ranch, abundance was much lower in1985 than in 2006, while the number of families found in these two years was not significantly different.

Although the overall Simpson diversity index was highest in 1993, the only significant difference between years was at Cluny, which had a much less diverse benthic community in 1985 than in the two other years (Figure 9-3). The overall Shannon diversity index was highest in 1993 (Figures 9-4). The 2006 index value at Cochrane was significantly lower than it had been in 1993, and at Ronalane the 2006 index was significantly lower than in both other years. The Shannon index was most variable at Cluny; all three years were different, with 1985 having the lowest value and 2006 the highest.

Greater community richness throughout the Bow River in 1993 was reflected in overall higher numbers of taxa (genera or families) in various categories, whether based on feeding groups, behaviour, or pollution sensitivity. However, the patterns at individual sites varied. For Ephemeroptera, Plecoptera, and Trichoptera (EPT) genera, numbers were significantly higher in 1993 at all sites than in 2006, and higher at Stier's Ranch and Cluny in 1993 than in 1985 (Figure 9-5). At Cochrane and Ronalane, the number of genera of these three "sensitive" groups was also larger in 1985 than in 2006. In terms of families within the orders Ephemeroptera, Trichoptera, and Odonata (ETO, another metric for grouping sensitive organisms), there was no difference among years for Stier's Ranch or for Carseland, while counts in 1985 and 1993 were significantly higher than those in 2006 for both Cochrane and Ronalane (Figure 9-6). Numbers for Cluny were significantly higher in 1993 than in both other years.

Numbers of various taxa at Cochrane often showed the largest differences, particularly between 1985 and 2006. For example, the largest number of predator taxa for all sites and years was found at Cochrane in 1985, while the lowest number occurred at the same site in 2006 (Figure 9-7). At Carseland and Cluny, the highest number of predator taxa occurred in 1993, contributing to high overall numbers at this site, while at Stier's Ranch and Ronalane, there were no significant differences among years. The pattern for clinger taxa was similar; the highest overall numbers occurred in 1993, while the highest and lowest number of clinger taxa occurred at Cochrane in 1985 and 2006, respectively (Figure 9-8). The Cochrane site was not affected by the same September peak flow that the downstream sites experienced before sampling in 1985 (Appendix 9), which may have displaced taxa at these sites. Lower flows in 1985 may also have allowed samplers to access an area of the river bed at Cochrane that was not as much disturbed by discharge fluctuations resulting from operation of the Ghost Dam, and had a more representative fauna than the 2006 samples.

The overall number of pollution intolerant taxa was almost twice as high in 1993 as in the other two years. In 1985, pollution intolerant taxa were more common at Cochrane than at any other site, but in 2006, the number of intolerant taxa at this site was second only to Ronalane's count that year as the lowest for all years (Figure 9-9). The only site that did not differ significantly among years was Carseland. This was the case also for the average pollution sensitivity score per taxon, which showed similar year-to-year and site-to-site patterns (Figure 9-10).

The Biotic Index (based on data at the genus level or higher) produces scores between 1 and 10 where higher scores correspond to poorer water quality. The highest biotic index scores occurred at Carseland and Cluny in 1985; these were significantly higher (poorer) than in 1993 or 2006. At Cochrane, the index score in 2006 was significantly higher than in the previous years. At Stier's and Ronalane differences among years were not statistically significant (Figure 9-11). As for most other metrics, the overall biotic index results were lowest (best) in 1993. High flows throughout the summer may have constantly refreshed the substrate and kept oxygen levels high in that year (Appendix 9). In 1993 both phosphorus and nitrogen removal were fully implemented, but the population of Calgary was less than three quarters of what it was in 2006 (City of Calgary 2007). The alum treatment and resulting effluent phosphorus reduction may have helped to offset the loading increase due to population growth (A. Sosiak, pers. comm.).

#### *3.2.3.4 Proportions and Ratios*

The proportion of Oligochaeta in the samples differed little at each site over time, except for being lower in 2006 than 1993 at Stier's Ranch, and lower in 1985 than 1993 at Ronalane (Figure 9-12). The proportion of Nematoda differed more appreciably among years, with the overall proportion being much lower in 1993 samples than in other years (Figure 9-13). The overall proportion of Chironomidae was also lower in 1993 samples (Figure 9-14), although differences at Stier's Ranch and Carseland were not statistically significant. The overall proportion of EPT organisms and the corresponding EPT-to-Chironomidae ratio showed the opposite trend; these two measures were much higher in 1993 than in the other years (Figures 9-15 and 9-16). Stier's Ranch had slightly higher proportions of EPT compared to the other sites in all years, except for Cluny in 1993. Cluny had one of the lowest EPT-to-chironomid ratios in 1985 (mean of 0.11), while in 1993 the mean ratio at this site was 6.25 (Figure 9-16).

The percent by which one type of organism dominates in a sample provides an indication of balance in the community. The contribution of the dominant order of insects at each site as a percentage of total insect abundance was generally higher in 1985 and 2006. In these two years, maximum contributions at some sites were upwards of 90%, while in 1993, the maximum percent contribution was 78% at Cluny (Figure 9-17).

The ratio of relatively tolerant hydropsychid caddisflies to total Trichoptera tends to increase in response to organic enrichment. Hydropsychids are net spinning (filter feeding) caddisflies which are one of the most notable invertebrates at Stier's Ranch because of their abundance and size. The ratio of hydropsychids to caddisflies at this site was somewhat lower in 1993 than in the two other years (Figure 9-18). At Carseland that ratio was considerably higher in 2006.

The longitudinal differences in the proportions of filtering collectors was preserved between years, with Stier's Ranch having the greatest proportion of filterers in each year (Figure 9-19). Proportions of gathering collectors were always much higher than those for filtering collectors; this metric tended to be highest in all years at Ronalane (Figure 9-20).

The ratio of scrapers, which prefer areas with a large amount of algae, to filterers, which feed on fine particulate organic matter and are sensitive to any toxic material bound to these particles, can provide information about aquatic conditions. This ratio changed noticeably at some sites between years, particularly at Ronalane and Cluny (Figure 9-21), but did not appear to follow any particular pattern, nor was there any association between this metric and algal data.

The overall proportion of clinger taxa, which grasp onto rocks, plants, and debris, was greatest in 1993. In each year, the mean proportion of the invertebrate community made up by clingers was highest at Stier's Ranch, although in 1993 the maximum proportion was found at Cochrane (Figure 9-22). In contrast, the overall proportion of animals that burrow into the substrate was lowest in 1993, perhaps reflecting the fact that high flows kept the river bed more clear of sediment in that year. The largest difference between years was seen at Cluny where, in 1985, burrowers comprised 87% of the organisms present, while in 1993 only 14% of the organisms were burrowers (Figure 9-23). This difference, along with others such as the increase in EPT organisms at this site between 1985 and 1993 indicate that the nature of this site changed markedly in the intervening years, perhaps due to displacement of sediment from the river bed and/or decreased algal biomass as a result of flushing flows (see Appendix 9). Another possibility is that there were differences in the exact location from where samples were collected.

Changes in the condition of a site between years could be revealed further by an examination of habitat preference. For example, it appears Cluny may have changed from a depositional site to an erosional site between 1985 and 1993. However, as indicated in the previous analysis of the 2006 data, many of the invertebrate identifications for the historical data are not specific enough for adequate assignment of habitat preference.

## 3.3 Assessment Of Longitudinal Trends In Epilithic Algal Data

### *3.3.1 Epilithic Algae – 2006*

#### ***3.3.1.1*** <u>Community Analysis</u>

A total of 104 epilithic algae taxa, the majority of which were diatoms, were identified from the five Bow River sites in October of 2006 (Appendix 3). The greatest algal density (units/cm$^2$) was recorded at Carseland and was primarily due to diatoms (Figure 10-1). Diatoms made up the greatest portion of density at all sites. Cyanobacteria were the second largest contributor to density at all sites except for Cluny, where Chlorophyceae was the second densest group. The highest density of cyanobacteria occurred at Stier's Ranch (Figure 10-1).

Diatoms made up the majority of the biomass (μg/cm$^2$, estimated based on cell volume) at all sites; biomass calculated by this method was much higher at Carseland than at the other sites (Figure 10-2). Stier's Ranch and Carseland had the highest biomasses of cyanobacteria, while Cochrane and Ronalane had the highest biomasses of Chlorophyceae. Higher density and biomass of cyanobacteria is consistent with organic enrichment, while Chlorophyceae can be indicative of cleaner water sites. At Stier's Ranch, cyanobacteria made up 23% of the total biomass, while at Carseland, cyanobacteria contributed only 3% of the total biomass (Figure 10-3).

The fewest taxa were found at Cochrane (24), while Ronalane had the greatest taxa richness (50) (Figure 10-4). In terms of unique genera, richness was again lowest at Cochrane (15), while Carseland had the highest number (22) (Figure 10-5). Taxa were used to calculate the Shannon index at each site, which followed the general pattern for taxon richness (Figure 10-6).

Information on algal community composition can be used in a manner similar to the benthic invertebrate community for assessing environmental conditions. Although algal classes broadly suggest whether conditions are relatively "clean" or subject to nutrient enrichment, taxa within each class exhibit a range of responses to nutrient levels. These properties have been used to develop a number of water quality/nutrient indices, including some based on the taxonomic composition of cyanobacteria (Douterelo, Perona, and Mateo 2004) and diatoms (Kelly 1998, Jüttner *et al*. 2003, Potapova and Charles 2007). The dominance of diatoms at all the Bow River sites make these algae attractive as indicator taxa. Based on data from U.S. rivers, Potapova and Charles (2007) compiled a list of diatom species, indicating whether they were associated with low or high total phosphorus (≤ 10 μg/L, ≥ 100 μg/L) and with low or high total nitrogen (≤ 0.2 μg/L, ≥ 3.0 μg/L). Since these concentration ranges are applicable to the Bow River (*e.g.,* Sosiak 2002), the broad preference ranges were used at a scoping level to classify Bow River diatom species simply as either 'low' or 'high' TP species, and 'low' or 'high' TN species. Actual indicator values provided in Potapova and Charles (2007) were not used in this analysis.

By number of taxa and by biomass, the greatest proportion of diatoms preferring both low TP and TN (unclassified taxa excluded) were found at Cochrane, consistent with this site's location upstream from major sources of enrichment. Carseland had the next highest proportion of diatom taxa and biomass preferring lower nutrients (Figures 11-1 to 11-4). The greatest densities of low nutrient-preferring taxa, however, appeared at Cluny and Ronalane. At Ronalane, the densities of nutrient-tolerant and intolerant taxa were equal, while at all other sites the tolerant taxa were found at greater densities (Figures 11-5 and 11-6).

*Chlorophyll-a and Phaeophytin-a*

Chlorophyll-*a* provides a reliable indicator of algal biomass; phaeophytin-*a* is a breakdown product of chlorophyll-*a*. Between 3 and 9 samples for chlorophyll-*a* and phaeophytin-*a* were collected at each site. At Stier's Ranch, Carseland, and Cluny, more than one person collected the samples, adding to the range of variation seen at these sites and illustrating the value of consistency in field staff and training for spatial and temporal evaluations (Figure 12-1). In each case, the samples have been pooled for analysis. The highest mean chlorophyll-*a* (299 mg/m$^2$) was found at Stier's Ranch, while the lowest was 18.46 mg/m$^2$ at Cochrane (Figure 12-2). Mean phaeophytin-*a* was highest at Carseland, indicating a high amount of turn-over at this site, and suggesting that a large amount of dead cells contributed to the high density and biomass noted by the taxonomic analysis at this site (Figure 12-3). The chlorophyll-to-phaeophytin ratio was highest at Stier's Ranch, indicating rapid growth at this site. This ratio was lowest at Cochrane and Ronalane, suggesting a slower rate of growth in comparison to algal decline (Figure 12-4).

*Correlations with Invertebrate Data*

Epilithic algal community metrics, including density, biomass, taxa richness, and the Shannon index, along with chlorophyll-*a* data, were compared to the 2006 invertebrate abundance, taxa richness, and Shannon index data using simple correlation. The strongest relationships were between chlorophyll-*a* and invertebrate abundance (Figure 13-1, $r = 0.87$), the chlorophyll-*a* to phaeophytin-*a* ratio and the invertebrate Shannon index (Figure 13-2, $r = 0.85$), and algal richness and invertebrate richness (Figure 13-3, $r = 0.85$). These relationships are not unexpected since periphyton is a major food source for many invertebrate taxa.

### 3.3.2 Comparison with Historical Data

Limited historical epilithic chlorophyll-*a* data are available for most of the Bow River sites. Data from 2006 were compared with data collected in September of 1993 (three replicates per site) and pooled data for autumn samples from 1983 through 1986. Data were pooled to represent conditions in the mid-eighties (after phosphorus removal but before nitrogen reduction) because only one sample was collected for each sampling month during this period. No fall data are available for Cochrane from this period.

The highest mean and maximum chlorophyll-*a* levels occurred at Carseland and Cluny in the 1980s. Algal biomass at these two sites was lower in 1993 and 2006. In both 1993 and 2006, the largest mean Chl-*a* values were found at Stier's Ranch, followed by

Carseland (Figure 14). These results are consistent with those of Sosiak (2002), who found that periphytic biomass did not change directly downstream from Calgary in response to enhanced phosphorus removal, but declined at sites further downstream where total dissolved phosphorus levels were lower.

The chlorophyll results relate well to the invertebrate findings for these three periods. In particular, the lower amounts of algae in 1993, perhaps in part a result of higher flows throughout the summer, are consistent with the abundance of "clean water" taxa in that year. Also, the much lower levels of Chl-*a* at Cluny in 1993 and 2006 as compared to the 1980s supports the change in fauna at this site between these periods.

A small amount of epilithic community data is also available. In this case, data from October 1980 and 1981 (averaged) were compared to data from October 1994 and 2006. For the historical data, samples from Bowness and Bow City were used in place of Cochrane and Cluny. Overall, densities were lower in 2006 than for the other two periods. Carseland had the highest total cell densities of all sites in 1994 and 2006, while Bow City followed by Stier's Ranch had the highest densities in the early 80s (Figure 15). Diatoms made up the greatest percentage of density at most sites with the exception of Bowness in 80/81 and Ronalane in 1994 (Figure 16). Green algae were more prevalent in the 80/81 samples than in 1994 or 2006. Overall, cyanobacteria contributed more to the algal density at Stier's Ranch in 2006 than historically.

## 4.0 GENERAL DISCUSSION AND CONCLUSIONS

Although there are some municipal discharges upstream of Cochrane (*i.e.*, Banff, Canmore) the sampling site at Cochrane, in the foothills upstream from Calgary, experiences low nutrient levels and showed few signs of nutrient enrichment. Epilithic algal chlorophyll-*a* and biomass levels were low and a large proportion of the diatoms present were taxa which prefer low levels of nutrients. The benthic invertebrate community at this site was impoverished in 2006, having the lowest abundance and diversity of all sites. The abundance of invertebrates was low, in particular the number and variety of mayflies and stoneflies was much lower than would be expected at a "clean water" site. Rather than being related to water quality, this situation is likely the result of rapidly changing flow levels from the operation of the Ghost Dam for hydropower generation. Diurnal fluctuations in discharges from the dam can expose and flood the riverbed within short periods of time, making the access to a constantly submerged sampling site difficult. In addition, and perhaps also as a result of flow regulation (*e.g*., Kirkwood et al. 2007), *Didymosphenia geminata*, a colonial diatom, frequently forms extensive mats of cotton-like material at this site and contributes further to poor habitat for invertebrates. The effects of these perturbations were evident in some of the zoobenthic samples from previous years (Anderson 1991). Overall benthic invertebrate numbers were quite variable and no clear temporal trend emerged.

In contrast, Stier's Ranch, immediately downstream from two wastewater treatment plants, showed vivid signs of organic nutrient enrichment. It had the highest abundance of organisms and the richest, most diverse benthic community. However, the numbers of pollution-intolerant taxa tended to be slightly lower at this site than at sites further downstream from Calgary's influence. Nutrient enrichment was also apparent in the higher epilithic chlorophyll-*a* levels, larger proportions of cyanobacteria, and higher number of diatom taxa preferring greater nutrient concentrations at this site. The invertebrate community at Stier's Ranch in 2006 was more similar to samples taken in the 1980s (*i.e*., after implementation of phosphorus removal at Calgary's wastewater treatment plants) than to the sample taken in 1993 (*i.e*., after further implementation of phosphorus and nitrogen removal). In 1993 taxonomic diversity, number of EPT taxa, and ratio of EPT to chironomids were higher, and the biotic index, proportion of nematodes and chironomids, and proportion of hydropsychids to Trichoptera were lower. These are all signs that conditions were better in 1993 than in the other years that were examined in detail. While invertebrates clearly respond to the great abundance of food, responses to diurnal oxygen deficit, a recurring summer issue in the Bow River (A. Sosiak, 2007 pers. comm.), were not apparent at the erosional sampling location. However, an indication of such response to stress was apparent in the low benthic invertebrate diversity indices calculated for the Stier's Ranch depositional site.

Carseland also showed the effects of nutrient enrichment. Invertebrate abundance, periphytic algal biomass, cell density, and chlorophyll-*a* levels were relatively high at this site in 2006. However, the numbers of pollution-sensitive zoobenthic taxa were slightly higher, and the proportions of cyanobacteria and diatoms preferring high nutrient levels were slightly lower, than at Stier's Ranch. This site benefited significantly from nutrient removal in the 1980s (Sosiak 2002). Based on available data, the invertebrate community, although it still exhibits responses to nutrient enrichment, has remained in relatively healthy condition since that time. Given its location, the response at this site to Calgary's expansion should be monitored closely in the future.

While invertebrate abundance was lower at Cluny than at Carseland in 2006, community composition was similar. Epilithic chlorophyll-*a* was also lower at this site than at Carseland; in the 1980s, chlorophyll-*a* levels tended to be higher. Zoobenthic abundance has been historically higher at this site; however, most metrics from 1985 suggest that conditions at this site were poor, or more typical of depositional conditions. This site exhibits changes over time which suggest a shift from a depositional to an erosional environment. Essentially, zoobenthos from Cluny has become more like that from Carseland and less like that from Ronalane. Such changes may be quite independent of water quality and could be related to the effect of flushing flows experienced in 2005 (Appendix 9) and to differences in the exact sampling location historically and in 2006.

In 2006, Ronalane was defined by a large proportion of burrowers and other depositional fauna. This finding is consistent with this site's location near the mouth of the Bow River and is reflected in historical conditions. There is some indication that this site may be experiencing deterioration. While flow regulation and discharges of municipal effluents have well-documented impacts on benthic invertebrate distribution, the effects of other potential stressors, such as irrigation return flows, need to be evaluated, particularly at lower sites on the Bow River.

Despite the temporal changes observed at some of the sites, the consistent way in which sites are separated by multivariate analysis suggests that many of the basic longitudinal differences in the zoobenthic community of the Bow River remained constant over the 23 year period of study. This is an indication of the strong influence of physical and chemical ecoregional differences on river dynamics and benthic invertebrate distribution – an observation which has been made in previous studies on rivers from the South Saskatchewan River basin (*e.g.*, Culp and Davies 1982, Anderson 1991, Powell 2008).

Aside from substrate type, flow conditions have a definite influence on benthic invertebrate and algal population density and taxa distribution. Biological responses to man-made improvements such as nutrient load reductions from municipal wastewater discharges may be overshadowed by responses to flow fluctuations. This is particularly so for the Bow River benthic invertebrate data set which had too few collections (time and space) to adequately tease out the sometimes confounding influence of flow and responses to municipal wastewater treatment plant improvements.

In order to build on these data, a regular sampling schedule should be established. More frequent sampling would make determination of trends in biological communities due to natural and human-induced variations in flow easier to determine. In addition, more intensive spatial sampling would facilitate the interpretation of longitudinal trends in water quality and biota as they relate to point-source management changes in the basin.

Overall, benthic invertebrate and epilithic algae data collected from the Bow River provided useful and complementary information about longitudinal and temporal trends at Bow River long-term monitoring sites. A large number of metrics was used and it is evident that they each provide different information, some being more indicative of the general nutrient status of a site, others of the physical habitat conditions. These different but important features need to be recognized and metrics for analysis selected accordingly.

Detailed identification and enumeration of invertebrate and algal samples is labour intensive, but essential for extracting the maximum value from the samples collected. Rapid assessment techniques generally rely on invertebrate data at higher taxonomic levels (*i.e.*, family). While some useful information can be derived from this type of analysis, more detailed taxonomy is often necessary for describing certain trends. The need for greater detail was apparent for habitat preference information. The evaluation of metrics based on other classifications such as behaviour or feeding group was more successful at the level of taxonomic detail available for this study, but might also have been improved by greater taxonomic detail. Species-level identification proved important for evaluating the epilithic algal community data, as this allowed the classification of diatoms according to their preferences for phosphorus and nitrogen levels.

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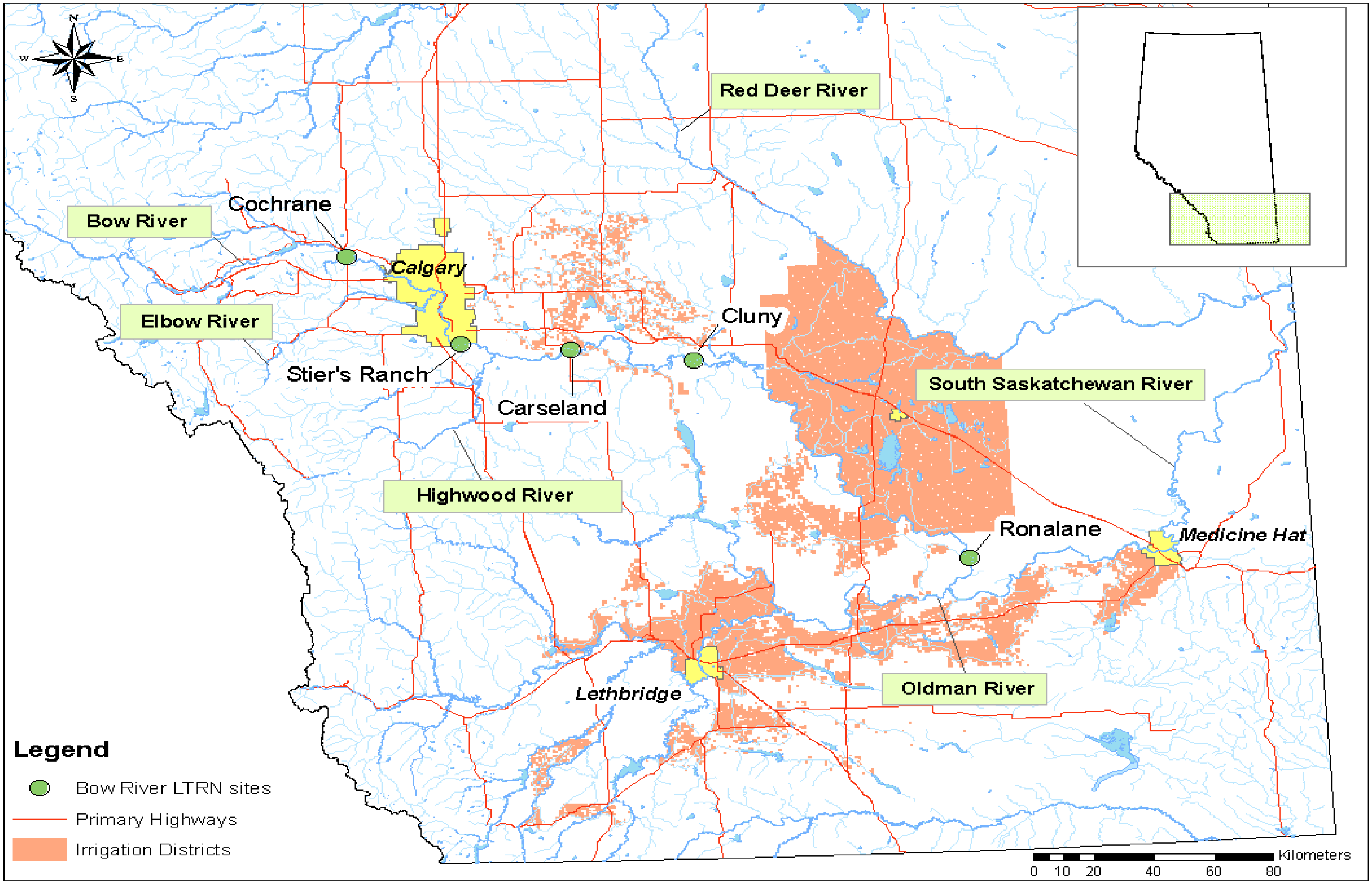
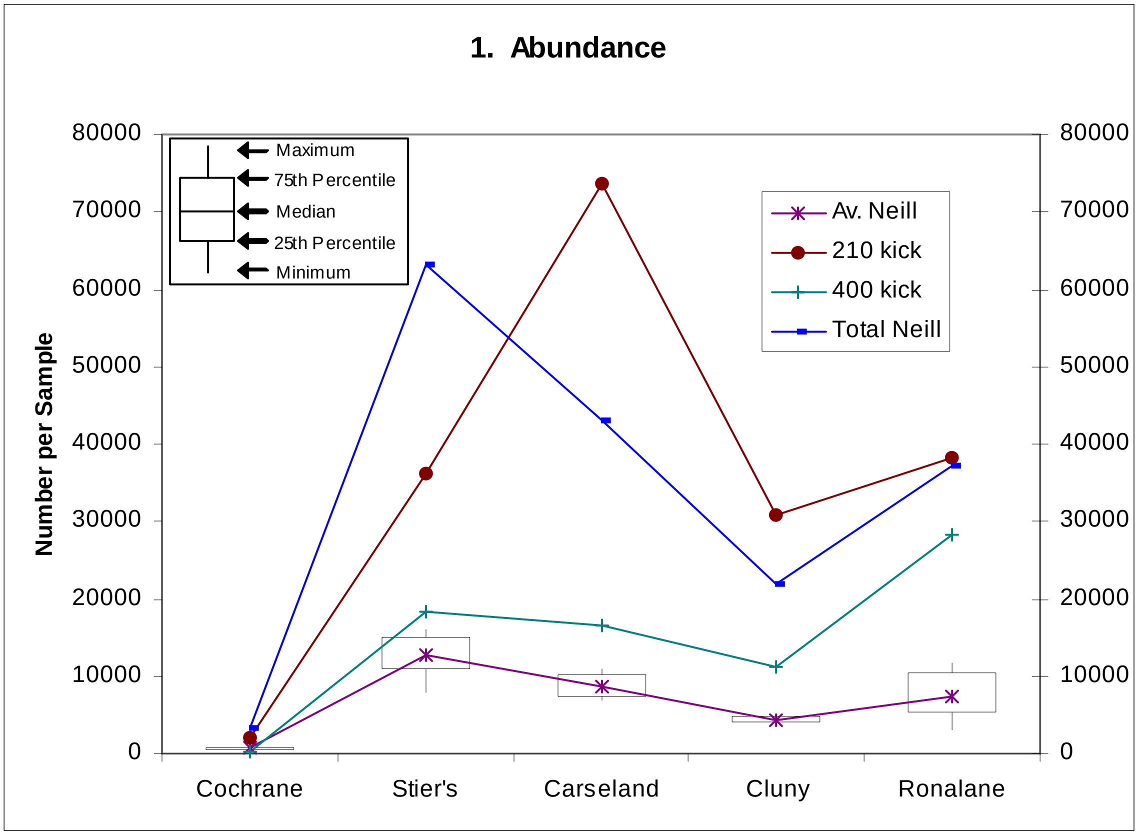



**Figure 1 Map of study area**



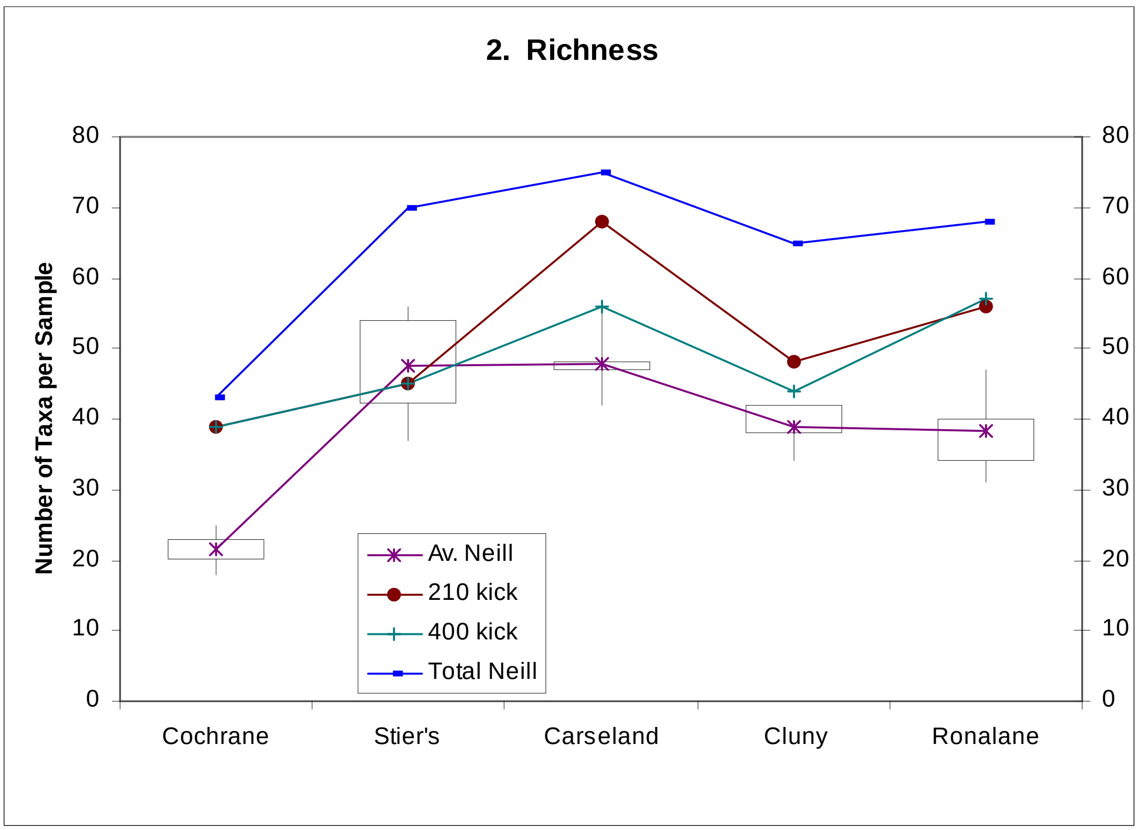
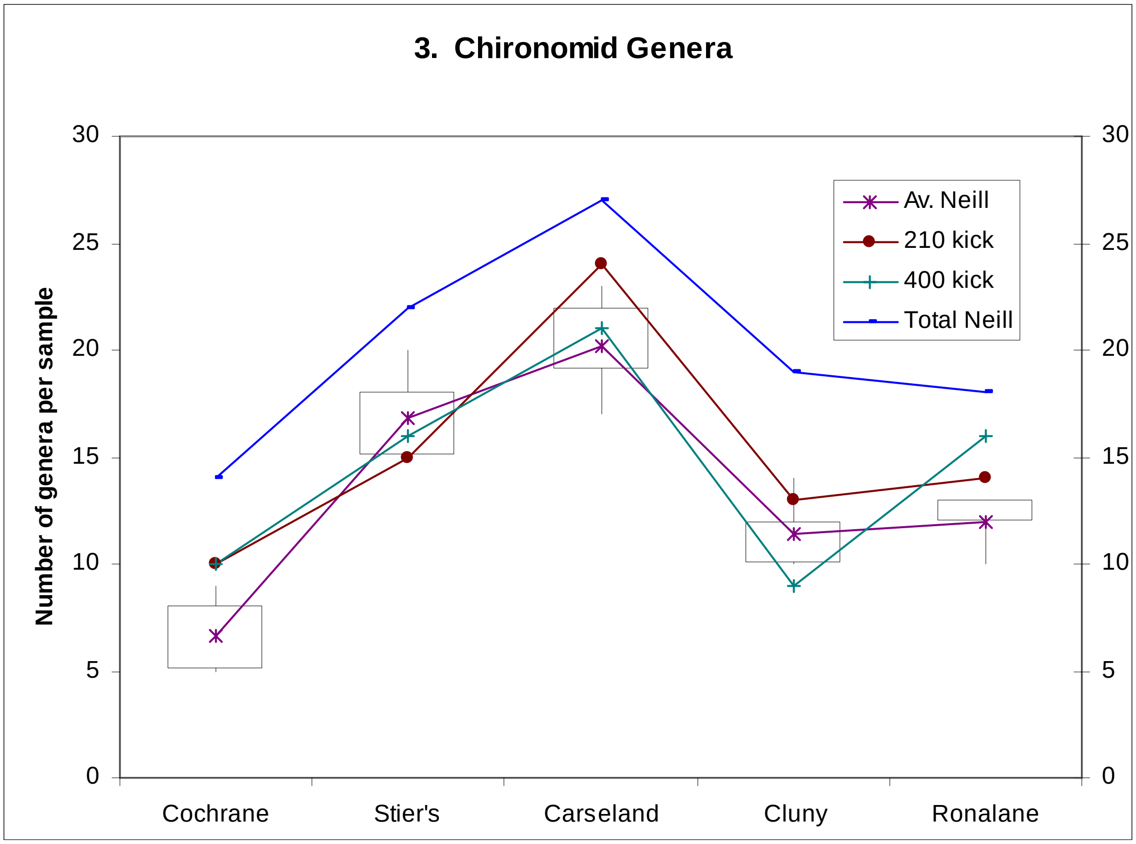




**Figure 2 Comparison of benthic invertebrate data obtained with a Neill cylinder and kick nets (210 and 400µm mesh size) in erosional areas from the Bow River (October 2006)**



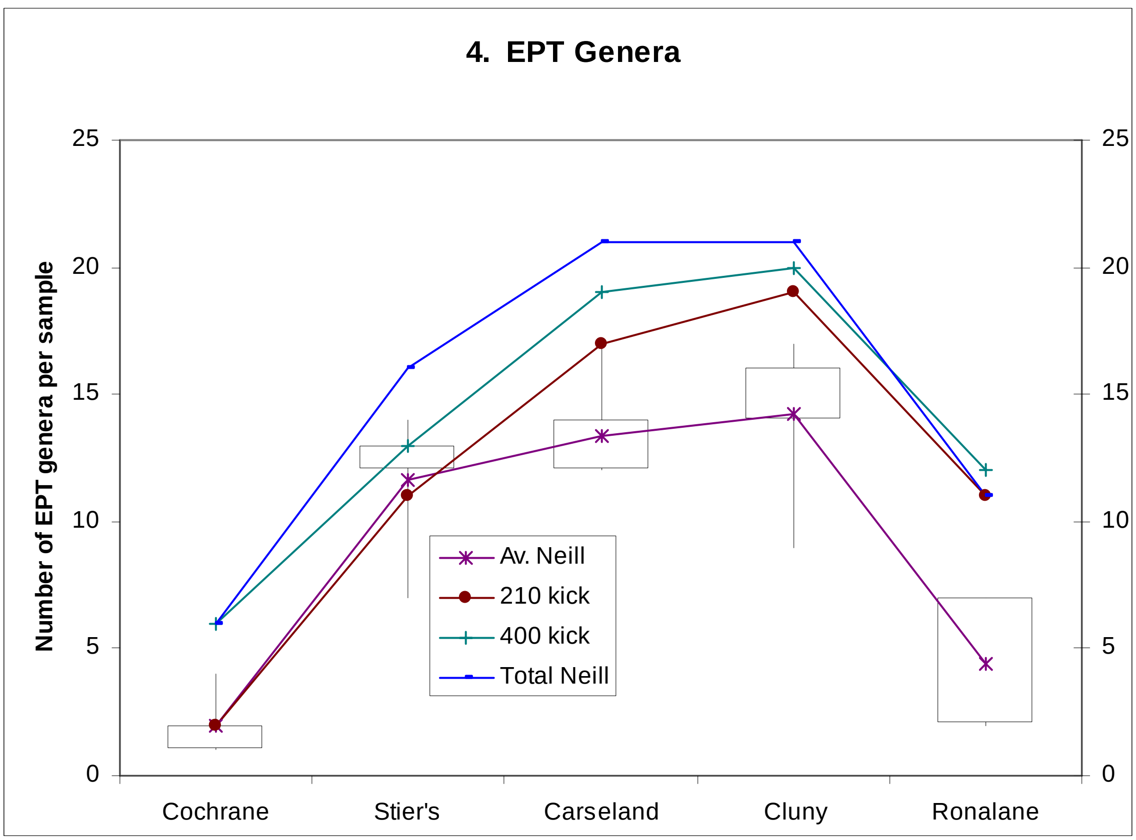
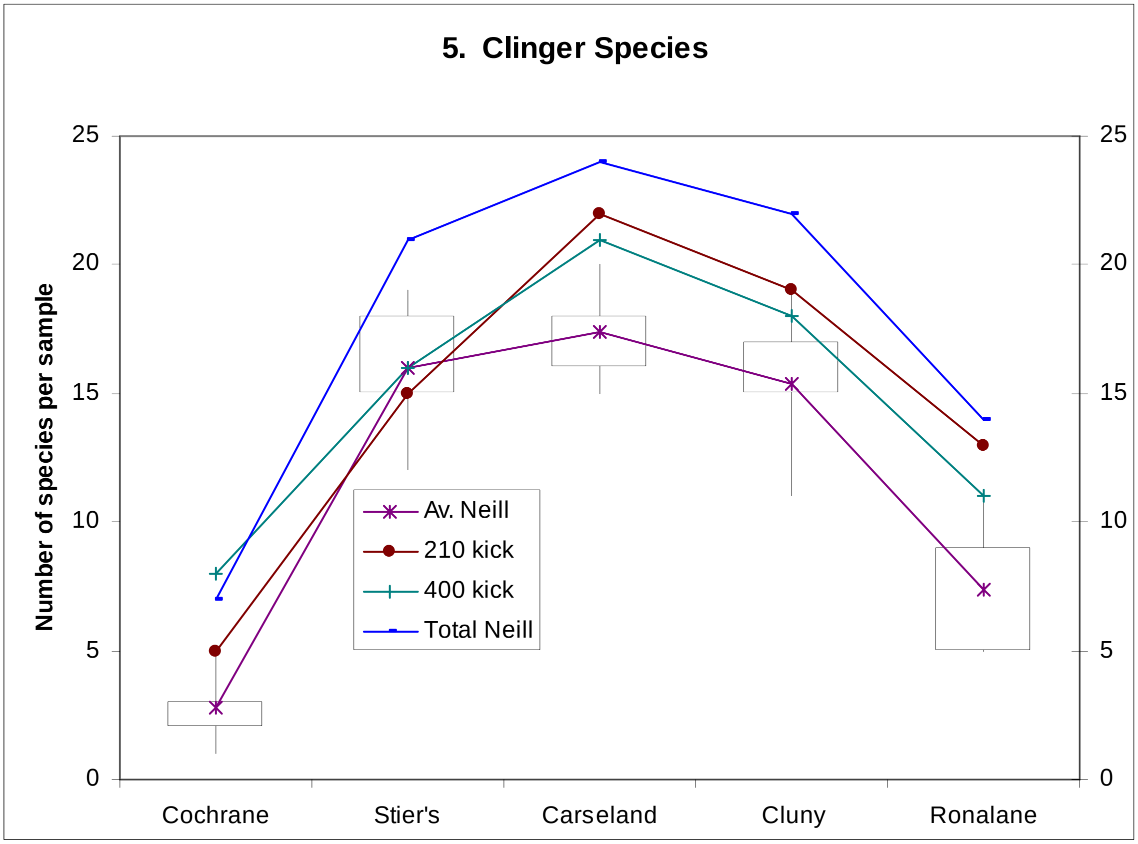
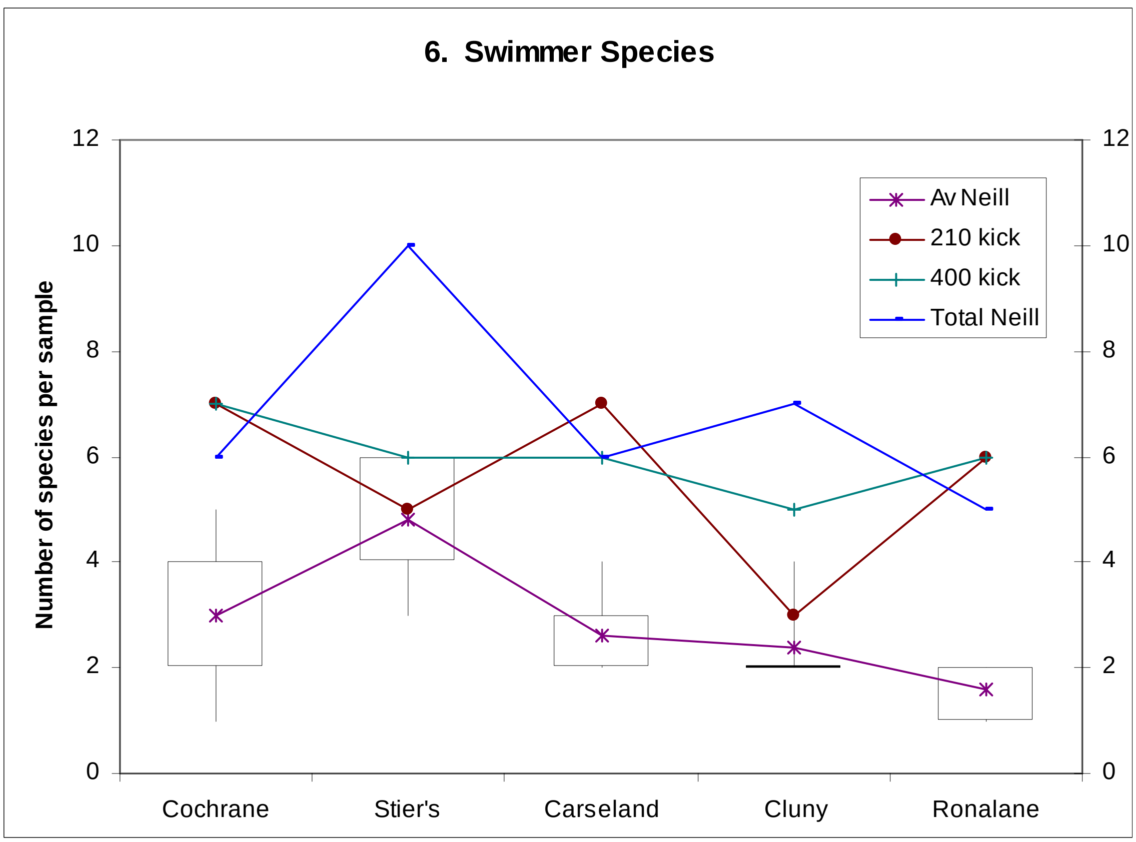




**Figure 2 Comparison of benthic invertebrate data obtained with a Neill cylinder and kick nets (210 and 400µm mesh size) in erosional areas from the Bow River (October 2006) (con't)**

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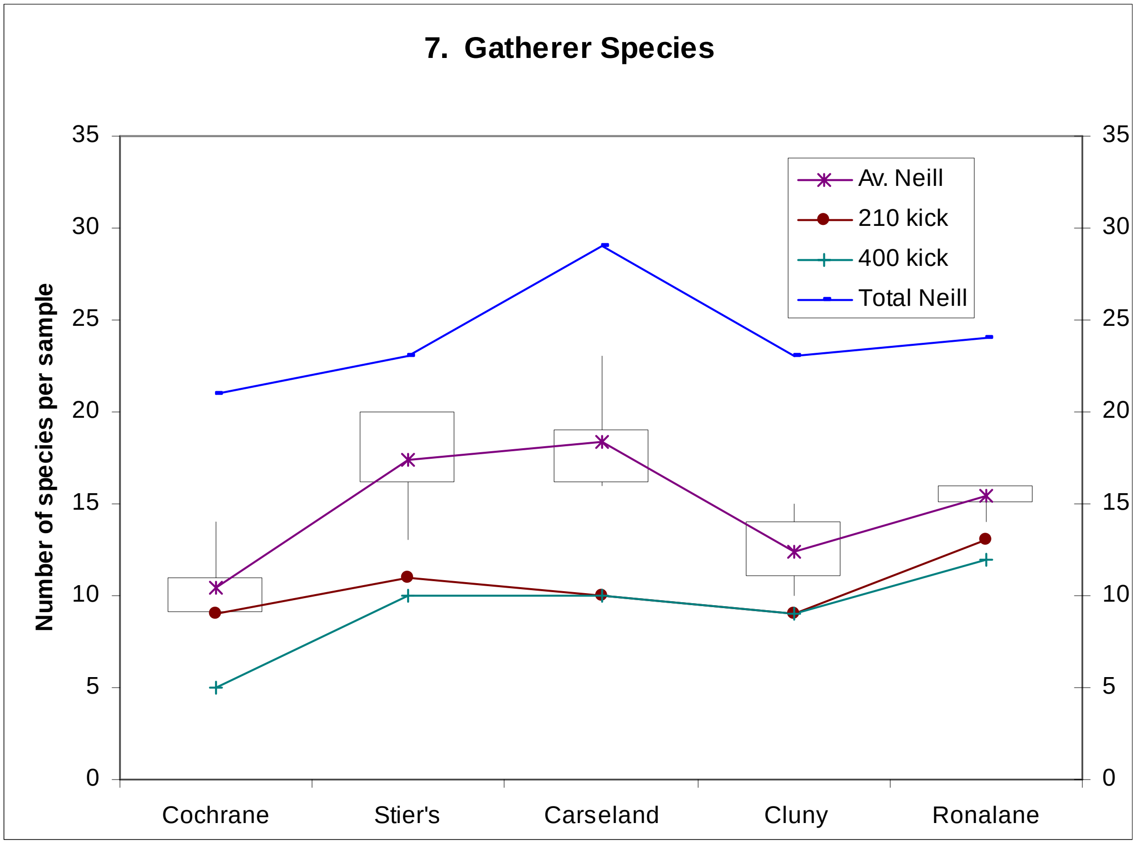


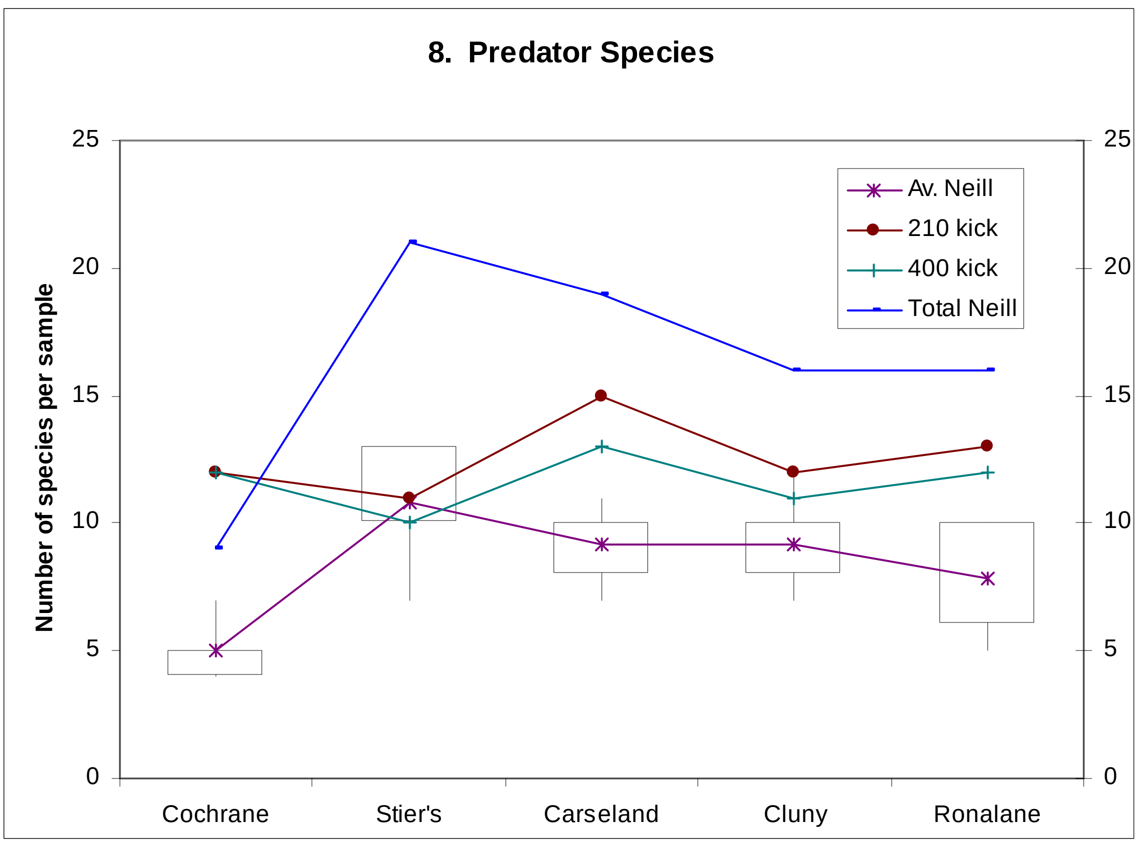
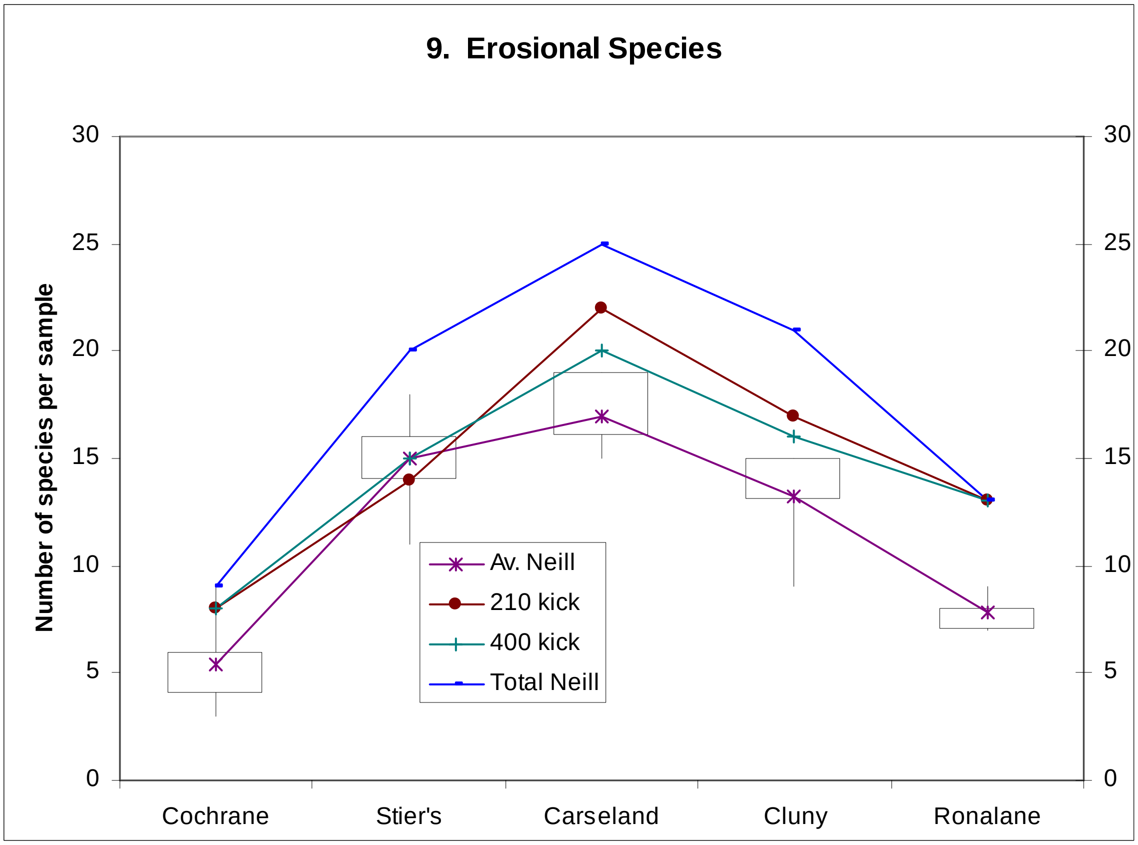




**Figure 2 Comparison of benthic invertebrate data obtained with a Neill cylinder and kick nets (210 and 400μm mesh size) in erosional areas from the Bow River (October 2006) (con't)**



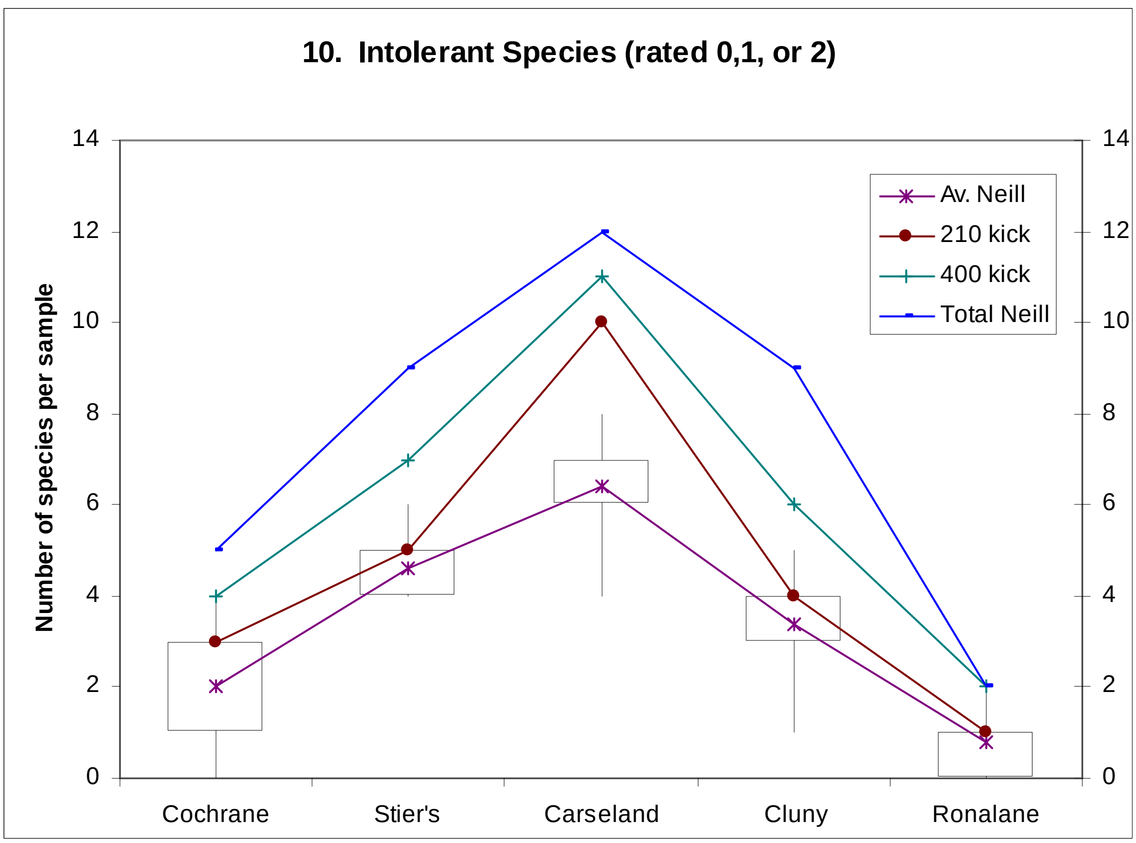
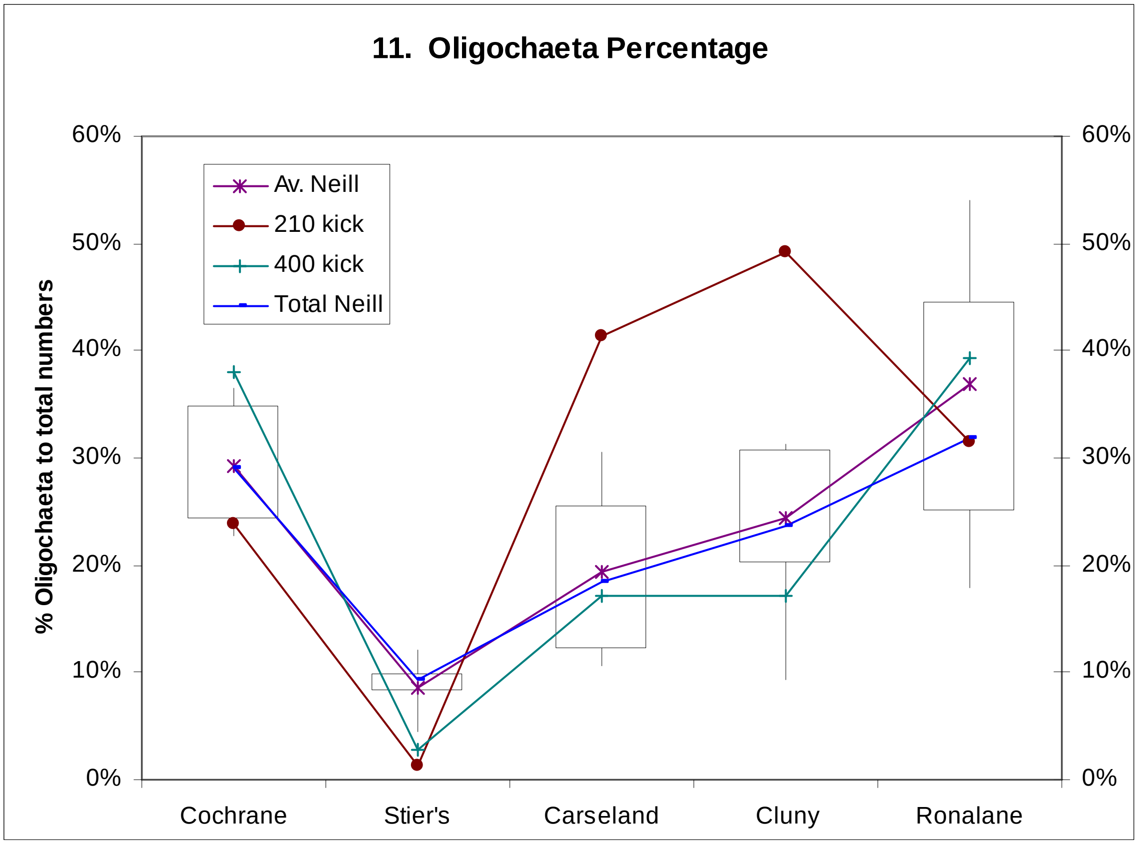
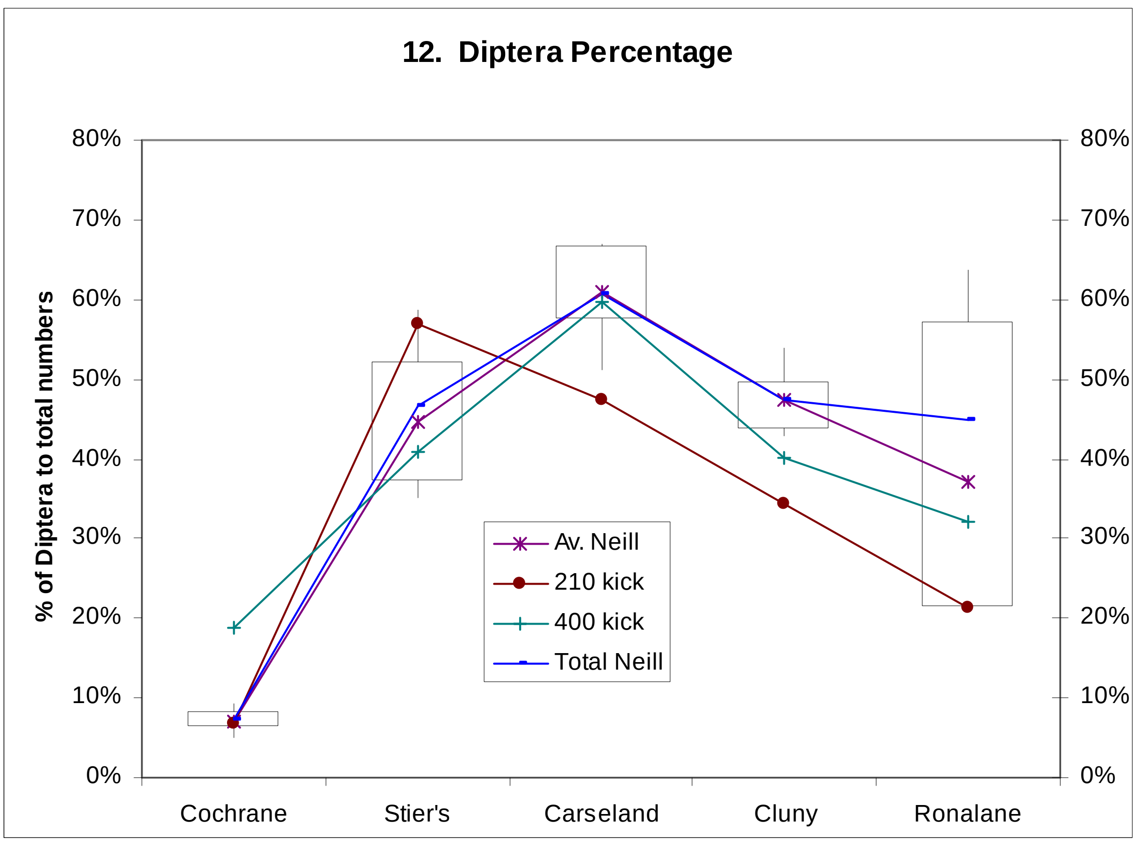




**Figure 2** **Comparison of benthic invertebrate data obtained with a Neill cylinder and kick nets (210 and 400µm mesh size) in erosional areas from the Bow River (October 2006) (con't)**

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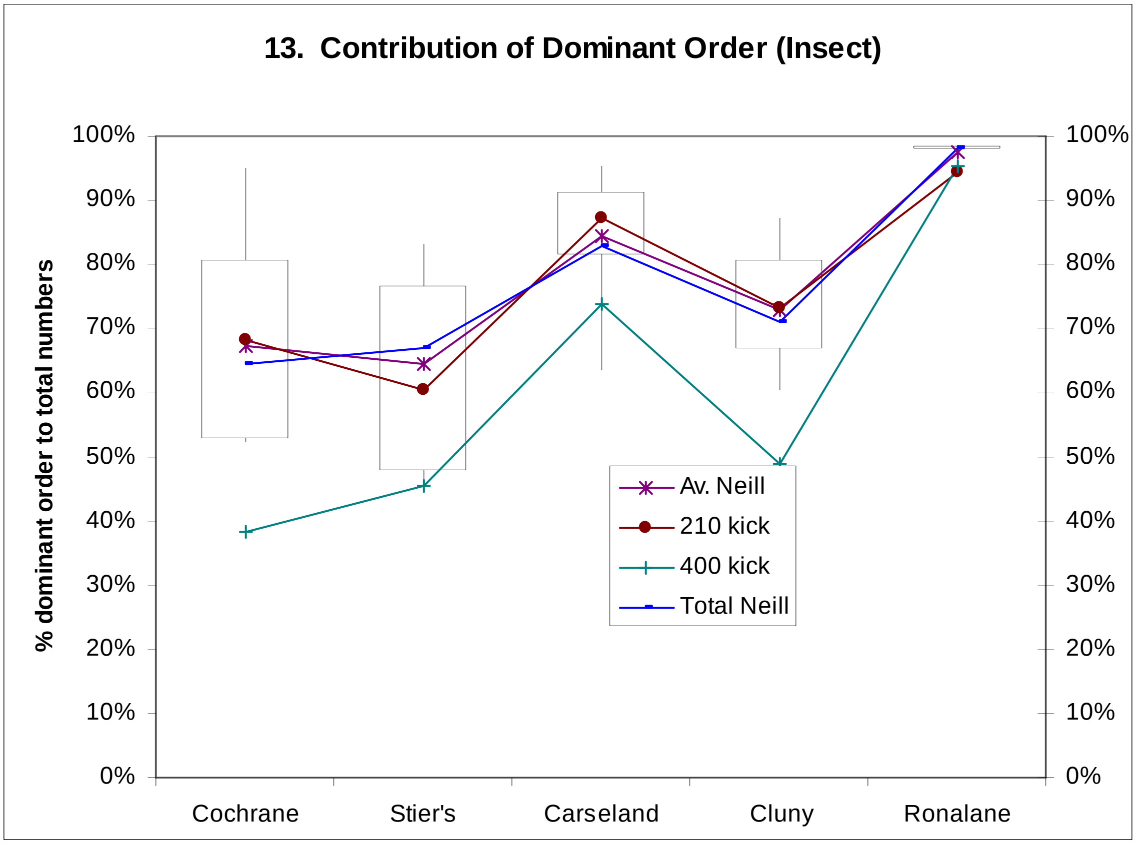


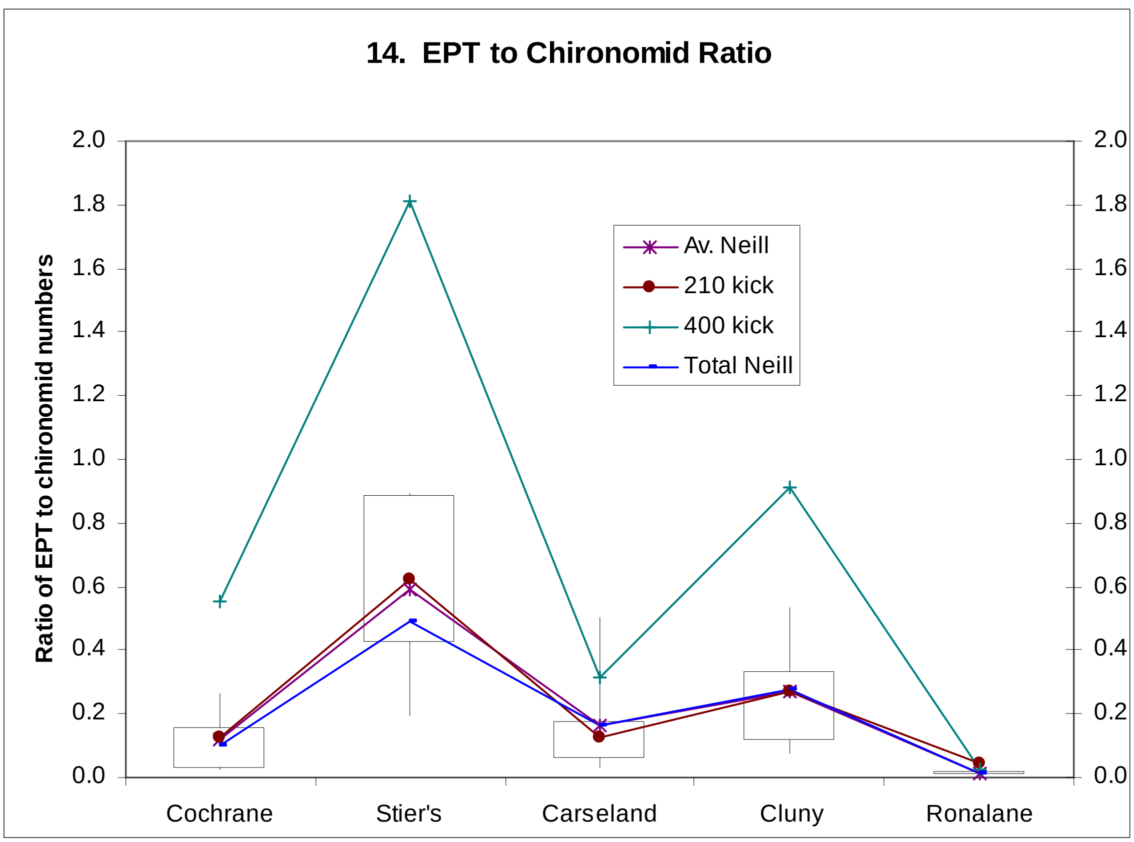


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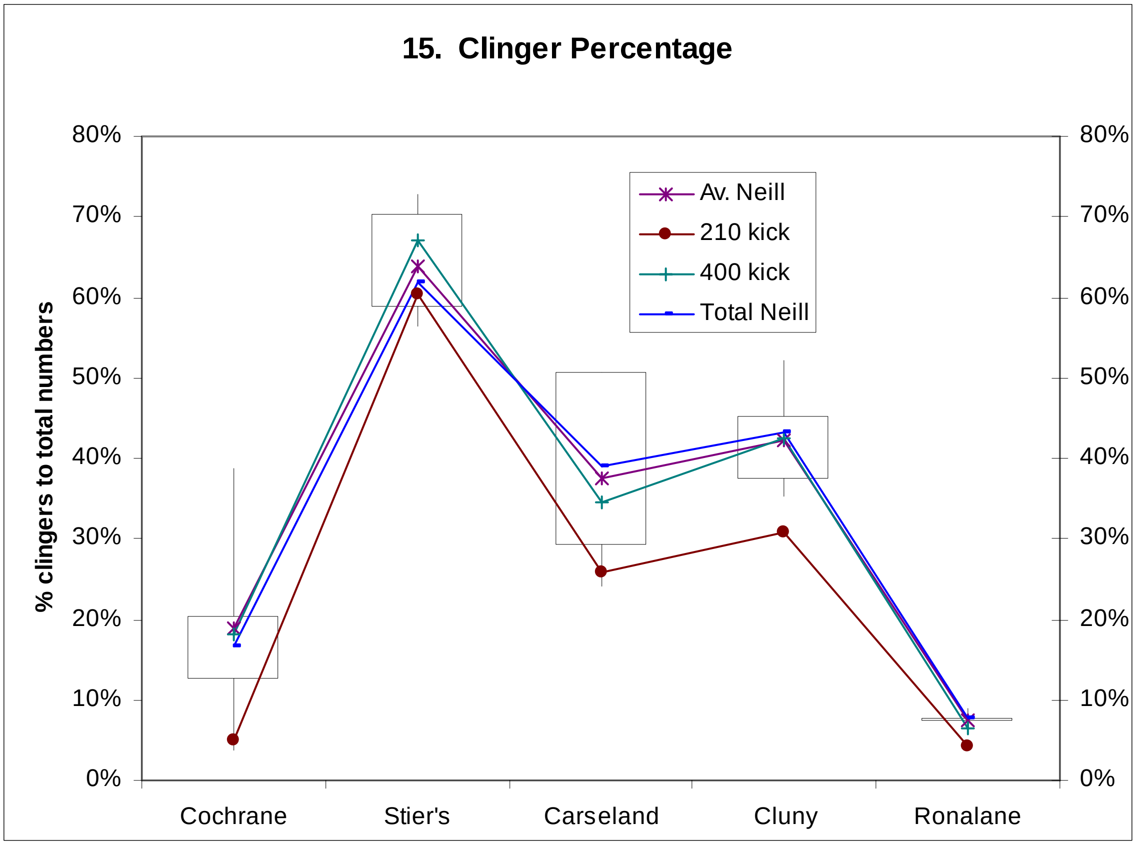


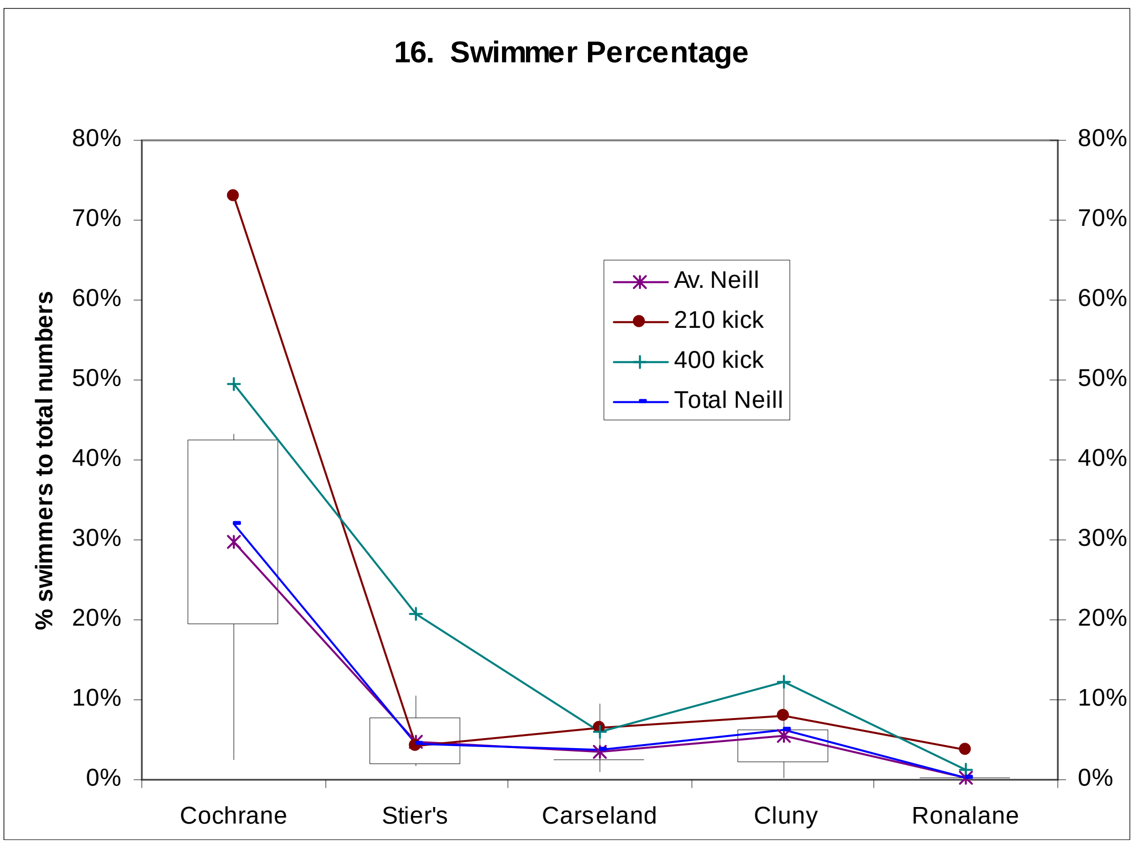


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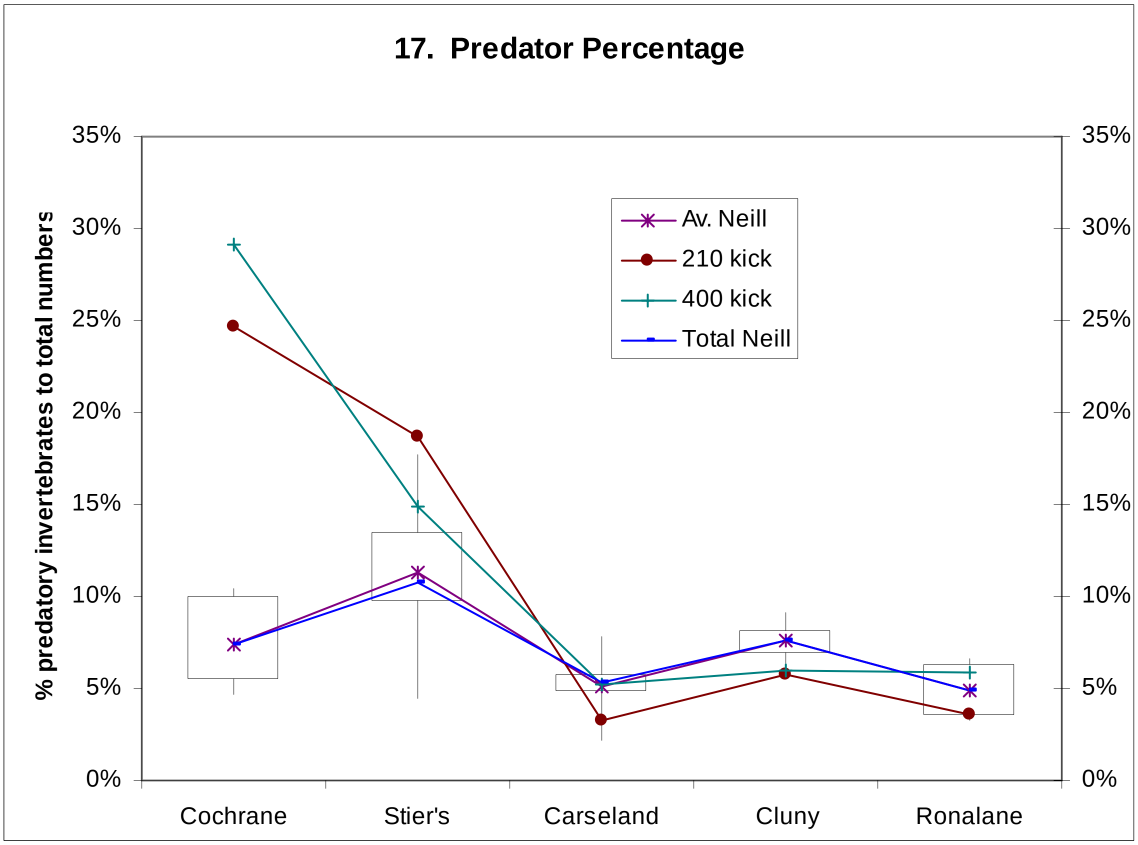


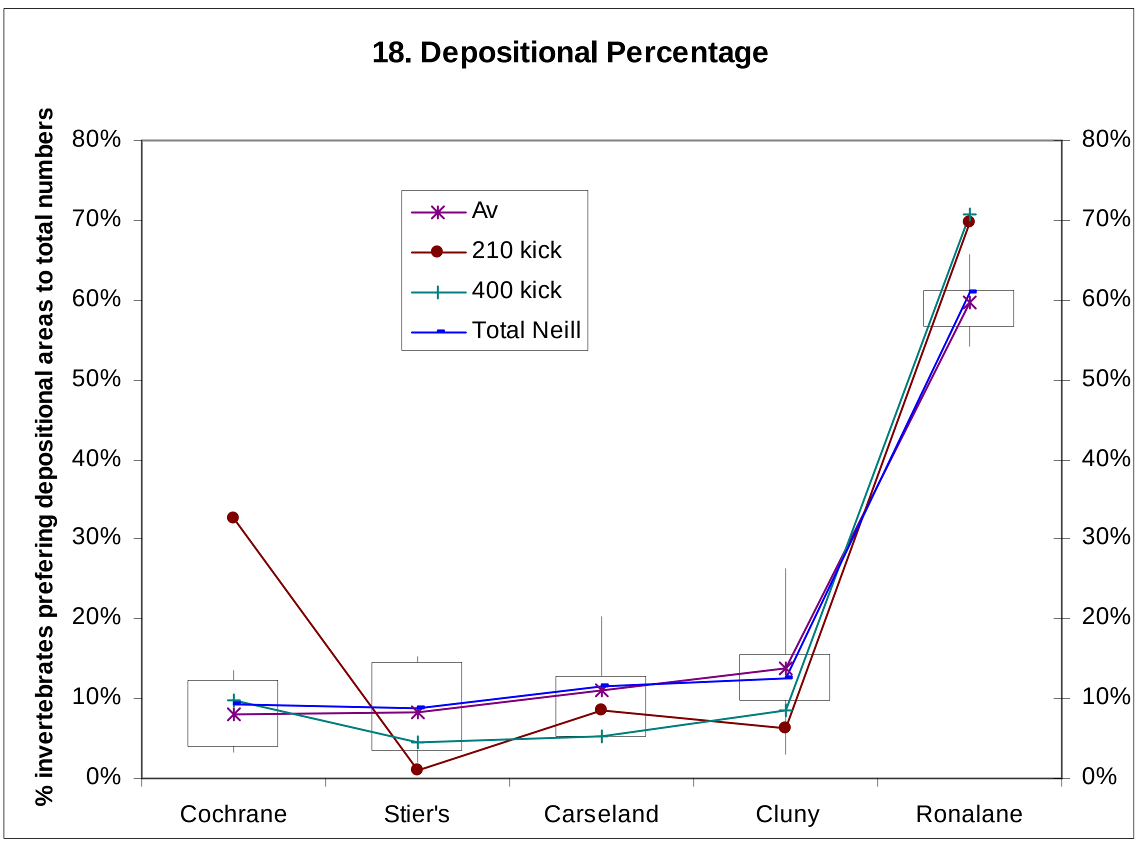


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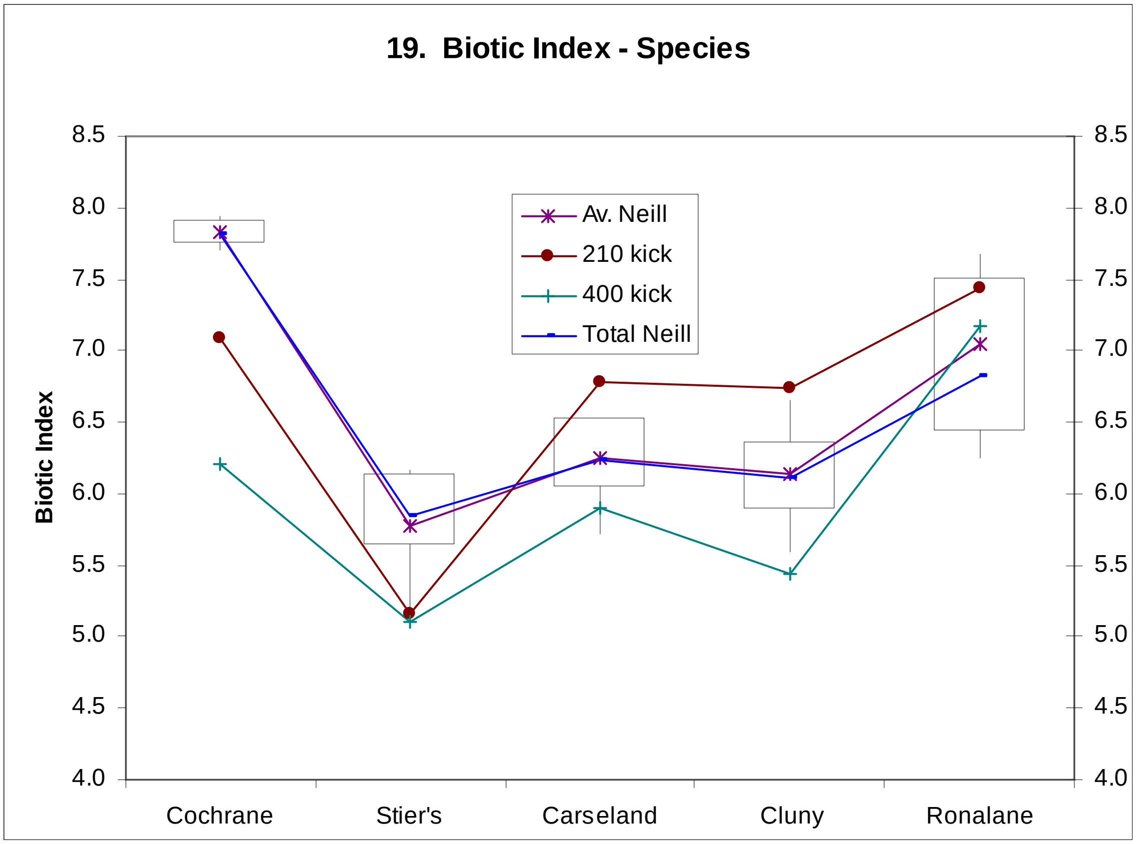


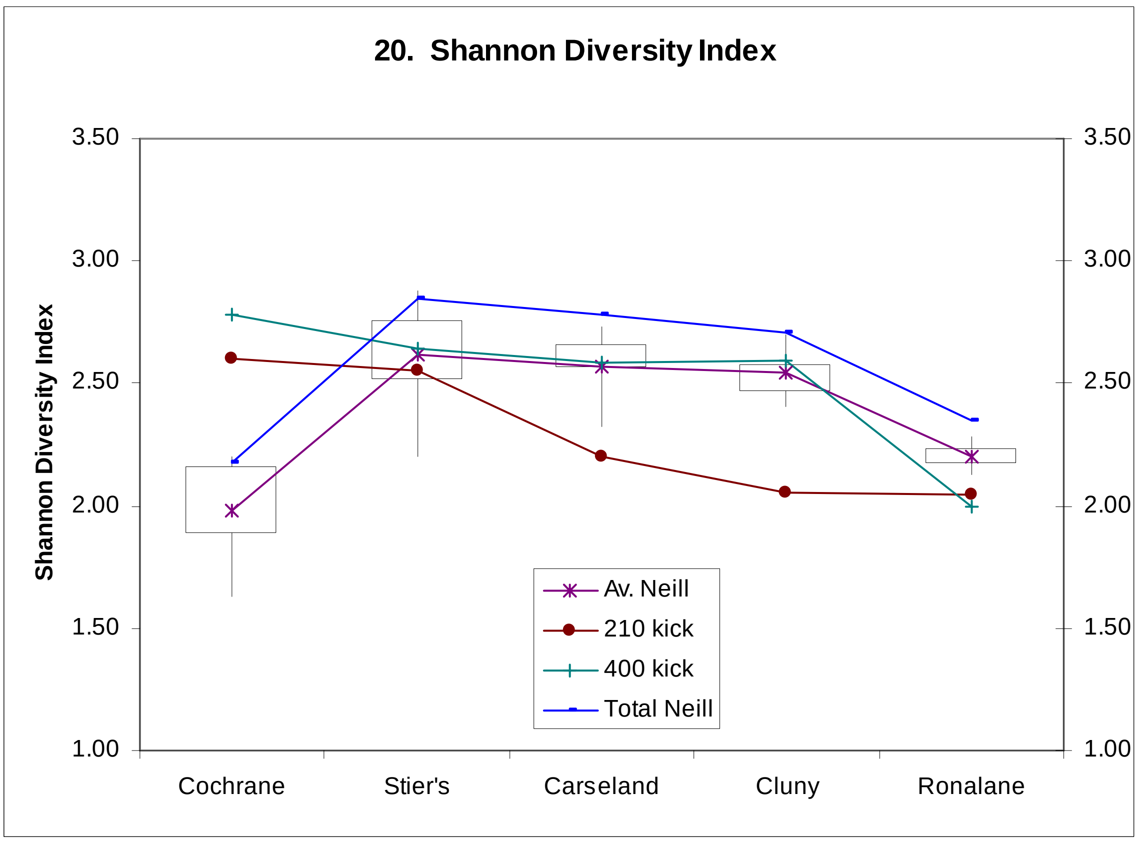


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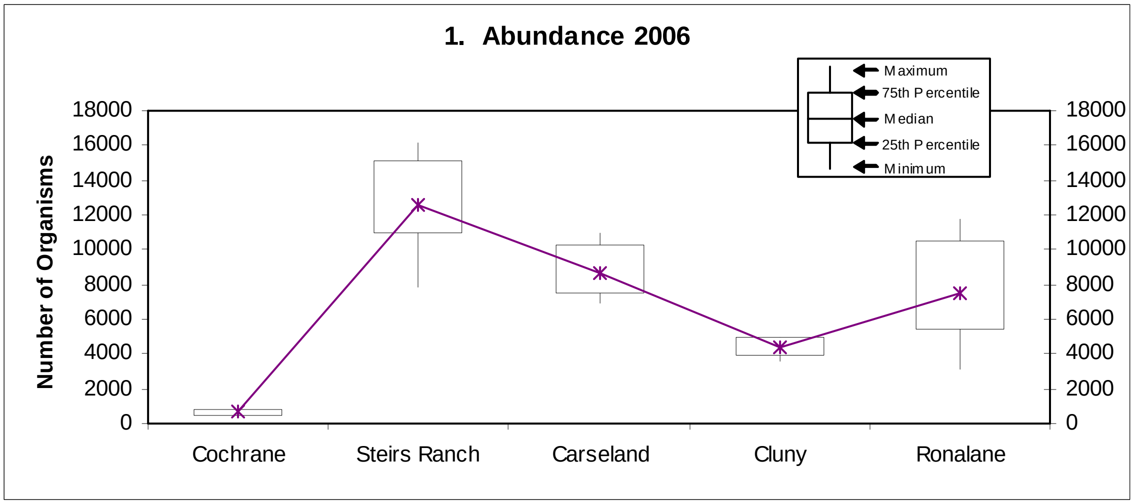
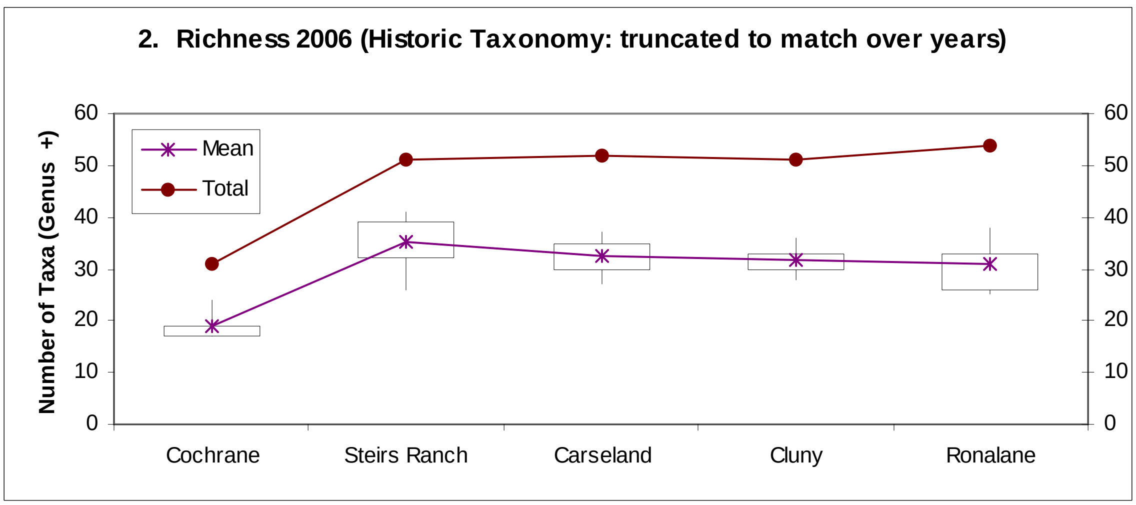


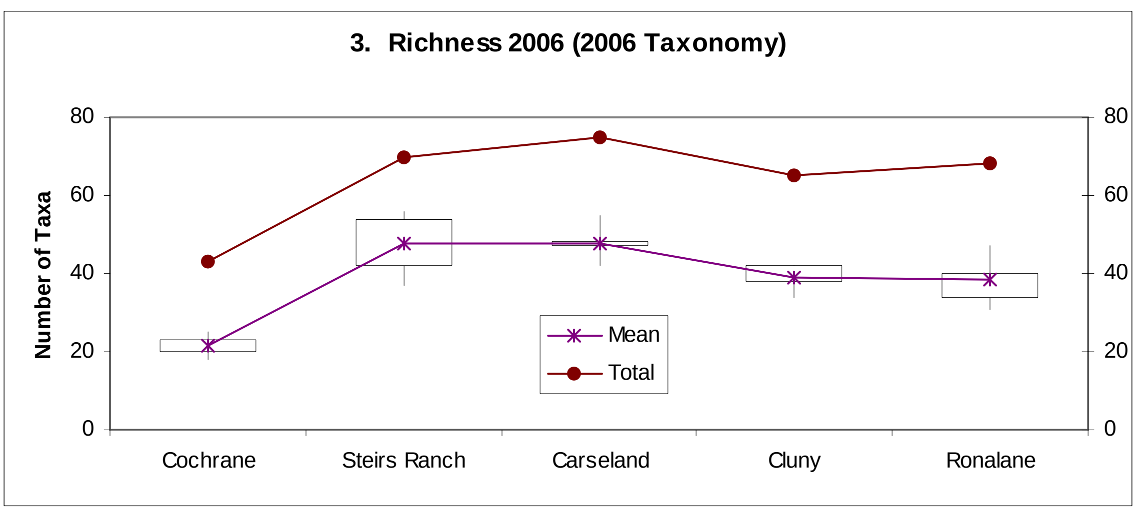
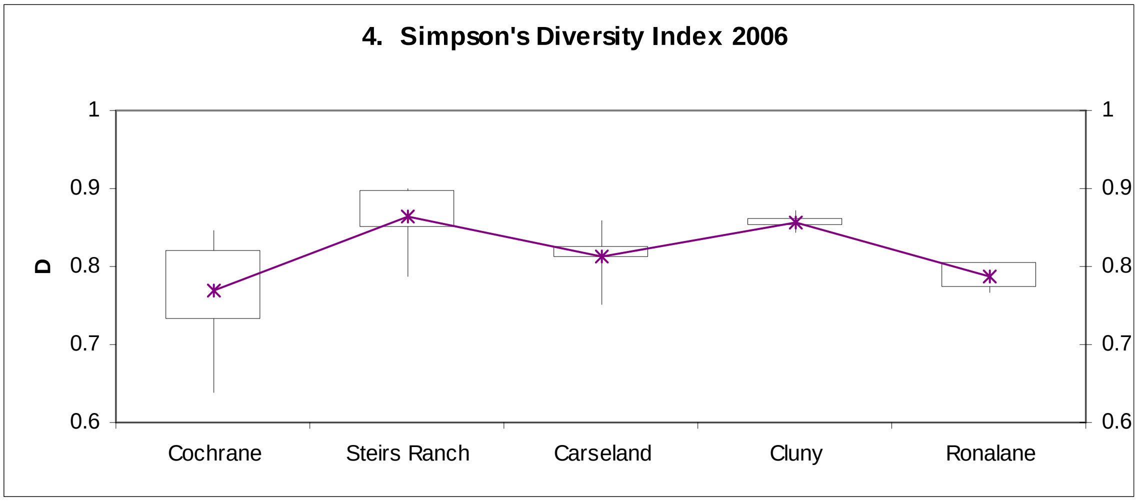
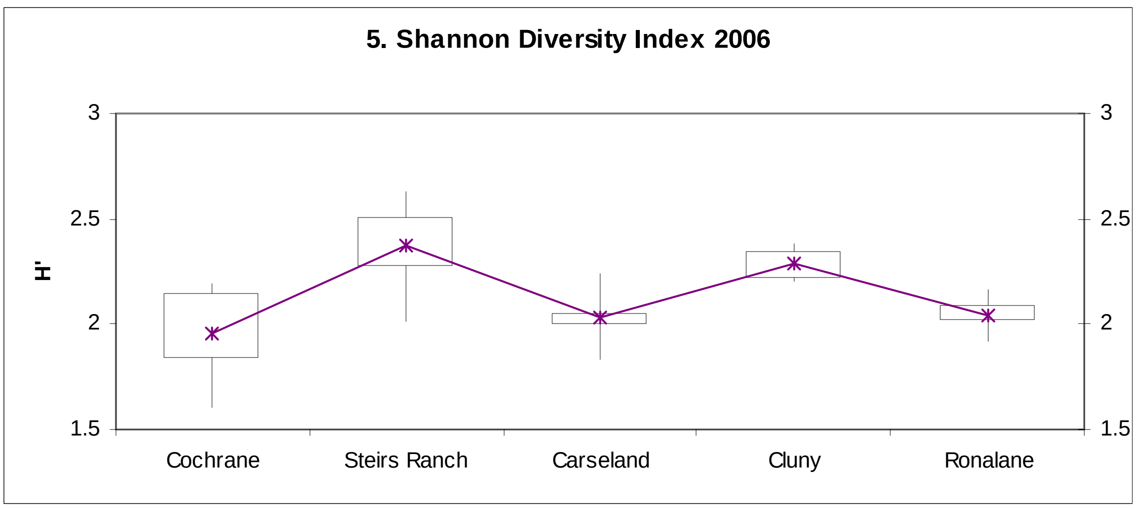




**Figure 3 Bow River benthic invertebrate metrics depicting longitudinal trends in erosional habitats (October 2006)**



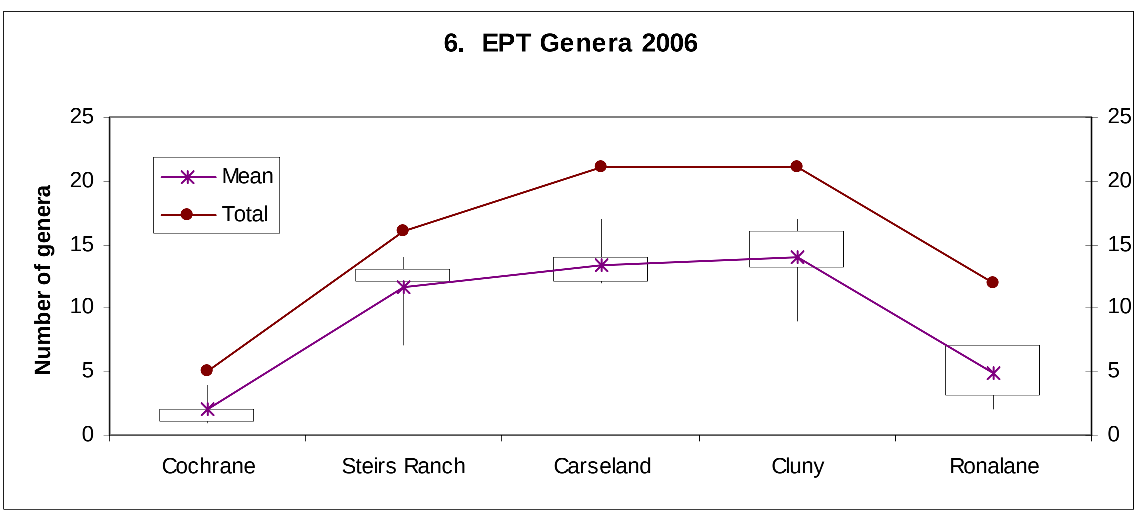
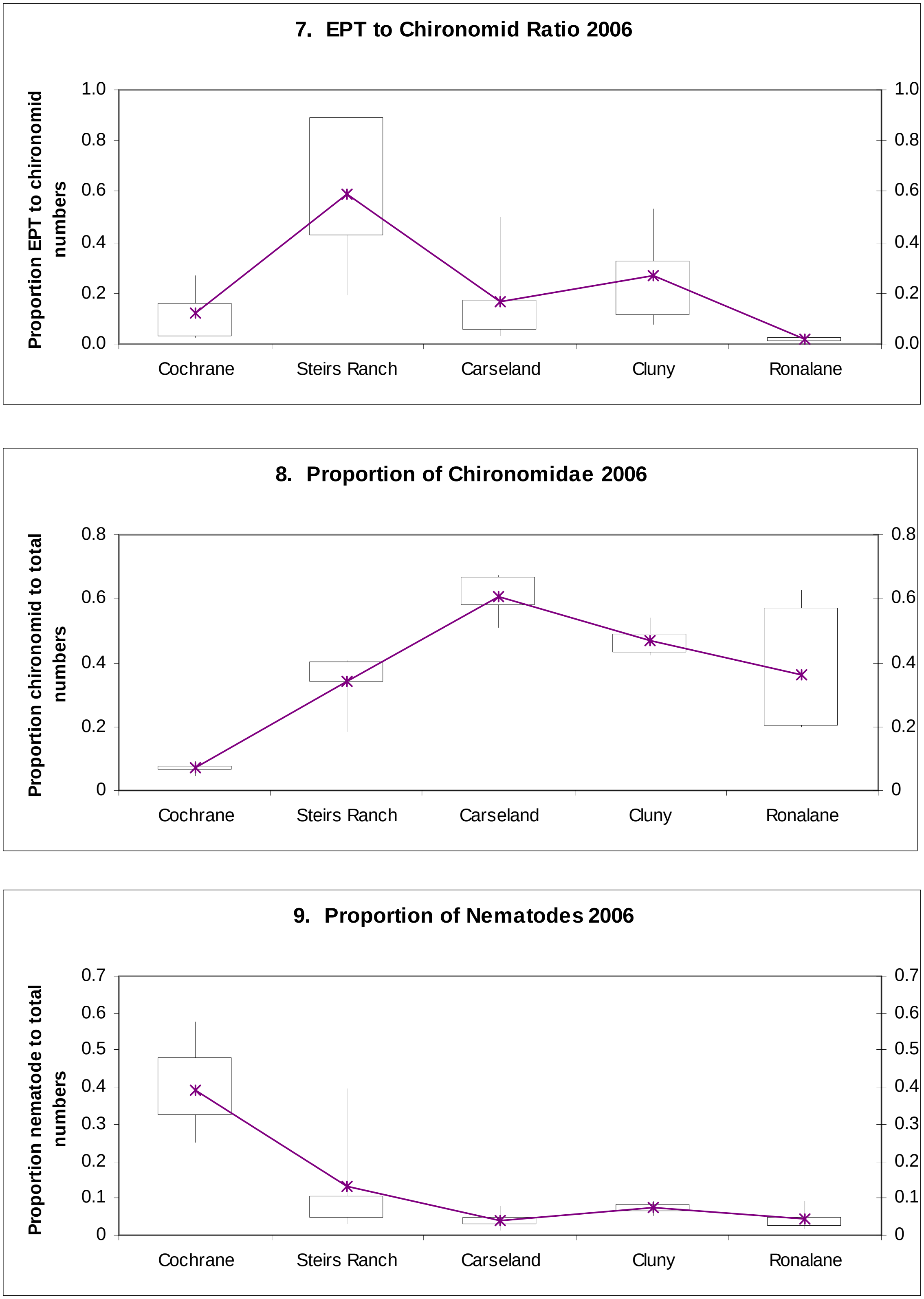




**Figure 3 Bow River benthic invertebrate metrics depicting longitudinal trends in erosional habitats (October 2006) (con't)**

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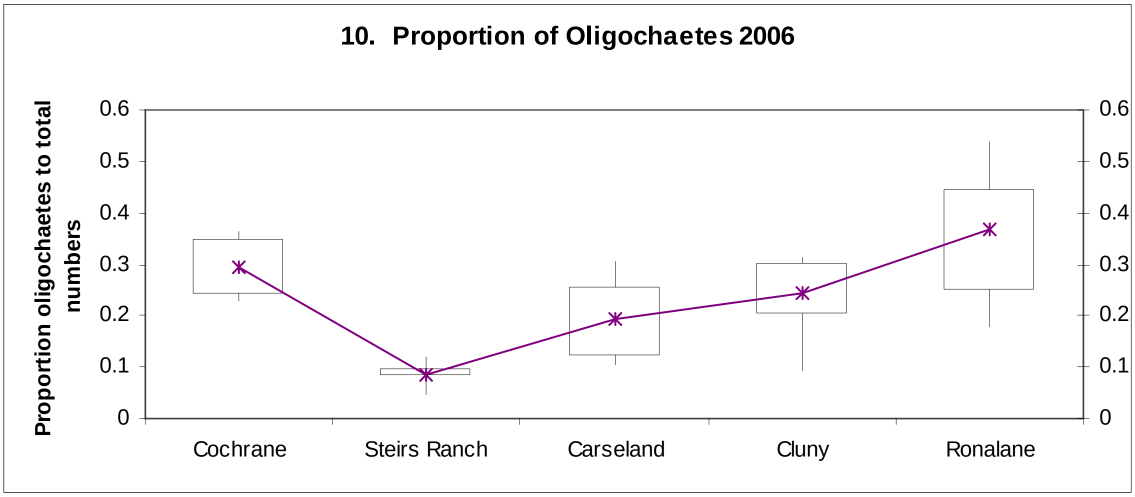


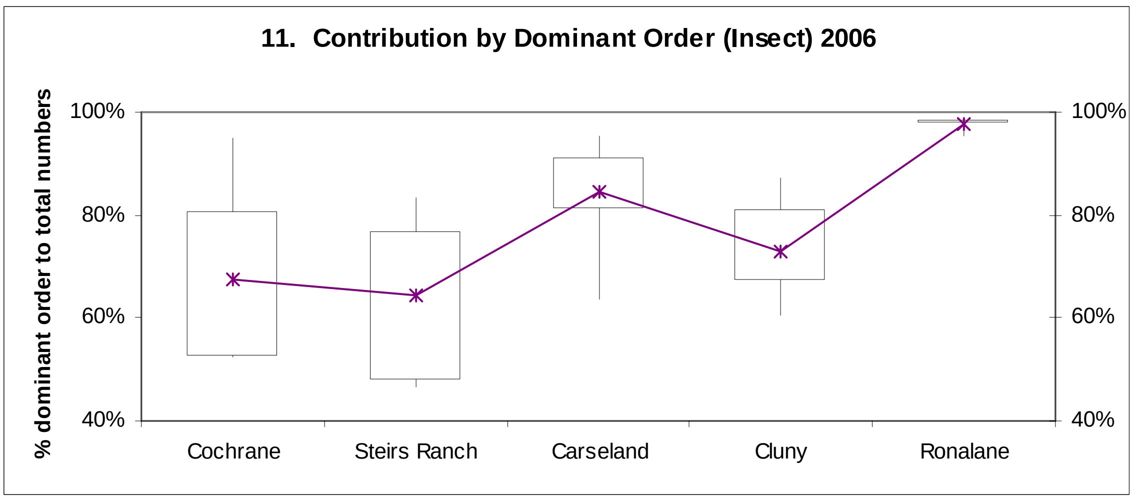


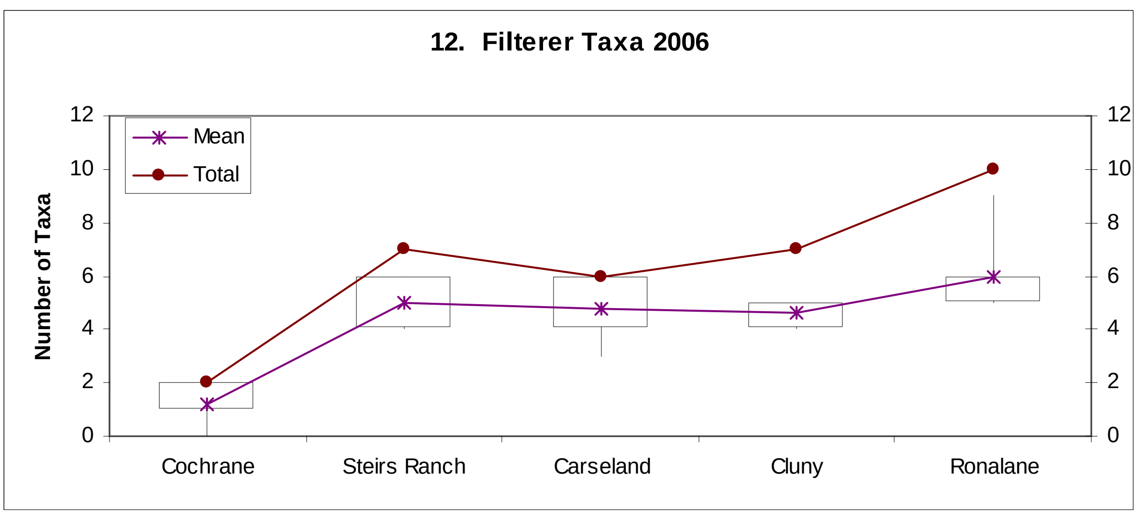


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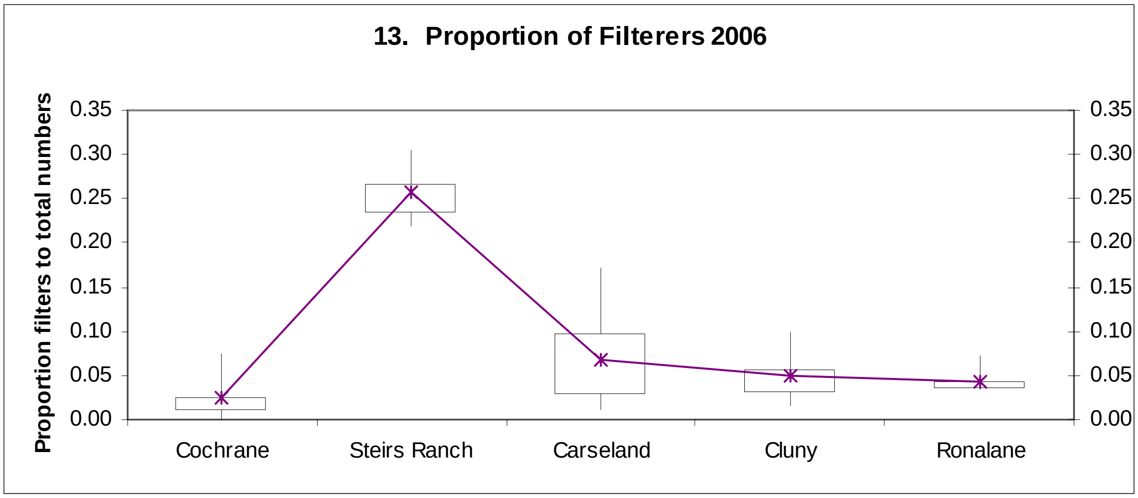


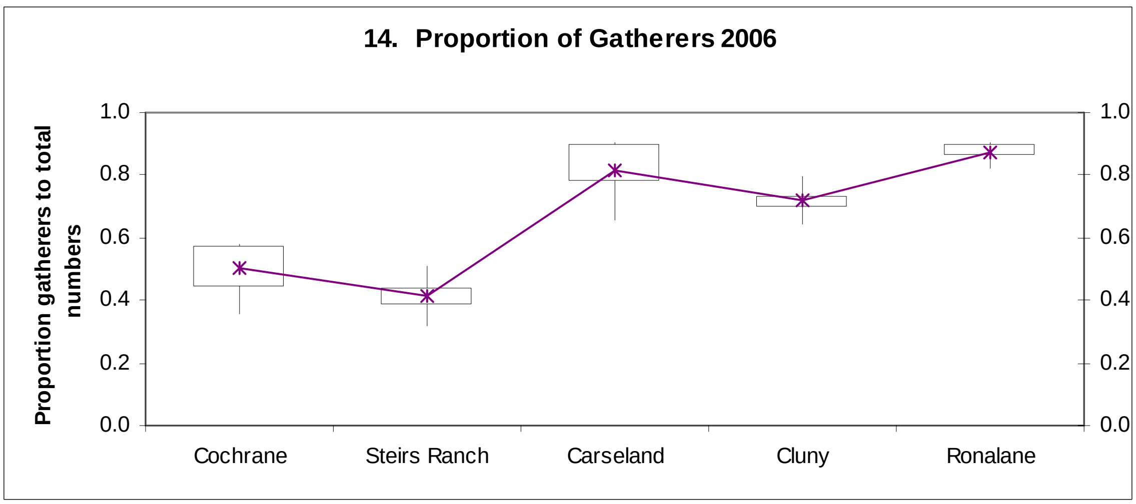


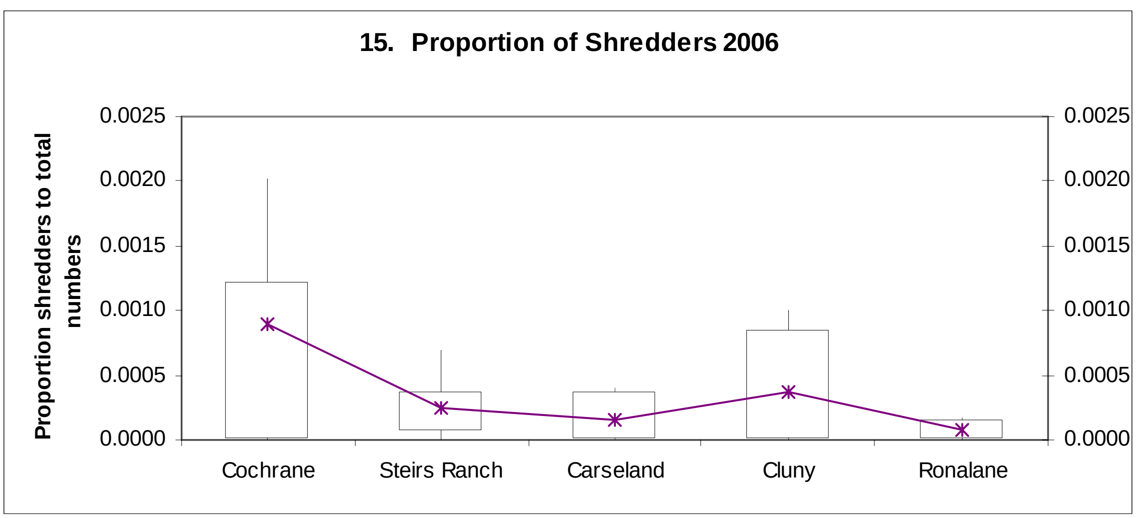


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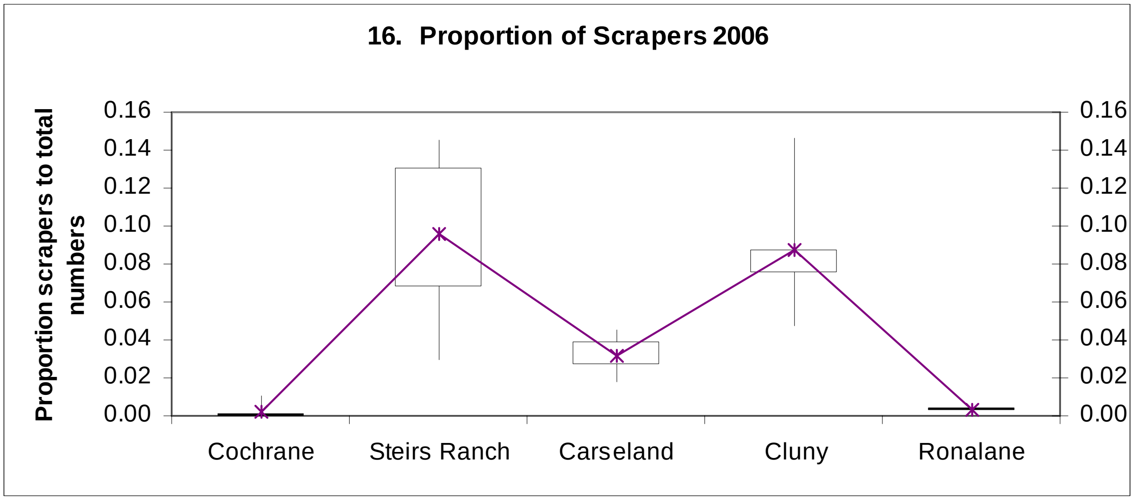


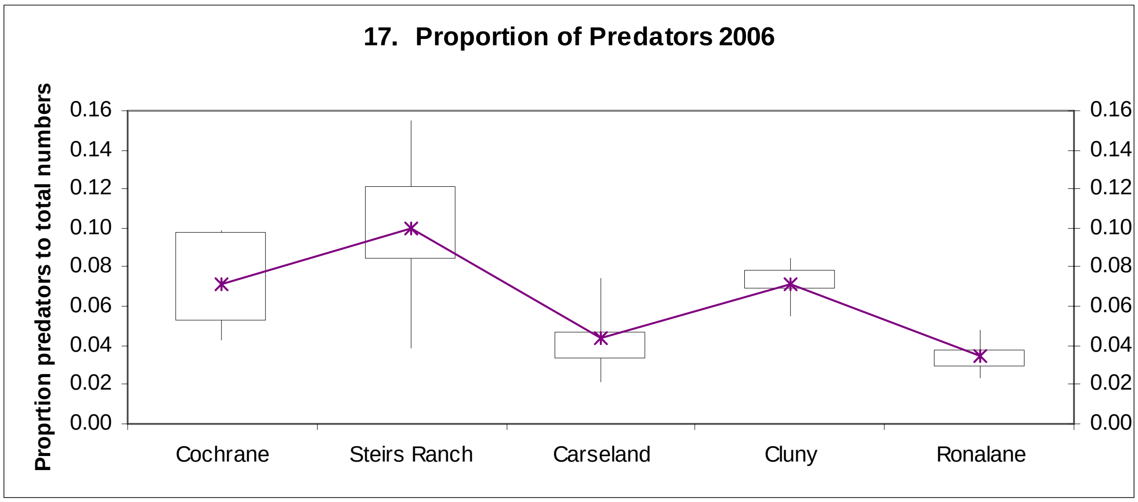


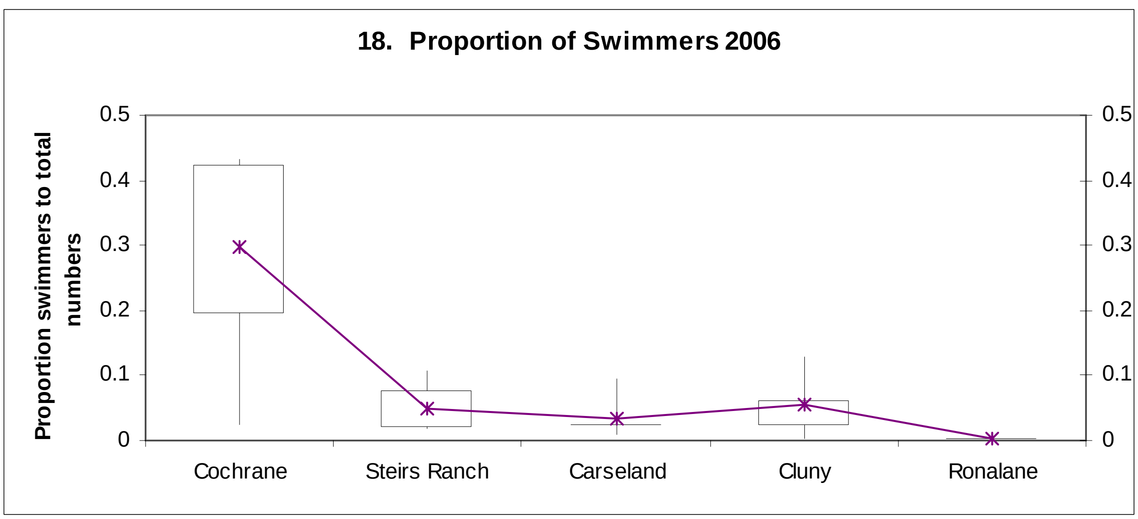


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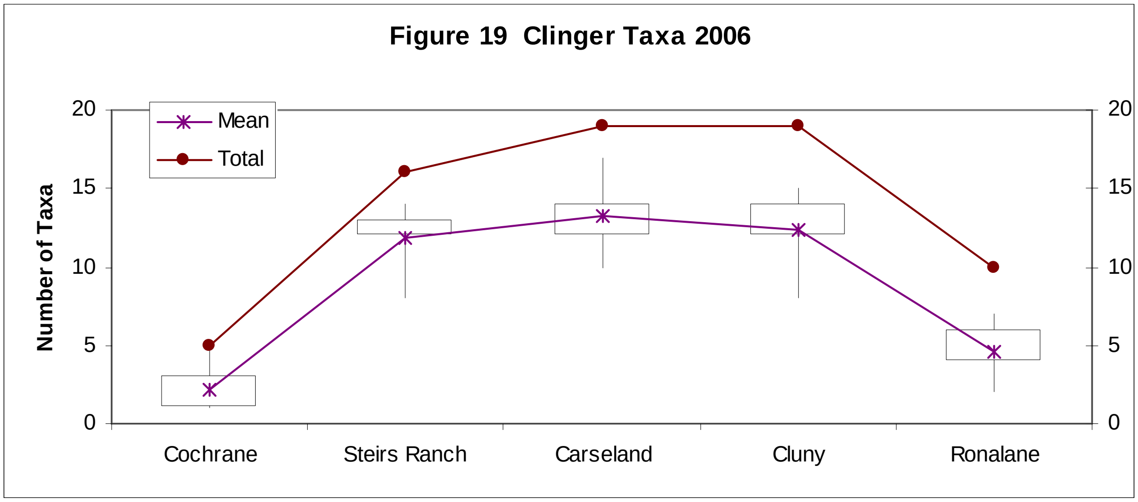


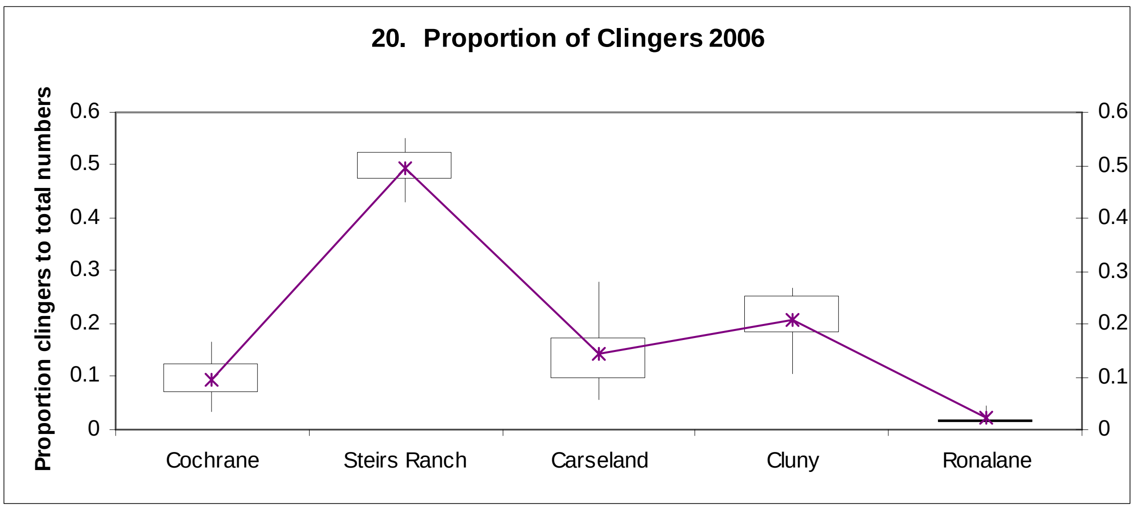


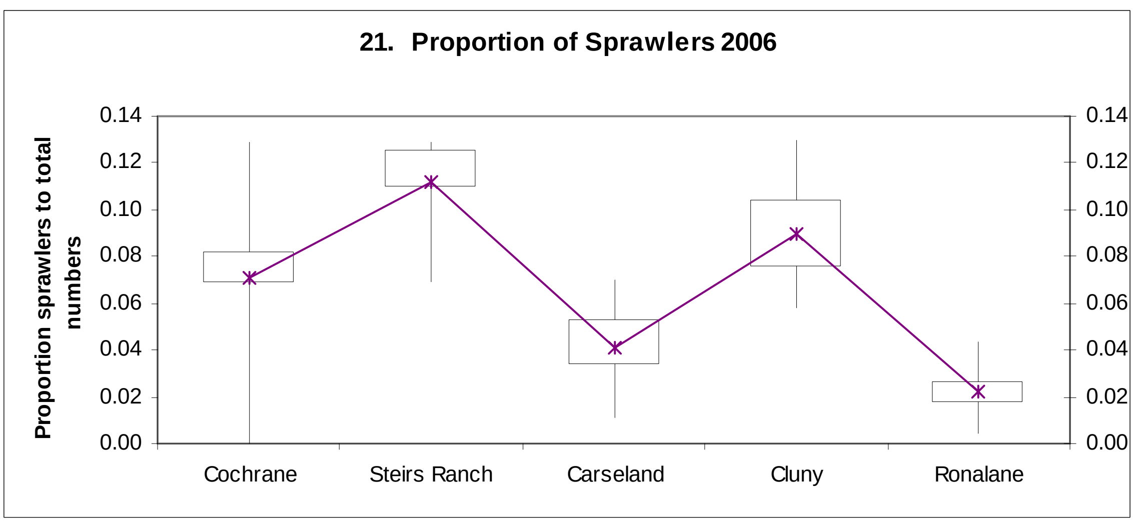


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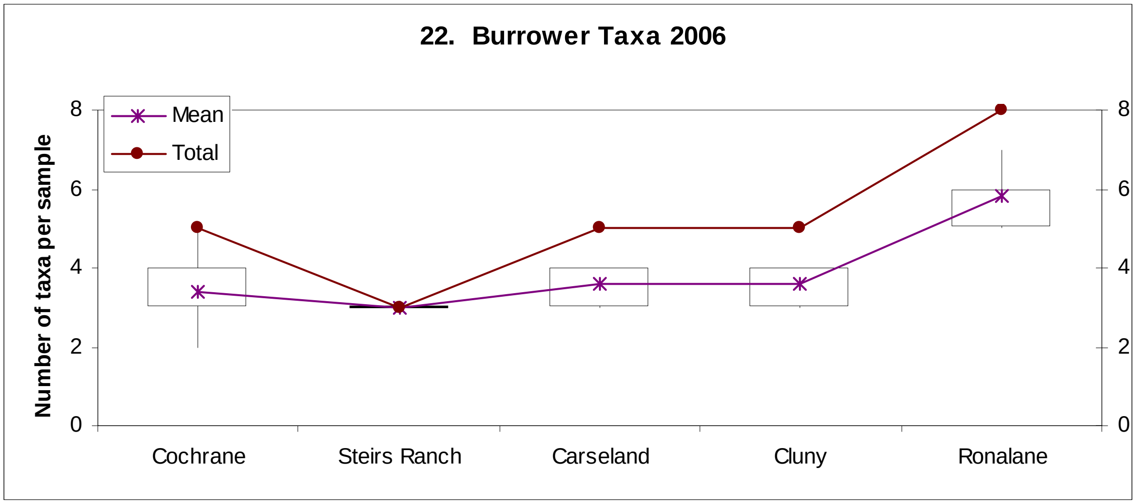
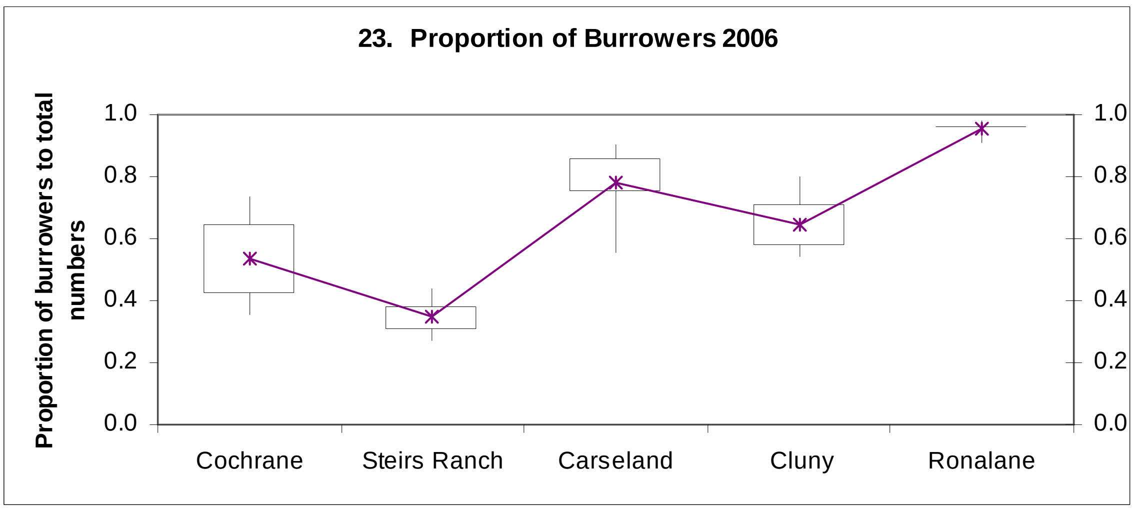


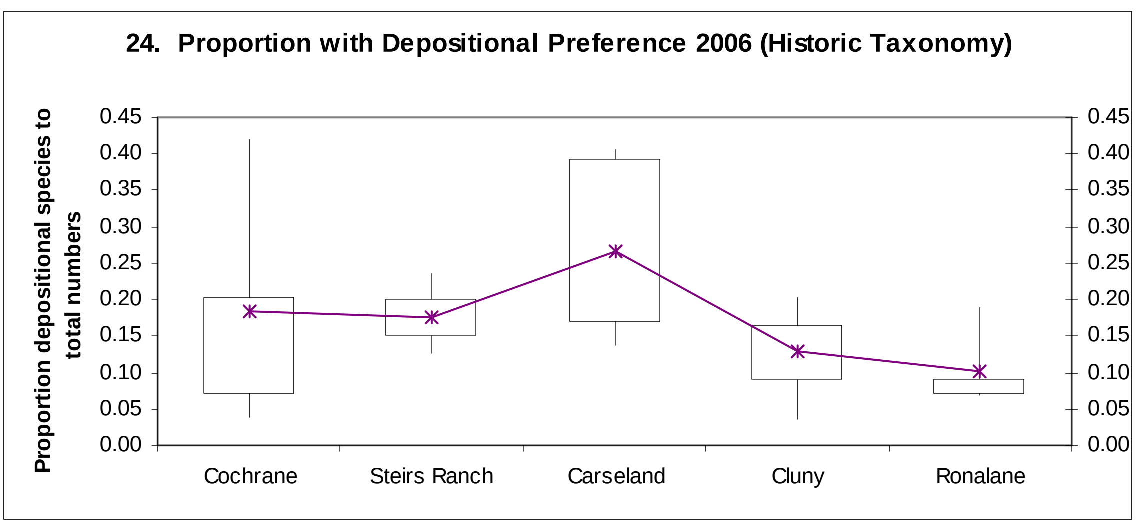
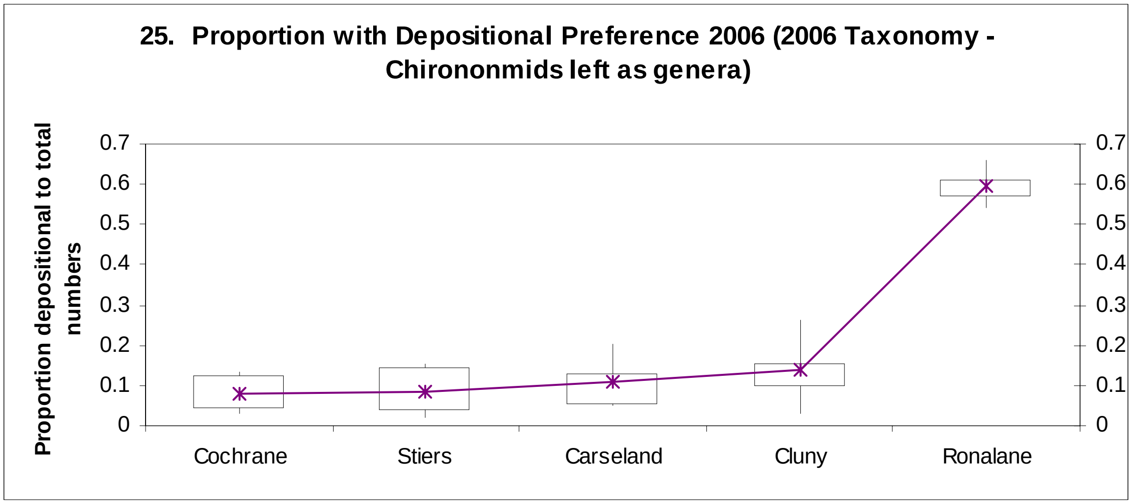
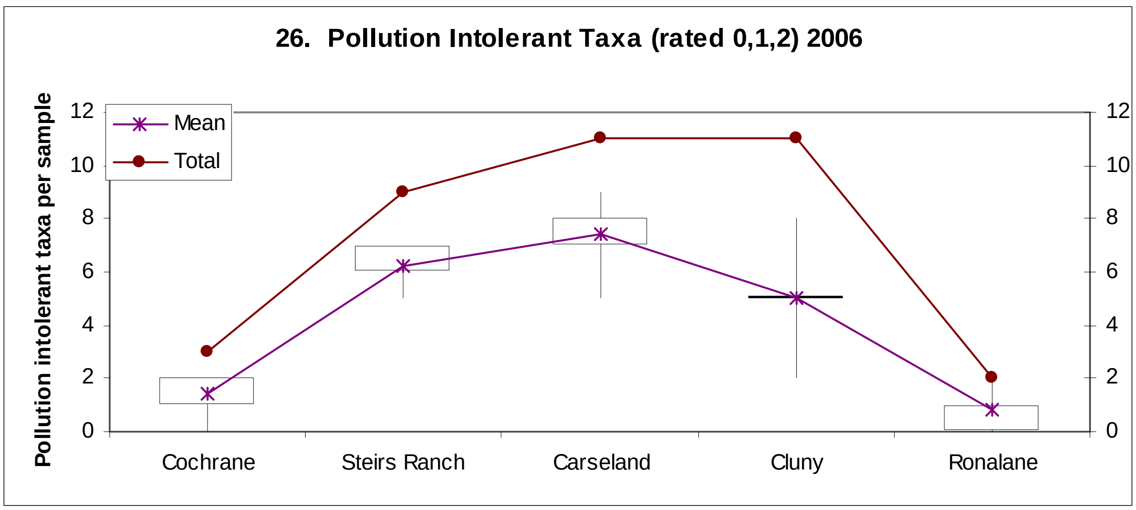




**Figure 3 Bow River benthic invertebrate metrics depicting longitudinal trends in erosional habitats (October 2006) (con't)**



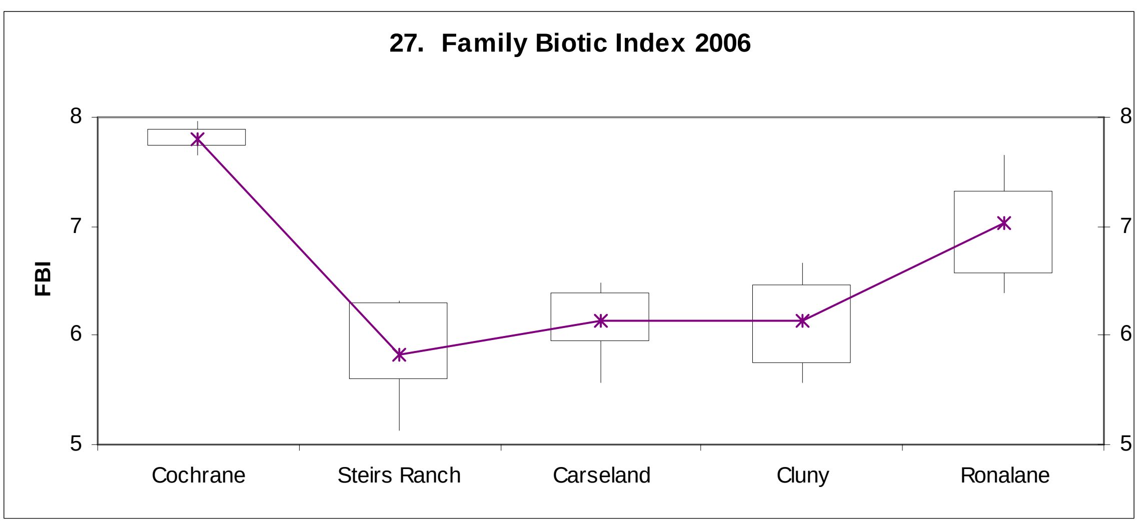
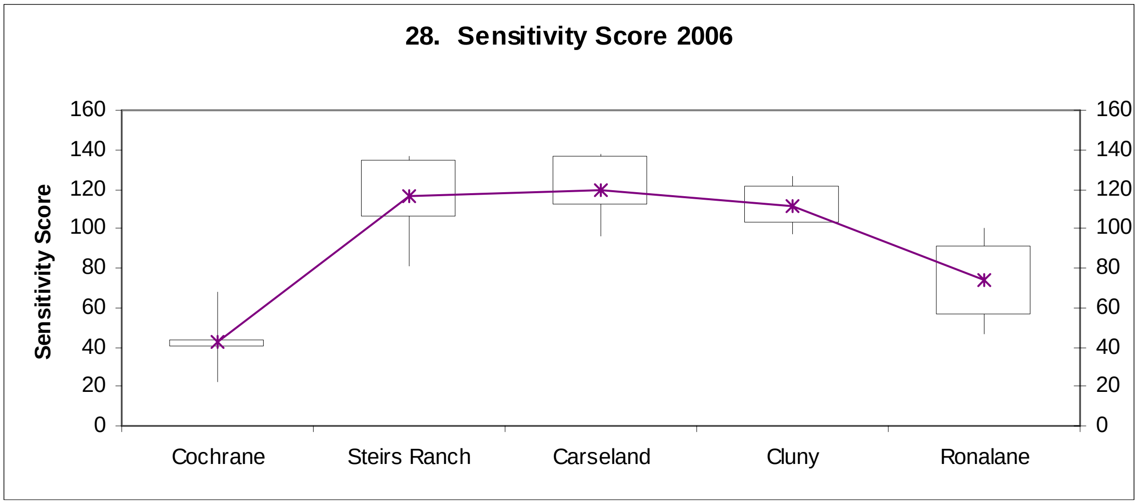




**Figure 3 Bow River benthic invertebrate metrics depicting longitudinal trends in erosional habitats (October 2006) (con't)**



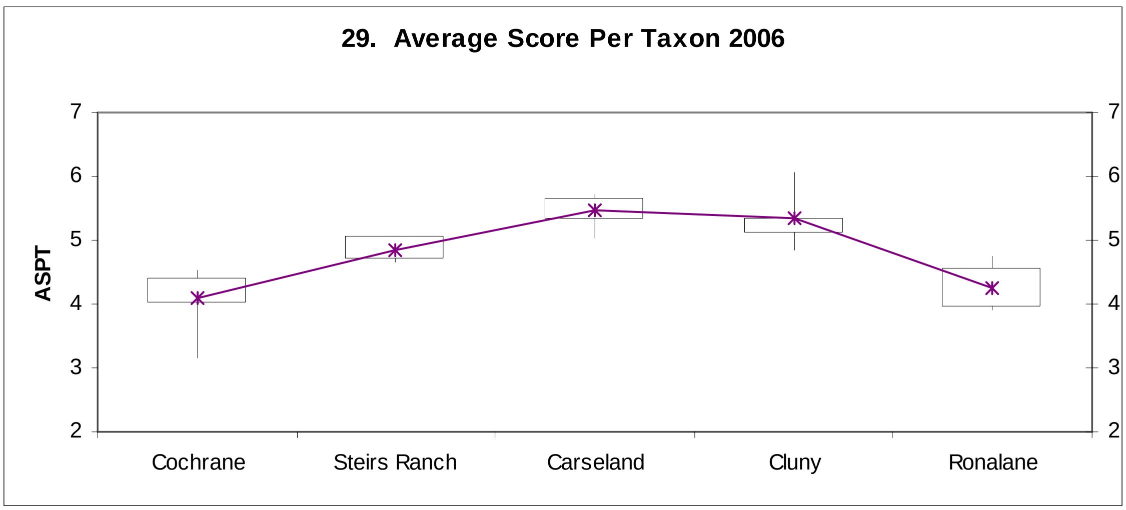




**Figure 3 Bow River benthic invertebrate metrics depicting longitudinal trends in erosional habitats (October 2006) (con't)Figure 3**

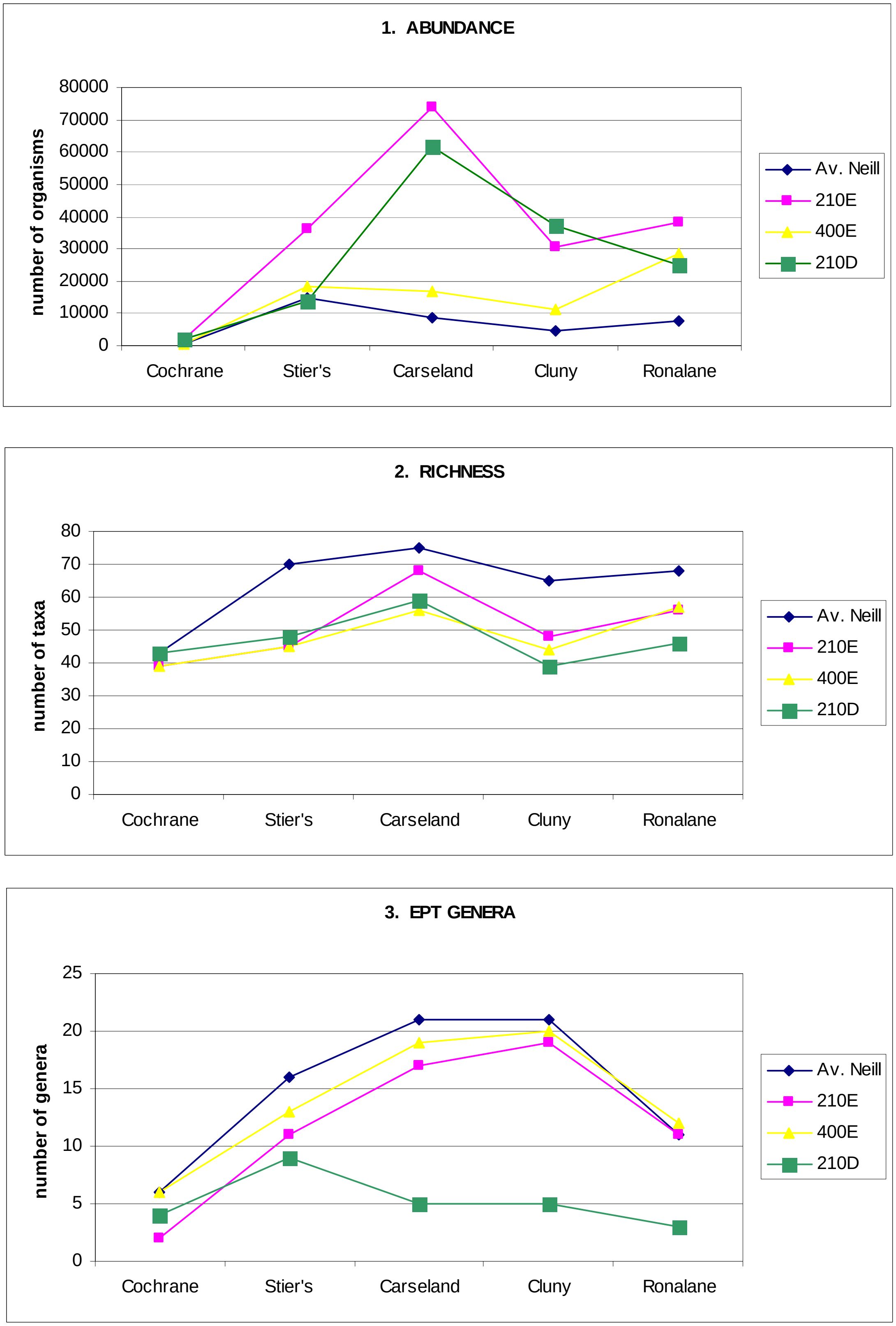
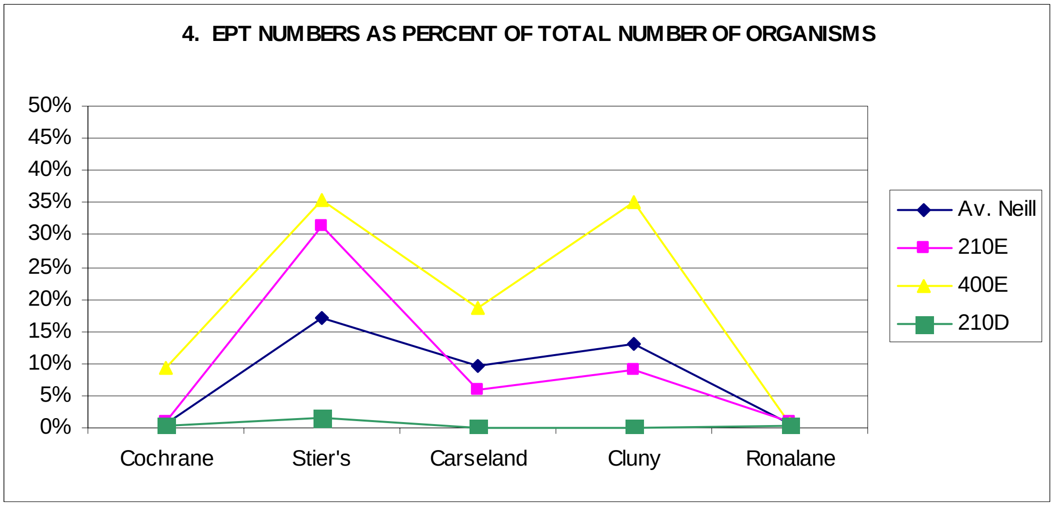
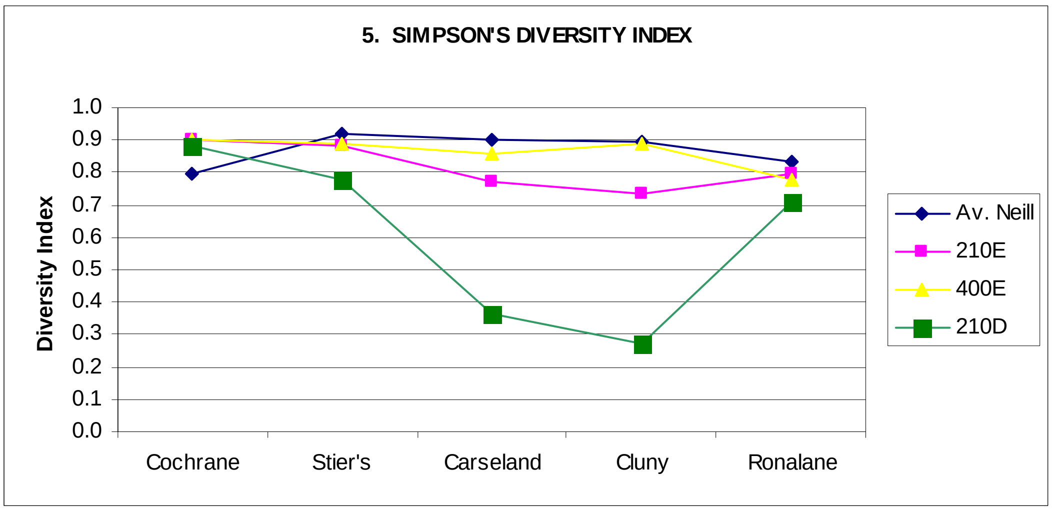



**Figure 4** **Comparison of various benthic invertebrate metrics depicting longitudinal trends in erosional (E) and depositional (D) areas (October 2006)**



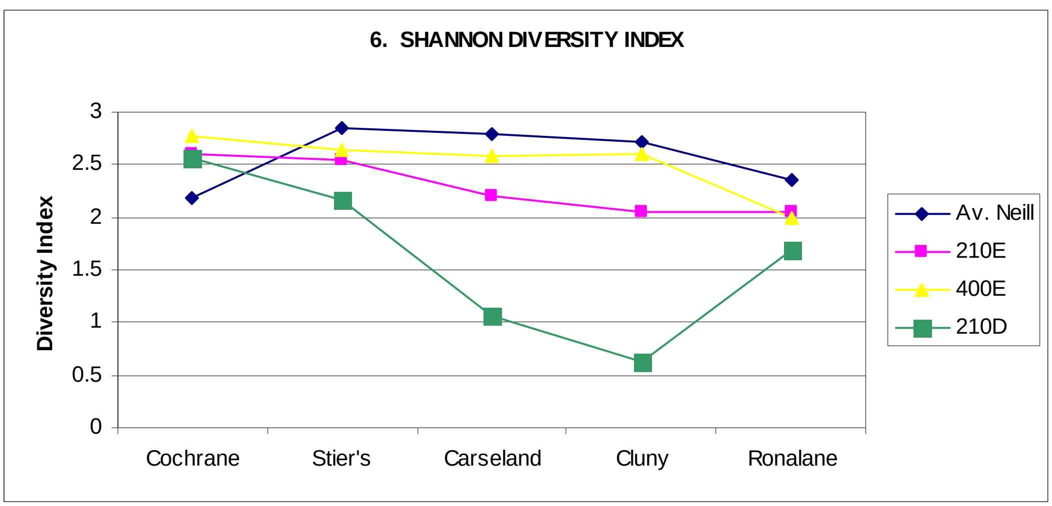
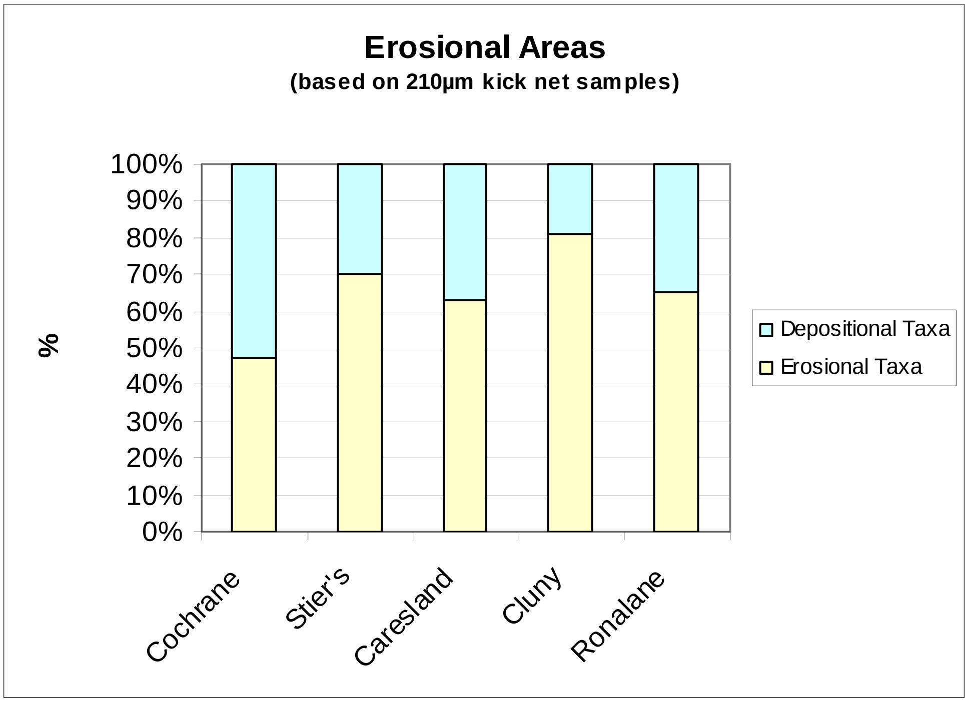




**Figure 4 Comparison of various benthic Invertebrate metrics depicting longitudinal trends in erosional (E) and depositional (D) areas (October 2006) (con't)**



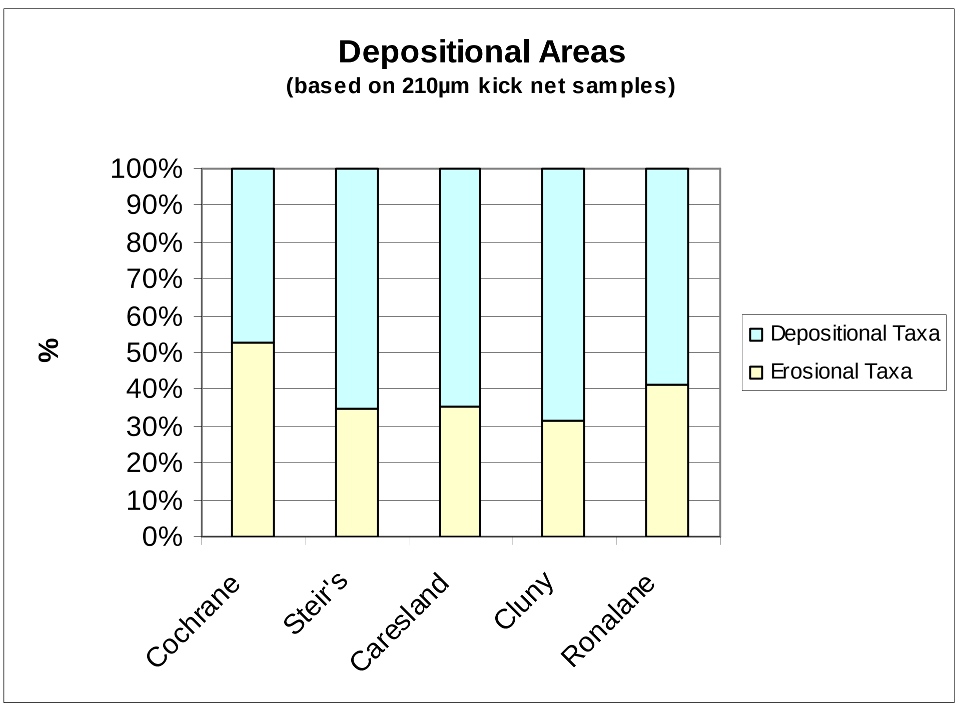
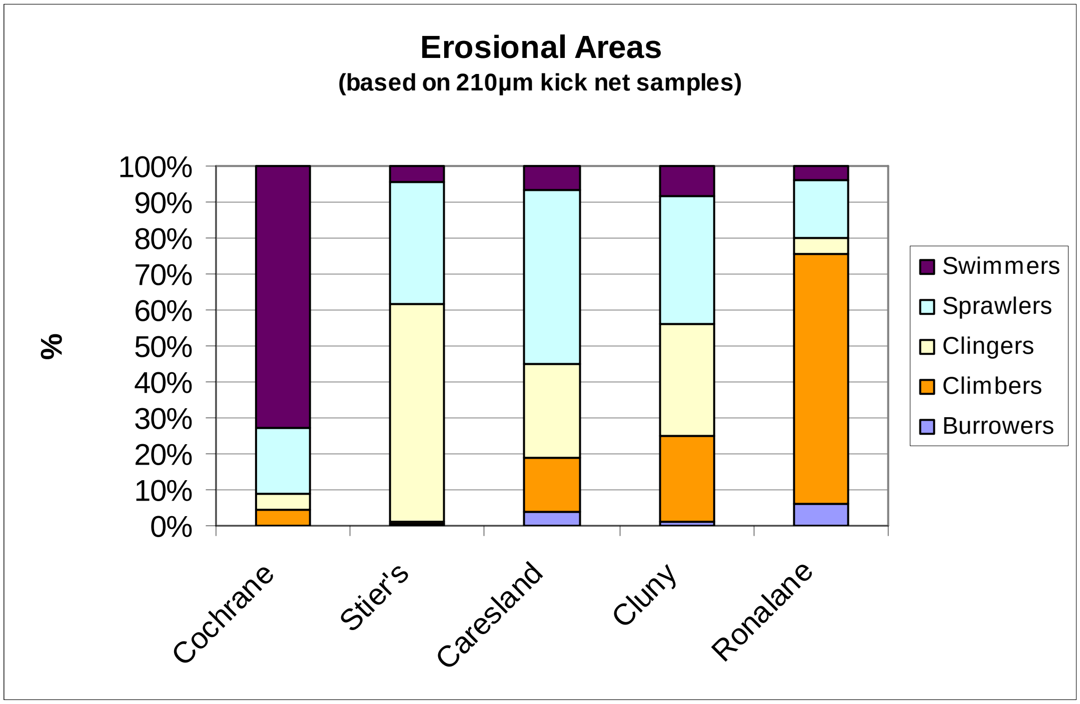




**Figure 5 Comparison of habitat preferences of invertebrates in erosional and depositional areas from the Bow River (October 2006)**



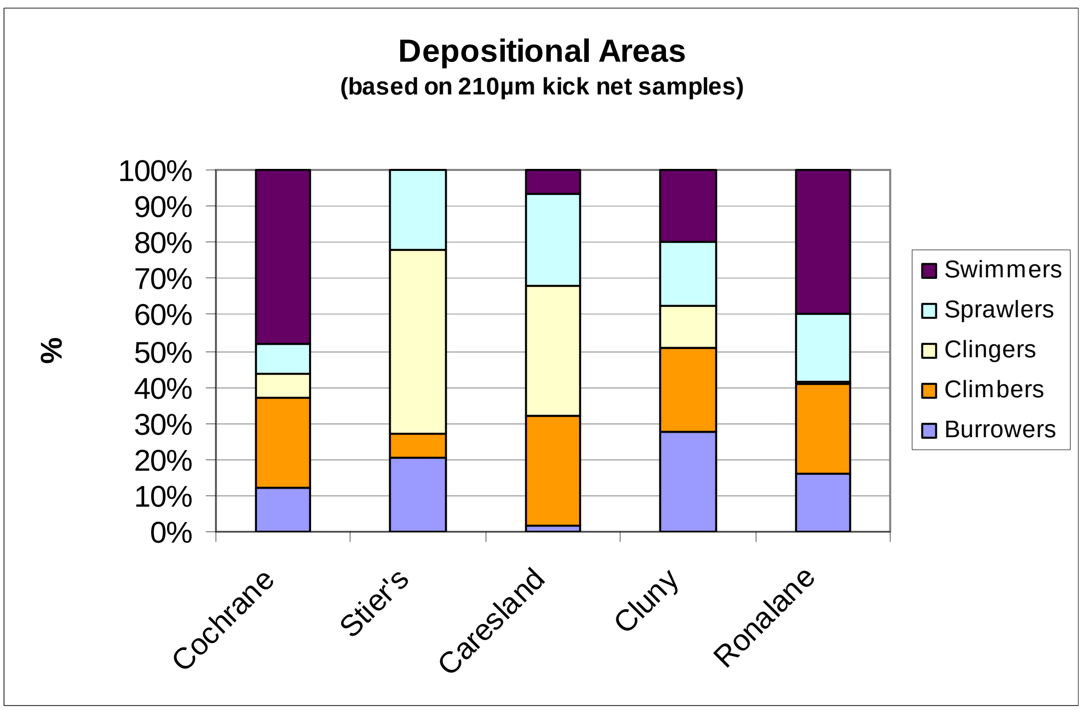




**Figure 6** **Comparison of habits of invertebrates in erosional and depositional areas from the Bow River (October 2006)**

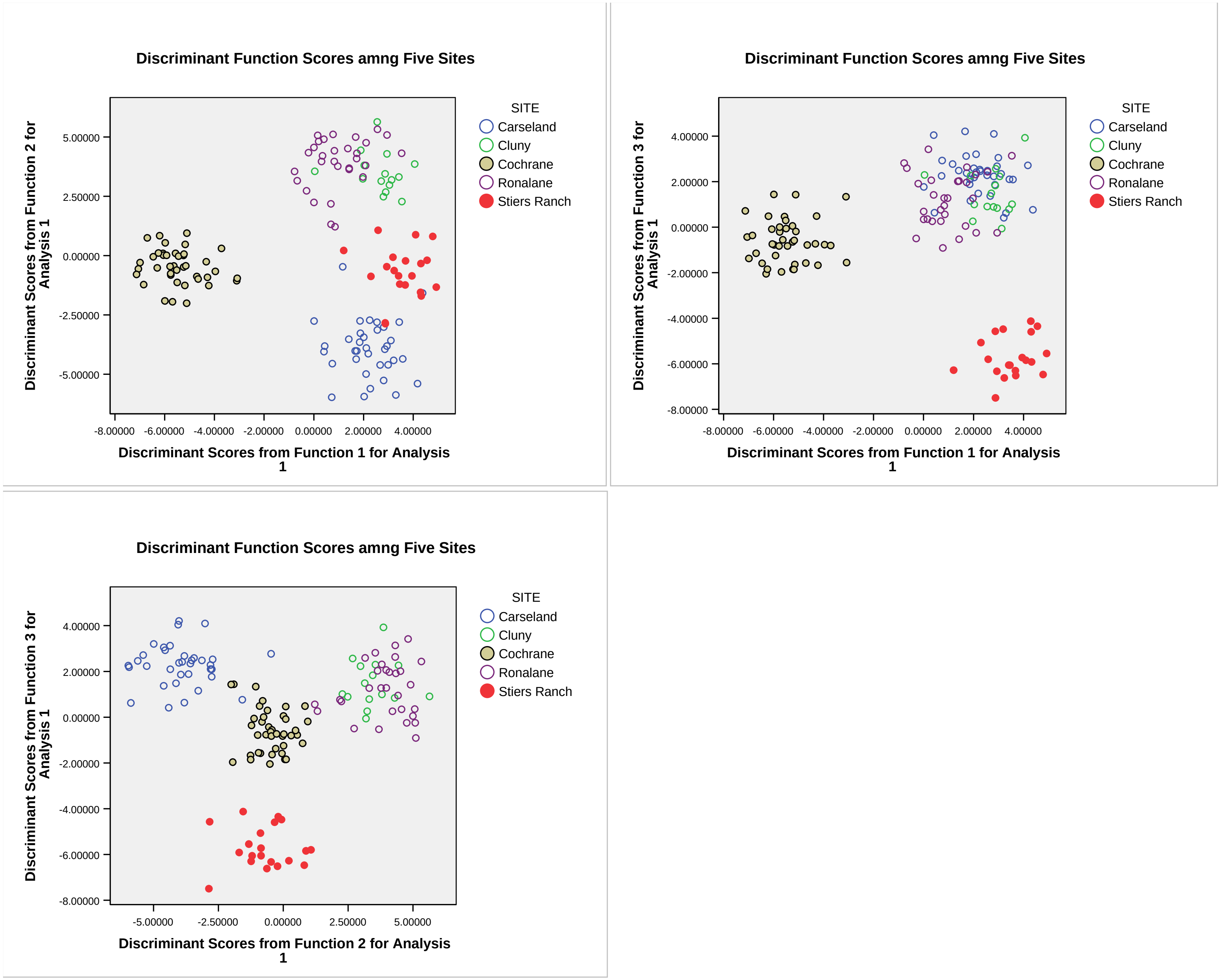
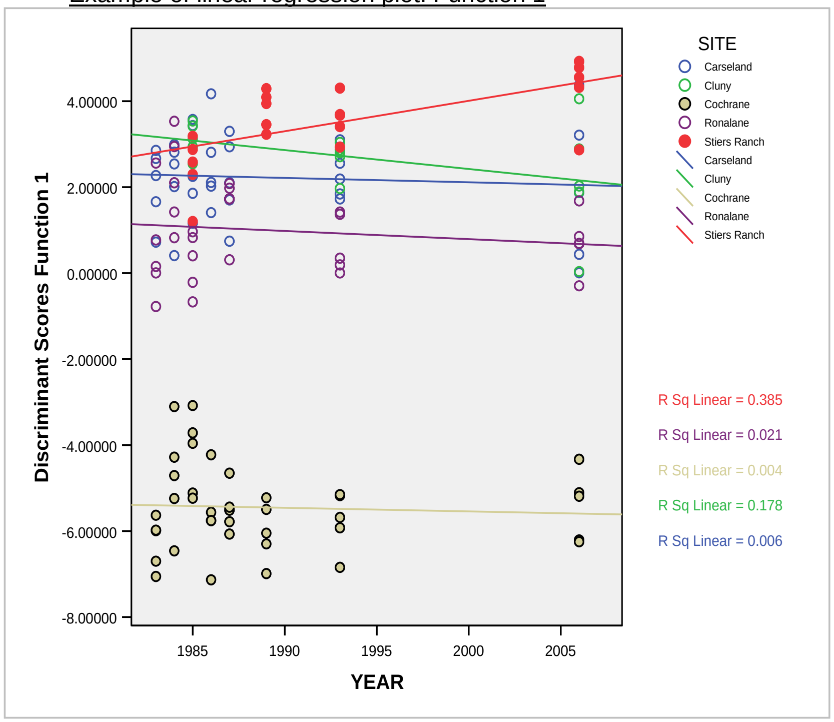



**Figure 7 Plots for Discriminant Functions 1, 2, and 3 (each symbol represents data from 1 Neill sample)**

| | Function 1 | | | Function 2 | | | Function 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Linear Regression | | ANOVA | Linear Regression | | ANOVA | Linear Regression | | ANOVA |
| | $r^2$ | slope | Significance (p) | $r^2$ | slope | Significance (p) | $r^2$ | slope | Significance (p) |
| Cochrane | 0.004 | | 0.715 | 0.062 | | 0.121 | 0.051 | | 0.162 |
| Stiers Ranch | **0.385** (1) | **increase** (2) | **0.004**(3) | 0.035 | | 0.426 | 0.035 | | 0.431 |
| Carseland | 0.006 | | 0.666 | 0.071 | | 0.123 | **0.400** | **increase** | **0.000** |
| Cluny | 0.178 | | 0.118 | 0.002 | | 0.963 | **0.499** | **decline** | **0.003** |
| Ronalane | 0.021 | | 0.440 | **0.293** | **decline** | **0.002** | 0.071 | | 0.154 |

Example of linear regression plot: Function 1



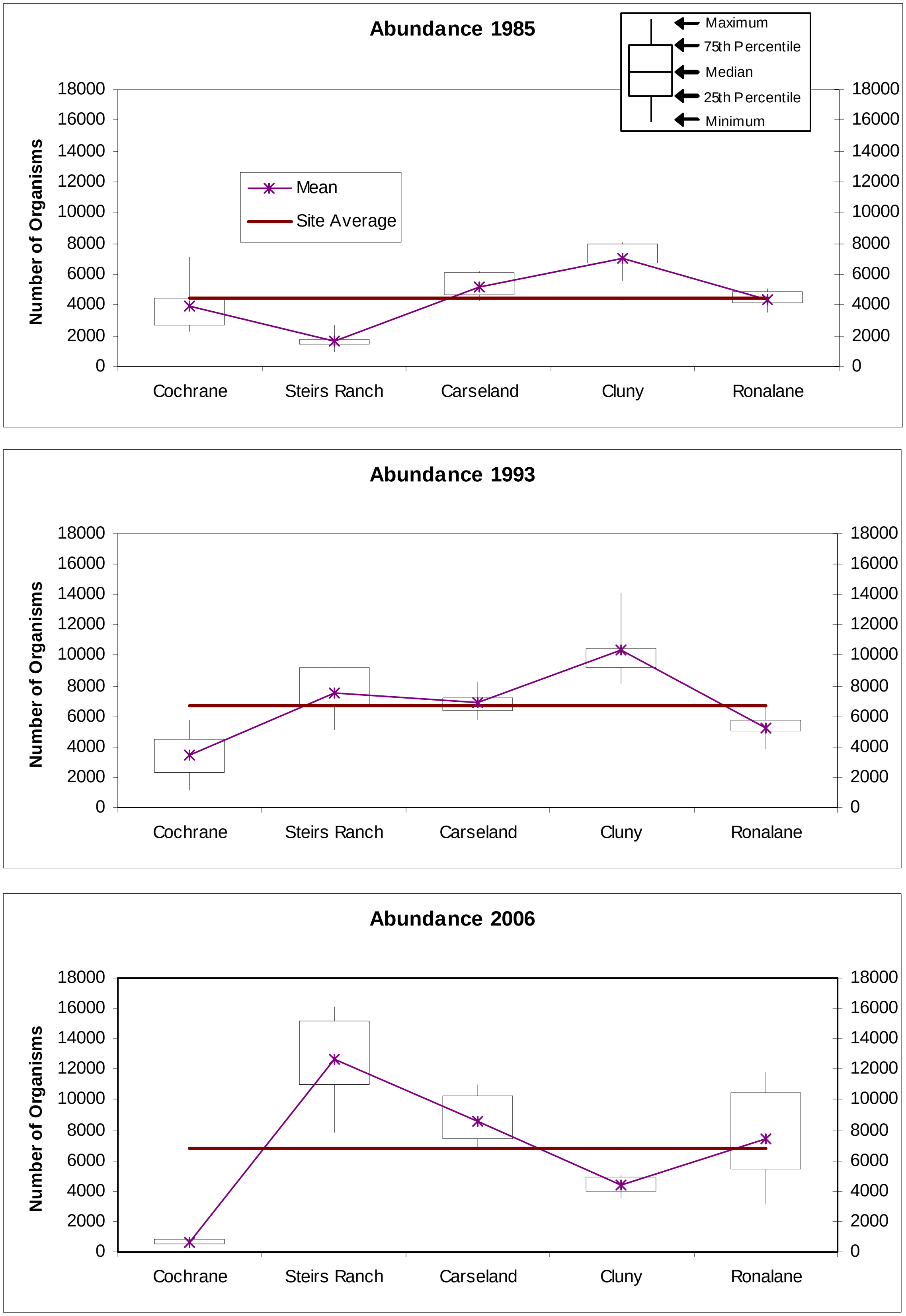

*Notes:*

*(1) A significant $r^2$* **(bold)** *indicates that scores have changed in a consistent way over time*

*(2) An increase in slope implies that taxa with positive scores have increased in importance, and vice versa*

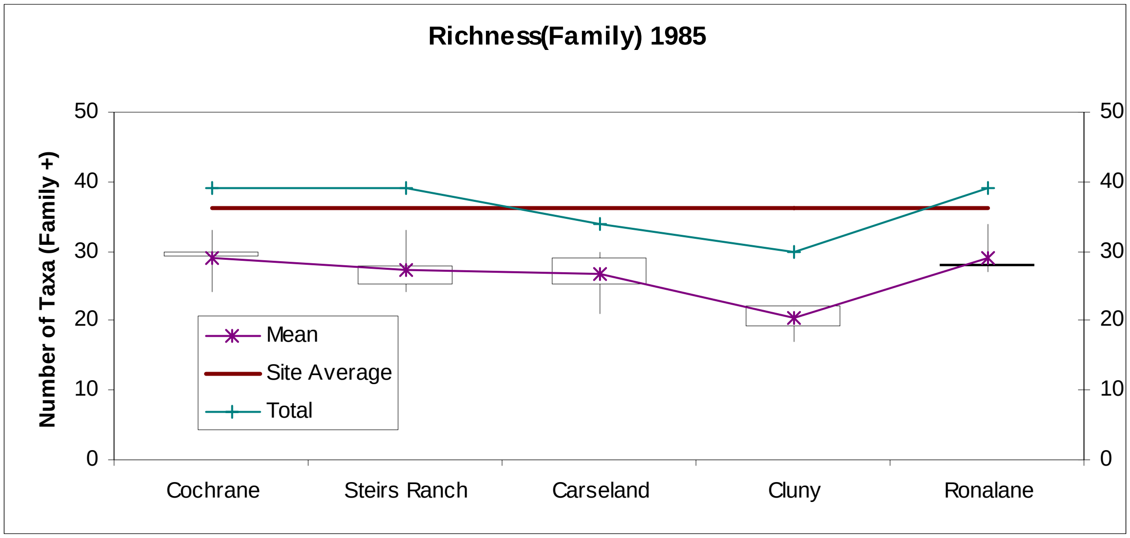
*(3) The ANOVA confirms the significance of differences in scores among years*

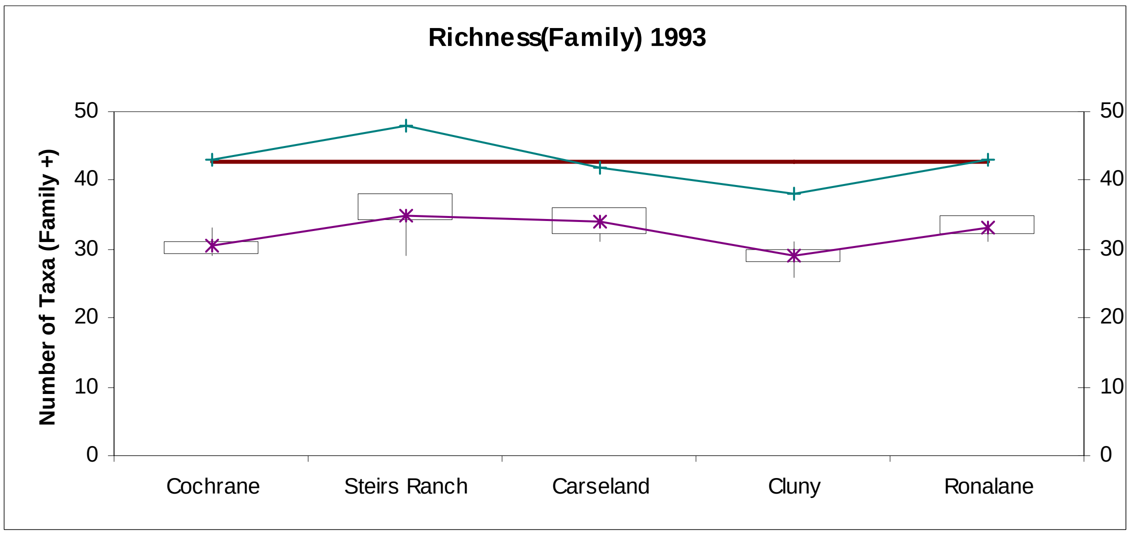
**Figure 8 Summary of linear regression and ANOVAs on discriminant scores by year**

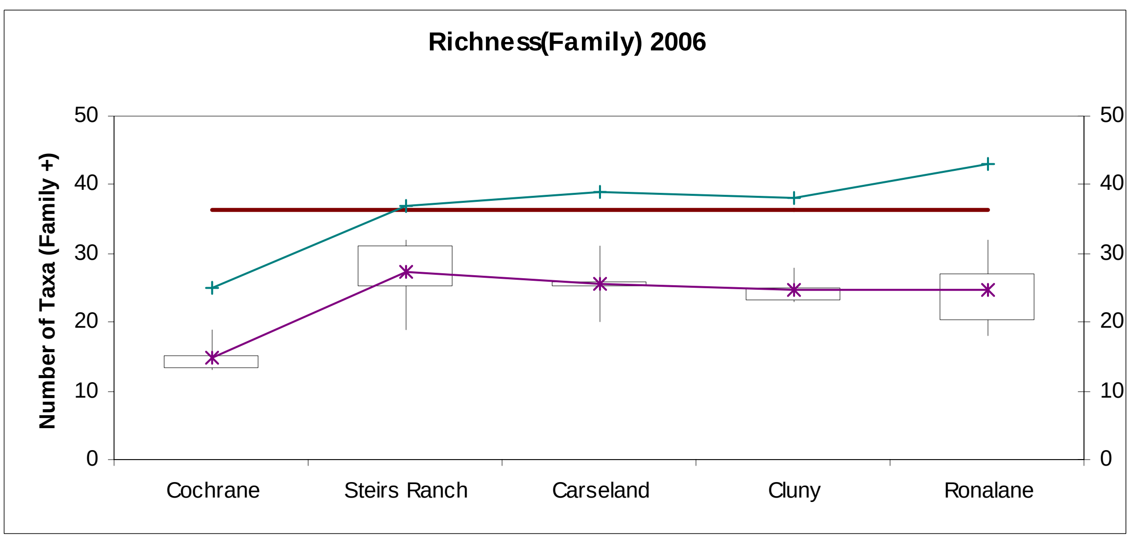



(Straight line indicates the mean of the 5 sites)

**Figure 9-1 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006**

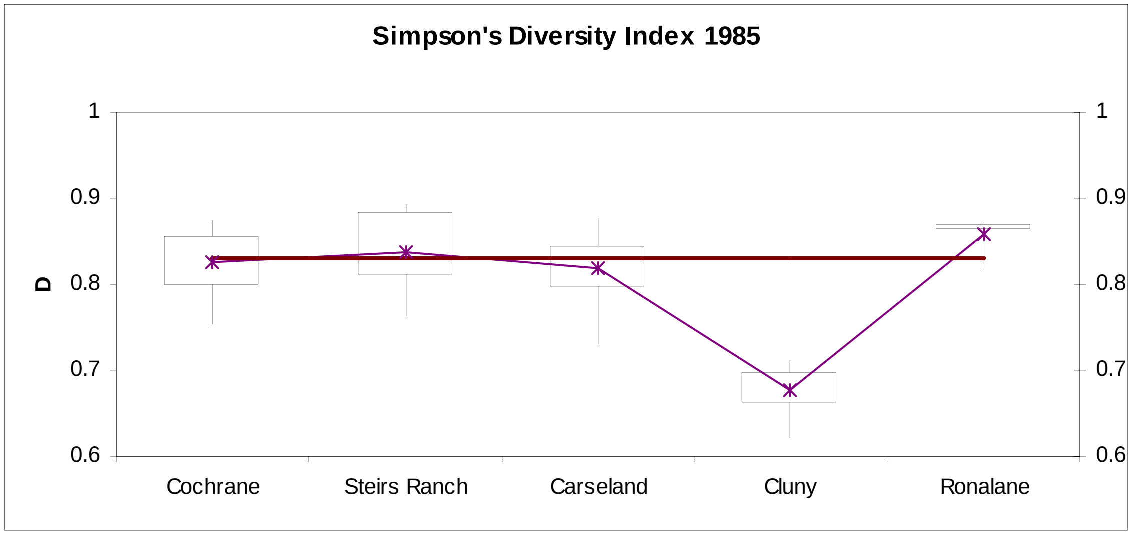


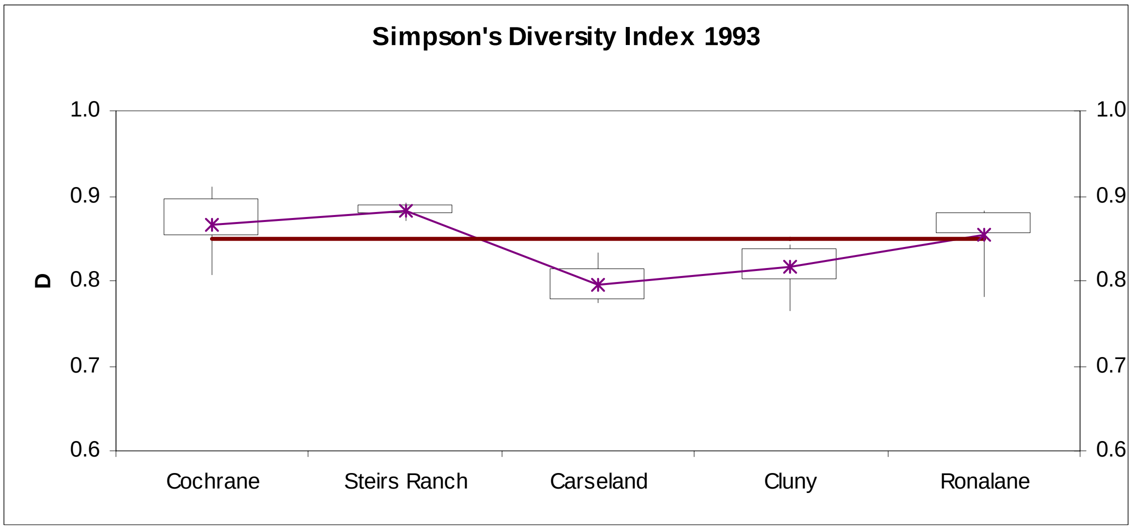




Total refers to the count of total unique taxa per site (replicates pooled)
Site average is the mean of these values.

**Figure 9-2 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



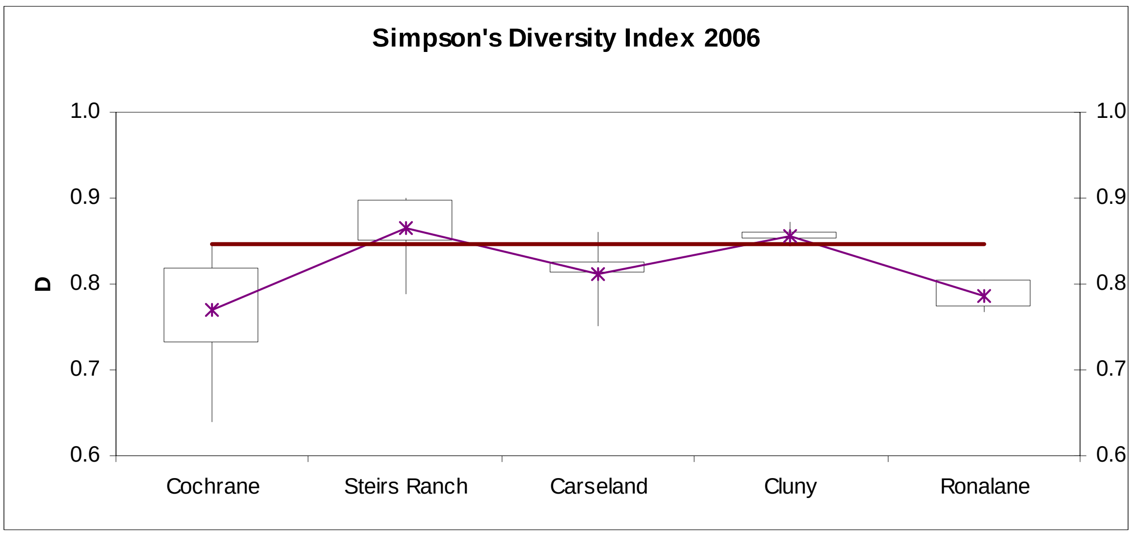
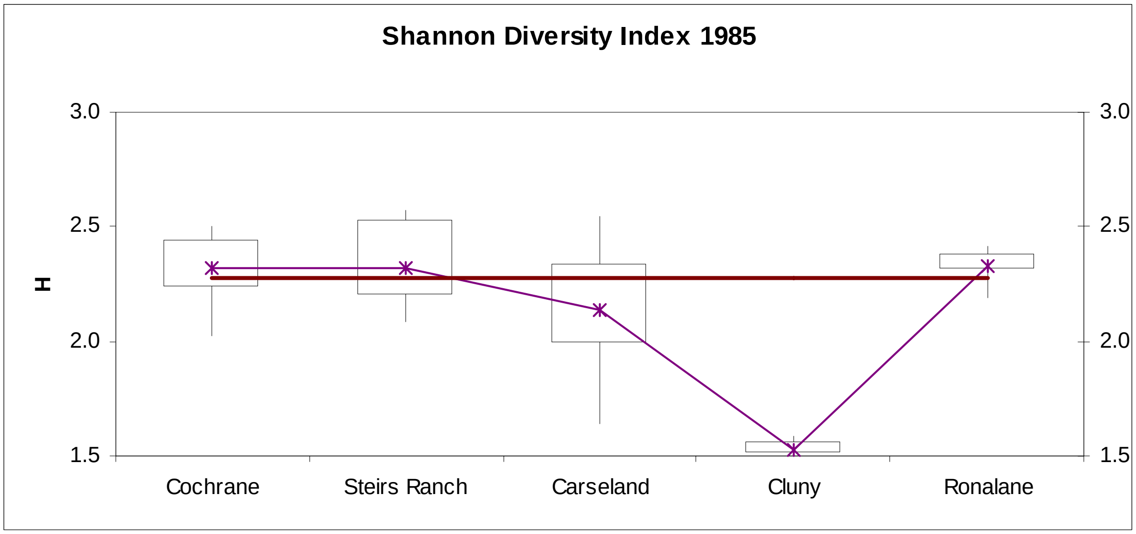
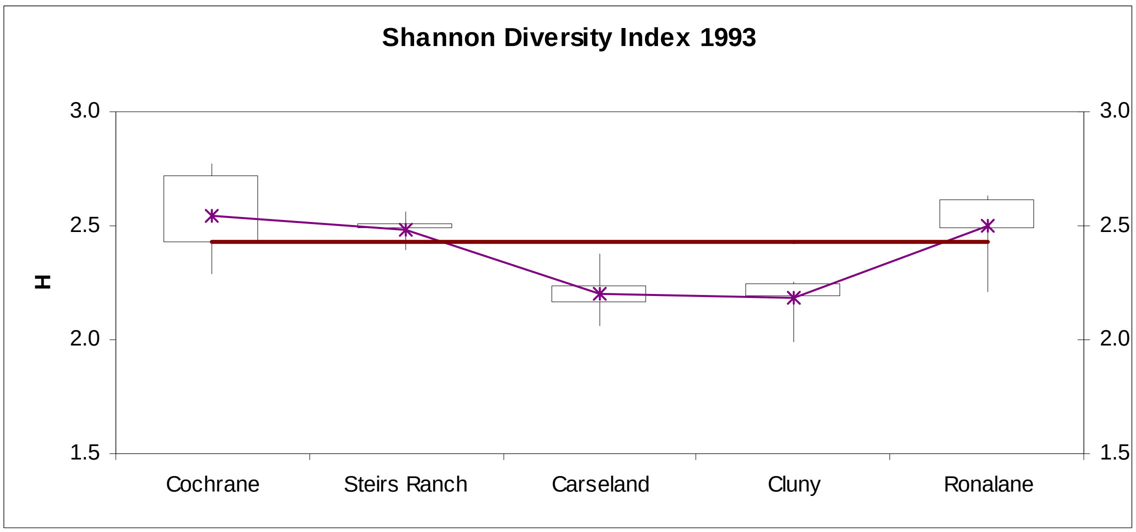




**Figure 9-3 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



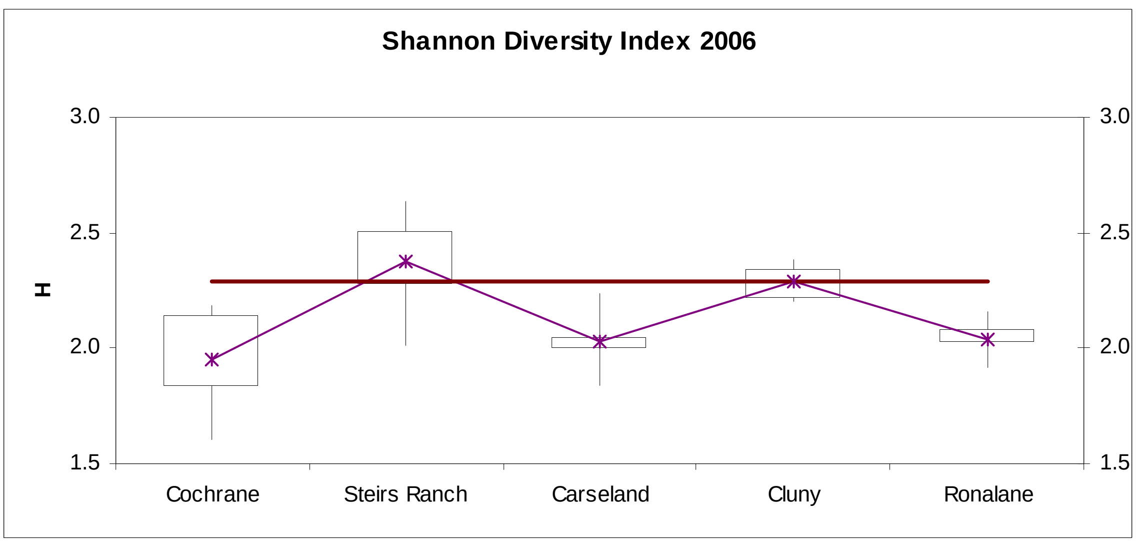




**Figure 9-4 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**

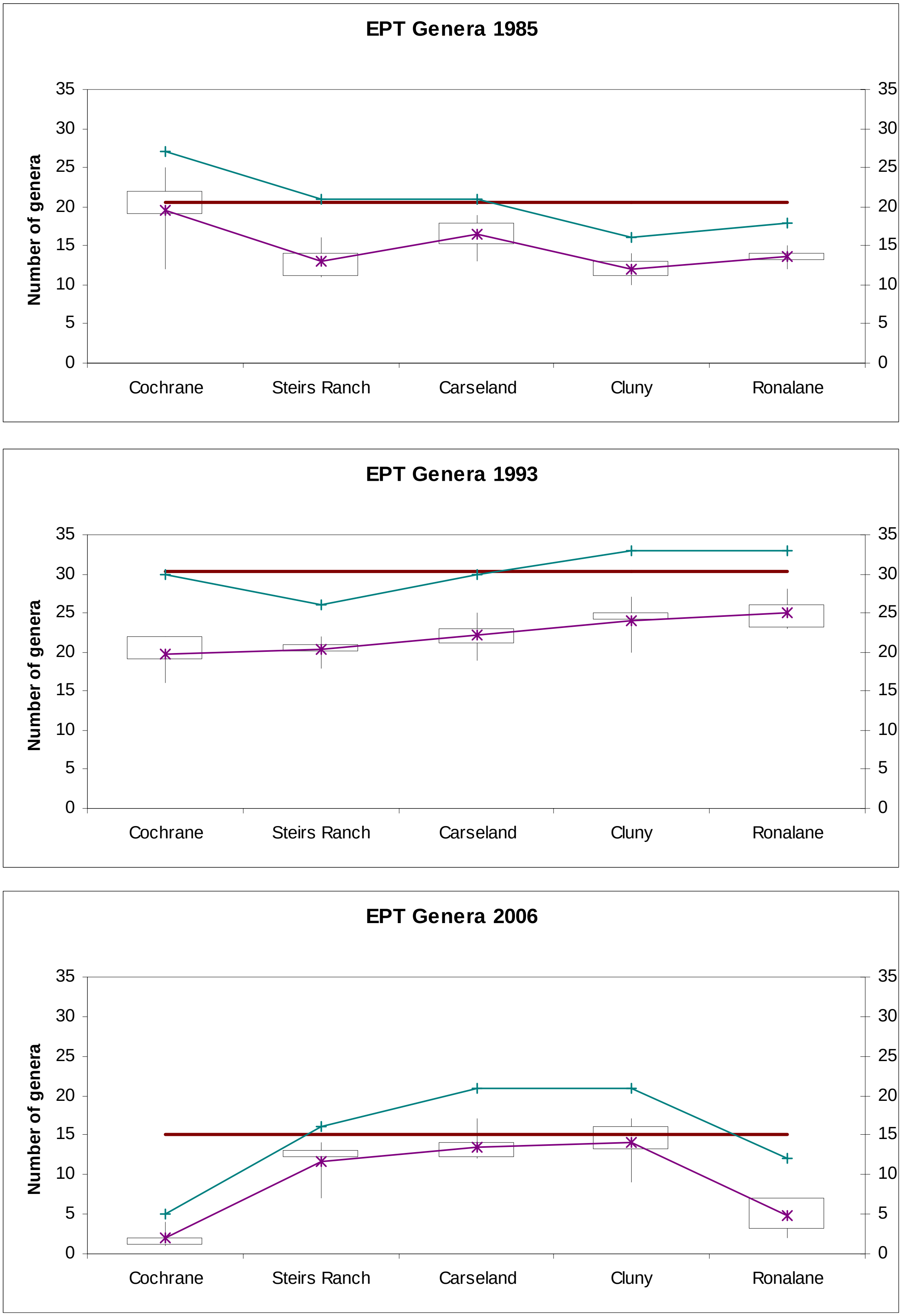
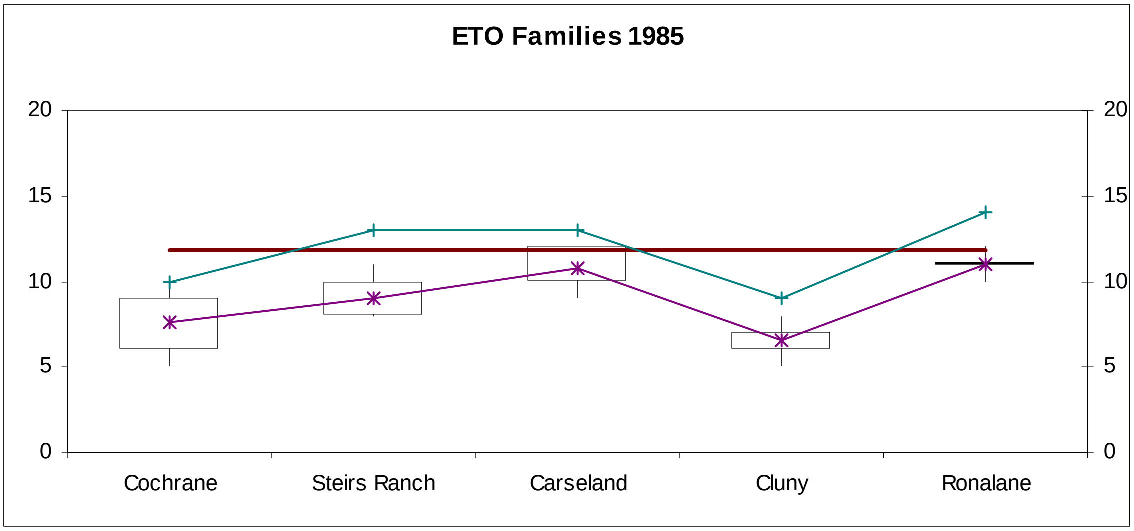
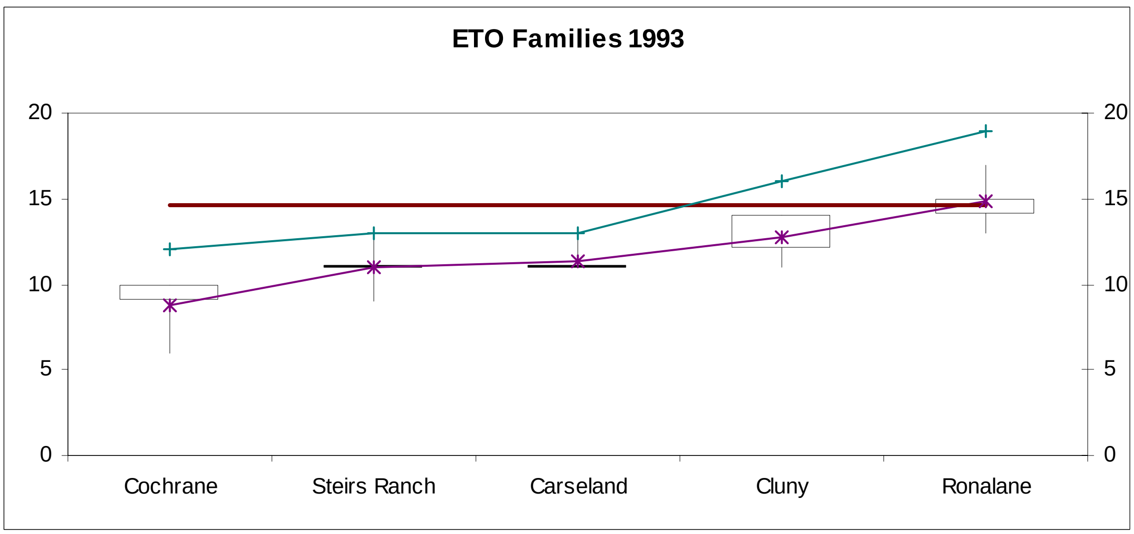



**Figure 9-5 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



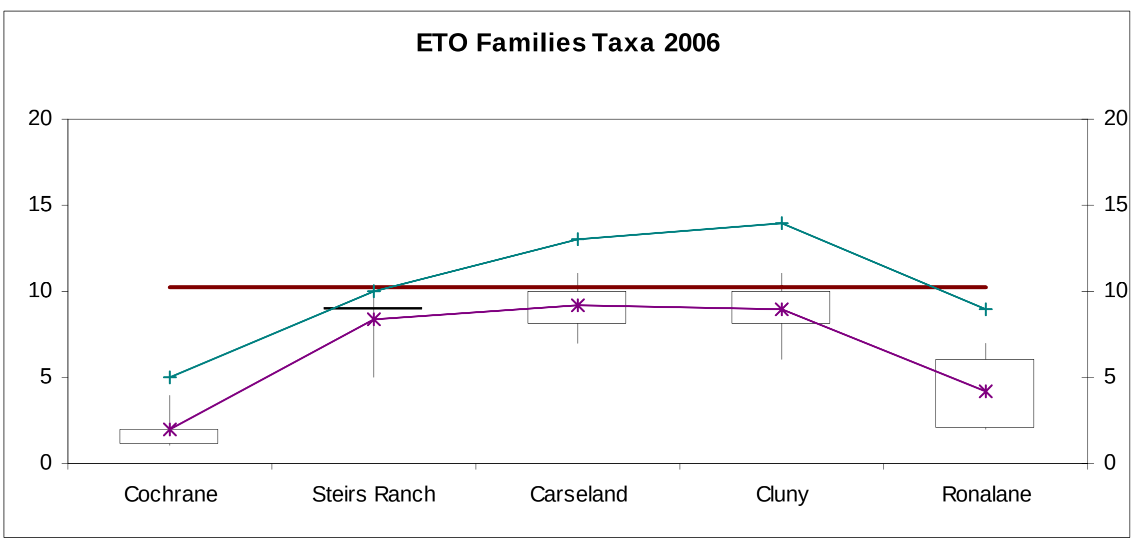
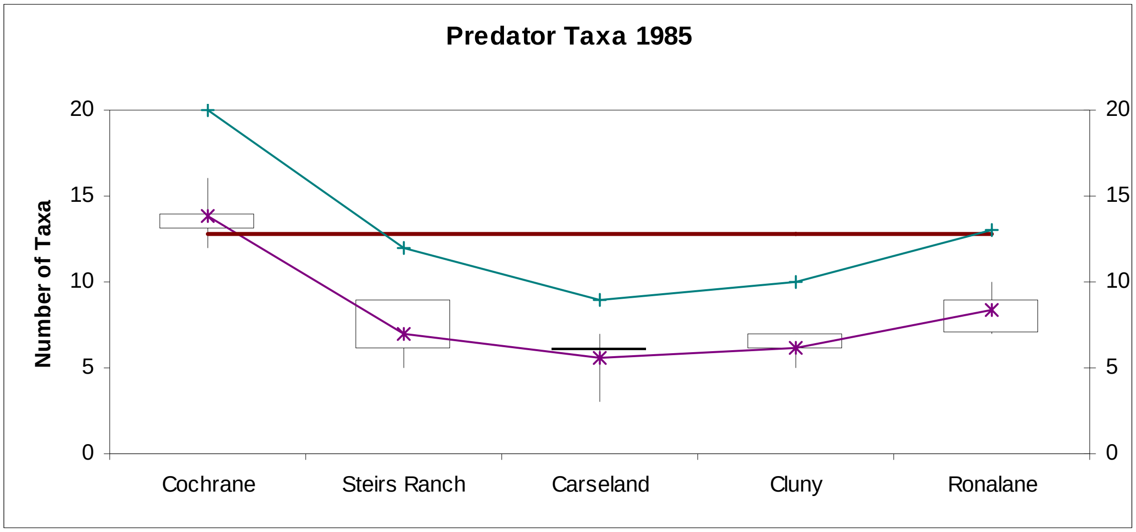
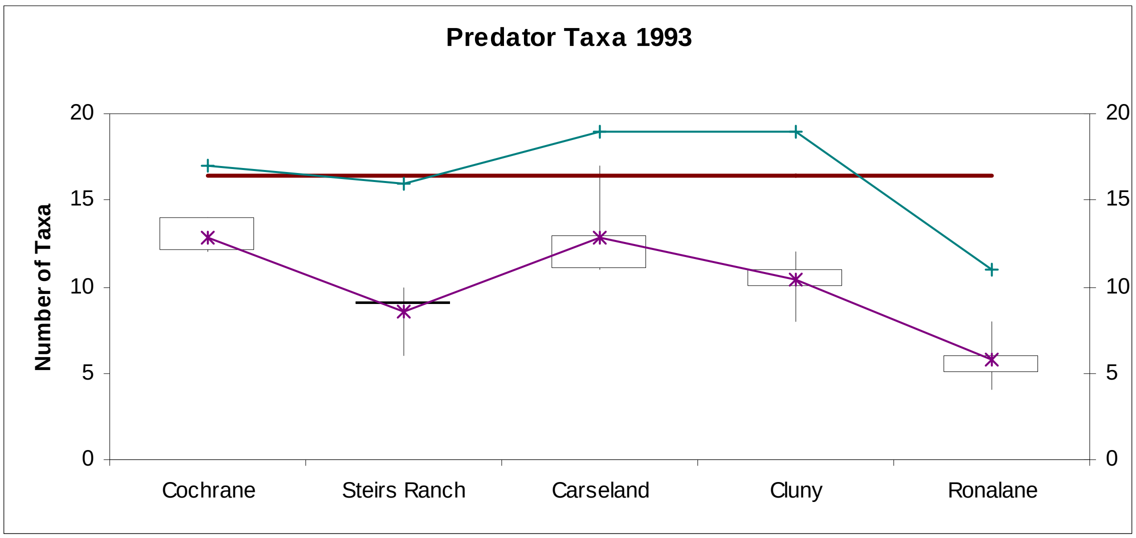




**Figure 9-6 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



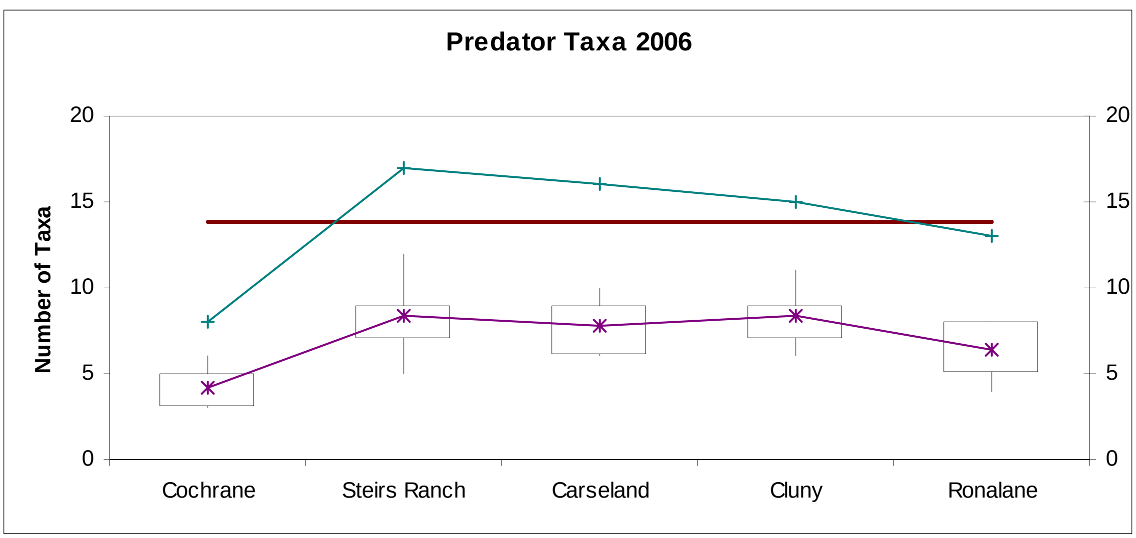
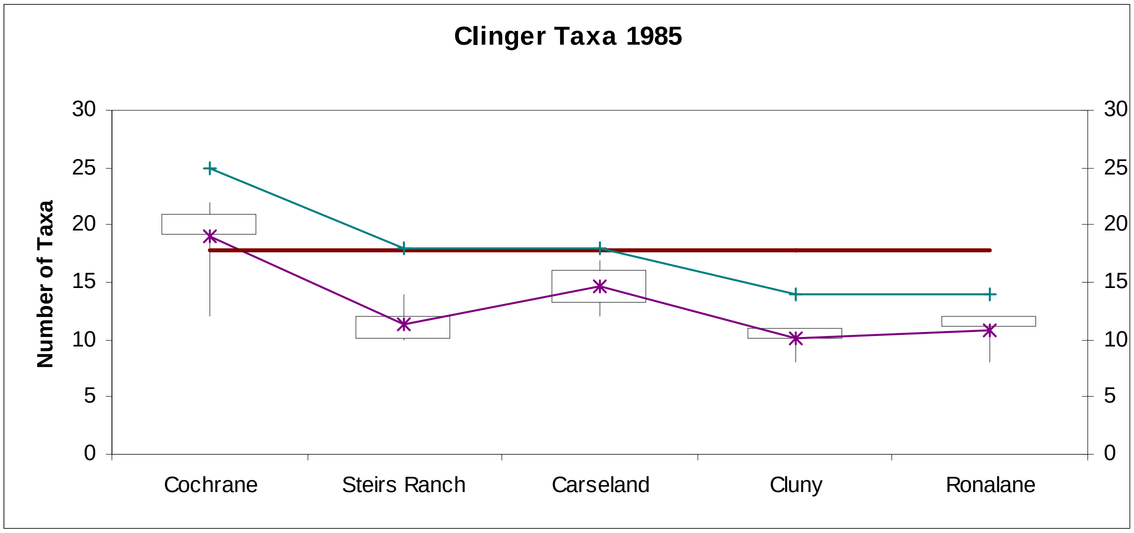
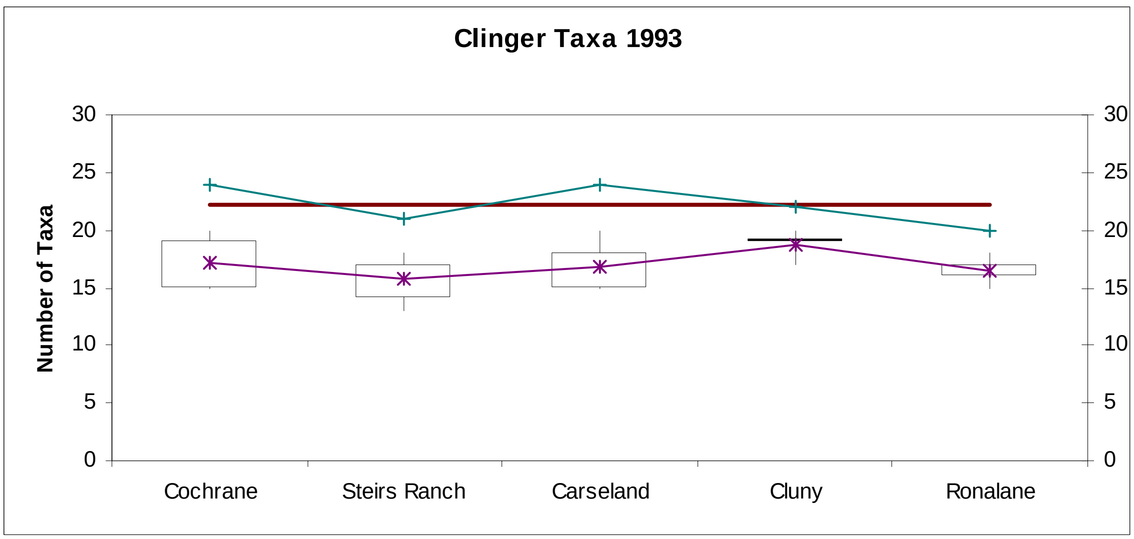




**Figure 9-7 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



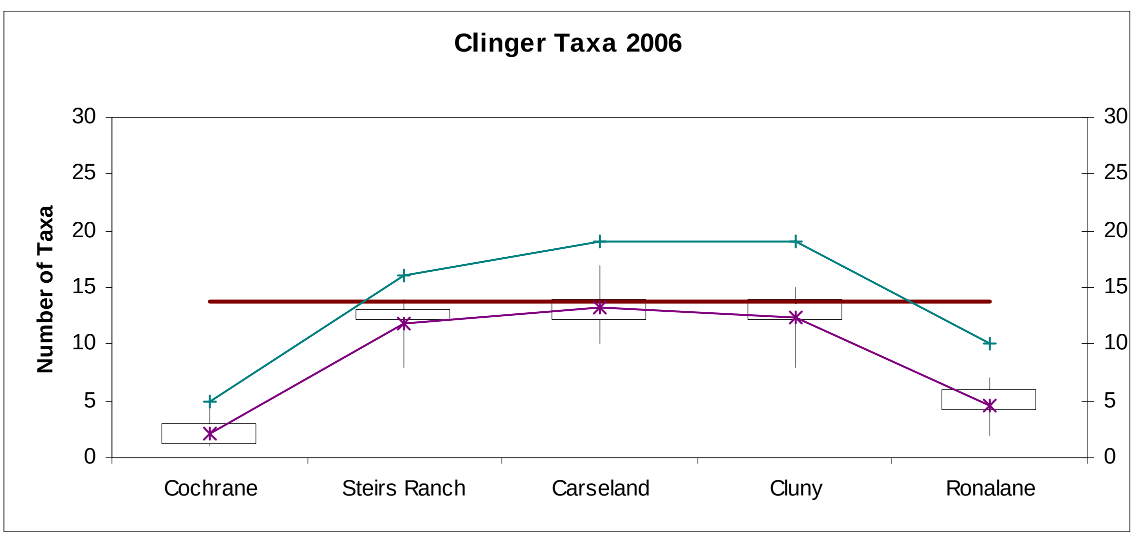
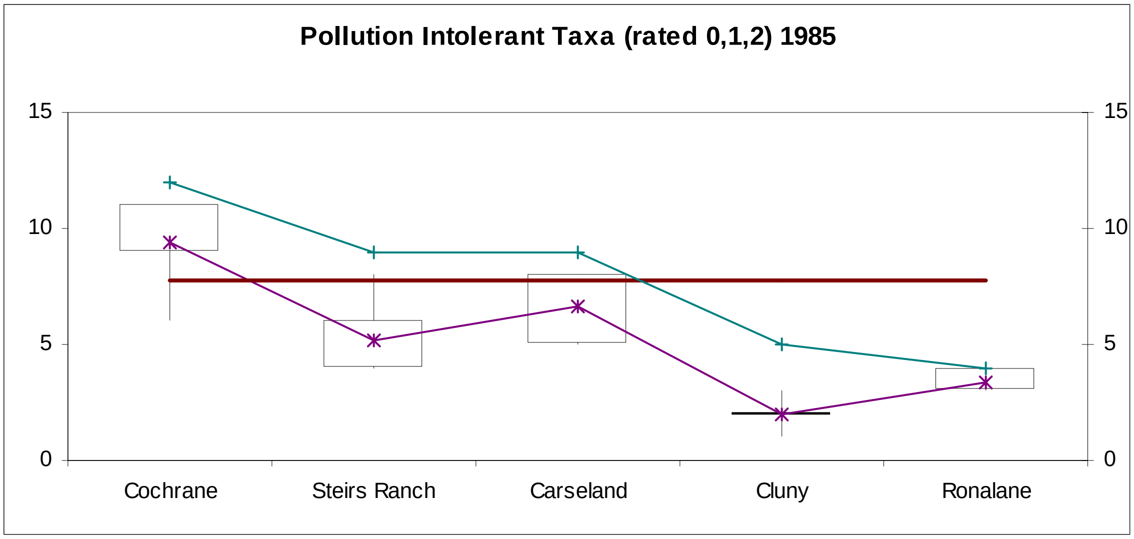
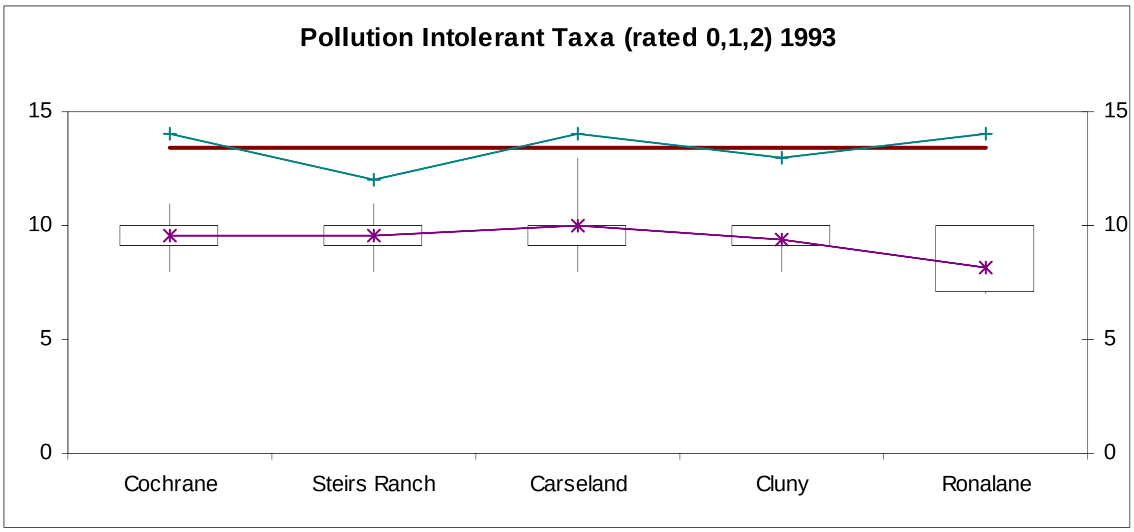




**Figure 9-8 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



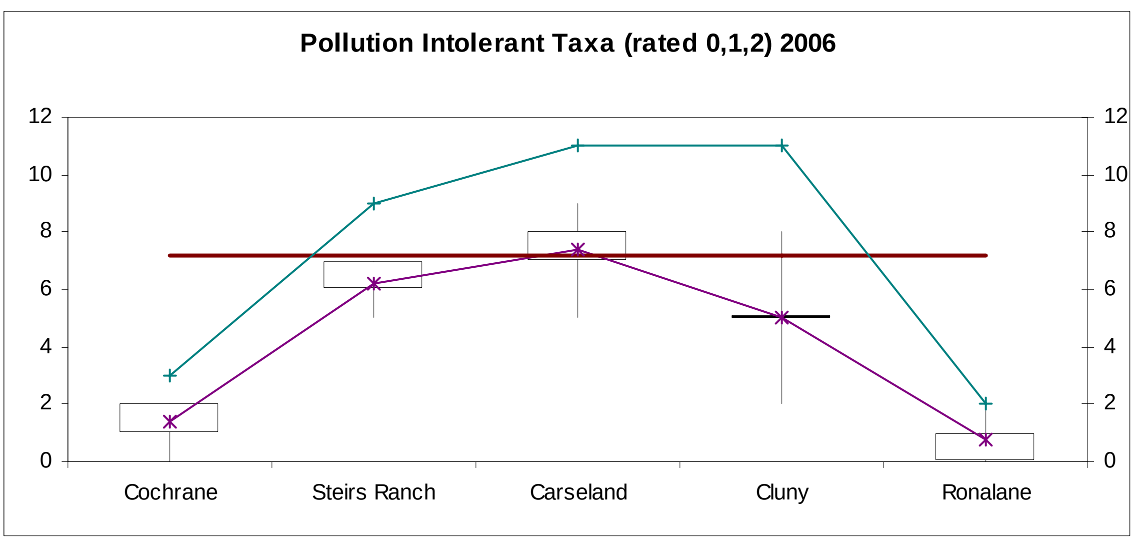
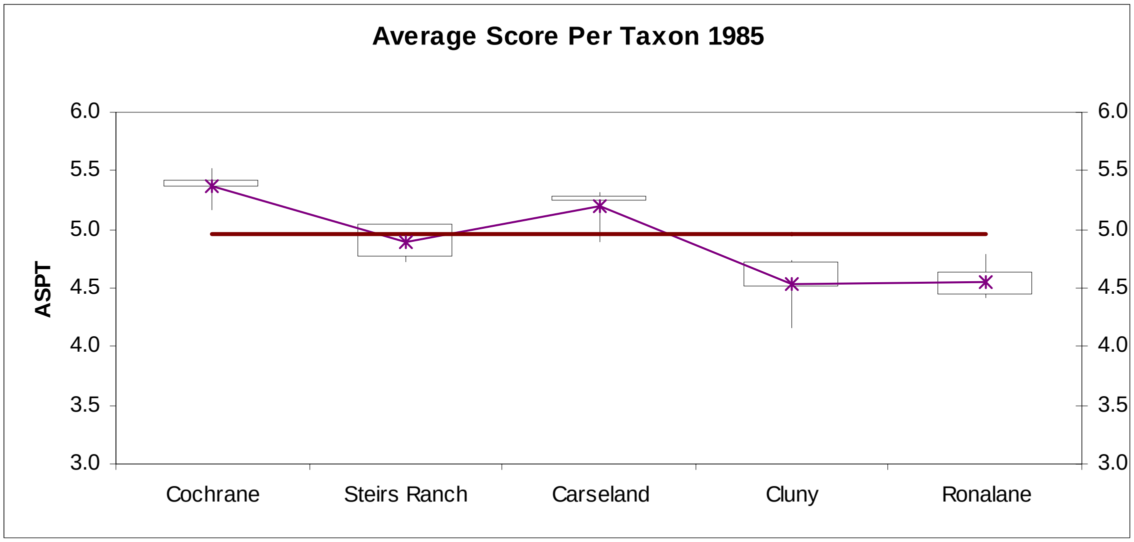
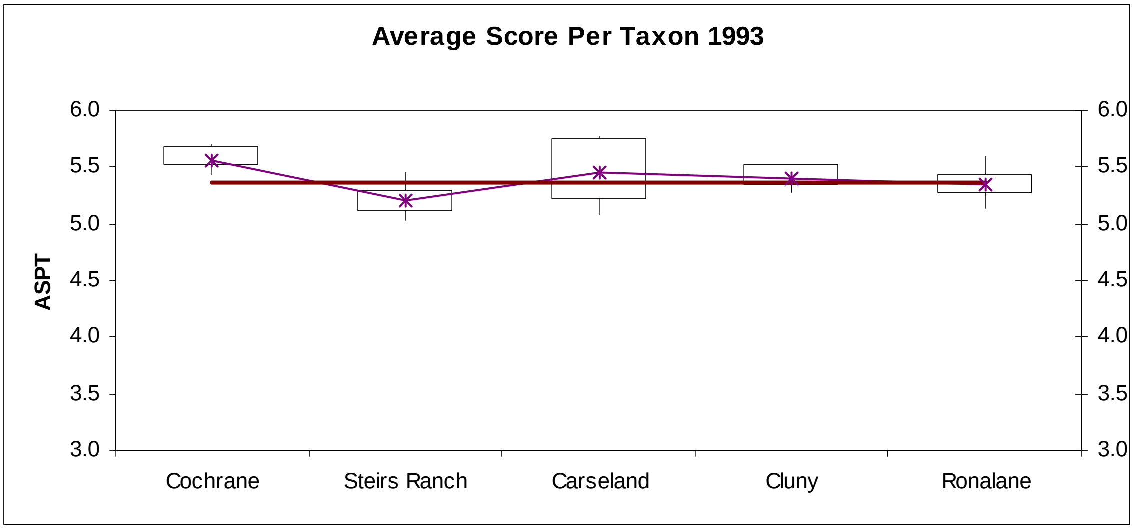




**Figure 9-9 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



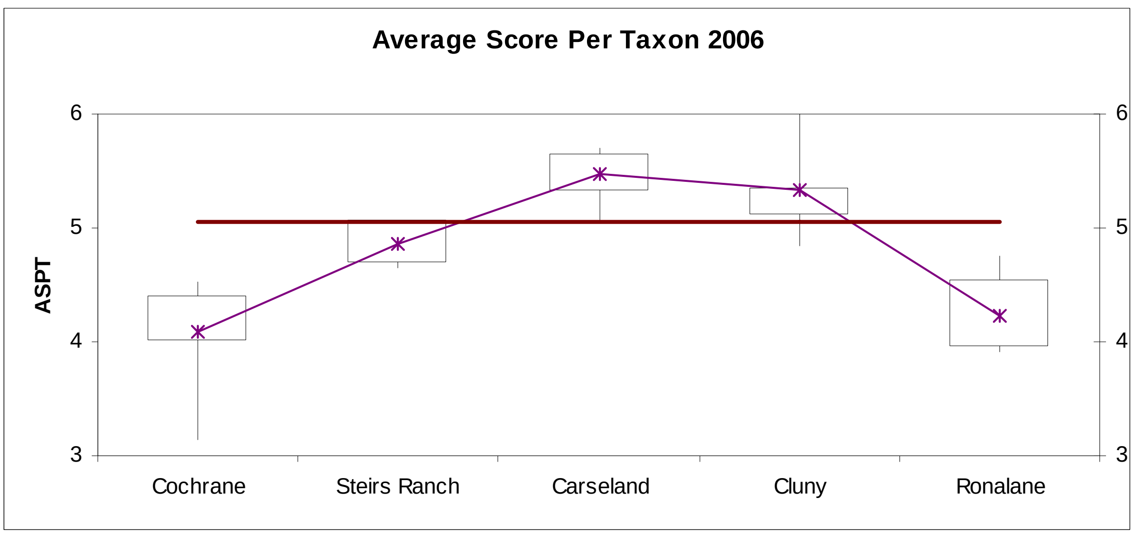
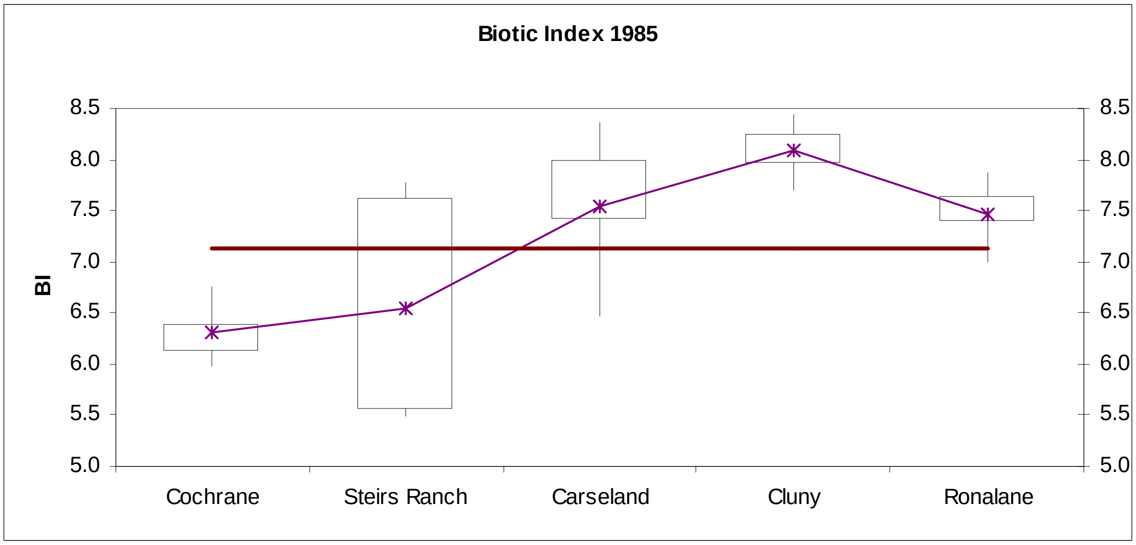
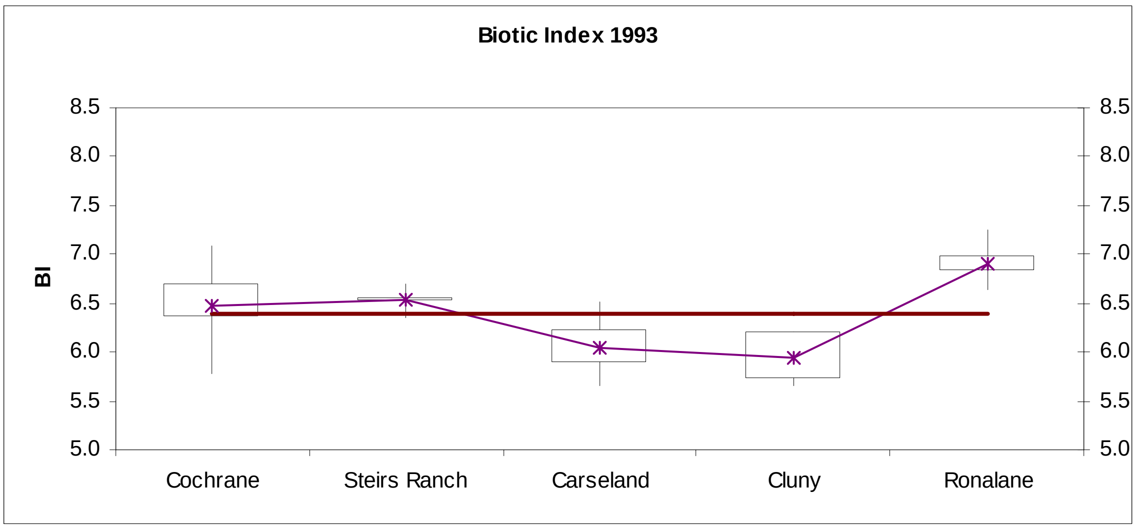




**Figure 9-10 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



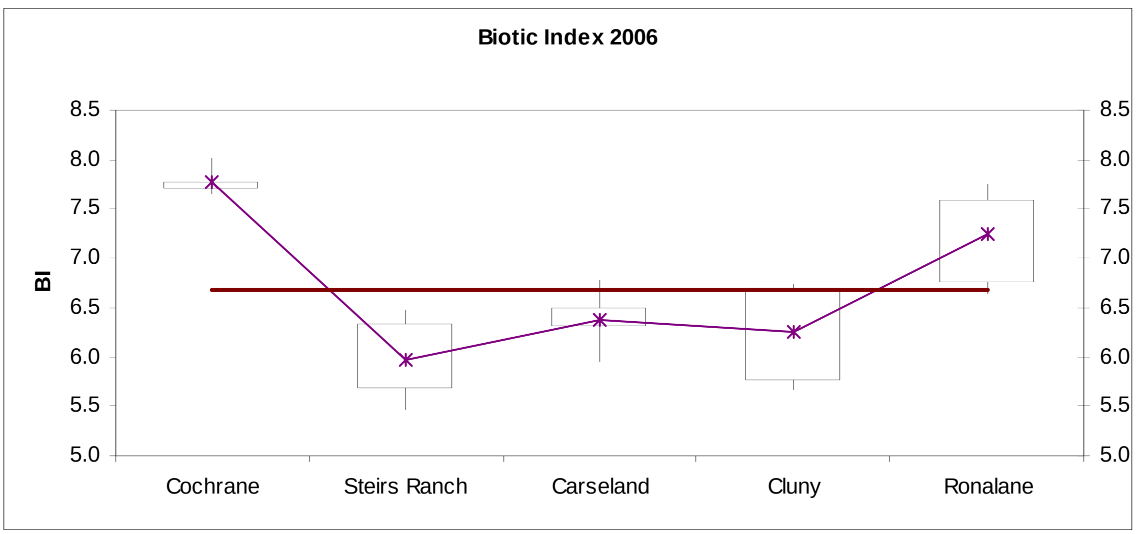
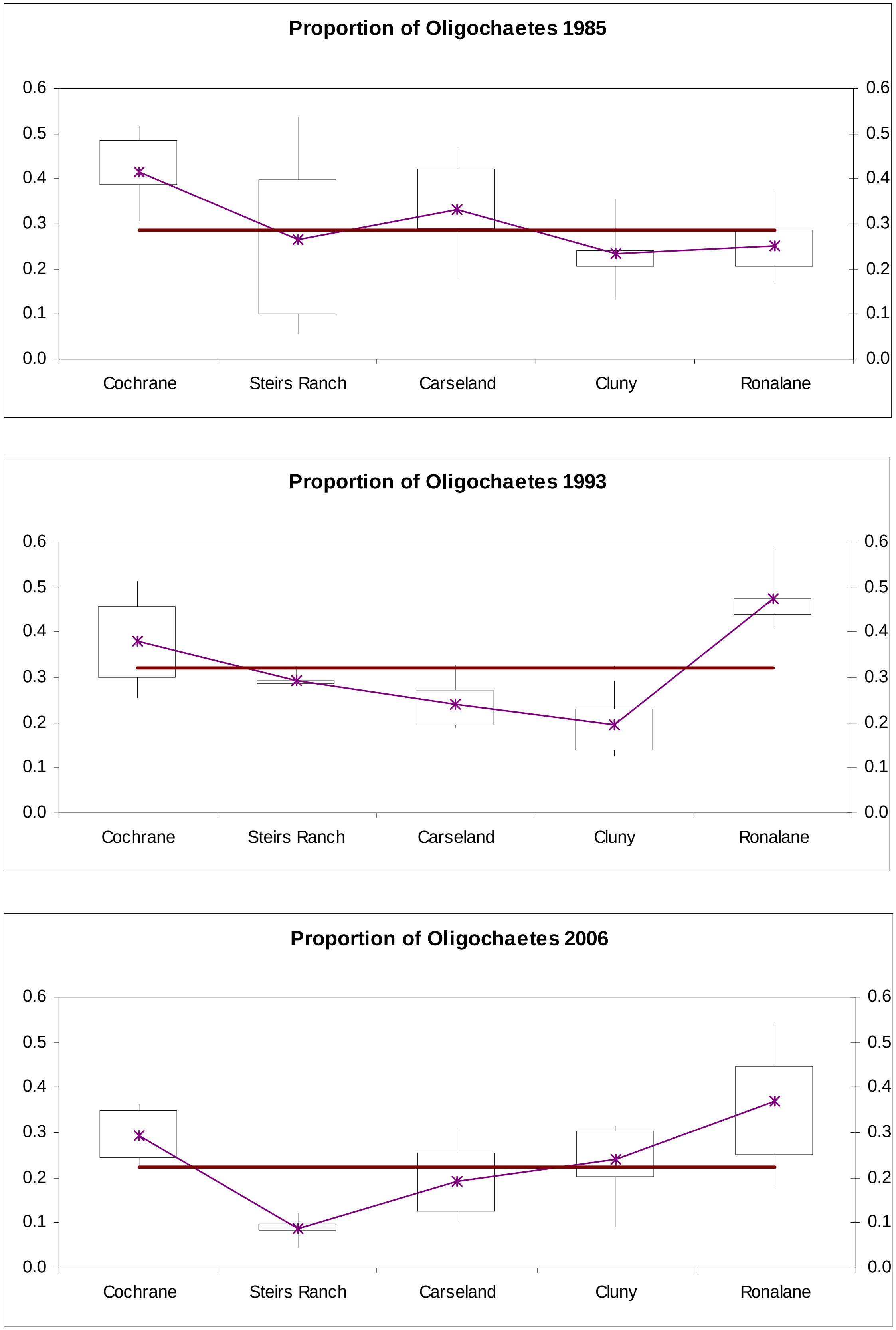
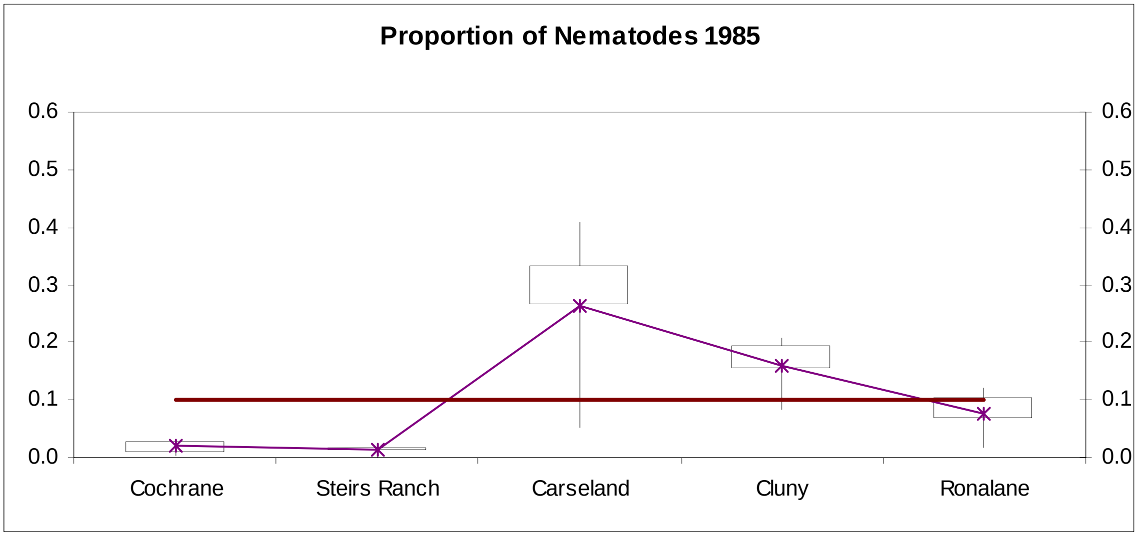



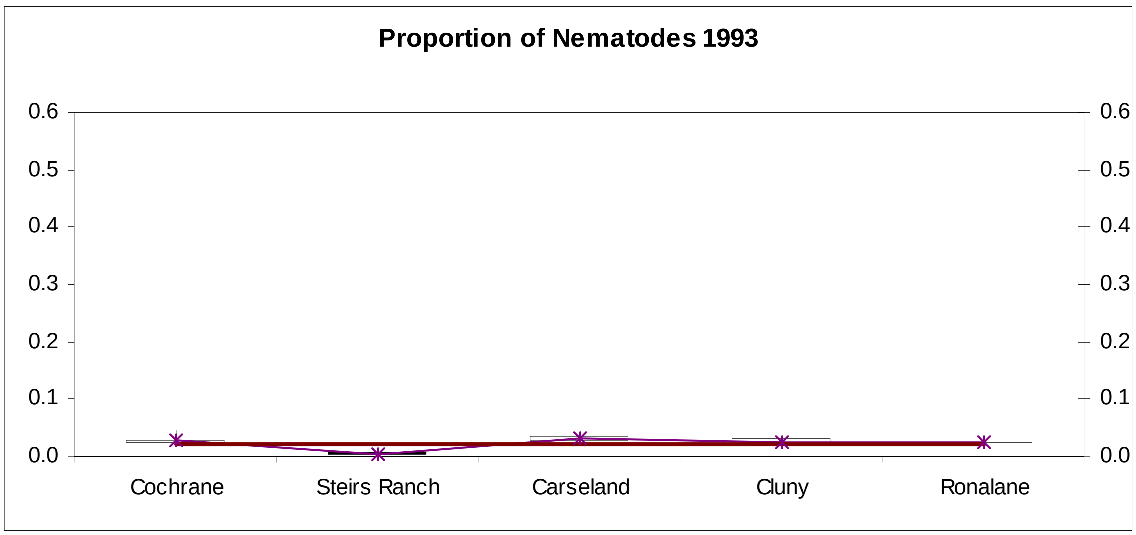

**Figure 9-11 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**




Straight line indicates the mean of the 5 sites

**Figure 9-12 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



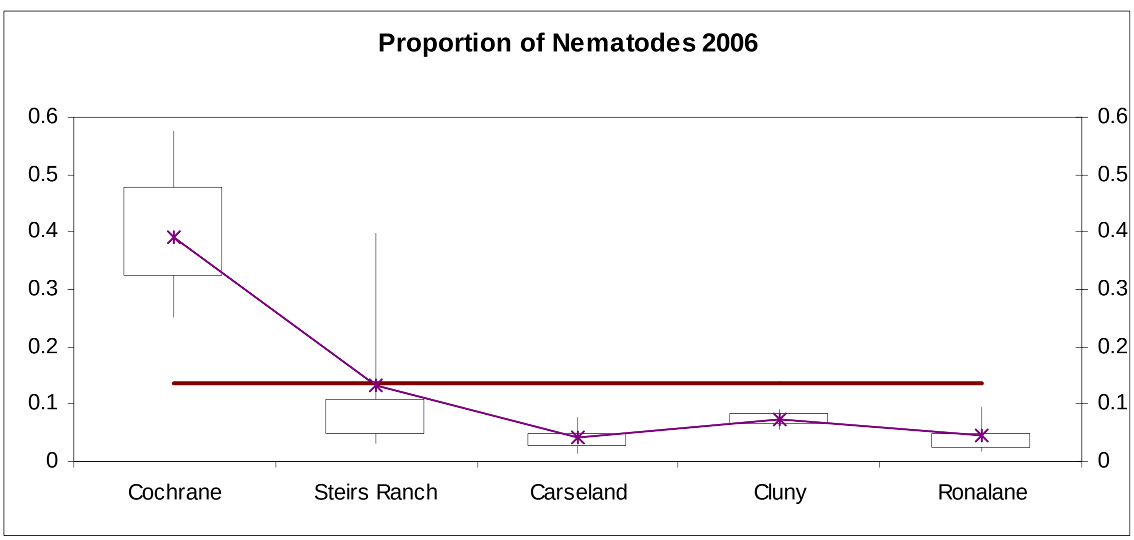
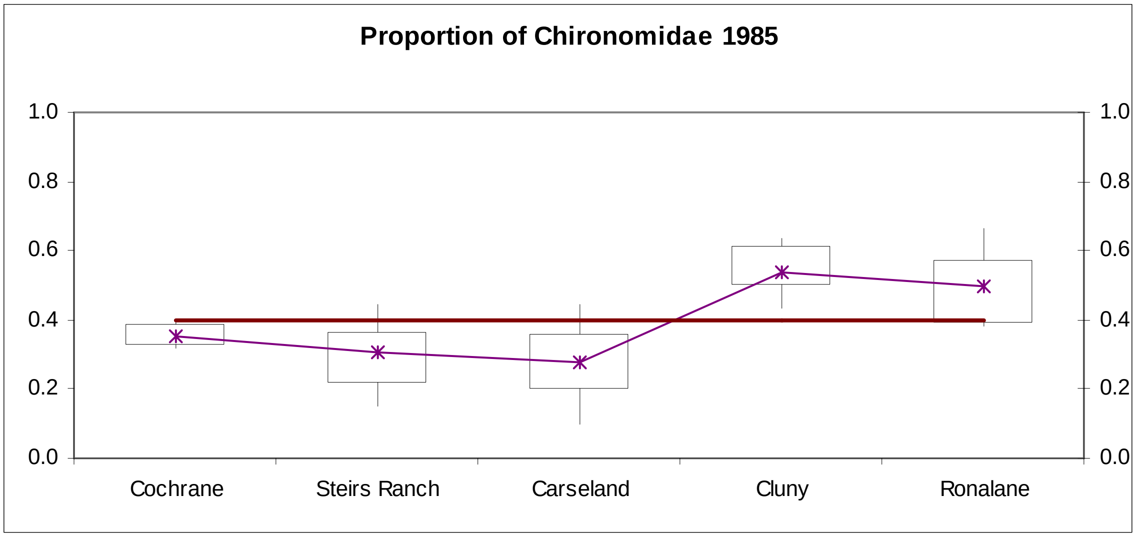
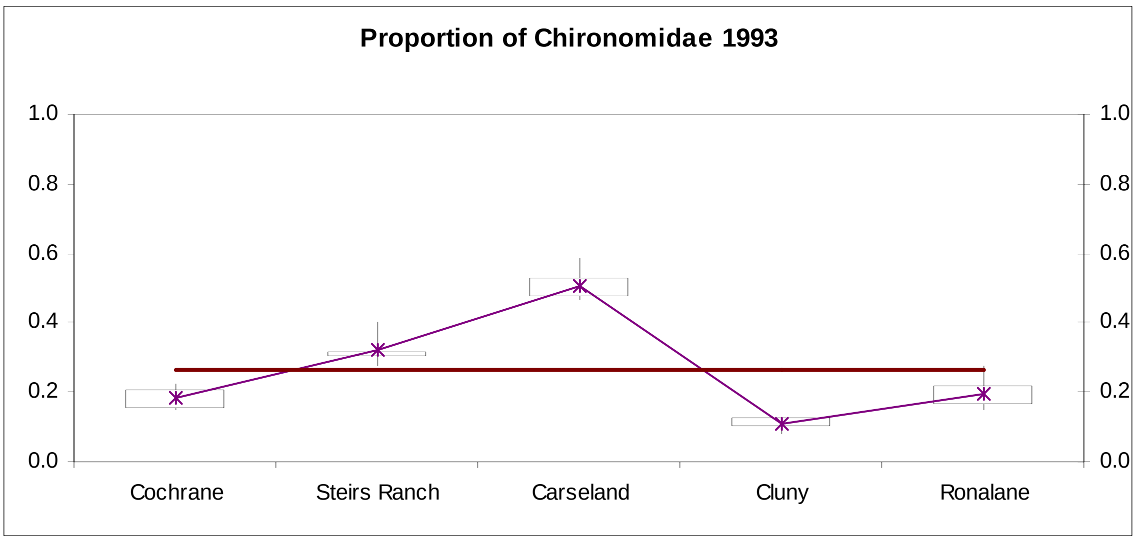




**Figure 9-13 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



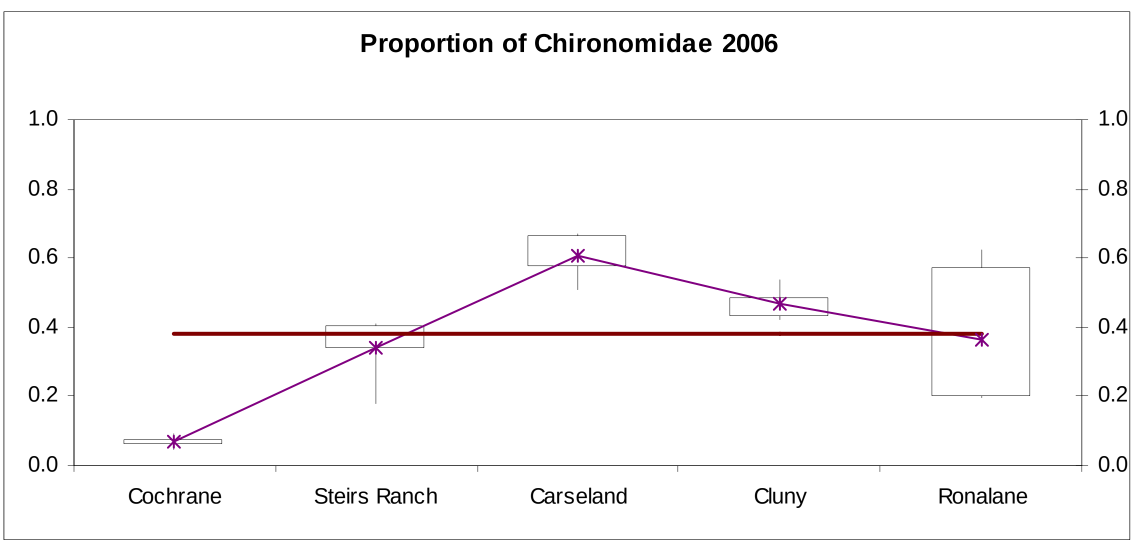
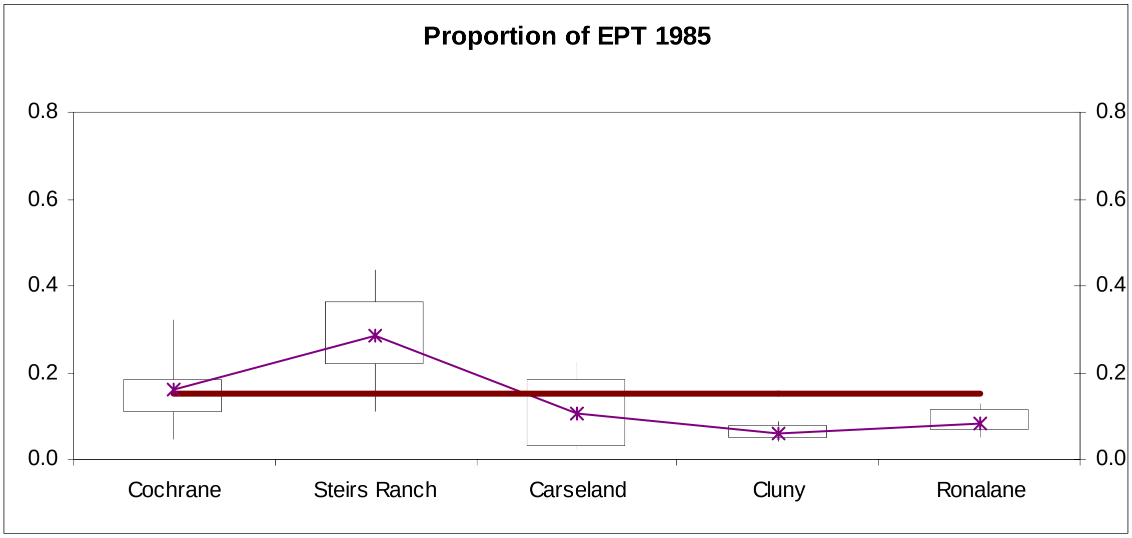
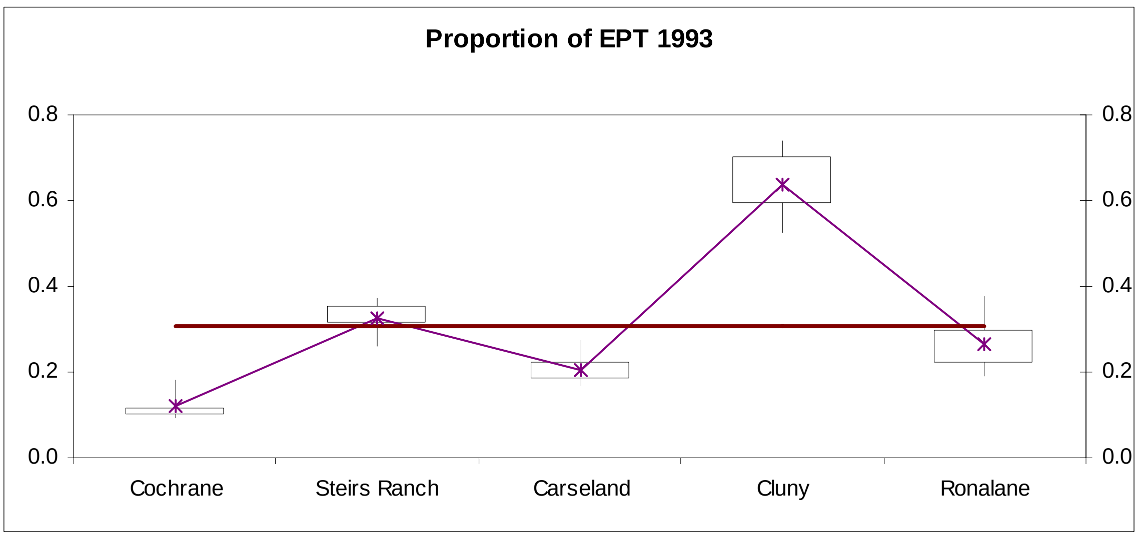




**Figure 9-14 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



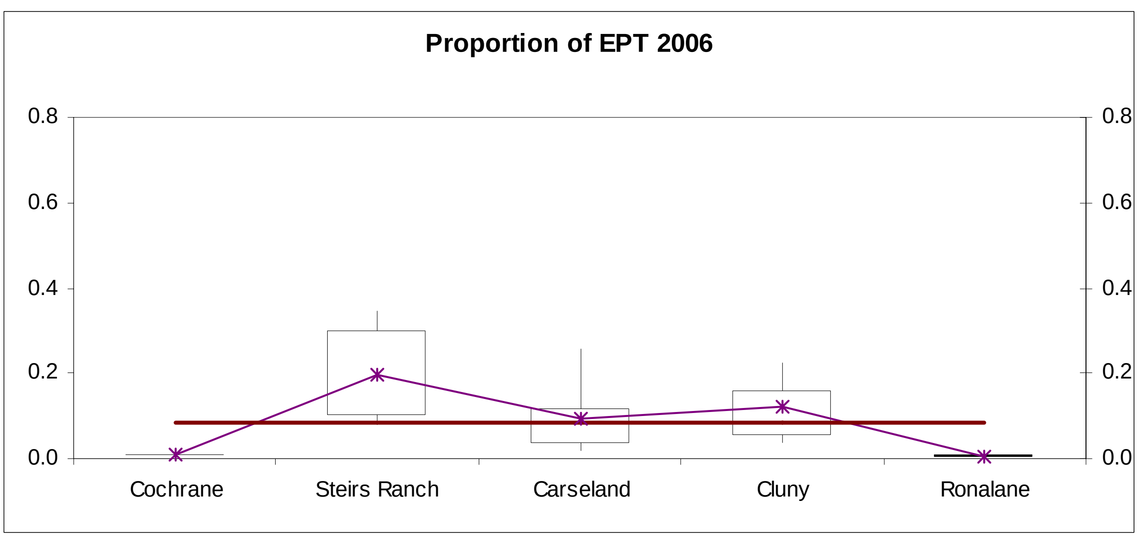
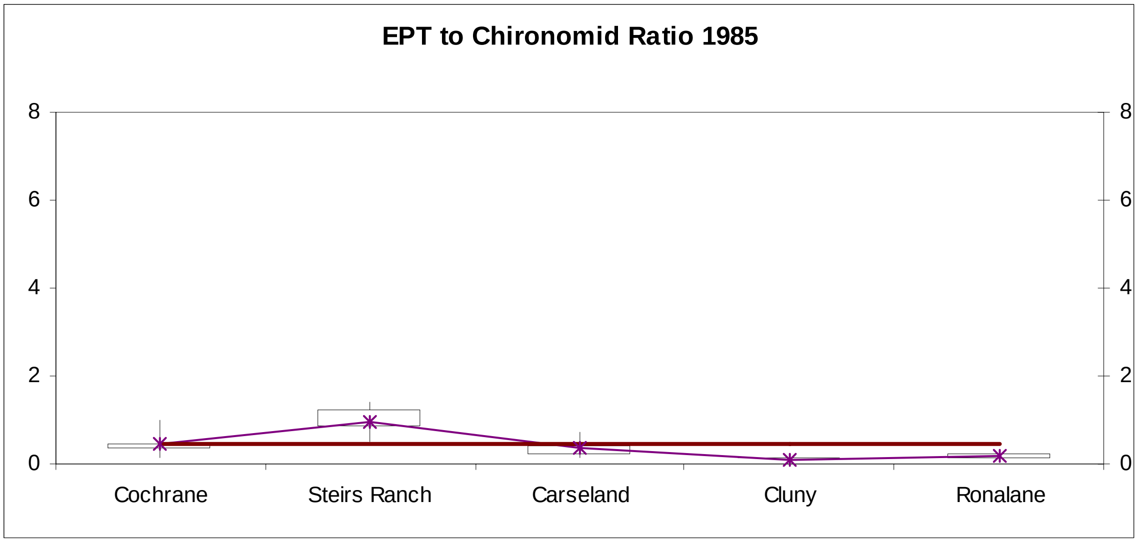
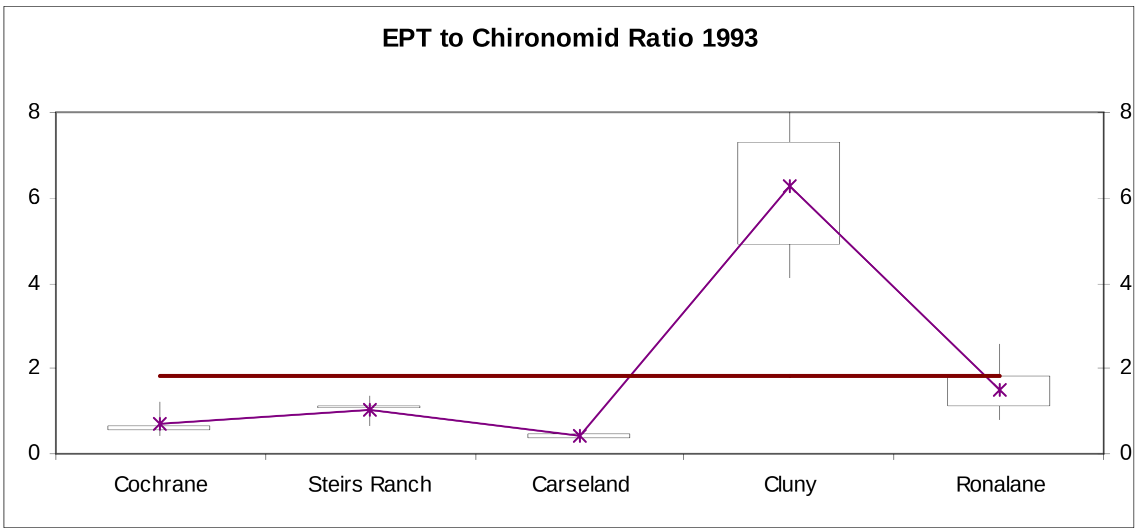




**Figure 9-15 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



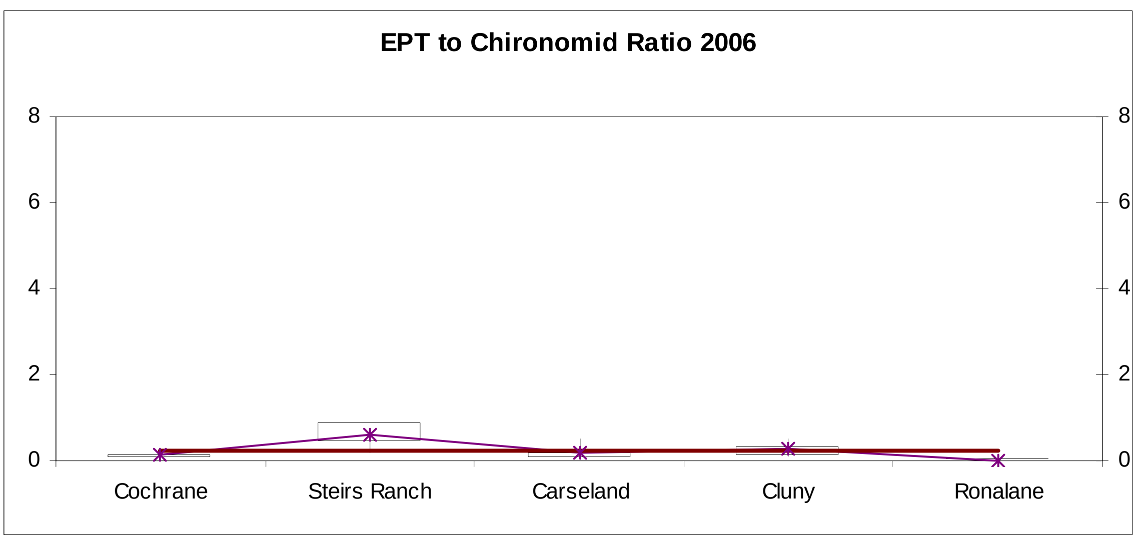
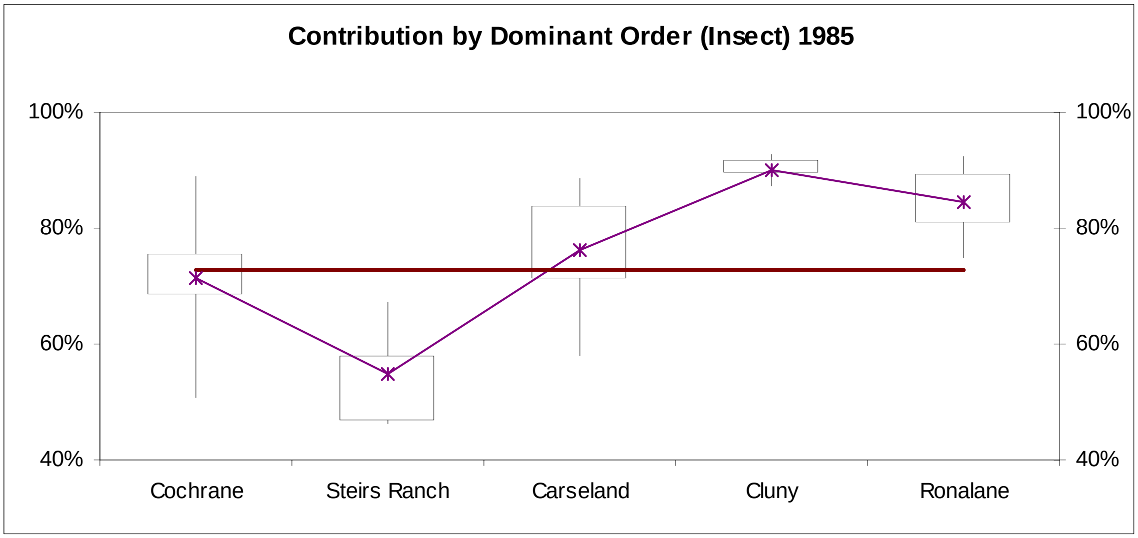
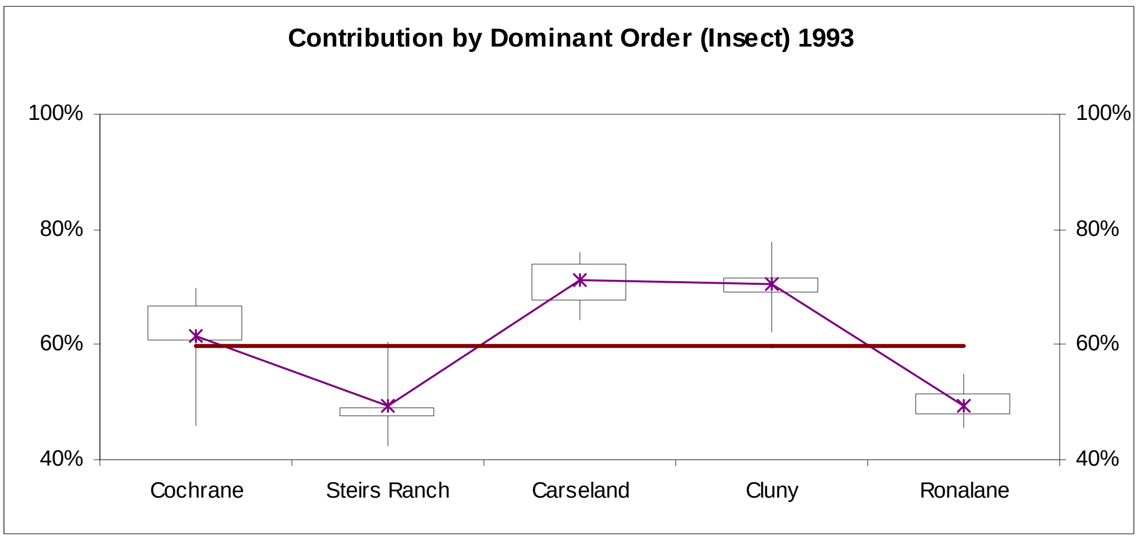




**Figure 9-16 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



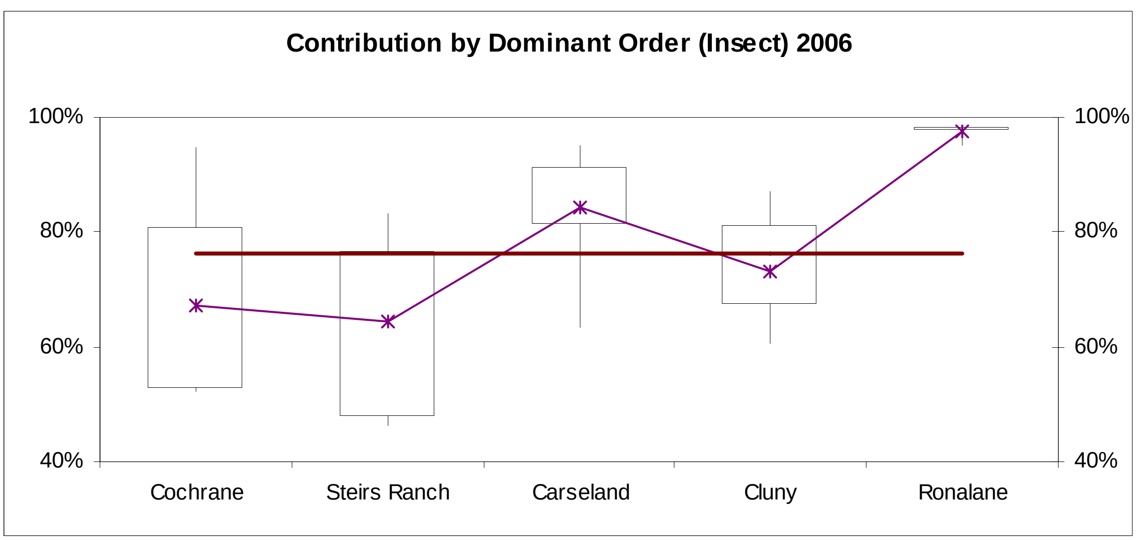
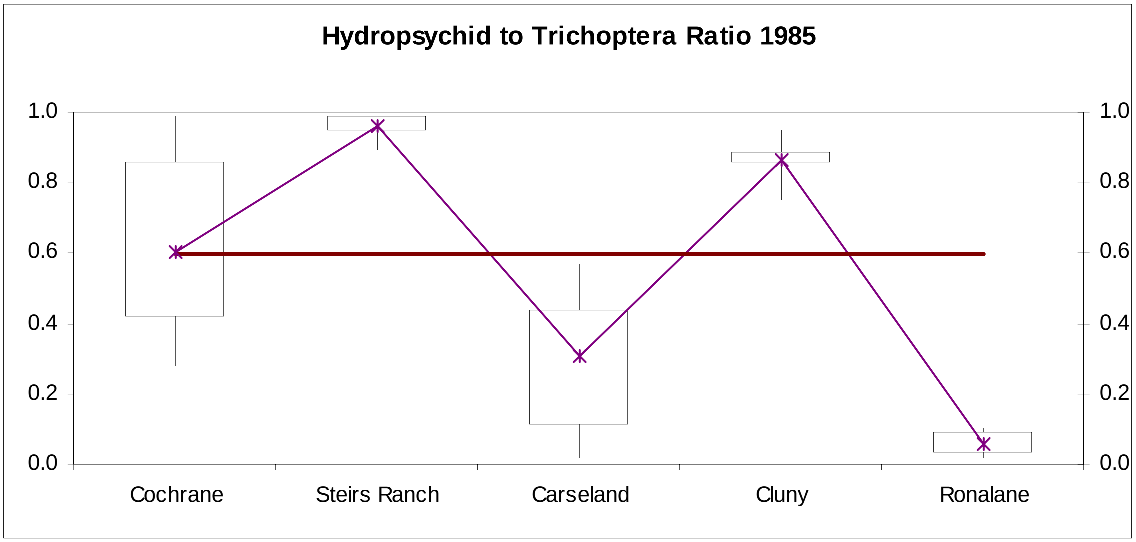
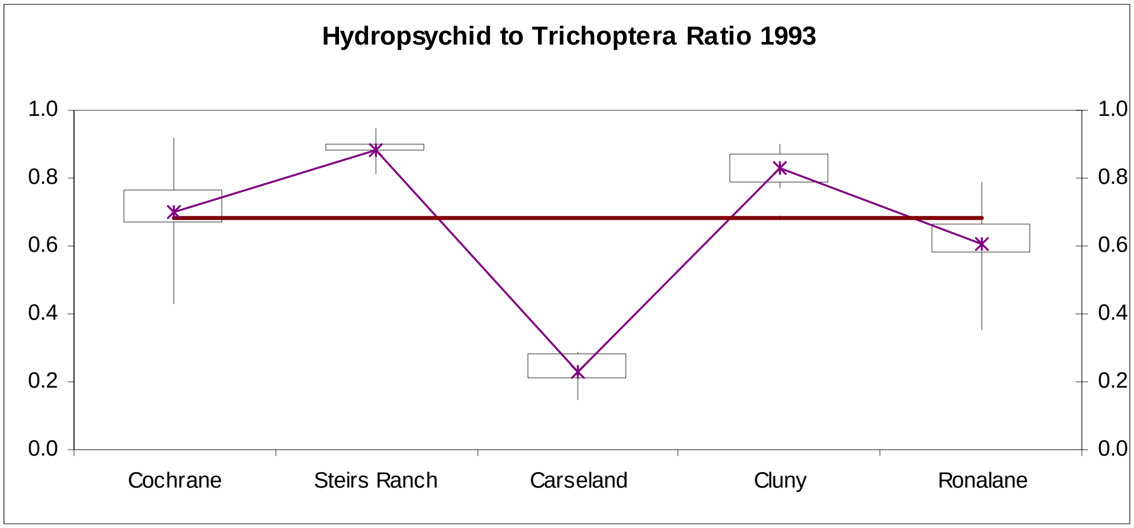




**Figure 9-17 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



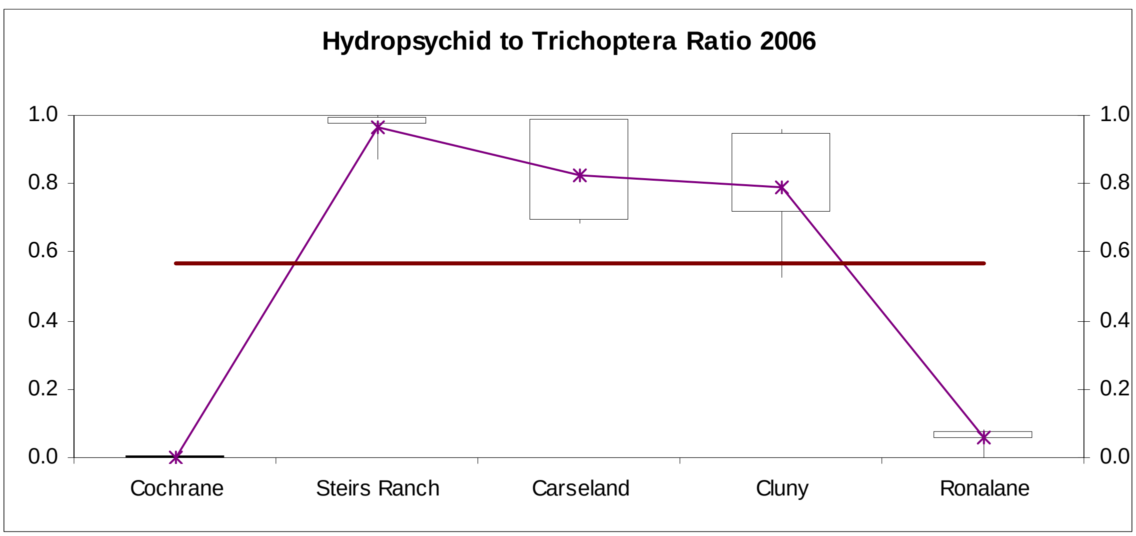
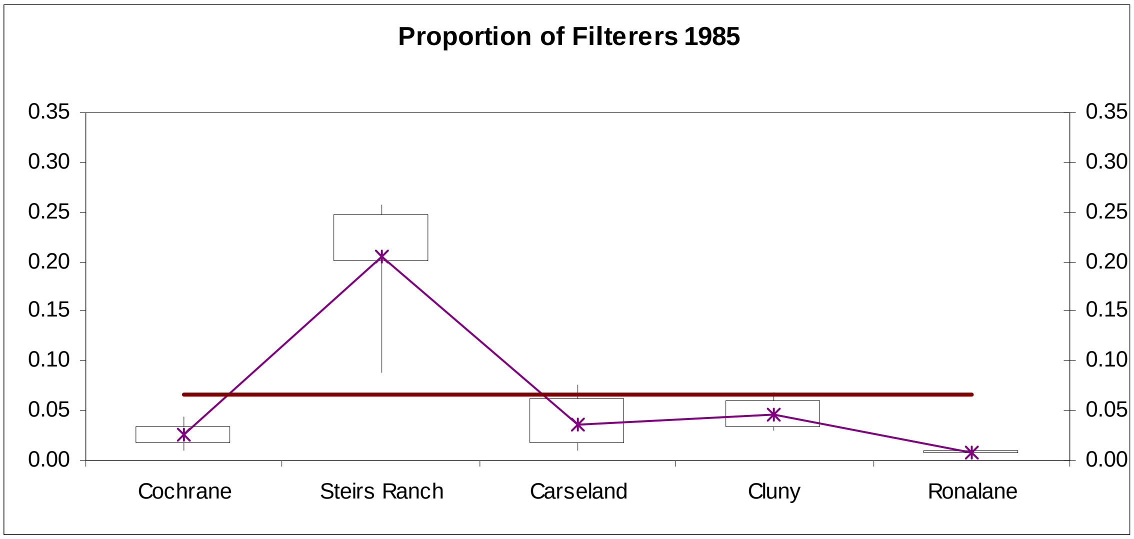
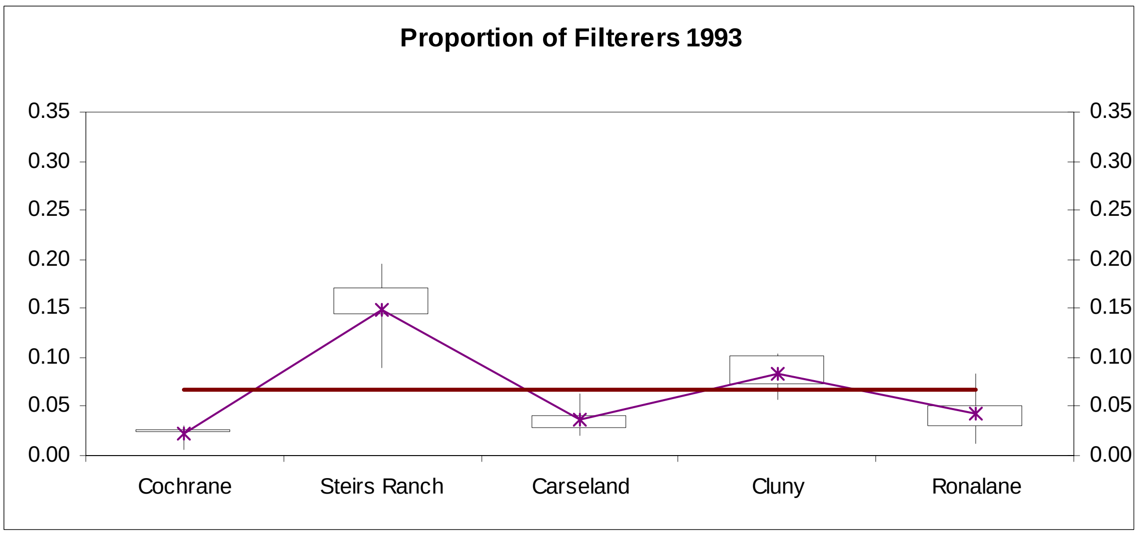




**Figure 9-18 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



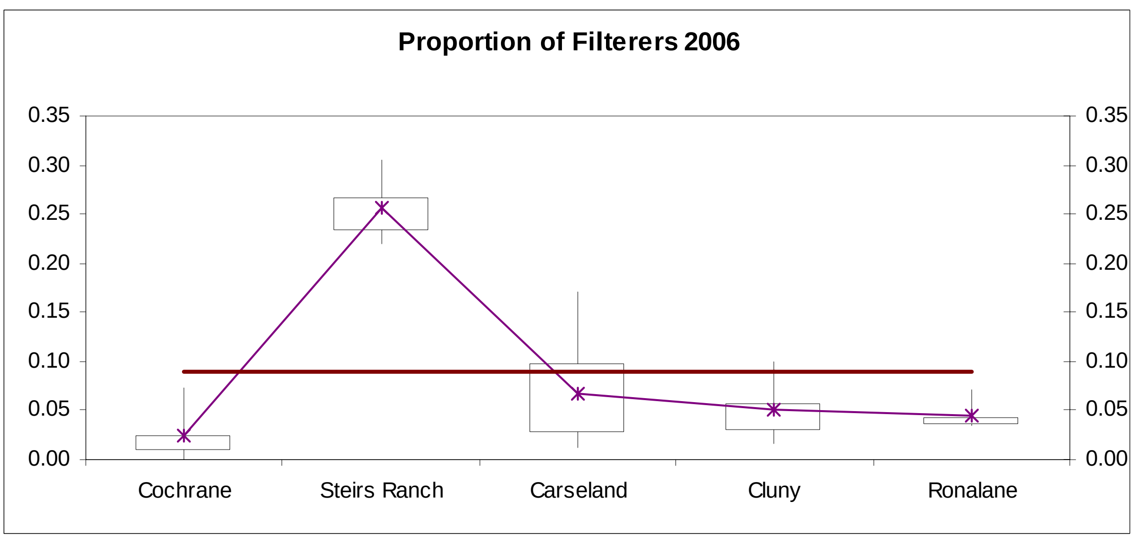
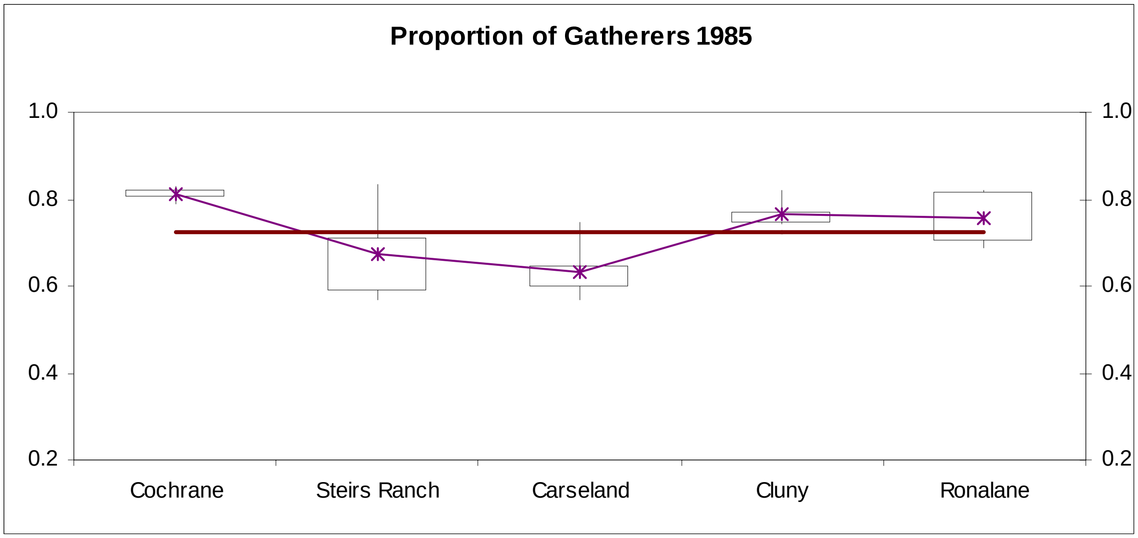
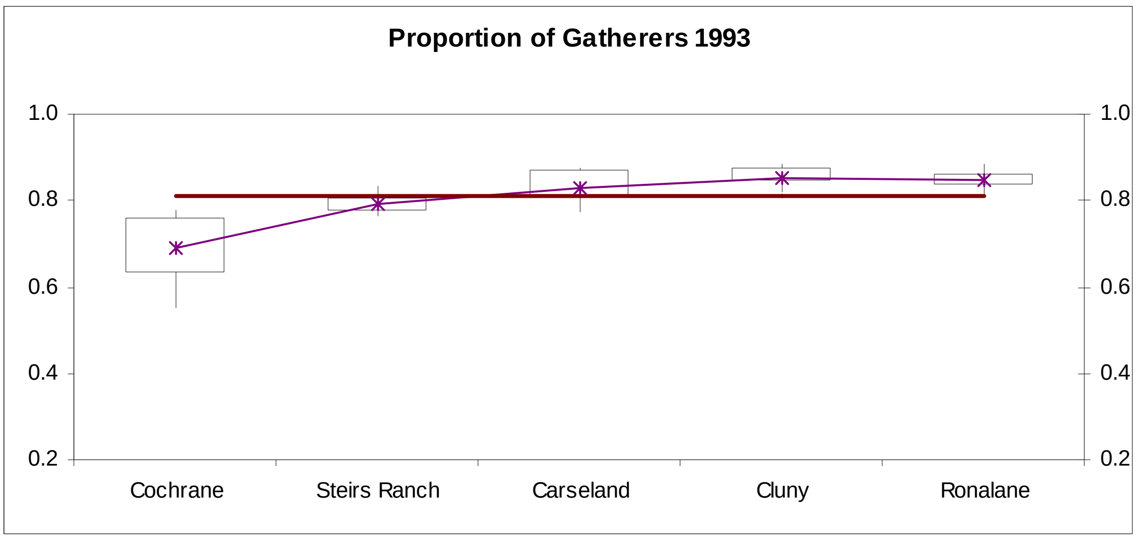




**Figure 9-19 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



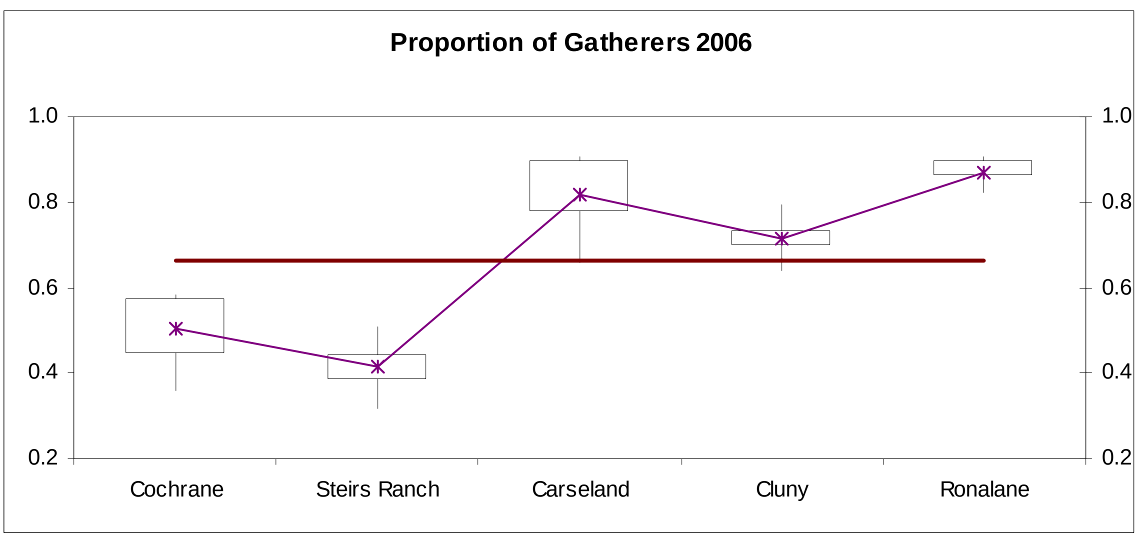




**Figure 9-20 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**

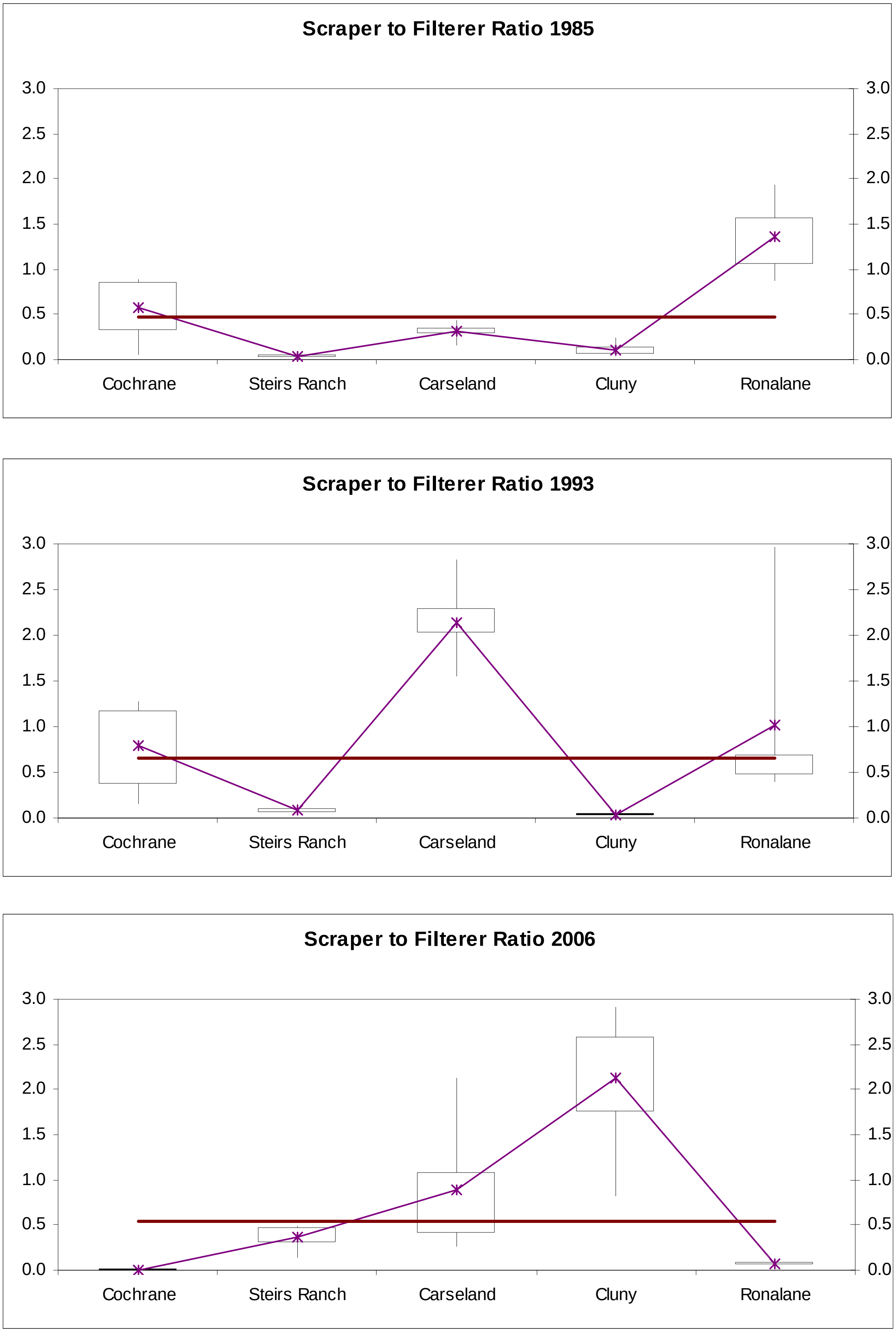
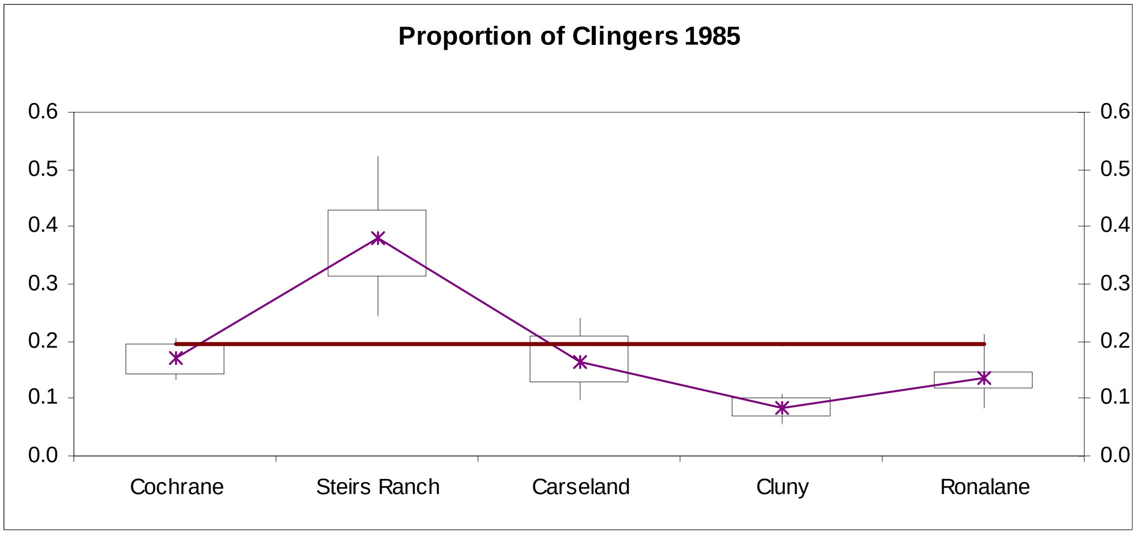
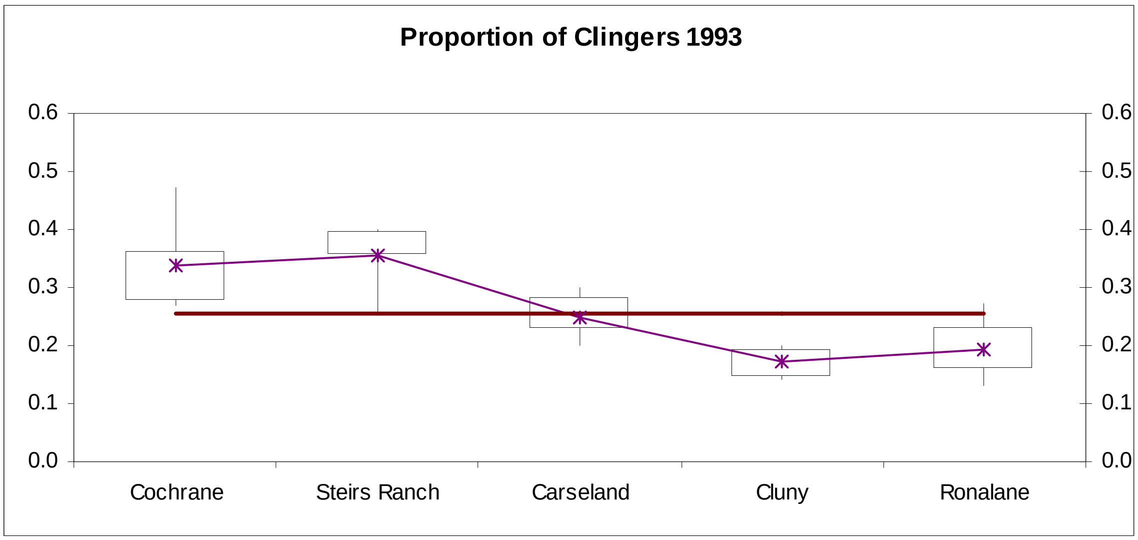



**Figure 9-21 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



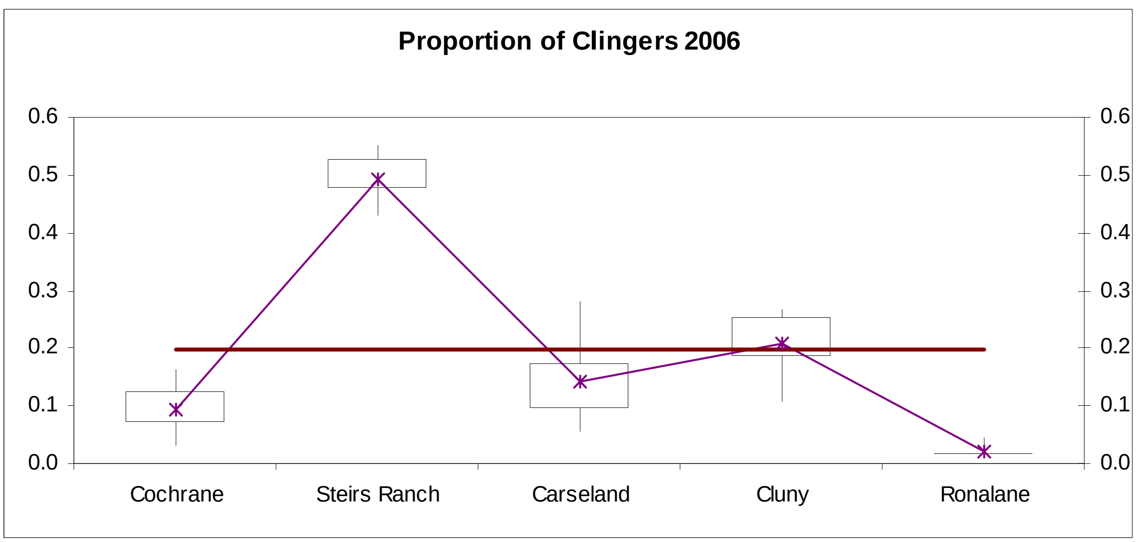




**Figure 9-22 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**

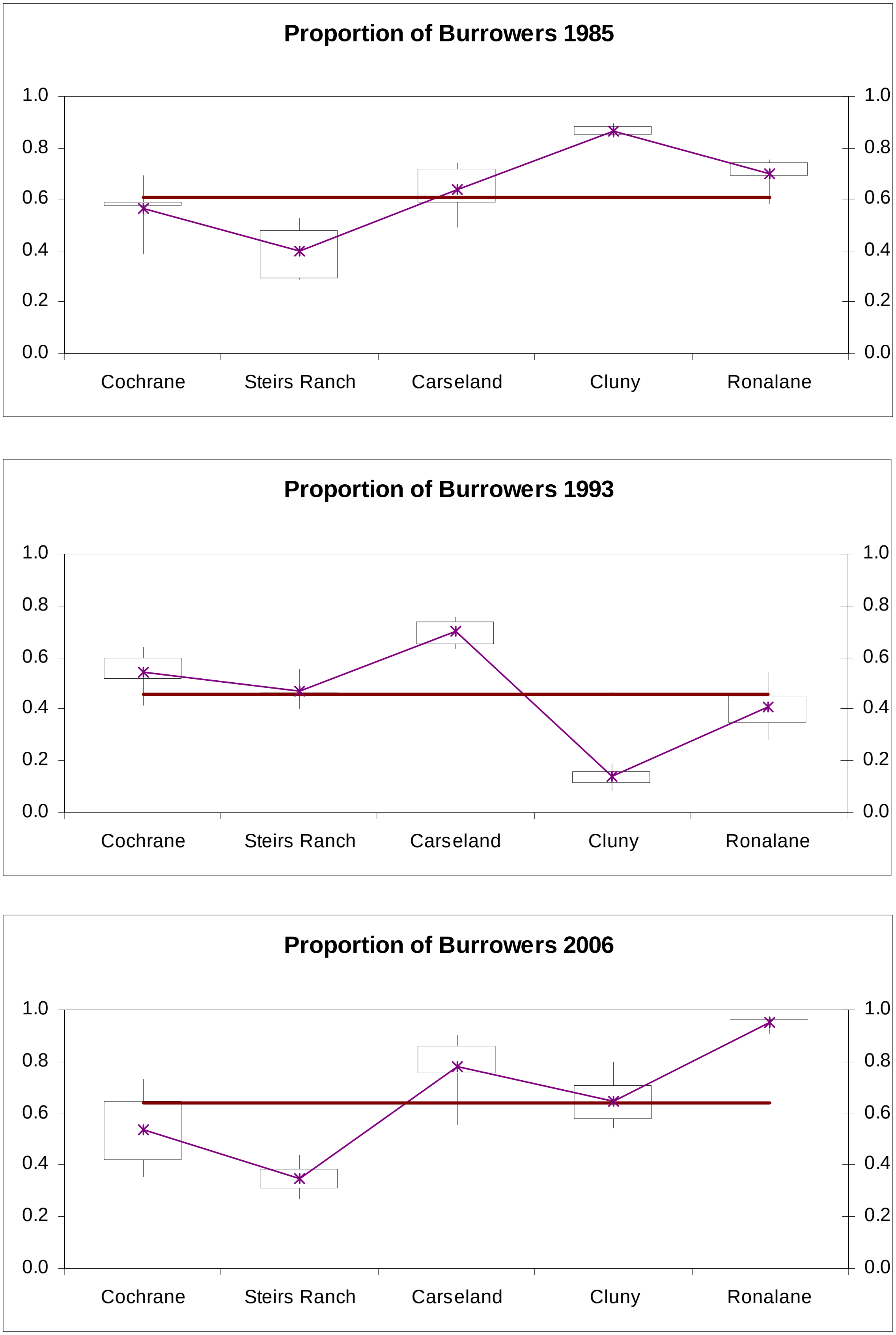
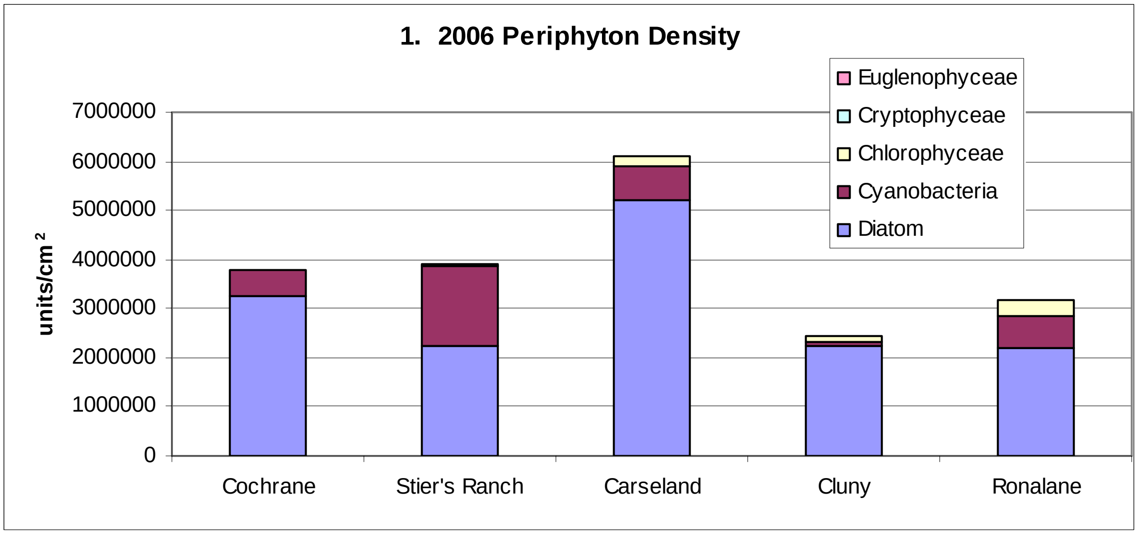
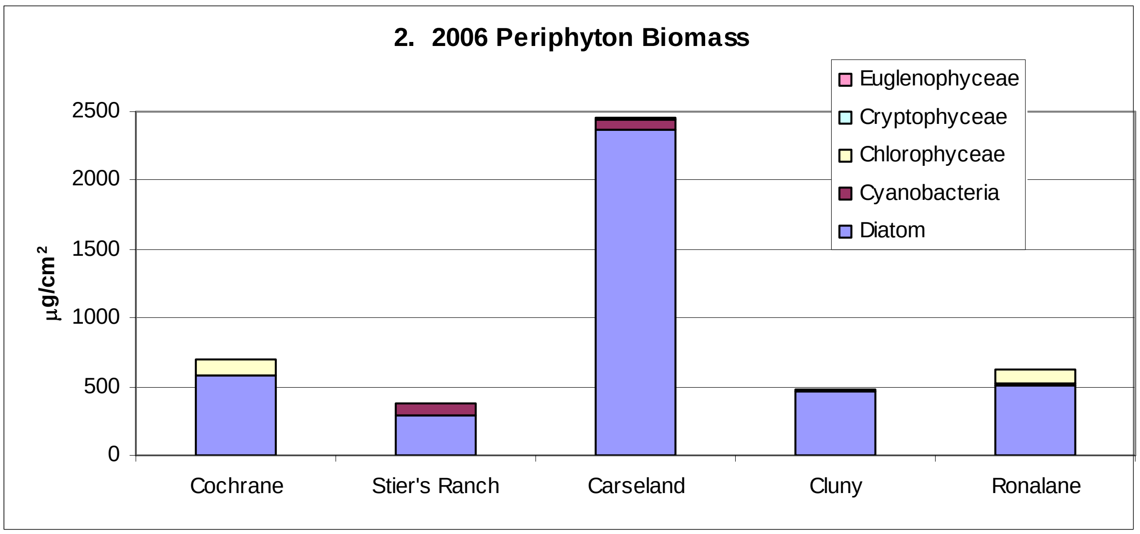



**Figure 9-23 Comparison of benthic invertebrate metrics at erosional sites on the Bow River for 1985, 1993 and 2006 (con't)**



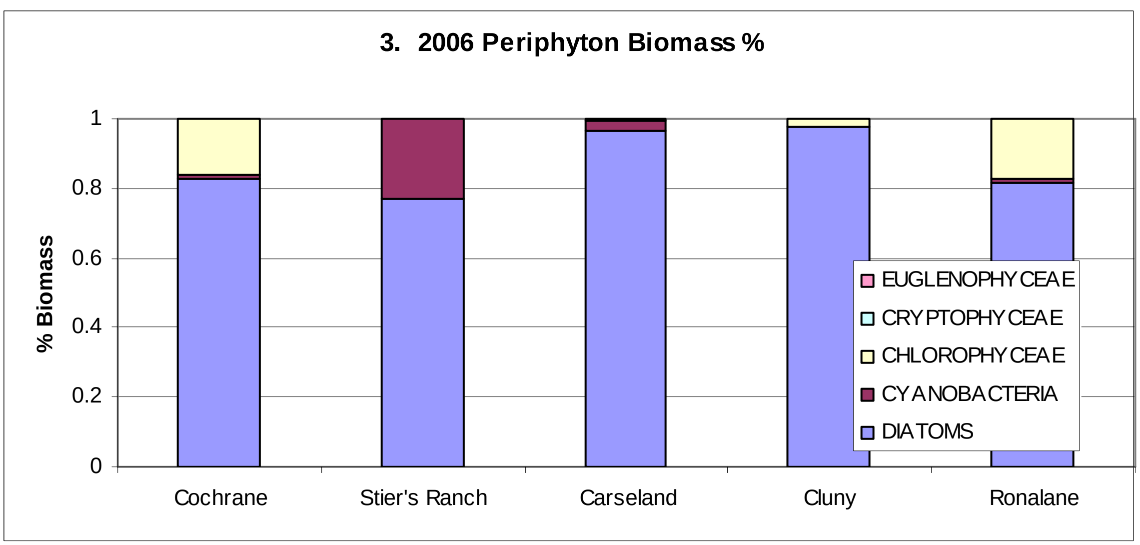
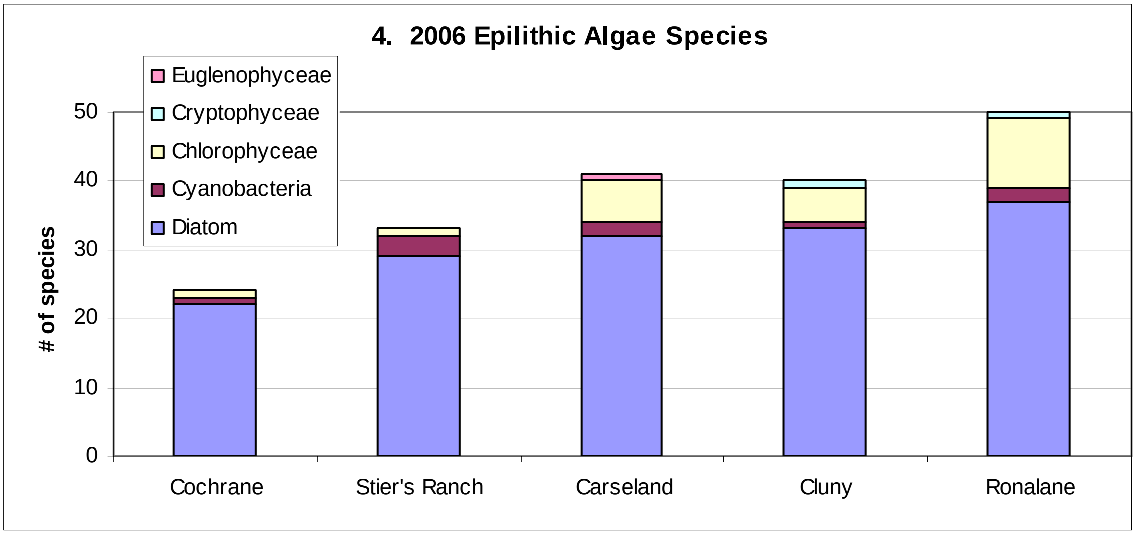
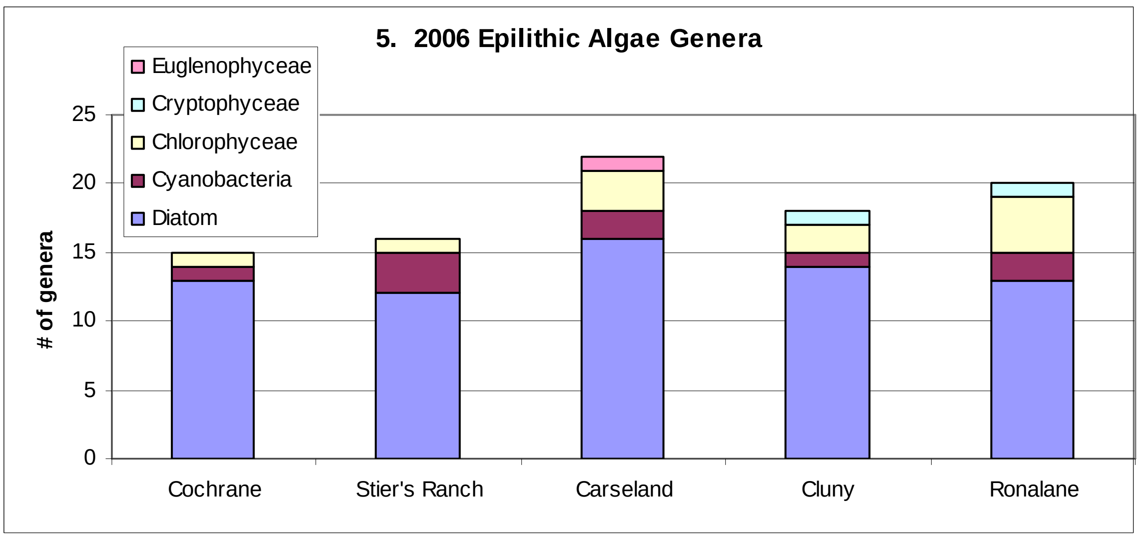




**Figure 10 Summary of metrics for epilithic algae collected from the Bow River in 2006**



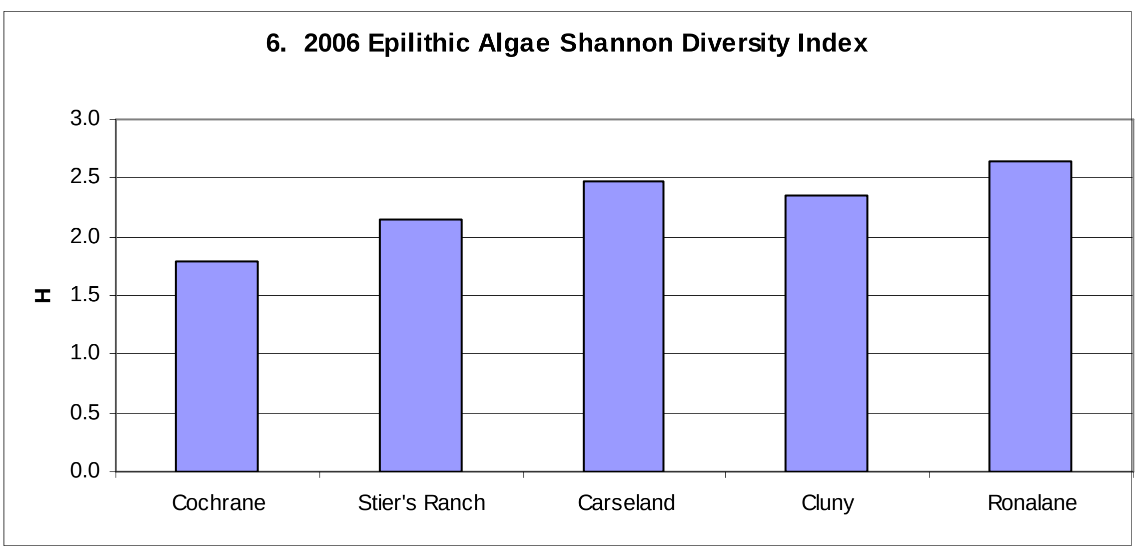




**Figure 10 Summary of metrics for epilithic algae collected from the Bow River in 2006 (con't)**

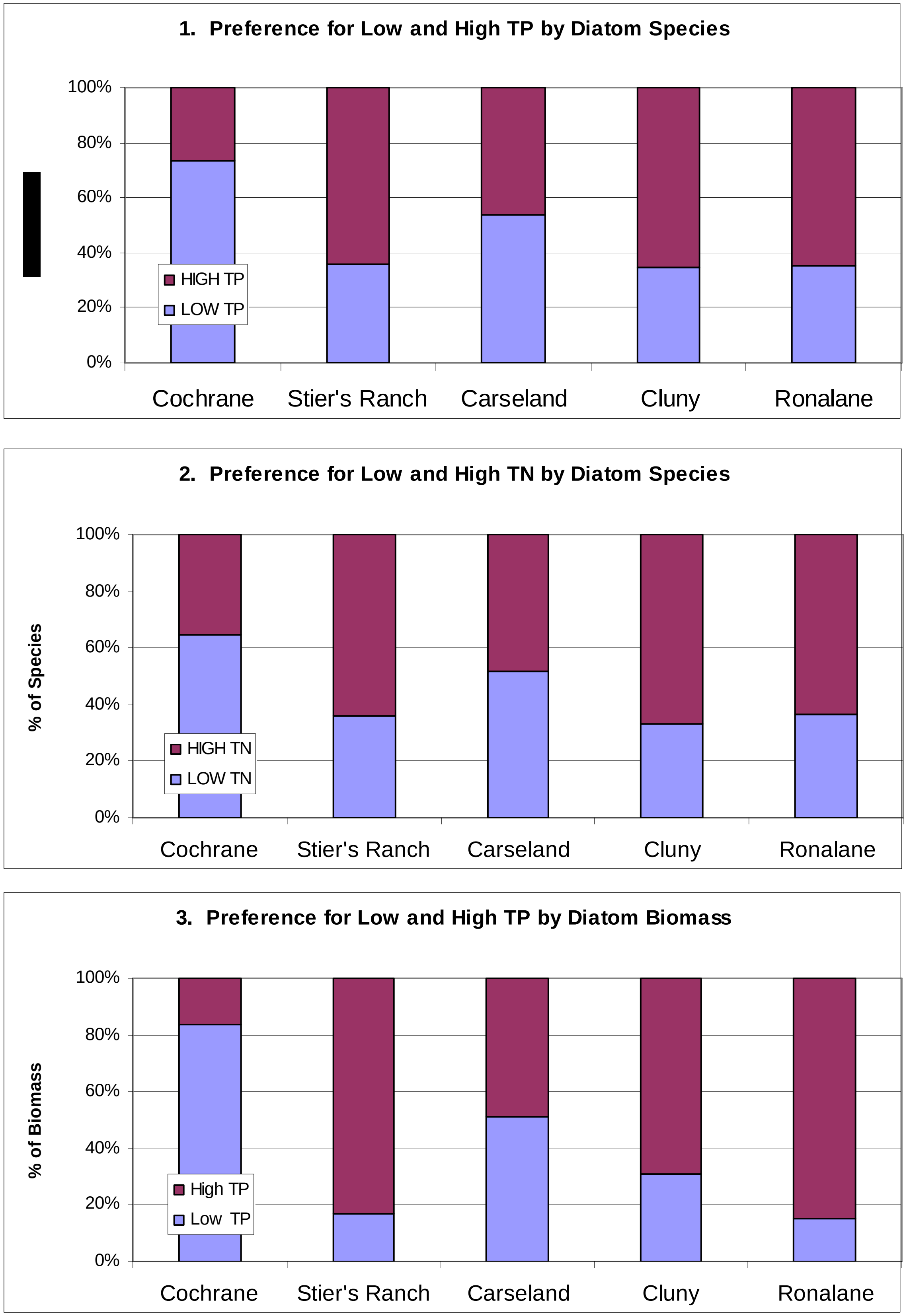
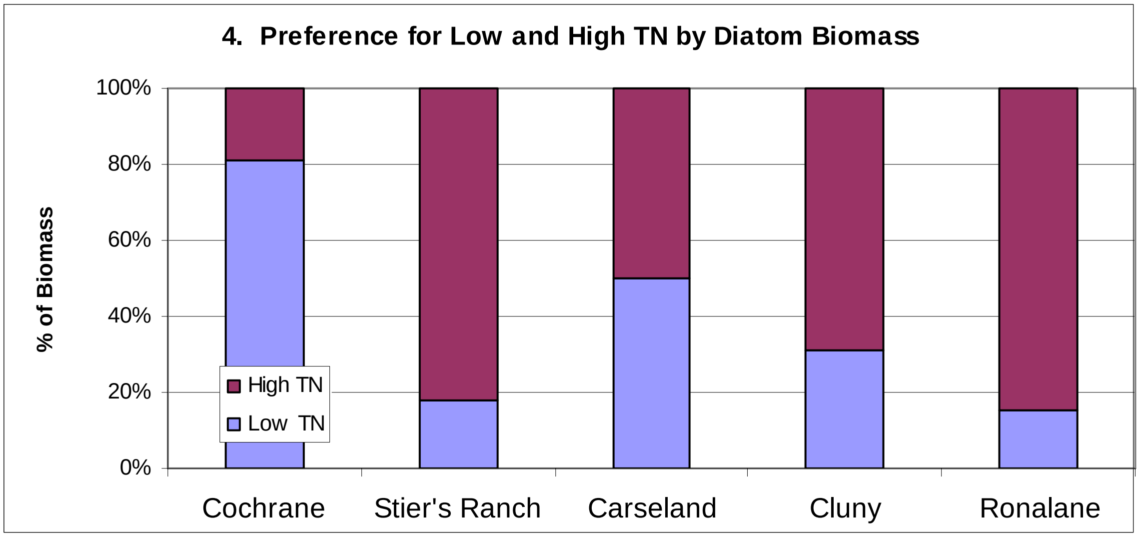
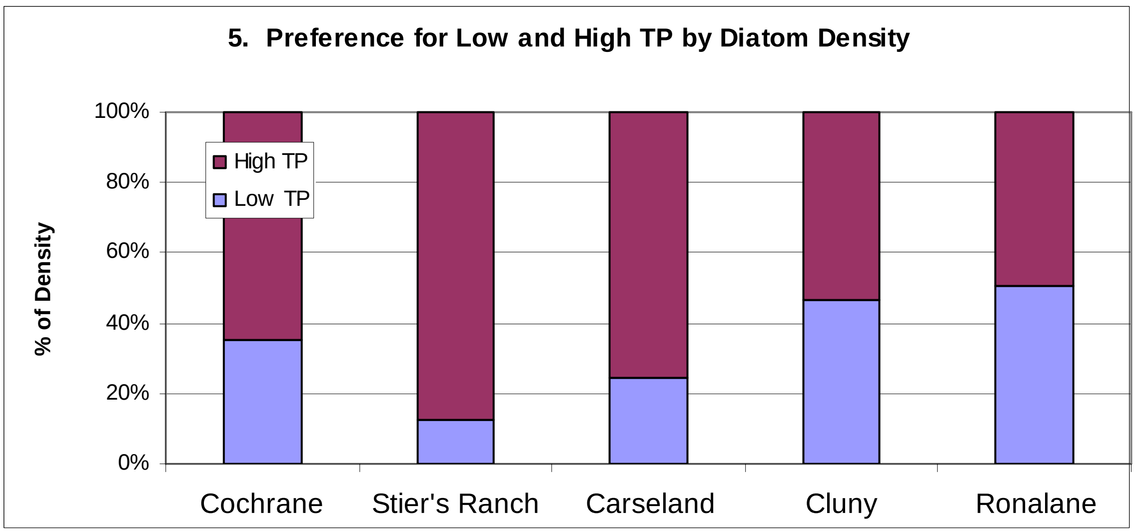



**Figure 11 Longitudinal trends in epilithic diatoms classified according to broad preference ranges for phosphorus and nitrogen concentrations**



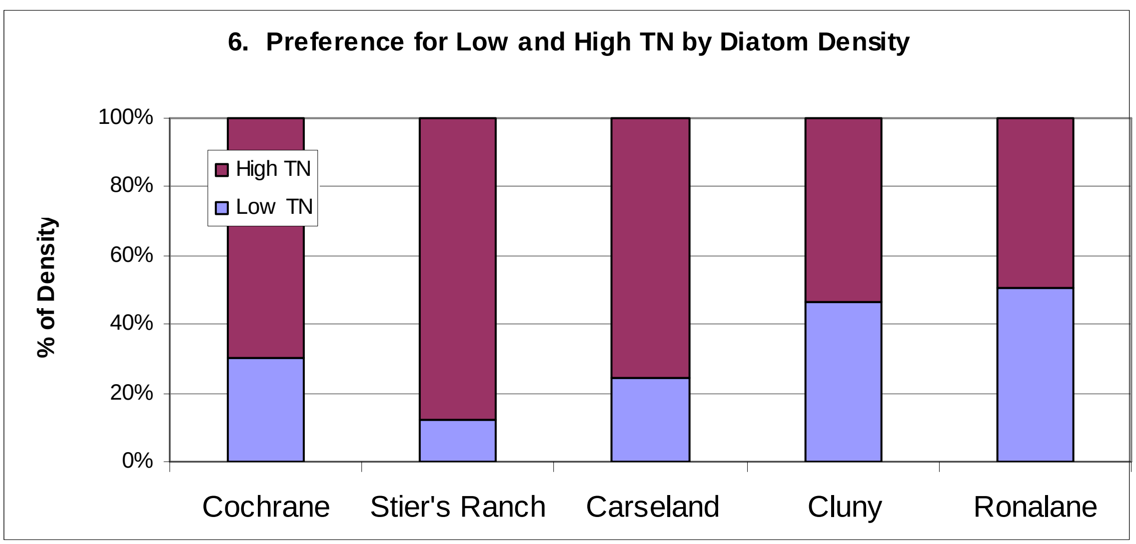
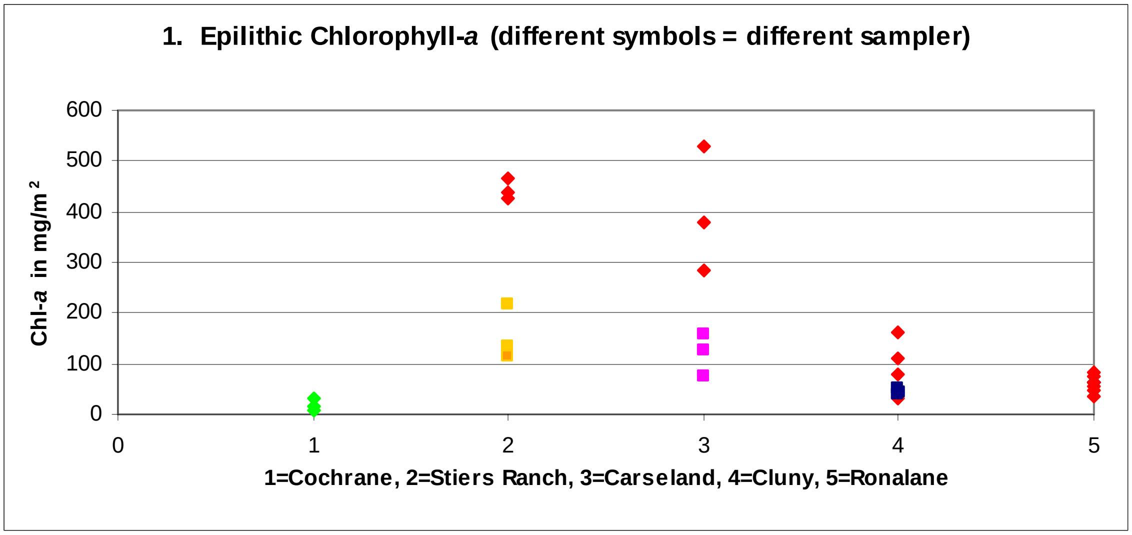
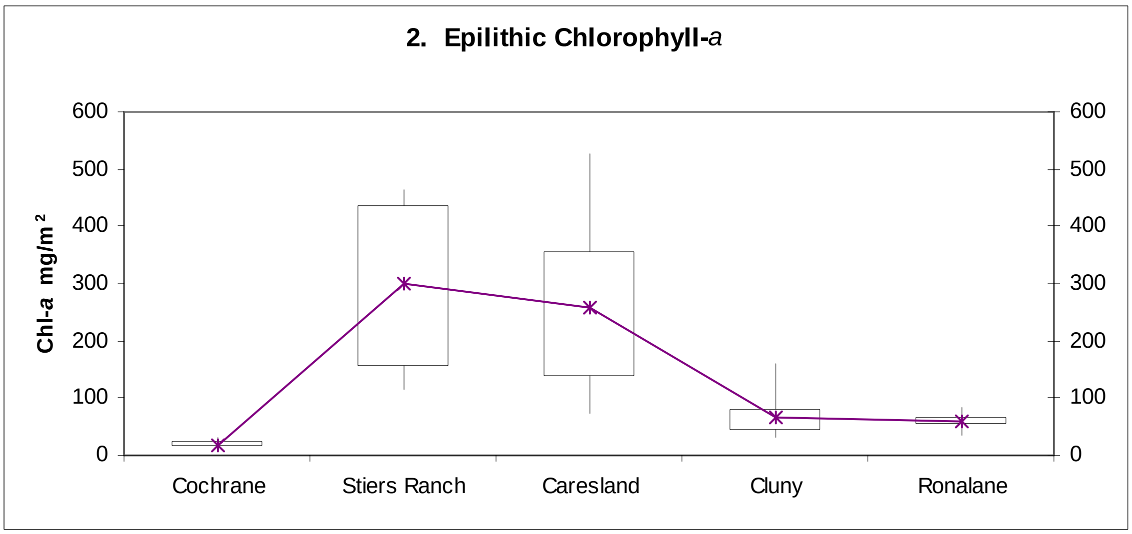




**Figure 11 Longitudinal trends in epilithic diatoms classified according to broad preference ranges for phosphorus and nitrogen concentrations (con't)**



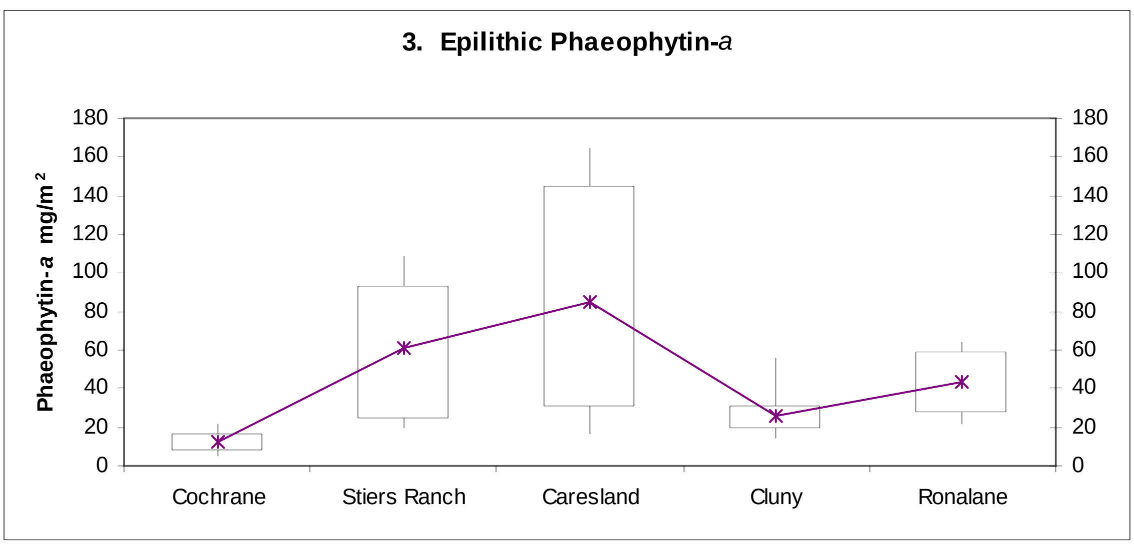




**Figure 12 Longitudinal trends in chlorophyll-*a* in epilithic algal samples from the Bow River (Oct 2006)**

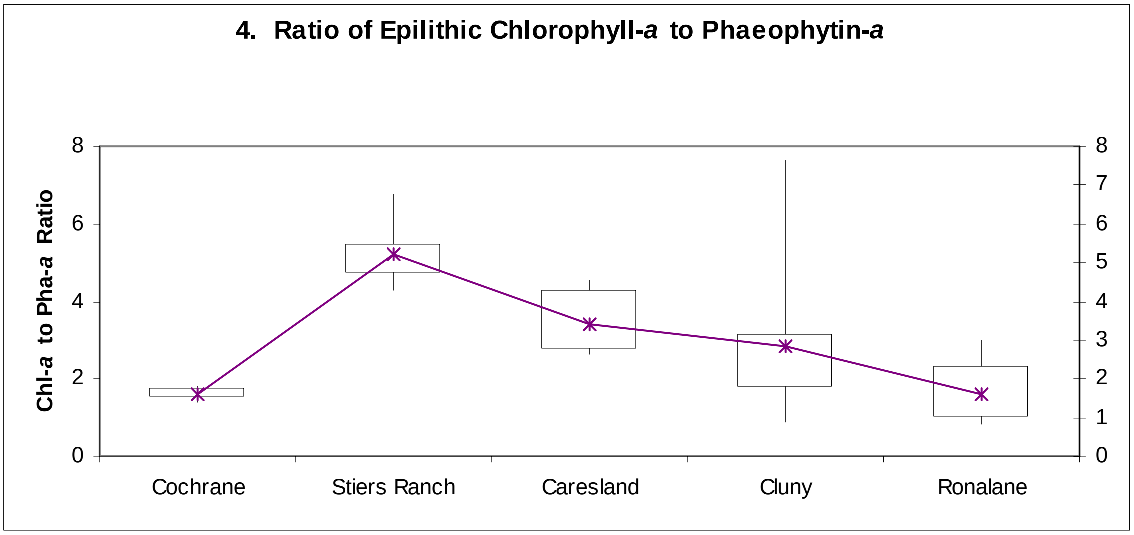
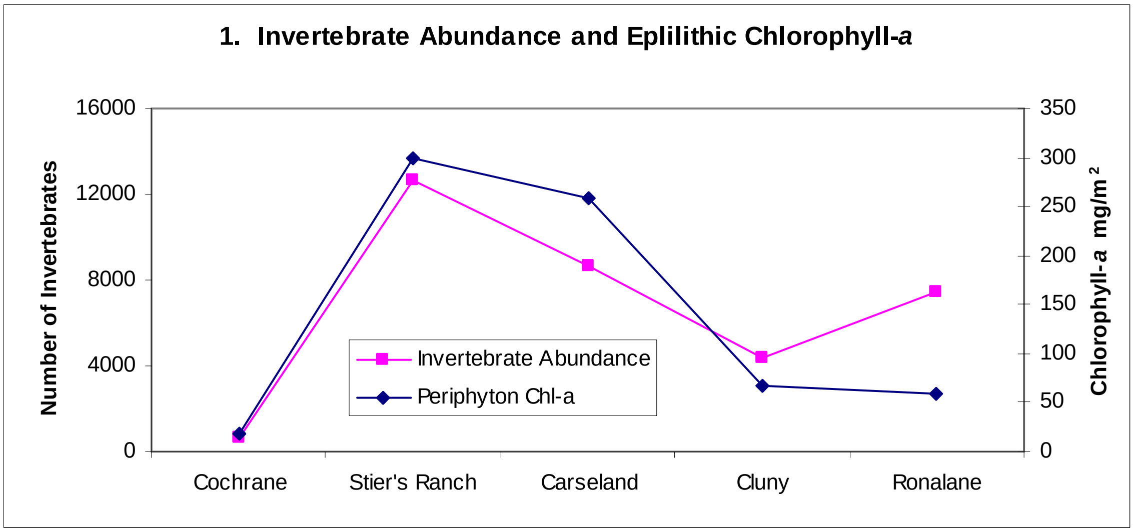
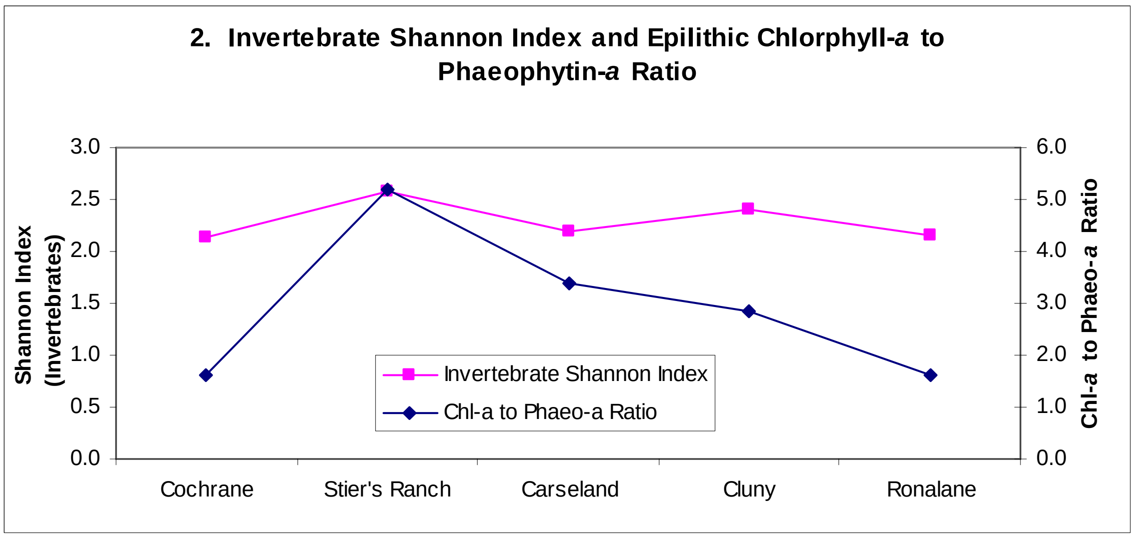



**Figure 12 Longitudinal Trends in chlorophyll-*a* in epilithic algal samples from the Bow River (Oct 2006) (con't)**



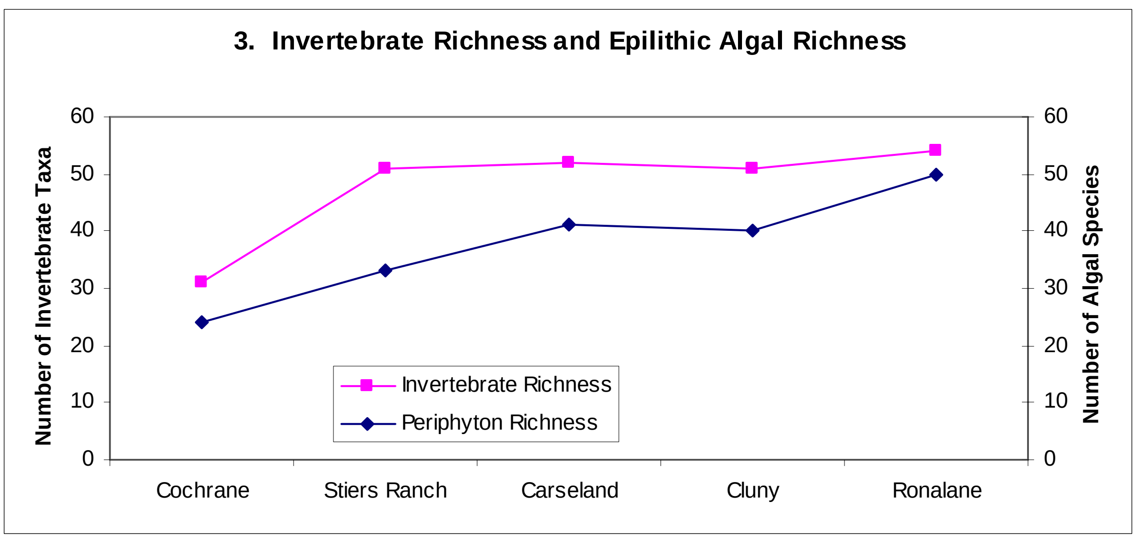




**Figure 13 Comparison of longitudinal trends for a selection of benthic invertebrate and epilithic algal metrics in the Bow River (Oct 2006)**

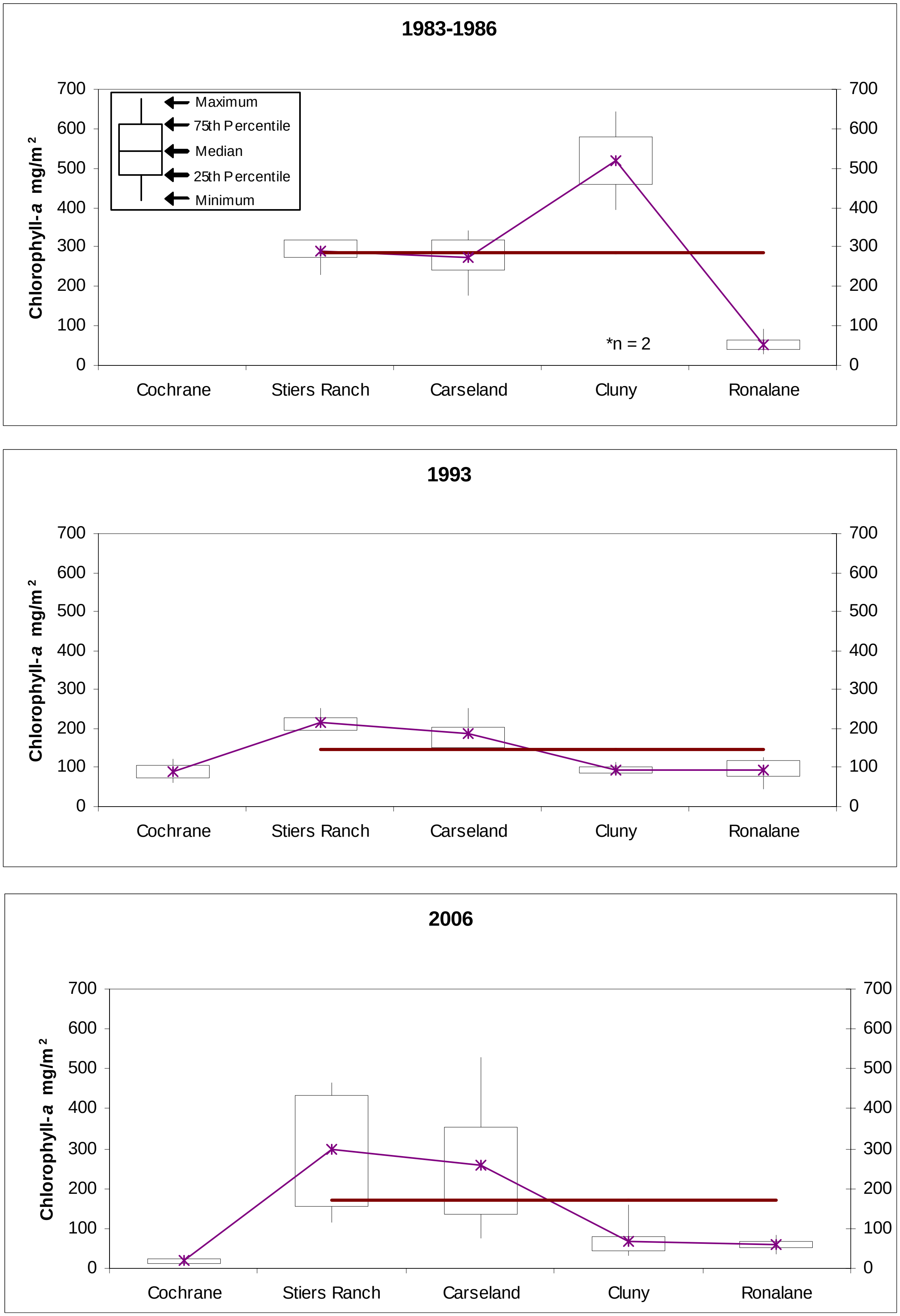



**Figure 14 Comparison of longitudinal trends in epilithic chlorophyll-*a* for the Bow River in 1983-1986, 1993 and 2006**

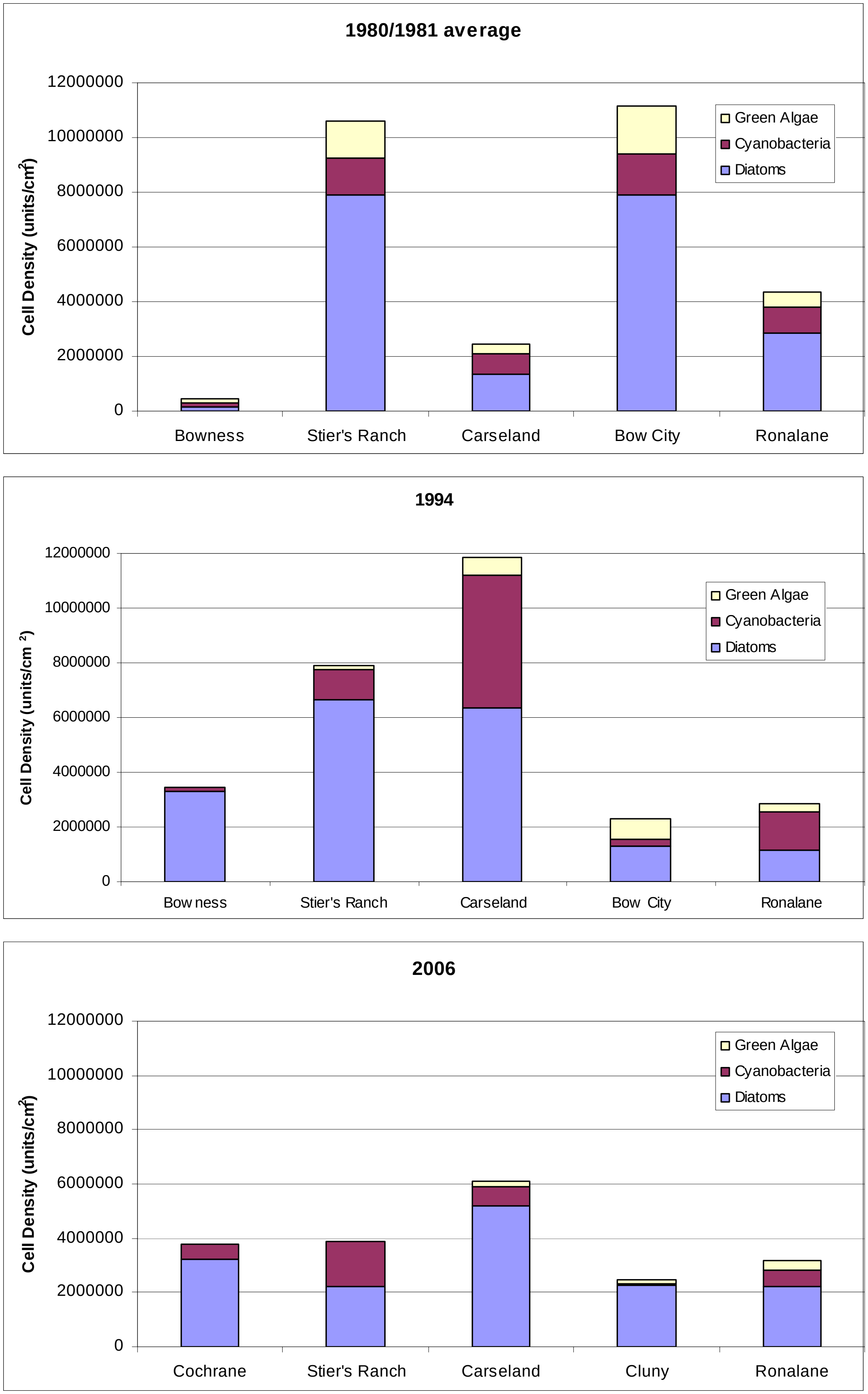



**Figure 15 Comparison of epilithic algal density in the Bow River in 1980-81, 1994, and 2006**

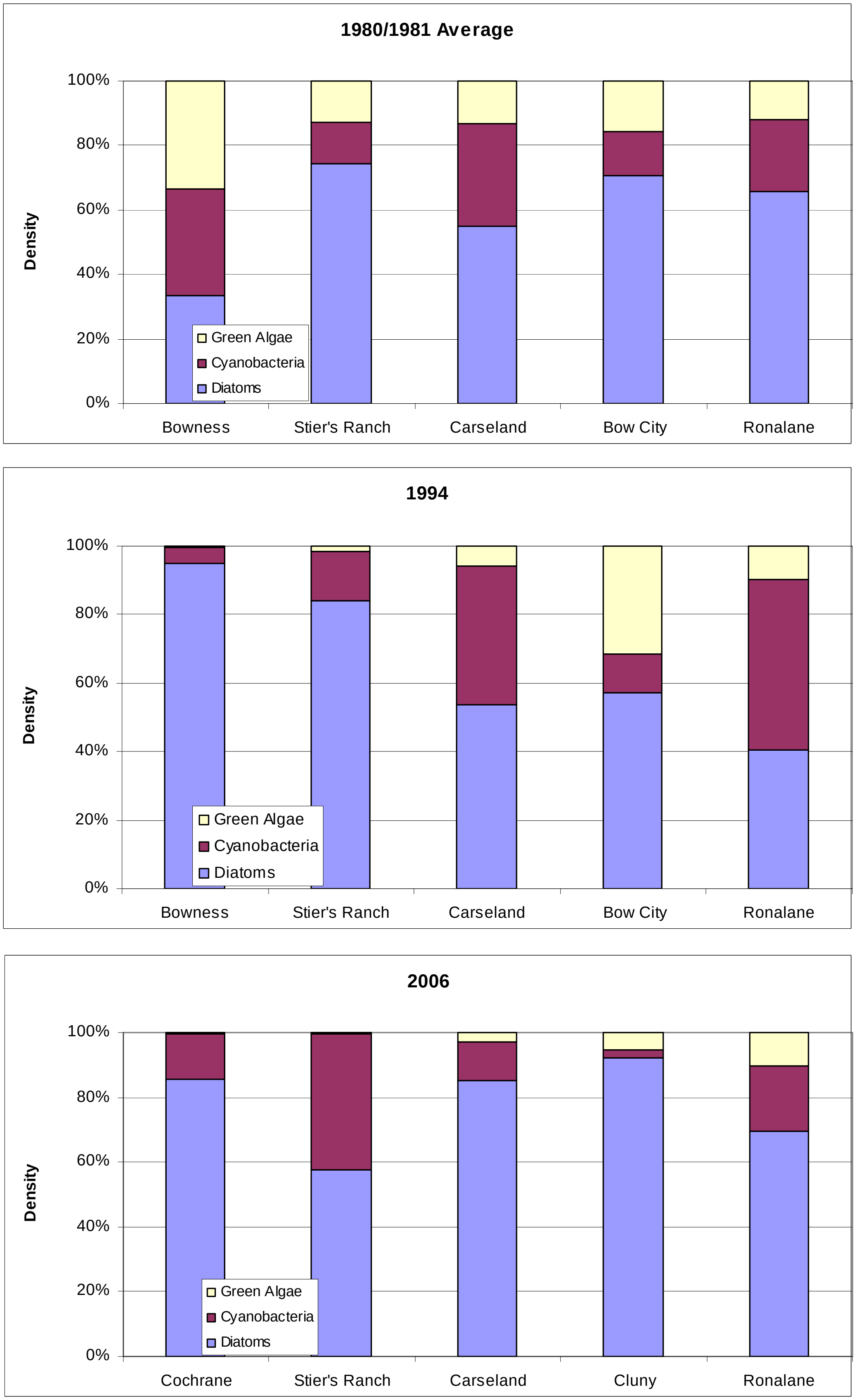



**Figure 16 Comparison of the relative density (%) of epilithic algal taxa in the Bow River in 1980-81, 1994 and 2006**

## Appendix 1 Summary of field data from the Bow River, October 2006

| Site | Site Location | Sampling Date | Erosional site | | Depositional site | |
|---|---|---|---|---|---|---|
| | | | *Lats* | *Longs* | *Lats* | *Longs* |
| Cochrane | LB, u/s Bridge | 16-Oct-06 | 51 11 00 | 114 29 18 | 51 11 129 | 114 |
| Stier's Ranch | RB, d/s Boat launch | 17-Oct-06 | 50 50 55.4 | 113 56 35.5 | 50 50 46.6 | 113 56 43.7 |
| Carseland | RB, d/s Weir | 17-Oct-06 | 50 49 40.3 | 113 26 32.1 | 50 49 56.9 | 113 25 12.7 |
| Cluny | LB, d/s Boat launch | 18-Oct-06 | 50 46 14.8 | 113 50 38.2 | 50 46 10.6 | 112 50 38.2 |
| Ronalane | RB, u/s Old Bridge | 19-Oct-06 | 50 02 40.7 | 111 34 56.2 | 50 02 42.4 | 111 34 58.3 |

**Information Pertaining to Erosional Site**

| Site | Flow velocity (m/sec) | Depth (m) | Substrate Composition | | | | | Substrate Embeddedness |
|---|---|---|---|---|---|---|---|---|
| | | | *%Boulder* | *%Cobble* | *%Gravel* | *%Sand* | *%Fines* | |
| Cochrane | 0.27 | 0.51 | - | 15 | 80 | 5 | - | 28.33 |
| Stier's Ranch | 0.26 | 0.49 | - | 10 | 85 | 5 | - | 58.33 |
| Carseland | 0.24 | 0.37 | - | 10 | 80 | 10 | - | 31.67 |
| Cluny | 0.55 | 0.39 | - | 7.5 | 82.5 | 10 | - | 16.67 |
| Ronalane | 0.27 | 0.43 | - | 45 | 55 | NA | cover substr. | 63.00 |

| Site | Primary Producer Coverage | | | | Comments Pertaining to Primary Producers |
|---|---|---|---|---|---|
| | *0-25%* | *25-50%* | *50-75%* | *75-100%* | |
| Cochrane | 0 | | | | none visible |
| Stier's Ranch | | | | X | *Potamogeton* spp. Epilithic algae, Mosses |
| Carseland | X | | | | *Potamogeton* spp. And epilithic algae |
| Cluny | X | | | | Epilithic algae |
| Ronalane | X | | | | Epilithic algae, bits of *Potamogeton* spp |

Flow velocity: average of 5 measurements
Depth: average of 5 measurements
Embeddedness: % of large substrate (e.g., cobble) covered in fines (average of 2 to 6 observations)

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006

### Cochrane

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0002** | **06SWB0003** | **06SWB0004** | **06SWB0005** | **06SWB0006** | **06SWB0031** | **06SWB00032** | **06SWB0053** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **CNIDARIA** | | | | | | | | |
| *Hydra* sp. | 8 | 0 | 28 | 17 | 12 | 15 | 4 | 15 |
| **TURBELLARIA** | | | | | | | | |
| Microturbellaria | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 15 |
| *Dugesia tigrina* | 0 | 0 | 0 | 0 | 0 | 1 | 8 | 1 |
| **NEMATODA** | 264 | 285 | 95 | 275 | 388 | 357 | 15 | 194 |
| **TARDIGRADA** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| **OLIGOCHAETA** | | | | | | | | |
| Enchytraeidae | 187 | 77 | 95 | 125 | 110 | 226 | 32 | 89 |
| Lumbricidae | 55 | 15 | 21 | 26 | 5 | 62 | 21 | 0 |
| Naididae | 58 | 28 | 16 | 83 | 69 | 214 | 75 | 304 |
| Tubificidae | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 487 |
| **GASTROPODA** | | | | | | | | |
| *Fossaria* sp. | 7 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| *Physa* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **PELECYPODA** | | | | | | | | |
| *Pisidium* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **ARACHNIDA** | | | | | | | | |
| **Hydracarina** | 0 | 4 | 0 | 0 | 24 | 40 | 2 | 15 |
| **Oribatei** | 12 | 0 | 4 | 0 | 0 | 10 | 2 | 0 |
| **CRUSTACEA** | | | | | | | | |
| **OSTRACODA** | | | | | | | | |
| *Candona* sp. | 96 | 16 | 32 | 44 | 24 | 190 | 2 | 85 |
| *Ilyocypris* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| **CLADOCERA** | | | | | | | | |
| *Bosmina* sp. | 0 | 0 | 4 | 0 | 8 | 10 | 0 | 0 |
| *Ceriodaphnia* sp. | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Ilyocryptus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Chydoridae | 0 | 0 | 0 | 0 | 0 | 65 | 0 | 15 |
| **COPEPODA** | | | | | | | | |
| Calanoida | 0 | 8 | 0 | 0 | 0 | 0 | 1 | 0 |
| Cyclopoida | 0 | 4 | 24 | 16 | 12 | 20 | 2 | 20 |
| Harpacticoida | 4 | 0 | 28 | 168 | 76 | 295 | 0 | 191 |
| **AMPHIPODA** | | | | | | | | |
| Hyalella azteca | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Cochrane

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB0002 | 06SWB0003 | 06SWB0004 | 06SWB0005 | 06SWB0006 | 06SWB0031 | 06SWB00032 | 06SWB0053 |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **HEXAPODA** | | | | | | | | |
| **Ephemeroptera** | | | | | | | | |
| *Acerpenna* sp. | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Baetis* sp. | 4 | 0 | 4 | 0 | 0 | 0 | 10 | 0 |
| *Ephemerella* sp. | 1 | 0 | 0 | 0 | 1 | 5 | 12 | 1 |
| *Stenonema* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Plecoptera** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Taenionema* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Trichoptera** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Hydroptila* sp. | 2 | 4 | 0 | 0 | 1 | 12 | 3 | 5 |
| *Hydropsyche* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| *Lepidostoma* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| *Ceraclea* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nectospsyche* s p. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Hemiptera** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Callicorixa audeni* | 31 | 12 | 1 | 27 | 0 | 242 | 58 | 62 |
| *Hesperocorixa atopodonta* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| *Sigara alternata* | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 7 |
| *S. bicoloripennis* | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 13 |
| *S. conocephala* | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 20 |
| *S. decoratella* | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 4 |
| *S. grossolineata* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *S. solensis* | 5 | 2 | 1 | 0 | 2 | 146 | 5 | 103 |
| **Coleoptera** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Liodessus* sp. | 17 | 5 | 0 | 4 | 0 | 28 | 9 | 26 |
| *Optioservus* sp. | 2 | 0 | 0 | 0 | 0 | 1 | 3 | 1 |
| **Diptera** | | | | | | | | |
| *Atherix* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Bezzia / Palpomyia* gp sp. | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chelifer* sp. | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 0 |
| *Simulium* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| *Antocha* sp. | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 |
| *Dicranota* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| *Tipula* sp. | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tipulidae | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Chironomidae** | | | | | | | | |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Cochrane

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0002** | **06SWB0003** | **06SWB0004** | **06SWB0005** | **06SWB0006** | **06SWB0031** | **06SWB00032** | **06SWB0053** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **Chironomini** | | | | | | | | |
| *Dicrotendipes sp.* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Microtendipes* sp. | 0 | 0 | 0 | 1 | 1 | 6 | 3 | 22 |
| *Paratendipes sp.* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 |
| *Phaenopsectra* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Polypedilum* spp. | 20 | 8 | 12 | 4 | 0 | 0 | 1 | 0 |
| **Tanytarsini** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cladotanytarsus* sp. | 0 | 0 | 0 | 4 | 0 | 5 | 0 | 5 |
| *Micropsectra* sp. | 13 | 1 | 0 | 4 | 0 | 15 | 5 | 99 |
| *Rheotanytarsus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| *Sublettea* sp. | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| *Tanytarsus* sp. | 12 | 0 | 0 | 0 | 4 | 5 | 0 | 20 |
| **Diamesinae** | | | | | | | | |
| *Diamesa* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Pagastia* sp. | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 |
| *Potthastia gaedii* gp. | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| *Potthastia longimana* gp. | 5 | 0 | 1 | 5 | 6 | 20 | 10 | 15 |
| **Orthocladiinae** | | | | | | | | |
| *Cricotopus/Orthocladius* spp. | 0 | 16 | 4 | 9 | 41 | 37 | 18 | 10 |
| *Eukiefferiella* sp. | 0 | 0 | 0 | 0 | 8 | 5 | 0 | 0 |
| *Nanocladius* sp. | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Parametriocnemus* sp. | 5 | 0 | 4 | 0 | 4 | 14 | 6 | 10 |
| *Tvetenia* sp. | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 0 |
| **Prodiamesinae** | | | | | | | | |
| *Monodiamesa* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| **Tanypodinae** | | | | | | | | |
| *Thienemannimyia* gp. | 9 | 0 | 4 | 5 | 6 | 18 | 6 | 1 |
| **Total Taxa** | **25** | **20** | **18** | **21** | **23** | **39** | **39** | **43** |
| **Total Numbers** | **823** | **496** | **378** | **827** | **811** | **2112** | **337** | **1973** |
| **OTHERS** | | | | | | | | |
| Carabidae (terrestrial) | 1 | 2 | 2 | 1 | 1 | 15 | 5 | 0 |

Bryozoa present in sample but not counted

Oligochaeta egg capsules present in sample but not counted

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006

### Stier's Ranch

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB008 | 06SWB0009 | 06SWB0010 | 06SWB0011 | 06SWB0012 | 06SWB0033 | 06SWB0034 | 06SWB0054 |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **CNIDARIA** | | | | | | | | |
| *Hydra* sp. | 0 | 0 | 10 | 0 | 40 | 0 | 0 | 40 |
| **TURBELLARIA** | | | | | | | | |
| Microturbellaria | 0 | 20 | 40 | 0 | 0 | 0 | 0 | 1000 |
| *Dugesia tigrina* | 1 | 4 | 0 | 8 | 0 | 0 | 0 | 43 |
| **NEMATODA** | 359 | 1170 | 1441 | 424 | 5998 | 40 | 20 | 81 |
| **OLIGOCHAETA** | | | | | | | | |
| Enchytraeidae | 1 | 20 | 31 | 160 | 0 | 0 | 40 | 0 |
| Lumbricidae | 2 | 2 | 8 | 1 | 0 | 10 | 0 | 0 |
| Naididae | 131 | 60 | 70 | 40 | 40 | 200 | 0 | 6007 |
| Tubificidae | 216 | 1250 | 1202 | 914 | 1447 | 290 | 459 | 365 |
| **HIRUDINEA** | | | | | | | | |
| *Dina parva* | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| *Erpobdella punctata* | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Nephelopsis obscura* | 0 | 9 | 2 | 0 | 1 | 0 | 0 | 0 |
| Erpobdellidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Glossiphonia complanata* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **GASTROPODA** | | | | | | | | |
| *Fossaria* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Gyraulus* sp. | 1 | 0 | 1 | 1 | 0 | 0 | 21 | 17 |
| *Physa* sp. | 181 | 330 | 418 | 904 | 340 | 630 | 1023 | 605 |
| **PELECYPODA** | | | | | | | | |
| *Pisidium* sp. | 0 | 0 | 0 | 20 | 0 | 1 | 65 | 8 |
| **ARACHNIDA** | | | | | | | | |
| **Hydracarina** | 100 | 40 | 80 | 40 | 40 | 240 | 0 | 40 |
| **Oribatei** | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 |
| **CRUSTACEA** | | | | | | | | |
| **OSTRACODA** | | | | | | | | |
| *Candona* sp. | 0 | 0 | 0 | 0 | 0 | 400 | 220 | 400 |
| *Ilyocypris* sp. | 90 | 60 | 100 | 280 | 240 | 40 | 0 | 0 |
| **CLADOCERA** | | | | | | | | |
| *Ilyocryptus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| **COPEPODA** | | | | | | | | |
| Cyclopoida | 0 | 40 | 40 | 0 | 0 | 40 | 0 | 1240 |
| Harpacticoida | 40 | 220 | 290 | 120 | 80 | 120 | 0 | 80 |
| **AMPHIPODA** | | | | | | | | |
| *Gammarus lacustris* | 0 | 1 | 0 | 4 | 0 | 2 | 22 | 7 |
| *Hyalella azteca* | 0 | 15 | 0 | 1 | 0 | 0 | 0 | 2 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Stier's Ranch

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB008 | 06SWB0009 | 06SWB0010 | 06SWB0011 | 06SWB0012 | 06SWB0033 | 06SWB0034 | 06SWB0054 |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **HEXAPODA** | | | | | | | | |
| **Ephemeroptera** | | | | | | | | |
| *Baetis* sp. | 107 | 167 | 220 | 396 | 506 | 1260 | 1892 | 1 |
| *Callibaetis sp.* | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 1 |
| *Caenis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41 |
| *Ephemerella* sp. | 163 | 70 | 126 | 390 | 211 | 1050 | 897 | 139 |
| *Epeorus* sp. | 71 | 0 | 46 | 60 | 0 | 0 | 128 | 0 |
| *Heptagenia* sp. | 12 | 1 | 30 | 1 | 0 | 234 | 13 | 0 |
| *Rhithrogena* sp. | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Stenonema* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 |
| *Leptophlebia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| *Paraleptophlebia* sp. | 8 | 4 | 8 | 16 | 5 | 170 | 114 | 0 |
| **Plecoptera** | | | | | | | | |
| *Claassenia* sp. | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 |
| *Isoperla* sp. | 0 | 0 | 0 | 0 | 1 | 10 | 10 | 1 |
| **Trichoptera** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Brachycentrus* sp. | 0 | 0 | 5 | 16 | 1 | 9 | 11 | 0 |
| *Cheumatopsyche* sp. | 65 | 4 | 40 | 150 | 7 | 158 | 76 | 1 |
| *Hydropsyche* sp. | 2269 | 547 | 2199 | 2826 | 759 | 8491 | 3330 | 37 |
| *Lepidostoma* sp. | 1 | 4 | 1 | 9 | 0 | 12 | 10 | 2 |
| *Ceraclea* sp. | 5 | 65 | 60 | 10 | 0 | 0 | 0 | 0 |
| *Oecetis* sp. | 0 | 2 | 1 | 5 | 0 | 1 | 5 | 0 |
| *Neureclipsis* sp. | 1 | 5 | 1 | 3 | 0 | 1 | 0 | 0 |
| *Psychomyia* sp. | 13 | 4 | 2 | 0 | 0 | 0 | 0 | 0 |
| **Hemiptera** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Callicorixa audeni* | 6 | 5 | 0 | 650 | 18 | 32 | 1421 | 3 |
| *Cenocorixa bifida* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Sigara alternata* | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| *S. bicoloripennis* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *S. solensis* | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| *S. washingtonensis* | | | | | | | | |
| **Coleoptera** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Liodessus* sp. | 0 | 8 | 1 | 0 | 0 | 0 | 8 | 0 |
| *Oreodytes* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Stictotarsus* sp. | 0 | 0 | 0 | 4 | 0 | 13 | 9 | 0 |
| *Optioservus* sp. | 876 | 409 | 1232 | 723 | 105 | 2085 | 1060 | 1 |
| **Diptera** | | | | | | | | |
| *Hemerodromia* sp. | 9 | 4 | 13 | 8 | 0 | 40 | 8 | 0 |
| *Simulium* sp. | 53 | 1952 | 1900 | 456 | 2560 | 2280 | 3950 | 41 |
| **Chironomidae** | | | | | | | | |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006) (con't)

### Stier's Ranch

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB008 | 06SWB0009 | 06SWB0010 | 06SWB0011 | 06SWB0012 | 06SWB0033 | 06SWB0034 | 06SWB0054 |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **Chironomini** | | | | | | | | |
| *Chironomus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 726 |
| *Cryptochironomus* sp. | 10 | 84 | 91 | 0 | 50 | 80 | 181 | 2 |
| *Demicryptochironomus* sp. | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| *Dicrotendipes sp.* | 0 | 0 | 0 | 20 | 1 | 0 | 0 | 6 |
| *Microtendipes* sp. | 71 | 680 | 339 | 232 | 714 | 64 | 514 | 114 |
| *Paratendipes sp.* | 40 | 200 | 220 | 60 | 240 | 120 | 0 | 80 |
| *Phaenopsectra* sp. | 93 | 285 | 310 | 248 | 295 | 170 | 394 | 1602 |
| *Polypedilum* spp. | 913 | 280 | 859 | 700 | 320 | 3360 | 301 | 40 |
| *Tribelos* sp. | 0 | 13 | 2 | 0 | 5 | 0 | 5 | 0 |
| **Tanytarsini** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cladotanytarsus* sp. | 0 | 0 | 0 | 16 | 0 | 0 | 8 | 0 |
| *Micropsectra* sp. | 11 | 149 | 151 | 20 | 45 | 80 | 49 | 48 |
| *Paratanytarsus* sp. | 10 | 0 | 14 | 20 | 5 | 0 | 0 | 4 |
| *Rheotanytarsus* sp. | 0 | 0 | 10 | 20 | 0 | 40 | 120 | 0 |
| *Sublettea* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| *Tanytarsus* sp. | 50 | 80 | 80 | 20 | 0 | 40 | 80 | 216 |
| **Diamesinae** | | | | | | | | |
| *Diamesa* sp. | 1 | 255 | 226 | 321 | 160 | 682 | 492 | 1 |
| *Potthastia longimana* gp.sp. | 0 | 4 | 1 | 0 | 0 | 0 | 20 | 45 |
| **Orthocladiinae** | | | | | | | | |
| *Cardiocladius* sp. | 101 | 64 | 91 | 288 | 50 | 2710 | 291 | 0 |
| *Cricotopus/Orthocladius* spp. | 683 | 1486 | 2380 | 780 | 215 | 5821 | 152 | 122 |
| *Nanocladius* sp. | 20 | 0 | 30 | 80 | 40 | 200 | 0 | 0 |
| *Parametriocnemus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| *Synorthocladius* sp. | 40 | 0 | 20 | 20 | 40 | 160 | 0 | 0 |
| *Thienemanniella* sp. | 0 | 20 | 20 | 8 | 0 | 0 | 0 | 0 |
| *Tvetenia* sp. | 182 | 41 | 131 | 196 | 85 | 1200 | 162 | 40 |
| **Tanypodinae** | | | | | | | | |
| *Procladius* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| *Thienemannimyia* gp.sp. | 832 | 839 | 1530 | 1294 | 479 | 3613 | 811 | 603 |
| **Total Taxa** | **42** | **49** | **56** | **54** | **37** | **45** | **45** | **48** |
| **Total Numbers** | **7839** | **10975** | **16135** | **12988** | **15145** | **36240** | **18438** | **13940** |
| **OTHERS** | | | | | | | | |
| Longnose Dace | | | | | | 4 | 2 | 0 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006

### Carseland

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0014** | **06SWB0015** | **06SWB0016** | **06SWB0017** | **06SWB0018** | **06SWB0035** | **06SWB0036** | **06SWB0055** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **CNIDARIA** | | | | | | | | |
| *Hydra* sp. | 60 | 20 | 140 | 80 | 100 | 584 | 140 | 0 |
| **TURBELLARIA** | | | | | | | | |
| Microturbellaria | 0 | 0 | 0 | 20 | 40 | 280 | 0 | 400 |
| *Dugesia tigrina* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 4 |
| **NEMATODA** | 849 | 310 | 516 | 183 | 88 | 570 | 112 | 1160 |
| **OLIGOCHAETA** | | | | | | | | |
| Enchytraeidae | 20 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Lumbricidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Naididae | 1826 | 883 | 1042 | 1849 | 2090 | 30465 | 2826 | 48860 |
| Tubificidae | 94 | 28 | 40 | 51 | 28 | 41 | 1 | 178 |
| **HIRUDINEA** | | | | | | | | |
| *Erpobdella punctata* | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Nephelopsis obscura* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| **GASTROPODA** | | | | | | | | |
| *Fossaria* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| *Gyraulus* sp. | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| *Physa* sp. | 62 | 4 | 21 | 1 | 0 | 159 | 40 | 10 |
| **PELECYPODA** | | | | | | | | |
| *Pisidium* sp. | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| **ARACHNIDA** | | | | | | | | |
| **Hydracarina** | 20 | 0 | 20 | 20 | 40 | 80 | 10 | 0 |
| **CRUSTACEA** | | | | | | | | |
| **OSTRACODA** | | | | | | | | |
| *Candona* sp. | 40 | 40 | 0 | 0 | 0 | 80 | 0 | 280 |
| *Cypridopsis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 120 |
| *Ilyocypris* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| *Limnocythere* sp. | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 120 |
| **CLADOCERA** | | | | | | | | |
| *Ceriodaphnia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| *Ilyocryptus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 280 |
| Chydoridae | 100 | 0 | 0 | 40 | 20 | 560 | 0 | 280 |
| **COPEPODA** | | | | | | | | |
| Cyclopoida | 140 | 30 | 0 | 40 | 0 | 360 | 20 | 3360 |
| Harpacticoida | 40 | 20 | 200 | 80 | 160 | 320 | 0 | 320 |
| **AMPHIPODA** | | | | | | | | |
| *Gammarus lacustris* | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 9 |
| *Hyalella azteca* | 1 | 0 | 0 | 0 | 0 | 34 | 0 | 47 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Carseland

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0014** | **06SWB0015** | **06SWB0016** | **06SWB0017** | **06SWB0018** | **06SWB0035** | **06SWB0036** | **06SWB0055** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **HEXAPODA** | | | | | | | | |
| **Ephemeroptera** | | | | | | | | |
| *Acentrella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 |
| *Baetis* sp. | 65 | 134 | 772 | 121 | 104 | 2545 | 727 | 40 |
| *Callibaetis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Caenis* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Ephemerella* sp. | 13 | 13 | 25 | 4 | 3 | 215 | 198 | 8 |
| *Epeorus* sp. | 0 | 0 | 0 | 0 | 0 | 40 | 40 | 0 |
| *Heptagenia* sp. | 0 | 0 | 26 | 3 | 4 | 11 | 44 | 1 |
| *Rhithrogena* sp. | 1 | 2 | 17 | 8 | 7 | 10 | 99 | 0 |
| *Stenonema* sp. | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| *Paraleptophlebia* sp. | 2 | 0 | 5 | 0 | 3 | 49 | 37 | 0 |
| *Tricorythodes* sp. | 0 | 1 | 1 | 0 | 0 | 8 | 6 | 0 |
| **Plecoptera** | | | | | | | | |
| *Claassenia* sp. | 0 | 0 | 3 | 1 | 0 | 17 | 19 | 0 |
| *Isogenoides* sp. | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| *Isoperla* sp. | 1 | 5 | 10 | 0 | 2 | 45 | 100 | 0 |
| *Skwala* sp. | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 0 |
| **Trichoptera** | | | | | | | | |
| *Brachycentrus* sp. | 1 | 1 | 7 | 1 | 1 | 0 | 5 | 0 |
| *Cheumatopsyche* sp. | 2 | 1 | 12 | 1 | 0 | 2 | 5 | 0 |
| *Hydropsyche* sp. | 99 | 704 | 1708 | 113 | 63 | 1324 | 1719 | 5 |
| *Helicopsyche* sp. | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Lepidostoma* sp. | 3 | 1 | 0 | 0 | 0 | 1 | 12 | 0 |
| *Ceraclea* sp. | 9 | 0 | 2 | 23 | 20 | 8 | 5 | 0 |
| *Oecetis* sp. | 20 | 3 | 3 | 2 | 2 | 1 | 1 | 0 |
| *Polycentropus* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Psychomyia* sp. | 12 | 5 | 11 | 5 | 5 | 33 | 52 | 0 |
| **Odonata** | | | | | | | | |
| *Ophiogomphus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Hemiptera** | | | | | | | | |
| *Callicorixa audeni* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 137 |
| *Cenocorixa bifida* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| *C. dakotensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Hesperocorixa vulgaris* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Sigara alternata* | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 31 |
| *S. bicoloripennis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| *S. conocephala* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| *S. decoratella* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Carseland

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0014** | **06SWB0015** | **06SWB0016** | **06SWB0017** | **06SWB0018** | **06SWB0035** | **06SWB0036** | **06SWB0055** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| *S. grossolineata* | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| *S. mathesoni* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *S. solensis* | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 46 |
| *S. trilineata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *S.washingtonensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 69 |
| *Trichocorixa borealis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| **Coleoptera** | | | | | | | | |
| *Liodessus* sp. | 2 | 0 | 0 | 1 | 0 | 0 | 10 | 4 |
| *Colymbetes* sp. | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Nebrioporus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| *Oreodytes* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 |
| *Stictotarsus* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 |
| *Helichus* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| *Optioservus* sp. | 138 | 287 | 396 | 198 | 167 | 835 | 407 | 50 |
| **Diptera** | | | | | | | | |
| *Atherix* sp. | 0 | 1 | 2 | 1 | 0 | 1 | 3 | 0 |
| *Bezzia / Palpomyia* gp sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| *Hemerodromia* sp. | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 |
| *Simulium* sp. | 3 | 0 | 20 | 0 | 0 | 184 | 205 | 0 |
| *Hexatoma* sp. | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Tipula* sp. | 1 | 2 | 0 | 0 | 0 | 7 | 1 | 0 |
| **Chironomidae** | | | | | | | | |
| **Chironomini** | | | | | | | | |
| *Chironomus* sp. | 1 | 0 | 0 | 0 | 1 | 5 | 6 | 17 |
| *Cryptochironomus* sp. | 195 | 82 | 40 | 1 | 20 | 242 | 80 | 0 |
| *Dicrotendipes* sp. | 1023 | 540 | 89 | 174 | 136 | 1088 | 542 | 82 |
| *Microtendipes* sp. | 843 | 596 | 264 | 236 | 79 | 278 | 86 | 52 |
| *Nilothauma* sp. | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Phaenopsectra* sp. | 81 | 10 | 0 | 80 | 40 | 1378 | 240 | 1461 |
| *Polypedilum* spp. | 820 | 1251 | 1502 | 349 | 301 | 4741 | 570 | 404 |
| *Sergentia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Stictochironomus* sp. | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 |
| *Tribelos* sp. | 81 | 18 | 1 | 9 | 20 | 10 | 5 | 0 |
| **Tanytarsini** | | | | | | | | |
| *Cladotanytarsus* sp. | 140 | 0 | 40 | 80 | 40 | 920 | 20 | 81 |
| *Micropsectra* sp. | 309 | 66 | 60 | 331 | 50 | 1857 | 503 | 1286 |
| *Paratanytarsus* sp. | 217 | 174 | 127 | 565 | 250 | 907 | 629 | 226 |
| *Rheotanytarsus* sp. | 0 | 71 | 40 | 42 | 0 | 176 | 106 | 0 |
| *Tanytarsus* sp. | 1240 | 391 | 60 | 620 | 120 | 3232 | 140 | 480 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Carseland

| | Neill Cylinder | | | | | Kick | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0014** | **06SWB0015** | **06SWB0016** | **06SWB0017** | **06SWB0018** | **06SWB0035** | **06SWB0036** | **06SWB0055** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 400µm | Depositional 210µm |
| **Diamesinae** | | | | | | | | |
| *Diamesa* sp. | 35 | 2 | 5 | 29 | 23 | 169 | 56 | 50 |
| *Pagastia* sp. | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Potthastia longimana* gp. | 85 | 53 | 64 | 158 | 111 | 638 | 322 | 82 |
| **Orthocladiinae** | | | | | | | | |
| *Corynoneura* sp. | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 |
| *Cricotopus/Orthocladius* spp. | 1802 | 1185 | 1738 | 1676 | 2066 | 15650 | 4976 | 1371 |
| *Cricotopus* sp. | 2 | 6 | 0 | 55 | 101 | 120 | 105 | 4 |
| *Eukiefferiella* sp. | 20 | 20 | 1 | 21 | 40 | 120 | 20 | 0 |
| *Nanocladius* sp. | 0 | 10 | 0 | 0 | 0 | 160 | 0 | 0 |
| *Parakiefferriella* sp. | 40 | 0 | 0 | 0 | 20 | 120 | 0 | 0 |
| *Parametriocnemus* sp. | 20 | 10 | 0 | 0 | 0 | 0 | 20 | 0 |
| *Pseudosmittia* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 40 |
| *Synorthocladius* sp. | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Thienemanniella* sp. | 106 | 61 | 240 | 90 | 323 | 552 | 426 | 0 |
| *Tvetenia* sp. | 41 | 132 | 363 | 42 | 60 | 912 | 370 | 0 |
| **Tanypodinae** | | | | | | | | |
| *Procladius* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Thienemannimyia* gp. sp. | 258 | 322 | 575 | 55 | 165 | 1385 | 477 | 5 |
| **Total Taxa** | **55** | **47** | **47** | **48** | **42** | **68** | **56** | **59** |
| **Total Numbers** | **11010** | **7509** | **10214** | **7465** | **6915** | **73675** | **16571** | **61634** |

**OTHERS**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Longnose Dace | 0 | 0 | 1 | 0 | 0 | 5 | 9 | 1 |
| *Catostomus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006

## Cluny

| | Neill Cylinder | | | | | Kick | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB0020 | 06SWB0021 | 06SWB0022 | 06SWB0023 | 06SWB0024 | 06SWB0038 | 06SWB0039 | 06SWB0040 | 06SWB0042 | 06SWB0043 | 06SWB0044 | 06SWB0056 |
| **TAXA** | | | | | | Erosional 210µm | Erosional 210µm | Erosional 210µm | Erosional 400µm | Erosional 400µm | Erosional 400µm | Depositional 210µm |
| **CNIDARIA** | | | | | | | | | | | | |
| *Hydra* sp. | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 20 | 41 |
| **TURBELLARIA** | | | | | | | | | | | | |
| Microturbellaria | 0 | 0 | 8 | 0 | 0 | 480 | 0 | 120 | 0 | 0 | 0 | 0 |
| *Dugesia tigrina* | 2 | 2 | 8 | 0 | 0 | 42 | 0 | 0 | 9 | 0 | 24 | 0 |
| **NEMATODA** | 381 | 273 | 298 | 430 | 249 | 200 | 43 | 160 | 21 | 20 | 0 | 3722 |
| **OLIGOCHAETA** | | | | | | | | | | | | |
| Enchytraeidae | 0 | 0 | 250 | 93 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Lumbricidae | 2 | 34 | 4 | 12 | 5 | 1 | 3 | 0 | 1 | 1 | 5 | 0 |
| Naididae | 451 | 963 | 857 | 1325 | 1168 | 15043 | 6580 | 15207 | 1910 | 1265 | 685 | 31611 |
| Tubificidae | 0 | 0 | 0 | 1 | 1 | 89 | 2 | 0 | 4 | 4 | 20 | 133 |
| **HIRUDINEA** | | | | | | | | | | | | |
| *Erpobdella punctata* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 2 | 0 |
| *Nephelopsis obscura* | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 | 1 | 0 |
| **GASTROPODA** | | | | | | | | | | | | |
| *Physa* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| **PELECYPODA** | | | | | | | | | | | | |
| *Pisidium* sp. | 0 | 0 | 1 | 0 | 0 | 40 | 0 | 1 | 0 | 0 | 2 | 0 |
| **ARACHNIDA** | | | | | | | | | | | | |
| **Hydracarina** | 60 | 60 | 24 | 0 | 1 | 160 | 40 | 0 | 0 | 0 | 0 | 40 |
| **CRUSTACEA** | | | | | | | | | | | | |
| **OSTRACODA** | | | | | | | | | | | | |
| *Candona* sp. | 10 | 20 | 56 | 20 | 20 | 40 | 0 | 80 | 0 | 0 | 40 | 120 |
| *Cypridopsis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| *Ilyocypris* sp. | 0 | 0 | 0 | 0 | 0 | 80 | 42 | 120 | 40 | 0 | 160 | 0 |
| *Limnocythere* sp. | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 |
| **CLADOCERA** | | | | | | | | | | | | |
| *Ilyocryptus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 40 |
| Chydoridae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| **COPEPODA** | | | | | | | | | | | | |
| Cyclopoida | 30 | 20 | 16 | 30 | 20 | 120 | 80 | 200 | 0 | 0 | 40 | 1000 |
| Harpacticoida | 0 | 0 | 0 | 20 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **AMPHIPODA** | | | | | | | | | | | | |
| *Hyalella azteca* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 1 | 0 | 0 | 0 |
| **HEXAPODA** | | | | | | | | | | | | |
| **Ephemeroptera** | | | | | | | | | | | | |
| *Acentrella* sp. | 0 | 1 | 0 | 0 | 24 | 7 | 20 | 2 | 4 | 140 | 19 | 0 |
| *Acerpenna* sp. | | | | | | | | | | | | |
| *Baetis* sp. | 246 | 463 | 41 | 6 | 127 | 1158 | 1759 | 650 | 1096 | 1598 | 402 | 41 |
| *Caenis* sp. | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 | 1 | 4 | 0 |
| *Ephemerella* sp. | 1 | 0 | 0 | 0 | 0 | 3 | 40 | 2 | 21 | 65 | 4 | 0 |
| *Ephemera* sp. | | | | | | | | | | | | |
| *Epeorus* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Heptagenia* sp. | 46 | 26 | 0 | 10 | 11 | 269 | 32 | 114 | 444 | 164 | 199 | 2 |
| *Rhithrogena* sp. | 68 | 35 | 1 | 2 | 3 | 115 | 11 | 2 | 272 | 36 | 41 | 0 |
| *Stenonema* sp. | 89 | 32 | 30 | 60 | 103 | 447 | 200 | 382 | 713 | 363 | 634 | 3 |
| *Paraleptophlebia* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 5 | 0 | 0 |
| *Tricorythodes* sp. | 44 | 12 | 3 | 4 | 36 | 146 | 56 | 54 | 384 | 52 | 138 | 0 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Cluny

| | Neill Cylinder | | | | | Kick | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB0020 | 06SWB0021 | 06SWB0022 | 06SWB0023 | 06SWB0024 | 06SWB0038 | 06SWB0039 | 06SWB0040 | 06SWB0042 | 06SWB0043 | 06SWB0044 | 06SWB0056 |
| **TAXA** | | | | | | Erosional 210µm | Erosional 210µm | Erosional 210µm | Erosional 400µm | Erosional 400µm | Erosional 400µm | Depositional 210µm |
| **Plecoptera** | | | | | | | | | | | | |
| *Claassenia* sp. | 4 | 2 | 0 | 1 | 0 | 10 | 2 | 1 | 34 | 1 | 2 | 0 |
| *Cultus* sp. | | | | | | | | | | | | |
| *Isogenoides* sp. | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 1 | 0 | 0 |
| *Isoperla* sp. | 28 | 73 | 2 | 9 | 22 | 166 | 22 | 130 | 257 | 76 | 121 | 0 |
| *Skwala* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Taenionema* sp. | | | | | | | | | | | | |
| **Trichoptera** | | | | | | | | | | | | |
| *Brachycentrus* sp. | 1 | 13 | 0 | 13 | 5 | 12 | 5 | 7 | 22 | 9 | 20 | 0 |
| *Culoptila* sp. | | | | | | | | | | | | |
| *Hydroptila* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cheumatopsyche* sp. | 79 | 92 | 22 | 39 | 46 | 59 | 24 | 6 | 80 | 17 | 18 | 1 |
| *Hydropsyche* sp. | 168 | 357 | 19 | 42 | 121 | 386 | 188 | 75 | 513 | 74 | 62 | 0 |
| *Helicopsyche* sp. | 3 | 9 | 8 | 4 | 26 | 2 | 0 | 5 | 7 | 0 | 9 | 0 |
| *Lepidostoma* sp. | 0 | 0 | 0 | 1 | 1 | 5 | 0 | 0 | 23 | 0 | 1 | 0 |
| *Nectopsyche* sp. | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 9 | 2 | 28 | 19 | 1 |
| *Oecetis* sp. | 5 | 4 | 2 | 27 | 25 | 2 | 2 | 3 | 2 | 20 | 31 | 0 |
| *Neureclipsis* sp. | 0 | 0 | 0 | 14 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Psychomyia* sp. | 1 | 0 | 0 | 11 | 1 | 0 | 0 | 0 | 20 | 0 | 4 | 0 |
| **Odonata** | | | | | | | | | | | | |
| *Ophiogomphus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Hemiptera** | | | | | | | | | | | | |
| *Callicorixa audeni* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 9 |
| *Cenocorixa bifida* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 13 |
| *Hesperocorixa vulgaris* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| *Sigara alternata* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| *S. bicoloripennis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| *S. conocephala* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| *S. grossolineata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| *S. lineata* | | | | | | | | | | | 0 | 0 |
| *S. solensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| *S.washingtonensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| *Trichocorixa borealis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| **Coleoptera** | | | | | | | | | | | | |
| *Liodessus* sp. | 0 | 0 | 1 | 0 | 0 | 2 | 6 | 7 | 4 | 21 | 8 | 0 |
| *Stictotarsus* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dubiraphia* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Optioservus* sp. | 512 | 304 | 130 | 274 | 204 | 1080 | 446 | 344 | 799 | 651 | 597 | 0 |
| **Diptera** | | | | | | | | | | | | |
| *Atherix* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Bezzia / Palpomyia* gp spp. | 0 | 0 | 10 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Hemerodromia* sp. | 15 | 62 | 21 | 23 | 2 | 157 | 44 | 3 | 168 | 28 | 64 | 0 |
| *Simulium* sp. | 0 | 10 | 0 | 0 | 0 | 0 | 40 | 0 | 20 | 40 | 0 | 0 |
| *Dicranota* sp. | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 |
| *Hexatoma* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Chironomidae** | | | | | | | | | | | | |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

## Cluny

| | Neill Cylinder | | | | | Kick | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB0020 | 06SWB0021 | 06SWB0022 | 06SWB0023 | 06SWB0024 | 06SWB0038 | 06SWB0039 | 06SWB0040 | 06SWB0042 | 06SWB0043 | 06SWB0044 | 06SWB0056 |
| TAXA | | | | | | Erosional 210µm | Erosional 210µm | Erosional 210µm | Erosional 400µm | Erosional 400µm | Erosional 400µm | Depositional 210µm |
| **Chironomini** | | | | | | | | | | | | |
| *Chironomus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 101 |
| *Cryptochironomus* sp. | 12 | 0 | 24 | 32 | 26 | 40 | 0 | 0 | 0 | 20 | 40 | 0 |
| *Cyphomella* sp. | | | | | | | | | | | | |
| *Demicryptochironomus* sp. | | | | | | | | | | | | |
| *Dicrotendipes* sp. | 0 | 1 | 9 | 10 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 |
| *Microtendipes* sp. | 44 | 8 | 55 | 59 | 56 | 48 | 41 | 44 | 41 | 24 | 74 | 0 |
| *Phaenopsectra* sp. | 10 | 0 | 0 | 0 | 0 | 40 | 0 | 40 | 0 | 0 | 80 | 2 |
| *Polypedilum* spp. | 226 | 101 | 242 | 432 | 261 | 1120 | 320 | 600 | 250 | 20 | 120 | 40 |
| *Sergentia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| *Tribelos* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Tanytarsini** | | | | | | | | | | | | |
| *Cladotanytarsus* sp. | 243 | 90 | 233 | 612 | 230 | 681 | 242 | 40 | 320 | 120 | 340 | 0 |
| *Micropsectra* sp. | 30 | 0 | 0 | 0 | 0 | 0 | 122 | 0 | 40 | 60 | 61 | 42 |
| *Paratanytarsus* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 360 | 0 | 0 | 0 | 0 | 0 |
| *Rheotanytarsus* sp. | 755 | 424 | 203 | 12 | 222 | 694 | 3 | 42 | 416 | 287 | 105 | 0 |
| *Stempellinella* sp. | | | | | | | | | 0 | 20 | 0 | 40 |
| *Tanytarsus* sp. | 50 | 60 | 88 | 230 | 80 | 2760 | 1320 | 3960 | 340 | 100 | 284 | 81 |
| **Diamesinae** | | | | | | | | | | | | |
| *Diamesa* sp. | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Potthastia longimana* gp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Orthocladiinae** | | | | | | | | | | | | |
| *Brillia* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 |
| *Cricotopus/Orthocladius* spp. | 824 | 1019 | 728 | 505 | 488 | 3509 | 2249 | 1785 | 2662 | 2625 | 2541 | 47 |
| *Eukiefferiella* sp. | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nanocladius* sp. | 0 | 0 | 0 | 0 | 1 | 40 | 0 | 80 | 0 | 0 | 20 | 0 |
| *Parakiefferriella* sp. | 0 | 10 | 0 | 0 | 10 | 0 | 1 | 40 | 0 | 0 | 40 | 0 |
| *Thienemanniella* sp. | 1 | 10 | 0 | 0 | 0 | 161 | 42 | 80 | 50 | 69 | 80 | 40 |
| *Tvetenia* sp. | 133 | 235 | 20 | 0 | 41 | 87 | 244 | 80 | 0 | 0 | 0 | 0 |
| **Tanypodinae** | | | | | | | | | | | | |
| *Procladius* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| *Thienemannimyia* gp. sp. | 265 | 136 | 126 | 260 | 284 | 1160 | 393 | 297 | 194 | 216 | 321 | 0 |
| **Total Taxa** | **42** | **38** | **34** | **42** | **39** | **48** | **38** | **41** | | | **51** | **39** |
| **Total Numbers** | **4855** | **4974** | **3542** | **4645** | **3965** | **30746** | **15027** | **24854** | | | **7589** | **37274** |

**OTHERS**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Longnose Dace | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 5 | 4 | 1 | 2 |

Bryozoa present in sample but not counted

Oligochaeta egg capsules present in sample but not counted

# Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006)

## Ronalane

| | Neill Cylinder | | | | | Kick | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | 06SWB0026 | 06SWB0027 | 06SWB0028 | 06SWB0029 | 06SWB0030 | 06SWB0046 | 06SWB0047 | 06SWB0048 | 06SWB0050 | 06SWB0051 | 06SWB0052 | 06SWB0057 |
| **TAXA** | | | | | | Erosional 210µm | Erosional 210µm | Erosional 210µm | Erosional 400µm | Erosional 400µm | Erosional 400µm | Depositional 210µm |
| **CNIDARIA** | | | | | | | | | | | | |
| *Hydra* sp. | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TURBELLARIA** | | | | | | | | | | | | |
| Microturbellaria | 20 | 100 | 40 | 50 | 80 | 40 | 360 | 720 | 0 | 0 | 0 | 160 |
| *Dugesia tigrina* | 161 | 22 | 120 | 91 | 97 | 457 | 135 | 782 | 495 | 105 | 428 | 6 |
| **NEMATODA** | 576 | 241 | 223 | 293 | 122 | 524 | 240 | 322 | 83 | 126 | 44 | 680 |
| **OLIGOCHAETA** | | | | | | | | | | | | |
| Enchytraeidae | 0 | 0 | 0 | 0 | 40 | 4 | 42 | 1 | 2 | 85 | 1 | 0 |
| Lumbricidae | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| Naididae | 1947 | 2220 | 2471 | 1216 | 2488 | 10943 | 11878 | 10066 | 10106 | 12857 | 9285 | 1048 |
| Tubificidae | 161 | 708 | 137 | 142 | 324 | 1145 | 228 | 994 | 1066 | 443 | 2058 | 6729 |
| **HIRUDINEA** | | | | | | | | | | | | |
| *Helobdella stagnalis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Nephelopsis obscura* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **GASTROPODA** | | | | | | | | | | | | |
| *Fossaria* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 |
| *Ferrissia* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 40 | 0 |
| *Physa* sp. | 0 | 0 | 1 | 0 | 1 | 3 | 1 | 2 | 7 | 3 | 43 | 0 |
| **PELECYPODA** | | | | | | | | | | | | |
| *Lampsilis radiata siliquoidea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Pisidium* sp. | 30 | 6 | 3 | 2 | 2 | 122 | 50 | 159 | 270 | 79 | 149 | 268 |
| *Sphaerium* sp. | 0 | 0 | 0 | 3 | 14 | 9 | 1 | 3 | 10 | 16 | 10 | 0 |
| **ARACHNIDA** | | | | | | | | | | | | |
| **Hydracarina** | 80 | 0 | 20 | 0 | 20 | 120 | 40 | 40 | 0 | 0 | 40 | 0 |
| **CRUSTACEA** | | | | | | | | | | | | |
| **OSTRACODA** | | | | | | | | | | | | |
| *Candona* sp. | 60 | 20 | 40 | 10 | 60 | 40 | 161 | 280 | 0 | 0 | 40 | 480 |
| *Cypridopsis* sp. | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| *Ilyocypris* sp. | 440 | 490 | 540 | 100 | 800 | 11564 | 7203 | 9766 | 5840 | 3040 | 4480 | 2128 |
| *Limnocythere* sp. | 260 | 210 | 360 | 380 | 500 | 2840 | 2640 | 3640 | 0 | 0 | 0 | 1120 |
| Unidentified Ostracoda | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CLADOCERA** | | | | | | | | | | | | |
| *Bosmina* sp. | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ilyocryptus* sp. | 60 | 50 | 80 | 20 | 120 | 440 | 1160 | 600 | 600 | 1000 | 360 | 200 |
| *Macrothrix* sp. | 20 | 20 | 0 | 10 | 0 | 40 | 40 | 40 | 0 | 0 | 0 | 40 |
| Chydoridae | 20 | 0 | 20 | 0 | 20 | 40 | 0 | 0 | 0 | 0 | 0 | 40 |
| **COPEPODA** | | | | | | | | | | | | |
| Cyclopoida | 220 | 110 | 280 | 100 | 300 | 1160 | 1761 | 840 | 40 | 0 | 0 | 11240 |
| **AMPHIPODA** | | | | | | | | | | | | |
| *Gammarus lacustris* | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 4 | 4 | 10 | 1 |
| *Hyalella azteca* | 42 | 49 | 23 | 4 | 5 | 158 | 165 | 109 | 316 | 525 | 341 | 6 |
| **DECAPODA** | | | | | | | | | | | | |
| *Orconectes virilis* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **HEXAPODA** | | | | | | | | | | | | |
| **Collembolla** | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 40 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

## Ronalane

| | Neill Cylinder | | | | | Kick | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0026** | **06SWB0027** | **06SWB0028** | **06SWB0029** | **06SWB0030** | **06SWB0046** | **06SWB0047** | **06SWB0048** | **06SWB0050** | **06SWB0051** | **06SWB0052** | **06SWB0057** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 210µm | Erosional 210µm | Erosional 400µm | Erosional 400µm | Erosional 400µm | Depositional 210µm |
| **Ephemeroptera** | | | | | | | | | | | | |
| *Acentrella* sp. | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 1 | 6 | 4 | 0 | 0 |
| *Acerpenna* sp. | 0 | 0 | 0 | 0 | 0 | 120 | 1 | 40 | 0 | 0 | 0 | 0 |
| *Baetis* sp. | 0 | 0 | 0 | 0 | 0 | 53 | 3 | 0 | 41 | 87 | 1 | 0 |
| *Fallceon* sp. | 0 | 10 | 0 | 1 | 0 | 88 | 45 | 43 | 12 | 5 | 44 | 0 |
| *Procloeon* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| *Caenis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 0 |
| *Ephemerella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |
| *Ephemera* sp. | 3 | 0 | 2 | 1 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |
| *Epeorus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Heptagenia* sp. | 0 | 1 | 0 | 0 | 0 | 5 | 0 | 1 | 6 | 15 | 4 | 0 |
| *Stenonema* sp. | 23 | 0 | 1 | 0 | 0 | 14 | 4 | 5 | 23 | 138 | 16 | 1 |
| *Leptophlebia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Tricorythodes* sp. | 9 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 8 | 9 | 4 | 0 |
| **Plecoptera** | | | | | | | | | | | | |
| *Acroneuria* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| *Claassenia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| *Isoperla* sp. | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 |
| **Trichoptera** | | | | | | | | | | | | |
| *Agraylea* sp. | | | | | | | | | 8 | 0 | 4 | 0 |
| *Hydroptila* sp. | 63 | 10 | 40 | 0 | 40 | 40 | 80 | 41 | 80 | 1 | 16 | 0 |
| *Cheumatopsyche* sp. | 5 | 0 | 1 | 0 | 0 | 3 | 4 | 1 | 1 | 13 | 45 | 0 |
| *Hydropsyche* sp. | 1 | 1 | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 3 | 3 | 1 |
| *Helicopsyche* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Nectopsyche* sp. | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 5 | 2 | 0 |
| *Oecetis* sp. | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 0 |
| *Polycentropus* sp. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Odonata** | | | | | | | | | | | | |
| *Ophiogomphus* sp. | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| Coenagrionidae sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Hemiptera** | | | | | | | | | | | | |
| Corixidae sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Callicorixa audeni* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 2 |
| *Cenocorixa bifida* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| *Hesperocorixa vulgaris* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Sigara alternata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 18 |
| *S. bicoloripennis* | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 32 |
| *S. conocephala* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *S. grossolineata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *S. lineata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 |
| *S. solensis* | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 55 |
| *S. trilineata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *S.washingtonensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Sigara sp.* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Trichocorixa borealis* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Ronalane

| | Neill Cylinder | | | | | Kick | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0026** | **06SWB0027** | **06SWB0028** | **06SWB0029** | **06SWB0030** | **06SWB0046** | **06SWB0047** | **06SWB0048** | **06SWB0050** | **06SWB0051** | **06SWB0052** | **06SWB0057** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 210µm | Erosional 210µm | Erosional 400µm | Erosional 400µm | Erosional 400µm | Depositional 210µm |
| **Coleoptera** | | | | | | | | | | | | |
| *Liodessus* sp. | 3 | 0 | 3 | 0 | 1 | 65 | 41 | 22 | 63 | 105 | 56 | 4 |
| *Haliplus* sp. | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Dubiraphia* sp. | 0 | 0 | 21 | 1 | 1 | 40 | 1 | 0 | 0 | 0 | 1 | 1 |
| *Optioservus* sp. | 10 | 2 | 26 | 11 | 22 | 33 | 58 | 59 | 166 | 347 | 160 | 0 |
| **Lepidoptera** | | | | | | | | | | | | |
| *Petrophila* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 1 | 0 |
| **Diptera** | | | | | | | | | | | | |
| Ceratopogonidae sp. | 0 | 0 | 0 | 0 | 0 | 44 | 0 | 43 | 124 | 0 | 120 | 40 |
| *Bezzia / Palpomyia* gp spp. | 46 | 32 | 2 | 3 | 2 | 128 | 10 | 115 | 255 | 197 | 267 | 103 |
| *Culicoides* sp. | 81 | 50 | 0 | 20 | 60 | 332 | 324 | 123 | 406 | 246 | 128 | 0 |
| *Rhaphium* sp. | 0 | 0 | 0 | 0 | 1 | 6 | 1 | 3 | 4 | 11 | 9 | 0 |
| Ephydridae sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Simulium* sp. | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 46 | 0 | 0 |
| Tipulidae sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 |
| *Dicranota* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ormosia* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 4 | 1 | 0 |
| *Tipula* sp. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Muscidae sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| Brachycera Diptera sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 0 |
| **Chironomidae** | | | | | | | | | | | | |
| **Chironomini** | | | | | | | | | | | | |
| *Chironomus* sp. | 2 | 12 | 0 | 4 | 4 | 0 | 1 | 0 | 3 | 3 | 1 | 2 |
| *Cryptochironomus* sp. | 211 | 50 | 66 | 81 | 80 | 97 | 43 | 85 | 237 | 142 | 270 | 0 |
| *Demicryptochironomus* sp. | 2 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dicrotendipes* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| *Microtendipes* sp. | 5 | 0 | 3 | 1 | 1 | 1 | 0 | 1 | 50 | 17 | 5 | 0 |
| *Paralauterborniella* sp. | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 40 | 0 | 0 | 120 | 0 |
| *Phaenopsectra* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 |
| *Polypedilum* spp. | 426 | 0 | 341 | 20 | 20 | 12 | 1 | 161 | 44 | 81 | 80 | 0 |
| *Stictochironomus* sp. | 24 | 20 | 1 | 23 | 16 | 34 | 5 | 6 | 100 | 25 | 36 | 0 |
| **Tanytarsini** | | | | | | | | | | | | |
| *Cladotanytarsus* sp. | 4764 | 634 | 3363 | 331 | 620 | 5821 | 2248 | 3174 | 6280 | 4892 | 4991 | 81 |
| *Micropsectra* sp. | 0 | 0 | 0 | 1 | 40 | 58 | 7 | 1 | 48 | 54 | 90 | 41 |
| *Paratanytarsus* sp. | 21 | 70 | 20 | 10 | 40 | 121 | 200 | 121 | 200 | 80 | 205 | 0 |
| *Rheotanytarsus* sp. | 20 | 0 | 0 | 0 | 0 | 40 | 0 | 80 | 40 | 0 | 0 | 0 |
| *Tanytarsus* sp. | 200 | 40 | 620 | 50 | 20 | 124 | 320 | 245 | 212 | 81 | 96 | 40 |
| **Diamesinae** | | | | | | | | | | | | |
| *Potthastia longimana* gp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |

## Appendix 2 Raw benthic invertebrate data from the Bow River, October 2006 (con't)

### Ronalane

| | Neill Cylinder | | | | | Kick | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | **06SWB0026** | **06SWB0027** | **06SWB0028** | **06SWB0029** | **06SWB0030** | **06SWB0046** | **06SWB0047** | **06SWB0048** | **06SWB0050** | **06SWB0051** | **06SWB0052** | **06SWB0057** |
| **TAXA** | | | | | | Erosional 210µm | Erosional 210µm | Erosional 210µm | Erosional 400µm | Erosional 400µm | Erosional 400µm | Depositional 210µm |
| **Orthocladiinae** | | | | | | | | | | | | |
| *Cricotopus/Orthocladius* spp. | 1475 | 176 | 1254 | 99 | 254 | 931 | 699 | 1322 | 671 | 1327 | 778 | 4 |
| *Parakiefferriella* sp. | 0 | 40 | 140 | 70 | 120 | 200 | 360 | 640 | 248 | 400 | 444 | 40 |
| *Parametriocnemus* sp. | 0 | 0 | 20 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| *Pseudosmittia* sp. | 0 | 0 | 20 | 0 | 0 | 0 | 41 | 81 | 40 | 84 | 56 | 0 |
| *Smittia* sp. | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synorthocladius sp.* | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Thienemanniella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 40 | 44 | 0 | 0 | 0 |
| Unidentified Orthocladiinae sp. | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Tanypodinae** | | | | | | | | | | | | |
| *Thienemannimyia* gp. sp. | 192 | 20 | 131 | 3 | 60 | 127 | 161 | 268 | 68 | 186 | 81 | 40 |
| **Total Taxa** | **47** | **31** | **40** | **34** | **40** | **56** | **53** | **54** | **57** | **49** | **57** | **46** |
| **Total Numbers** | **11790** | **5425** | **10460** | **3162** | **6400** | **38288** | **30899** | **35176** | **28366** | **26898** | **25482** | **24881** |

**OTHERS**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Longnose Dace | 1 | 0 | 0 | 0 | 0 | 3 | 5 | 1 | 2 | 3 | 5 | 0 |
| Curculionidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Staphyliniidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |

Bryozoa present in sample but not counted

## Appendix 3 Raw epilithic algal data for the Bow River (Fall 2006)

Epilithic algal density (number of units/cm$^2$) and biomass (micrograms/cm$^2$) at sampling sites on Bow River

| Site ID | Cochrane | | Stier's Ranch | | Carseland | | Cluny | | | | | | Ronalane | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Upstream of bridge | | Downstream of bridge/Right bank | | Downstream of bridge/Left bank | | Upstream of bridge | | Downstream of bridge/Rt. Bank | | Downstream of bridge/Left Bank | |
| **Sample Number** | **06SWEE006** | | **06SWEE007** | | **06SWEE008** | | **06SWEE010** | | **06SWEE011** | | **06SWEE0009** | | **06SWEE0013** | | **06SWEE0015** | | **06SWEE0016** | |
| Sampling Date | 16-Oct-06 | | 17-Oct-06 | | 17-Oct-06 | | 18-Oct-06 | | 18-Oct-06 | | 18-Oct-06 | | 19-Oct-06 | | 19-Oct-06 | | 19-Oct-06 | |
| | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass |
| | aep-06 | aep-06 | aep-07 | aep-07 | aep-08 | aep-08 | aep-09 | aep-09 | aep-10 | aep-10 | aep-11 | aep-11 | aep-12 | aep-12 | aep-13 | aep-13 | aep-14 | aep-14 |
| **DIATOMS** | | | | | | | | | | | | | | | | | | |
| *Achnanthes flexella* (Kuetzing) Braun | 6673 | 1.201 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Achnanthes lanceolata* (Brebisson) Grunow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 0.292 | 0 | 0 | 0 | 0 |
| *Achnanthes minutissima* Kuetzing | 1955281 | 79.189 | 1221217 | 35.721 | 2462454 | 157.597 | 930927 | 59.579 | 588920 | 18.551 | 1574902 | 88.195 | 592673 | 18.669 | 464907 | 14.645 | 745075 | 26.823 |
| *Amphora pediculus* (Kuetzing) Grunow | 0 | 0 | 32031 | 0.596 | 26693 | 0.466 | 6005 | 0.098 | 3336 | 0.05 | 26693 | 0.435 | 5839 | 0.109 | 8452 | 0.118 | 22021 | 0.41 |
| *Anomoeoneis vitrea* (Grunow) Ross | 106773 | 13.347 | 12011 | 1.501 | 20019 | 3.964 | 6005 | 0.863 | 3336 | 0.751 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Caloneis bacillum* (Grunow) Cleve | 13346 | 2.502 | 0 | 0 | 20019 | 1.441 | 6005 | 0.676 | 0 | 0 | 5338 | 0.342 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cocconeis pediculus* Ehrenberg | 0 | 0 | 0 | 0 | 146812 | 396.395 | 42041 | 197.071 | 0 | 0 | 21354 | 14.212 | 61311 | 310.847 | 33811 | 171.424 | 5505 | 32.372 |
| *Cocconeis placentula var lineata (Ehrenberg) Van Heurck* | 0 | 0 | 96095 | 43.243 | 213546 | 129.195 | 6005 | 3.634 | 13346 | 8.882 | 0 | 0 | 20437 | 17.715 | 2113 | 1.826 | 5505 | 6.048 |
| *Cocconeis placentula var. euglypta (Ehrenberg) Grunow* | 0 | 0 | 4003 | 2.883 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 2.312 | 2113 | 1.674 | 0 | 0 |
| *Cyclotella atomus* Hustedt | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1668 | 0.018 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cyclotella distiguenda* (Hustedt) Hakansson & Carter | 13346 | 5.241 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cyclotella hakanssoniae* Wendker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 0.104 | 0 | 0 |
| *Cyclotella meneghiniana* Kuetzing | 0 | 0 | 0 | 0 | 13346 | 9.057 | 3002 | 3.236 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1835 | 1.245 |
| *Cyclotella ocellata* Pantocsek | 0 | 0 | 0 | 0 | 0 | 0 | 3002 | 0.147 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cyclotella pseudostelligera Hustedt* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 0.143 | 2113 | 0.104 | 0 | 0 |
| *Cymbella affinis* Kuetzing | 0 | 0 | 0 | 0 | 33366 | 2.378 | 18017 | 2.653 | 3336 | 0.704 | 26693 | 5.824 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cymbella caespitosa (Kuetzing) Brun* | 0 | 0 | 0 | 0 | 427092 | 134.175 | 282281 | 88.681 | 61728 | 19.392 | 101434 | 31.867 | 55471 | 17.427 | 19018 | 5.975 | 20186 | 6.765 |
| *Cymbella microcephala* Grunow | 373705 | 10.871 | 12011 | 0.349 | 46713 | 1.359 | 114113 | 3.319 | 31698 | 0.922 | 80079 | 2.184 | 735733 | 21.402 | 215548 | 5.878 | 234900 | 6.833 |
| *Cymbella minuta* Hilse | 13346 | 0.485 | 48047 | 2.516 | 80079 | 3.774 | 105104 | 6.742 | 31698 | 2.259 | 42709 | 3.044 | 8758 | 0.624 | 2113 | 0.111 | 5505 | 0.392 |
| *Cymbella perpusilla* Cleve Euler | 46713 | 1.699 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cymbella silesiaca* Bleisch ex. Rabenhorst | 13346 | 3.106 | 12011 | 2.446 | 33366 | 5.503 | 6005 | 1.31 | 1668 | 0.587 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cymbella sinuata Gregory* | 0 | 0 | 12011 | 0.328 | 26693 | 0.582 | 12011 | 0.262 | 11678 | 0.276 | 21354 | 0.466 | 8758 | 0.191 | 2113 | 0.058 | 1835 | 0.05 |
| *Denticula subtilis* Grunow | 33366 | 3.754 | 8007 | 1.001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Diatoma moniliformis* Kuetzing | 173506 | 20.604 | 128127 | 15.215 | 113446 | 12.763 | 222221 | 15.111 | 76743 | 9.593 | 501833 | 62.729 | 87587 | 3.162 | 35924 | 4.491 | 44043 | 5.23 |
| *Diatoma tenuis* Agardh | 20019 | 3.604 | 0 | 0 | 6673 | 0.901 | 0 | 0 | 0 | 0 | 21354 | 1.297 | 0 | 0 | 0 | 0 | 7340 | 0.826 |
| *Diatoma vulgaris* Bory | 0 | 0 | 4003 | 5.205 | 220219 | 372.611 | 0 | 0 | 0 | 0 | 0 | 0 | 11678 | 20.18 | 14792 | 17.751 | 23857 | 42.943 |
| *Didymosphaeria germinata* (Lyngyb.) M. Schmidt | 6673 | 313.744 | 0 | 0 | 13346 | 418.125 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fragilaria brevistriata* Grunow | 13346 | 0.32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17517 | 0.911 | 0 | 0 | 0 | 0 |
| *Fragilaria capucina* Desmazieres | 186852 | 67.267 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 282948 | 20.372 | 11678 | 0.788 | 101434 | 22.316 | 31197 | 5.241 |
| *Fragilaria pinnata* (Ehrenberg) | 20019 | 0.48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fragilaria vaucheriae (Kuetzing) Petersen* | 13346 | 0.427 | 0 | 0 | 6673 | 0.4 | 246245 | 16.745 | 100099 | 7.207 | 0 | 0 | 96346 | 6.937 | 48603 | 3.694 | 14681 | 1.835 |
| *Gomphonema minutum* (Agardh) Agardh | 0 | 0 | 4003 | 0.847 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gomphonema olivaceum* (Hornemann) Brebisson | 0 | 0 | 20019 | 10.996 | 46713 | 11.9 | 12011 | 2.661 | 0 | 0 | 16015 | 8.21 | 8758 | 5.939 | 2113 | 1.161 | 5505 | 2.389 |
| *Gomphonema parvulum* Kuetzing | 0 | 0 | 4003 | 0.717 | 0 | 0 | 3002 | 0.489 | 1668 | 0.339 | 26693 | 4.779 | 14597 | 2.97 | 4226 | 0.757 | 0 | 0 |
| *Gomphonema pumilum* (Grunow) Reichardt & Lange-Bertalot | 166832 | 25.025 | 24023 | 1.564 | 26693 | 3.318 | 0 | 0 | 0 | 0 | 5338 | 0.603 | 11678 | 0.76 | 0 | 0 | 0 | 0 |
| *Gomphonema sp* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 0.516 | 0 | 0 |
| *Melosira varians* (Agardh) | 0 | 0 | 0 | 0 | 33366 | 52.412 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Naviucula capitatoradiata* Germain | 0 | 0 | 4003 | 2.434 | 266932 | 189.189 | 30029 | 18.258 | 10009 | 6.086 | 16015 | 9.738 | 35034 | 21.301 | 8452 | 5.139 | 14681 | 8.926 |
| *Navicula cincta* (Ehrenberg) Ralfs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26276 | 5.912 | 4226 | 2.029 | 3670 | 0.925 |
| *Navicula cryptocephala* Kuetzing | 0 | 0 | 4003 | 2.05 | 6673 | 3.203 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1835 | 0.719 |
| *Navicula cryptotenella* (Lange-Bertalot) | 26693 | 3.337 | 208207 | 37.477 | 240239 | 43.243 | 60059 | 11.892 | 6673 | 1.201 | 64063 | 11.531 | 72989 | 9.124 | 54943 | 6.868 | 139472 | 25.105 |
| *Navicula gregaria* Donkin | 0 | 0 | 12011 | 3.679 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 0.683 | 0 | 0 | 1835 | 0.413 |

## Appendix 3 Raw epilithic algal data for the Bow River (Fall 2006) (con't)

| Site ID | Cochrane | | Stier's Ranch | | Carseland | | Cluny | | | | | | Ronalane | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Upstream of bridge | | Downstream of bridge/Right bank | | Downstream of bridge/Left bank | | Upstream of bridge | | Downstream of bridge/Rt. Bank | | Downstream of bridge/Left Bank | |
| **Sample Number** | **06SWEE006** | | **06SWEE007** | | **06SWEE008** | | **06SWEE010** | | **06SWEE011** | | **06SWEE0009** | | **06SWEE0013** | | **06SWEE0015** | | **06SWEE0016** | |
| Sampling Date | 16-Oct-06 | | 17-Oct-06 | | 17-Oct-06 | | 18-Oct-06 | | 18-Oct-06 | | 18-Oct-06 | | 19-Oct-06 | | 19-Oct-06 | | 19-Oct-06 | |
| | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass |
| | aep-06 | aep-06 | aep-07 | aep-07 | aep-08 | aep-08 | aep-09 | aep-09 | aep-10 | aep-10 | aep-11 | aep-11 | aep-12 | aep-12 | aep-13 | aep-13 | aep-14 | aep-14 |
| *Navicula margalithii* Lange-Bertalot | 0 | 0 | 76075 | 89.389 | 260259 | 338.337 | 9008 | 11.712 | 3336 | 4.338 | 5338 | 6.673 | 5839 | 7.299 | 0 | 0 | 1835 | 2.294 |
| *Navicula menisculus* Schumann | 0 | 0 | 0 | 0 | 0 | 0 | 3002 | 0.405 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1835 | 2.147 |
| *Navicula miniscula* Grunow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1668 | 0.104 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Navicula notha* Wallace | 0 | 0 | 0 | 0 | 113446 | 14.181 | 18017 | 2.595 | 1668 | 0.188 | 5338 | 0.601 | 2919 | 0.511 | 4226 | 0.475 | 3670 | 0.413 |
| *Navicula schroeterii Meister* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 1.014 | 0 | 0 |
| *Navicula subminiscula* Mangiun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 0.132 | 0 | 0 |
| *Navicula veneta Kuetzing* | 0 | 0 | 4003 | 0.721 | 0 | 0 | 3002 | 0.338 | 0 | 0 | 0 | 0 | 72989 | 9.124 | 19018 | 2.377 | 20186 | 2.523 |
| *Nitzschia acicularis* (Kuetzing) W. Smith | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8758 | 1.331 | 4226 | 0.558 | 0 | 0 |
| *Nitzschia amphibia* Grunow | 0 | 0 | 28027 | 3.153 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3670 | 0.459 |
| *Nitzschia angustata* Grunow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5839 | 1.277 | 4226 | 1.057 | 3670 | 0.826 |
| *Nitzschia angustatula* Lange-Bertalot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 0.264 | 3670 | 0.264 |
| *Nitzschia dissipata* (Hantzsch) Grunow | 0 | 0 | 0 | 0 | 60059 | 15.015 | 30029 | 5.631 | 8341 | 1.168 | 0 | 0 | 5839 | 0.584 | 8452 | 2.219 | 14681 | 3.854 |
| *Nitzschia fonticola* Grunow | 0 | 0 | 84083 | 5.381 | 73406 | 8.258 | 0 | 0 | 0 | 0 | 0 | 0 | 5839 | 0.42 | 0 | 0 | 0 | 0 |
| *Nitzschia frustulum* (Kuetzing) Grunow | 0 | 0 | 16015 | 2.002 | 0 | 0 | 12011 | 0.865 | 0 | 0 | 0 | 0 | 58391 | 4.204 | 14792 | 1.757 | 3670 | 0.413 |
| *Nitzschia gracilis* Hantzsch | 0 | 0 | 0 | 0 | 0 | 0 | 6005 | 1.153 | 0 | 0 | 0 | 0 | 11678 | 2.803 | 0 | 0 | 9175 | 2.496 |
| *Nitzschia heufleriana* Grunow | 0 | 0 | 0 | 0 | 6673 | 5.839 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nitzschia inconspicua* Grunow | 0 | 0 | 24023 | 0.378 | 0 | 0 | 6005 | 0.068 | 0 | 0 | 0 | 0 | 14597 | 0.197 | 0 | 0 | 0 | 0 |
| *Nitzschia palea* (Kuetzing) W. Smith | 0 | 0 | 0 | 0 | 0 | 0 | 18017 | 2.595 | 0 | 0 | 0 | 0 | 0 | 0 | 8452 | 1.082 | 3670 | 0.617 |
| *Nitzschia perminuta* Lange-Bertalot | 20019 | 1.842 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nitzschia paleacae* Grunow | 13346 | 0.721 | 88087 | 8.456 | 93426 | 5.045 | 18017 | 6.284 | 8341 | 0.45 | 5338 | 0.288 | 40874 | 2.207 | 12679 | 0.685 | 22021 | 2.026 |
| *Nitzschia sinuata var tabellaria* (Grunow) Grunow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1835 | 0.45 |
| *Rhoicosphenia abbreviata* (Agardh) Lange-Bertalot | 0 | 0 | 44043 | 7.885 | 33366 | 3.205 | 15014 | 2.291 | 6673 | 1.412 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rhopalodia gibba* var *minuta* Krammer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 0.604 | 0 | 0 | 0 | 0 |
| *Stephanodiscus minutulus* (Kuetzing) Cleve & Mueller | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Stephanodiscus parvus* Stoermer & Hakansson | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 1.526 | 0 | 0 | 0 | 0 |
| *Surirella minuta* Brebisson | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 1.337 | 0 | 0 |
| *Synedra filiformis* Grunow | 0 | 0 | 0 | 0 | 0 | 0 | 3002 | 0.192 | 0 | 0 | 0 | 0 | 75908 | 9.394 | 8452 | 1.065 | 11010 | 1.486 |
| *Synedra filiformis var. exilis* Cl.-Eul. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 0.152 | 0 | 0 |
| *Synedra tenera* W. Smith | 0 | 0 | 0 | 0 | 0 | 0 | 3002 | 0.473 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synedra ulna* (Nitzsch) Ehr. | 13346 | 15.616 | 4003 | 3.924 | 26693 | 30.03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CYANOBACTERIA** | | | | | | | | | | | | | | | | | | |
| *Gloeotrichia sp* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18351 | 7.533 |
| *Leibleinia* sp | 533865 | 6.709 | 520518 | 6.541 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63396 | 0.797 | 0 | 0 |
| *Merismopedia elegans* A. Braun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16905 | 1.912 | 55054 | 3.603 |
| *Merismopedia glauca (Ehrenberg) Naegeli* | 0 | 0 | 0 | 0 | 106773 | 3.578 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Merismopedia tenusissima* Lemmermann | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 81748 | 1.156 | 0 | 0 | 0 | 0 |
| *Oscillatoria limnetica* Lemmerman | 0 | 0 | 80079 | 1.006 | 0 | 0 | 66065 | 0.83 | 0 | 0 | 0 | 0 | 551799 | 6.934 | 84528 | 1.062 | 110109 | 1.384 |
| *Phormidium formosum* (Bory ex Gomont) Anagnostidis et Komarek | 0 | 0 | 1033029 | 77.889 | 613945 | 61.721 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Phormidium* sp1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33366 | 3.354 | 0 | 0 | 0 | 0 | 21132 | 2.124 | 0 | 0 |
| *Pseudanabaena limnetica* Komarek | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22021 | 0.277 |

## Appendix 3 Raw epilithic algal data for the Bow River (Fall 2006) (con't)

| Site ID | Cochrane | | Stier's Ranch | | Carseland | | Cluny | | | | | | Ronalane | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Upstream of bridge | | Downstream of bridge/Right bank | | Downstream of bridge/Left bank | | Upstream of bridge | | Downstream of bridge/Rt. Bank | | Downstream of bridge/Left Bank | |
| **Sample Number** | **06SWEE006** | | **06SWEE007** | | **06SWEE008** | | **06SWEE010** | | **06SWEE011** | | **06SWEE0009** | | **06SWEE0013** | | **06SWEE0015** | | **06SWEE0016** | |
| Sampling Date | 16-Oct-06 | | 17-Oct-06 | | 17-Oct-06 | | 18-Oct-06 | | 18-Oct-06 | | 18-Oct-06 | | 19-Oct-06 | | 19-Oct-06 | | 19-Oct-06 | |
| | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass |
| | aep-06 | aep-06 | aep-07 | aep-07 | aep-08 | aep-08 | aep-09 | aep-09 | aep-10 | aep-10 | aep-11 | aep-11 | aep-12 | aep-12 | aep-13 | aep-13 | aep-14 | aep-14 |
| **CHLOROPHYCEAE** | | | | | | | | | | | | | | | | | | |
| *Ankistrodesmus falcatus* var. *mirabilis* West | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1668 | 0.224 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ankistrodesmus gracilis* (Reinsch) Kors. | 0 | 0 | 0 | 0 | 6673 | 0.503 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2113 | 0.049 | 0 | 0 |
| *Cosmarium meneghinii* Brebisson | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 5.992 | 0 | 0 | 0 | 0 |
| *Monoraphidium contortum* (Thuret) Komarkova-Legenerova | 0 | 0 | 0 | 0 | 0 | 0 | 15014 | 0.495 | 1668 | 0.063 | 5338 | 0.075 | 8758 | 0.33 | 2113 | 0.027 | 0 | 0 |
| *Monoraphidium griffithii (Berkeley) Komarkova-Legenerova* | 0 | 0 | 0 | 0 | 6673 | 0.629 | 3002 | 0.283 | 10009 | 1.677 | 0 | 0 | 2919 | 0.489 | 10566 | 0.996 | 7340 | 0.726 |
| *Monoraphidium minutum* (Nag.) Komarkova-Legenerova | 0 | 0 | 0 | 0 | 6673 | 0.094 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Monoraphidium pusillum* (Printz) Kom-Legn. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5004 | 0.419 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mougeotia* sp. | 20019 | 110.694 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3670 | 121.418 |
| *Oocystis solitaria* Wittrock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5338 | 1.208 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pediastrum boryanum* (Turpin) Meneghini | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 41.275 | 4226 | 607.733 | 1835 | 207.552 |
| *Pediastrum tetras* (Ehrenberg) Ralfs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2919 | 16.277 | 0 | 0 | 0 | 0 |
| *Scenedesmus acutiformis* Schroeder | 0 | 0 | 0 | 0 | 0 | 0 | 12011 | 0.453 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scenedesmus acutus* Meyen | 0 | 0 | 0 | 0 | 53386 | 4.472 | 78077 | 6.541 | 6673 | 0.447 | 154820 | 12.97 | 163496 | 25.682 | 25358 | 2.549 | 58725 | 4.92 |
| *Scenedesmus bijuga* (Turp.) Lagerheim | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5839 | 0.587 | 8452 | 0.567 | 7340 | 0.738 |
| *Scenedesmus obliquus* (Turpin) Kuetzing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 55471 | 5.577 | 48603 | 4.072 | 38538 | 3.551 |
| *Scenedesmus opoliensis* P. Richter | 0 | 0 | 16015 | 0.604 | 80079 | 8.05 | 12011 | 1.208 | 6673 | 0.671 | 0 | 0 | 52552 | 9.631 | 6339 | 0.85 | 40373 | 9.893 |
| *Scenedesmus quadricauda* (Turpin) Brebisson | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29195 | 2.446 | 42264 | 9.56 | 3670 | 0.83 |
| *Scenedesmus sempervirens* Chodat | 0 | 0 | 0 | 0 | 26693 | 2.684 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scenedesmus sp* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16905 | 1.133 | 0 | 0 |
| *Stigeoclonium* sp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53386 | 18.114 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CRYPTOPHYCEAE** | | | | | | | | | | | | | | | | | | |
| *Cryptomonas* sp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1668 | 1.118 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rhodomonas minuta* Skuja | 0 | 0 | 0 | 0 | 0 | 0 | 6005 | 1.359 | 1668 | 0.377 | 5338 | 1.208 | 2919 | 0.66 | 0 | 0 | 0 | 0 |
| **EUGLENOPHYCEAE** | | | | | | | | | | | | | | | | | | |
| *Euglena* cf. *minuta* Prescott | 0 | 0 | 0 | 0 | 6673 | 3.578 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Appendix 4 Metrics derived from benthic invertebrate data collected with a Neill cylinder and kick nets (210 and 400 µm mesh size) in erosional and depositional areas from the Bow River in Fall 2006

| | Cochrane | | | | Stier's | | | | Carseland | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metrics/Indices | NEILL | 210E | 400E | 210D | NEILL | 210E | 400E | 210D | NEILL | 210E | 400E | 210D |
| Abundance (total count) | 667 | 2112 | 337 | 1973 | 14811 | 36240 | 18438 | 13940 | 8623 | 73675 | 16571 | 61634 |
| Richness (total species) | 43 | 39 | 39 | 43 | 70 | 45 | 45 | 48 | 75 | 68 | 56 | 59 |
| Total Taxa (genus and higher) | 41 | 35 | 36 | 39 | 68 | 45 | 45 | 47 | 74 | 66 | 56 | 51 |
| Total Taxa (family and higher) | 25 | 24 | 26 | 27 | 37 | 29 | 25 | 28 | 39 | 36 | 28 | 29 |
| Simpson's Diversity Index D | 0.80 | 0.90 | 0.90 | 0.88 | 0.92 | 0.88 | 0.89 | 0.78 | 0.90 | 0.77 | 0.86 | 0.37 |
| Shannon Diversity Index H' | 2.18 | 2.60 | 2.78 | 2.57 | 2.84 | 2.55 | 2.64 | 2.16 | 2.78 | 2.20 | 2.59 | 1.05 |
| Number of Coleoptera genera | 2 | 2 | 2 | 2 | 4 | 2 | 3 | 1 | 3 | 3 | 4 | 3 |
| Number of Diptera genera (non Chironomidae) | 3 | 2 | 4 | 1 | 2 | 2 | 2 | 1 | 4 | 4 | 3 | 1 |
| Number of Chironomid genera | 14 | 10 | 10 | 11 | 22 | 15 | 16 | 17 | 27 | 24 | 21 | 17 |
| Number of Hemiptera genera | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 2 | 1 | 2 | 0 | 5 |
| Number of Odonata genera | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Number of Ephemeroptera genera | 3 | 1 | 2 | 2 | 6 | 4 | 7 | 5 | 8 | 7 | 9 | 4 |
| Number of Plecoptera genera | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 1 | 4 | 4 | 3 | 0 |
| Number of Trichoptera genera | 3 | 1 | 3 | 2 | 8 | 6 | 5 | 3 | 9 | 6 | 7 | 1 |
| Number of EPT genera | 6 | 2 | 6 | 4 | 16 | 11 | 13 | 9 | 21 | 17 | 19 | 5 |
| Number of Coleoptera families | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| Number of Diptera (non Chironomidae) families | 2 | 2 | 4 | 1 | 2 | 2 | 2 | 1 | 3 | 4 | 3 | 1 |
| Number of Chironomid subfamilies | 5 | 5 | 5 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Number of Hemiptera families | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| Number of Odonata families | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Number of Ephemeroptera families | 2 | 1 | 2 | 2 | 4 | 4 | 4 | 4 | 6 | 5 | 6 | 3 |
| Number of Plecoptera families | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 0 |
| Number of Trichoptera families | 3 | 1 | 3 | 2 | 6 | 5 | 4 | 2 | 7 | 4 | 5 | 1 |
| Number of EPT families | 5 | 2 | 6 | 4 | 12 | 10 | 9 | 7 | 15 | 11 | 13 | 4 |
| Number of ETO families | 5 | 2 | 5 | 4 | 10 | 9 | 8 | 6 | 13 | 9 | 12 | 4 |
| Proportion of Oligochaetes | 0.2908546 | 0.2386364 | 0.379822 | 0.4460213 | 0.093536 | 0.013797 | 0.027064 | 0.457102 | 0.1844455 | 0.4140618 | 0.1705992 | 0.7957459 |
| Proportion of Gastropods | 0.002099 | 0 | 0.0029674 | 0.0015205 | 0.033839 | 0.017384 | 0.056676 | 0.04462 | 0.0020643 | 0.0021853 | 0.0024742 | 0.0001785 |
| Proportion of Pelecypods | 0 | 0.0004735 | 0 | 0 | 0.00027 | 2.76E-05 | 0.003525 | 0.000574 | 4.639E-05 | 0 | 0 | 0 |
| Proportion of Amphipods | 0 | 0 | 0 | 0.0010137 | 0.0005 | 5.52E-05 | 0.001193 | 0.000646 | 2.319E-05 | 0.0005022 | 0 | 0.0009086 |
| Proportion of Coleoptera | 0.0083958 | 0.0137311 | 0.0356083 | 0.0136847 | 0.050988 | 0.057892 | 0.058412 | 7.17E-05 | 0.0276019 | 0.0113607 | 0.0260696 | 0.0009086 |
| Proportion of Diptera | 0.0722639 | 0.0677083 | 0.1869436 | 0.1282311 | 0.466195 | 0.570088 | 0.409914 | 0.267791 | 0.6079837 | 0.474245 | 0.597912 | 0.0916215 |
| Proportion of Diptera (non Chironomidae) | 0.002099 | 0.0047348 | 0.0207715 | 0.0005068 | 0.120326 | 0.064018 | 0.214665 | 0.002941 | 0.000719 | 0.003149 | 0.0126124 | 6.49E-05 |
| Proportion of Chironomids | 0.0701649 | 0.0629735 | 0.1661721 | 0.1277243 | 0.345869 | 0.506071 | 0.195249 | 0.264849 | 0.6072646 | 0.471096 | 0.5852996 | 0.0915566 |
| Proportion of Hemiptera | 0.0245877 | 0.1917614 | 0.1958457 | 0.1084643 | 0.009344 | 0.000911 | 0.077069 | 0.000359 | 4.639E-05 | 0.0001222 | 0 | 0.0058085 |
| Proportion of Odonata | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.035E-05 | 0 |
| Proportion of Ephemeroptera | 0.0041979 | 0.0023674 | 0.0652819 | 0.0010137 | 0.038659 | 0.07489 | 0.166395 | 0.013199 | 0.0310115 | 0.0390635 | 0.0698208 | 0.0008112 |
| Proportion of Plecoptera | 0 | 0 | 0.0029674 | 0 | 6.75E-05 | 0.000276 | 0.000542 | 7.17E-05 | 0.0005567 | 0.0008687 | 0.007483 | 0 |
| Proportion of Trichoptera | 0.0026987 | 0.0056818 | 0.0237389 | 0.0030411 | 0.131129 | 0.239294 | 0.186137 | 0.002869 | 0.065943 | 0.0185816 | 0.1085632 | 8.112E-05 |
| Proportion of EPT | 0.0068966 | 0.0080492 | 0.0919881 | 0.0040547 | 0.169856 | 0.314459 | 0.353075 | 0.016141 | 0.0975112 | 0.0585137 | 0.1858669 | 0.0008924 |
| Ratio of EPT to Chironomidae | 0.0982906 | 0.1278195 | 0.5535714 | 0.031746 | 0.491099 | 0.621374 | 1.808333 | 0.060943 | 0.1605745 | 0.1242077 | 0.3175585 | 0.0097466 |
| contribution by dominant family(insects only) | 0.644385 | 0.6818182 | 0.3837209 | 0.5039841 | 0.669452 | 0.604323 | 0.456236 | 0.941726 | 0.8292837 | 0.8713869 | 0.738246 | 0.9233159 |
| Proportion of Filterers | 0.0335832 | 0.0648674 | 0.0534125 | 0.0968069 | 0.298594 | 0.309161 | 0.444896 | 0.128336 | 0.2307889 | 0.1281303 | 0.206264 | 0.0442937 |
| Filterer Taxa | 7 | 9 | 5 | 8 | 13 | 11 | 10 | 11 | 12 | 10 | 10 | 9 |
| Proportion of Gatherers | 0.4818591 | 0.5127841 | 0.5727003 | 0.6482514 | 0.297339 | 0.323538 | 0.244224 | 0.650287 | 0.5330411 | 0.7323108 | 0.640939 | 0.9004932 |
| Gatherer Taxa | 21 | 14 | 11 | 14 | 23 | 15 | 14 | 20 | 29 | 27 | 20 | 23 |
| Proportion of Parasites | 0.391904 | 0.1690341 | 0.0445104 | 0.0983274 | 0.14262 | 0.001104 | 0.001085 | 0.005811 | 0.0451372 | 0.0077367 | 0.0067588 | 0.0188208 |
| Parasite Taxa | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Proportion of Piercing Herbivores | 0.0002999 | 0.0004735 | 0.0029674 | 0.0187532 | 4.05E-05 | 0 | 0 | 7.17E-05 | 0 | 6.787E-05 | 0 | 0.0005192 |
| Piercing Herbivore Taxa | 1 | 1 | 1 | 3 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 2 |
| Proportion of Predators | 0.0734633 | 0.2466856 | 0.2908012 | 0.1322859 | 0.107849 | 0.187086 | 0.148877 | 0.052869 | 0.0529771 | 0.0326026 | 0.0519582 | 0.0045267 |
| Predator Taxa | 9 | 12 | 12 | 11 | 21 | 11 | 10 | 10 | 19 | 15 | 13 | 17 |
| Proportion of Scrapers | 0.0047976 | 0.0061553 | 0.0237389 | 0.0050684 | 0.108038 | 0.086065 | 0.14405 | 0.159613 | 0.0361376 | 0.0330641 | 0.0525617 | 0.0247266 |
| Scraper Taxa | 3 | 2 | 4 | 5 | 7 | 4 | 8 | 4 | 8 | 9 | 7 | 6 |
| Proportion of Shredders | 0.014093 | 0 | 0.0118694 | 0.0005068 | 0.045519 | 0.093046 | 0.016867 | 0.003013 | 0.1019182 | 0.0660875 | 0.0415183 | 0.0066197 |
| Shredder Taxa | 3 | 0 | 4 | 1 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 2 |
| Scraper/Filterer Ratio | 0.1428571 | 0.0948905 | 0.4444444 | 0.052356 | 0.361823 | 0.278383 | 0.323784 | 1.243712 | 0.1565829 | 0.2580508 | 0.2548274 | 0.5582418 |
| Shredders/Total Ratio | 0.014093 | 0 | 0.0118694 | 0.0005068 | 0.045519 | 0.093046 | 0.016867 | 0.003013 | 0.1019182 | 0.0660875 | 0.0415183 | 0.0066197 |
| Total Insects | 75 | 594 | 172 | 502 | 10314 | 34187 | 16566 | 3964 | 6322 | 40097 | 13421 | 6116 |
| Total Insect Taxa | 29 | 23 | 27 | 25 | 49 | 32 | 35 | 31 | 57 | 52 | 48 | 39 |
| Proportion of Burrowers | 0.0187166 | 0 | 0.005814 | 0.1195219 | 0.023404 | 0.00819 | 0.000302 | 0.204844 | 0.0926981 | 0.041649 | 0.0730944 | 0.0168411 |
| Burrower Taxa | 3 | 0 | 1 | 1 | 6 | 2 | 1 | 3 | 8 | 6 | 6 | 3 |
| Proportion of Climbers | 0.1042781 | 0.0420875 | 0.0348837 | 0.249004 | 0.01687 | 0.003861 | 0.008874 | 0.067104 | 0.112345 | 0.1498865 | 0.0502943 | 0.3019948 |
| Climber Taxa | 4 | 3 | 2 | 4 | 4 | 3 | 4 | 3 | 4 | 4 | 4 | 3 |
| Proportion of Clingers | 0.1657754 | 0.0488215 | 0.1802326 | 0.0697211 | 0.618553 | 0.604411 | 0.671013 | 0.509586 | 0.3892053 | 0.2575754 | 0.3457268 | 0.3616743 |
| Clinger Taxa | 7 | 5 | 8 | 6 | 21 | 15 | 16 | 11 | 24 | 22 | 21 | 10 |
| Proportion of Sprawlers | 0.3903743 | 0.1801347 | 0.2848837 | 0.0836653 | 0.296149 | 0.340363 | 0.111433 | 0.216196 | 0.367407 | 0.4859466 | 0.4717234 | 0.2532701 |
| Sprawler Taxa | 9 | 8 | 9 | 6 | 8 | 7 | 8 | 8 | 15 | 13 | 11 | 6 |
| Proportion of Swimmers | 0.3208556 | 0.7289562 | 0.494186 | 0.4780876 | 0.045024 | 0.043174 | 0.208379 | 0.00227 | 0.0383447 | 0.0649425 | 0.059161 | 0.0662198 |
| Swimmer Taxa | 6 | 7 | 7 | 8 | 10 | 5 | 6 | 6 | 6 | 7 | 6 | 17 |
| Proportion with Depositional pref. | 0.0935829 | 0.3265993 | 0.0988372 | 0.6733068 | 0.088885 | 0.010472 | 0.046239 | 0.256307 | 0.1142749 | 0.0842208 | 0.0530512 | 0.2671681 |

## Appendix 4 Metrics derived from benthic invertebrate data collected with a Neill cylinder and kick nets (210 and 400 µm mesh size) in erosional and depositional areas from the Bow River in Fall 2006 (con't)

| | Cochrane | | | | Stier's | | | | Carseland | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metrics/Indices | NEILL | 210E | 400E | 210D | NEILL | 210E | 400E | 210D | NEILL | 210E | 400E | 210D |
| Depositional Taxa | 5 | 9 | 7 | 10 | 11 | 6 | 6 | 9 | 12 | 13 | 9 | 15 |
| Proportion with Erosional pref. | 0.4304813 | 0.1767677 | 0.2906977 | 0.1314741 | 0.657547 | 0.715155 | 0.579983 | 0.270434 | 0.5507466 | 0.6042846 | 0.6688026 | 0.3629823 |
| Erosional Taxa | 9 | 8 | 8 | 7 | 20 | 14 | 15 | 10 | 25 | 22 | 20 | 8 |
| Proportion Erosional - Depositional pref. | 0.1631016 | 0.0774411 | 0.2325581 | 0.0717131 | 0.124738 | 0.1304 | 0.235784 | 0.046418 | 0.0844406 | 0.0950196 | 0.117726 | 0.0179856 |
| Erosional - Depositional Taxa | 11 | 4 | 8 | 7 | 9 | 7 | 9 | 6 | 12 | 10 | 13 | 6 |
| Proportion with Lentic pref. | 0.3101604 | 0.4074074 | 0.3488372 | 0.123506 | 0.108101 | 0.104192 | 0.128214 | 0.416751 | 0.2023538 | 0.1797641 | 0.1007376 | 0.3453237 |
| Lentic Taxa | 3 | 1 | 3 | 1 | 5 | 3 | 4 | 5 | 3 | 4 | 3 | 9 |
| Proportion with Lotic (general) pref. | 0.0026738 | 0.0117845 | 0.0290698 | 0 | 0.020728 | 0.039781 | 0.009779 | 0.010091 | 0.048184 | 0.036711 | 0.0596826 | 0.0065402 |
| Lotic (general) Taxa | 1 | 1 | 1 | 0 | 4 | 2 | 1 | 1 | 5 | 3 | 3 | 1 |
| Proportion with Margin habitat pref. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Margin Taxa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Biotic Index (species) | 7.81 | 7.09 | 6.21 | 7.86 | 5.84 | 5.16 | 5.10 | 7.41 | 6.23 | 6.78 | 5.91 | 7.81 |
| BI Arthropods Only | 6.88 | 6.48 | 4.87 | 6.47 | 5.23 | 5.05 | 4.77 | 7.19 | 5.80 | 5.93 | 5.47 | 7.06 |
| BI Insects Only | 5.28 | 5.01 | 4.75 | 5.50 | 5.12 | 4.99 | 4.73 | 6.84 | 5.73 | 5.86 | 5.47 | 6.31 |
| Family Biotic Index (Modified) | 7.16 | 6.35 | 6.15 | 7.11 | 5.95 | 5.38 | 5.19 | 7.28 | 6.54 | 6.89 | 6.03 | 7.81 |
| FBI Arthropods only | 5.59 | 5.09 | 4.93 | 5.76 | 5.62 | 5.32 | 4.99 | 7.07 | 6.20 | 6.10 | 5.62 | 6.57 |
| FBI Insects Only | 5.78 | 5.18 | 4.95 | 5.80 | 5.63 | 5.33 | 4.99 | 7.10 | 6.21 | 6.11 | 5.62 | 6.56 |
| Number of Intolerant Taxa (0,1,2) | 5 | 3 | 4 | 2 | 9 | 5 | 7 | 4 | 12 | 10 | 11 | 2 |
| BMWP Score (Sensitivity) | 90 | 68 | 107 | 85 | 162 | 119 | 115 | 110 | 180 | 160 | 150 | 78 |
| Average Score Per Taxon (ASPT) | 5.00 | 4.25 | 5.10 | 4.47 | 4.91 | 5.17 | 5.00 | 4.78 | 5.29 | 5.33 | 5.77 | 4.11 |

## Appendix 4 Metrics derived from benthic invertebrate data collected with a Neill cylinder and kick nets (210 and 400 µm mesh size) in erosional and depositional areas from the Bow River in Fall 2006 (con't)

| | Cluny | | | | Ronalane | | | |
|---|---|---|---|---|---|---|---|---|
| **Metrics/Indices** | **NEILL** | **210E** | **400E** | **210D** | **NEILL** | **210E** | **400E** | **210D** |
| Abundance (total count) | 4396 | 23542 | 9027 | 37274 | 7447 | 34788 | 26915 | 24881 |
| Richness (total species) | 65 | 56 | 60 | 39 | 68 | 71 | 71 | 46 |
| Total Taxa (genus and higher) | 65 | 56 | 60 | 34 | 67 | 70 | 71 | 39 |
| Total Taxa (family and higher) | 37 | 32 | 36 | 18 | 43 | 40 | 41 | 27 |
| Simpson's Diversity Index D | 0.90 | 0.70 | 0.87 | 0.27 | 0.84 | 0.80 | 0.77 | 0.71 |
| Shannon Diversity Index H' | 2.71 | 1.93 | 2.59 | 0.63 | 2.35 | 2.13 | 2.01 | 1.69 |
| Number of Coleoptera genera | 4 | 2 | 2 | 1 | 3 | 4 | 3 | 2 |
| Number of Diptera genera (non Chironomidae) | 5 | 2 | 3 | 1 | 5 | 8 | 10 | 3 |
| Number of Chironomid genera | 19 | 17 | 16 | 12 | 18 | 20 | 17 | 7 |
| Number of Hemiptera genera | 2 | 0 | 2 | 5 | 2 | 1 | 2 | 6 |
| Number of Odonata genera | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Number of Ephemeroptera genera | 9 | 8 | 9 | 3 | 5 | 9 | 7 | 2 |
| Number of Plecoptera genera | 3 | 3 | 4 | 0 | 0 | 1 | 2 | 0 |
| Number of Trichoptera genera | 9 | 8 | 8 | 2 | 6 | 5 | 8 | 1 |
| Number of EPT genera | 21 | 19 | 21 | 5 | 11 | 15 | 17 | 3 |
| Number of Coleoptera families | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| Number of Diptera (non Chironomidae) families | 4 | 2 | 3 | 1 | 4 | 5 | 6 | 2 |
| Number of Chironomid subfamilies | 5 | 5 | 4 | 4 | 4 | 4 | 5 | 4 |
| Number of Hemiptera families | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Number of Odonata families | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Number of Ephemeroptera families | 6 | 4 | 6 | 2 | 4 | 5 | 4 | 2 |
| Number of Plecoptera families | 2 | 2 | 2 | 0 | 0 | 1 | 1 | 0 |
| Number of Trichoptera families | 7 | 6 | 6 | 2 | 4 | 3 | 5 | 1 |
| Number of EPT families | 15 | 12 | 14 | 4 | 8 | 9 | 10 | 3 |
| Number of ETO families | 13 | 10 | 12 | 4 | 9 | 8 | 10 | 4 |
| Proportion of Oligochaetes | 0.236113 | 0.522817 | 0.143833 | 0.851666 | 0.3183393 | 0.3382712 | 0.444654 | 0.3125678 |
| Proportion of Gastropods | 0 | 0 | 3.69E-05 | 0 | 8.057E-05 | 5.749E-05 | 0.001214 | 0 |
| Proportion of Pelecypods | 4.55E-05 | 0.000581 | 7.39E-05 | 0 | 0.0016113 | 0.0032962 | 0.006626 | 0.0107713 |
| Proportion of Amphipods | 0 | 0.000566 | 3.69E-05 | 0 | 0.00333 | 0.0041777 | 0.014861 | 0.0002813 |
| Proportion of Coleoptera | 0.06492 | 0.02669 | 0.076809 | 2.68E-05 | 0.0027124 | 0.0031045 | 0.011121 | 0.000201 |
| Proportion of Diptera | 0.474501 | 0.326362 | 0.455281 | 0.011053 | 0.4487204 | 0.1841457 | 0.306529 | 0.015755 |
| Proportion of Diptera (non Chironomidae) | 0.00687 | 0.003455 | 0.012001 | 2.68E-05 | 0.0085399 | 0.0108659 | 0.02275 | 0.0057875 |
| Proportion of Chironomids | 0.467631 | 0.322908 | 0.443279 | 0.011026 | 0.4401805 | 0.1732798 | 0.283779 | 0.0099674 |
| Proportion of Hemiptera | 9.1E-05 | 0 | 0.000148 | 0.001744 | 0.0001074 | 1.916E-05 | 6.19E-05 | 0.0086411 |
| Proportion of Odonata | 0 | 0 | 0 | 0 | 5.371E-05 | 0 | 2.48E-05 | 4.019E-05 |
| Proportion of Ephemeroptera | 0.069469 | 0.077449 | 0.252105 | 0.001234 | 0.0014502 | 0.0048868 | 0.005301 | 0.0016478 |
| Proportion of Plecoptera | 0.00646 | 0.004743 | 0.018242 | 0 | 0 | 4.791E-05 | 3.72E-05 | 0 |
| Proportion of Trichoptera | 0.053319 | 0.011214 | 0.036226 | 5.37E-05 | 0.0044848 | 0.0016768 | 0.002415 | 4.019E-05 |
| Proportion of EPT | 0.129248 | 0.093406 | 0.306573 | 0.001288 | 0.005935 | 0.0066115 | 0.007753 | 0.001688 |
| Ratio of EPT to Chironomidae | 0.276389 | 0.289266 | 0.691603 | 0.116788 | 0.013483 | 0.0381553 | 0.02732 | 0.1693548 |
| contribution by dominant family(insects only) | 0.709524 | 0.731003 | 0.542769 | 0.78327 | 0.9806902 | 0.9495528 | 0.941568 | 0.5640288 |
| Proportion of Filterers | 0.225194 | 0.164243 | 0.131056 | 0.005473 | 0.3339152 | 0.1824306 | 0.247542 | 0.4803264 |
| Filterer Taxa | 13 | 12 | 11 | 5 | 16 | 14 | 14 | 9 |
| Proportion of Gatherers | 0.475638 | 0.712235 | 0.601625 | 0.889333 | 0.5490775 | 0.7670247 | 0.682857 | 0.476267 |
| Gatherer Taxa | 23 | 18 | 21 | 14 | 24 | 30 | 25 | 18 |
| Proportion of Parasites | 0.0742 | 0.005706 | 0.001514 | 0.099855 | 0.039074 | 0.010406 | 0.003133 | 0.0273301 |
| Parasite Taxa | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Proportion of Piercing Herbivores | 4.55E-05 | 0 | 0 | 0.000295 | 0 | 0 | 1.24E-05 | 0.0011655 |
| Piercing Herbivore Taxa | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 3 |
| Proportion of Predators | 0.076111 | 0.038725 | 0.062962 | 0.003461 | 0.0493864 | 0.0347058 | 0.050318 | 0.0148708 |
| Predator Taxa | 16 | 13 | 16 | 11 | 16 | 15 | 17 | 15 |
| Proportion of Scrapers | 0.090988 | 0.049995 | 0.185007 | 0.000483 | 0.0067675 | 0.0036986 | 0.013264 | 4.019E-05 |
| Scraper Taxa | 6 | 8 | 7 | 4 | 6 | 6 | 8 | 1 |
| Proportion of Shredders | 0.057823 | 0.029097 | 0.017836 | 0.0011 | 0.0217794 | 0.0017343 | 0.002873 | 0 |
| Shredder Taxa | 4 | 3 | 4 | 2 | 5 | 4 | 5 | 0 |
| Scraper/Filterer Ratio | 0.40404 | 0.304397 | 1.411665 | 0.088235 | 0.020267 | 0.0202742 | 0.053582 | 8.368E-05 |
| Shredders/Total Ratio | 0.057823 | 0.029097 | 0.017836 | 0.0011 | 0.0217794 | 0.0017343 | 0.002873 | 0 |
| Total Insects | 2940 | 10511 | 7572 | 526 | 3408 | 6745 | 8762 | 655 |
| Total Insect Taxa | 51 | 40 | 44 | 29 | 42 | 50 | 51 | 29 |
| Proportion of Burrowers | 0.003197 | 0.008975 | 0.009817 | 0.273764 | 0.0265876 | 0.0614776 | 0.06585 | 0.1618321 |
| Burrower Taxa | 6 | 1 | 3 | 5 | 10 | 9 | 9 | 3 |
| Proportion of Climbers | 0.132925 | 0.289864 | 0.076513 | 0.235741 | 0.6271276 | 0.593279 | 0.638034 | 0.248855 |
| Climber Taxa | 5 | 5 | 5 | 3 | 5 | 6 | 6 | 4 |
| Proportion of Clingers | 0.433265 | 0.253457 | 0.346995 | 0.114068 | 0.0764761 | 0.0640969 | 0.076844 | 0.0045802 |
| Clinger Taxa | 22 | 21 | 20 | 7 | 14 | 16 | 18 | 3 |
| Proportion of Sprawlers | 0.368503 | 0.333185 | 0.420295 | 0.174905 | 0.2685174 | 0.2549049 | 0.202952 | 0.189313 |
| Sprawler Taxa | 11 | 10 | 10 | 3 | 8 | 11 | 12 | 4 |
| Proportion of Swimmers | 0.062109 | 0.114519 | 0.146379 | 0.201521 | 0.0012912 | 0.0262417 | 0.01632 | 0.3954198 |
| Swimmer Taxa | 7 | 3 | 6 | 11 | 5 | 8 | 6 | 15 |
| Proportion with Depositional pref. | 0.126395 | 0.048015 | 0.075853 | 0.355513 | 0.6098134 | 0.5746973 | 0.657017 | 0.4366412 |

## Appendix 4 Metrics derived from benthic invertebrate data collected with a Neill cylinder and kick nets (210 and 400 µm mesh size) in erosional and depositional areas from the Bow River in Fall 2006 (con't)

| | Cluny | | | | Ronalane | | | |
|---|---|---|---|---|---|---|---|---|
| **Metrics/Indices** | **NEILL** | **210E** | **400E** | **210D** | **NEILL** | **210E** | **400E** | **210D** |
| Depositional Taxa | 9 | 5 | 6 | 11 | 11 | 10 | 9 | 13 |
| Proportion with Erosional pref. | 0.551973 | 0.637575 | 0.541977 | 0.326996 | 0.306374 | 0.2975537 | 0.200708 | 0.1923664 |
| Erosional Taxa | 21 | 19 | 19 | 6 | 13 | 12 | 17 | 6 |
| Proportion Erosional - Depositional pref. | 0.203741 | 0.225168 | 0.352366 | 0.087452 | 0.0209532 | 0.0575241 | 0.080762 | 0.2274809 |
| Erosional - Depositional Taxa | 15 | 12 | 13 | 4 | 10 | 15 | 14 | 5 |
| Proportion with Lentic pref. | 0.087959 | 0.067233 | 0.021043 | 0.153992 | 0.0474821 | 0.0148258 | 0.012858 | 0.080916 |
| Lentic Taxa | 4 | 2 | 5 | 7 | 3 | 6 | 5 | 3 |
| Proportion with Lotic (general) pref. | 0.029932 | 0.022009 | 0.008761 | 0.076046 | 0.0023477 | 0.0120583 | 0.008521 | 0 |
| Lotic (general) Taxa | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 0 |
| Proportion with Margin habitat pref. | 0 | 0 | 0 | 0 | 0.0130297 | 0.0433407 | 0.040134 | 0.0625954 |
| Margin Taxa | 0 | 0 | 0 | 0 | 3 | 4 | 4 | 2 |
| Biotic Index (species) | 6.10 | 6.87 | 5.58 | 7.98 | 6.82 | 7.47 | 7.20 | 8.43 |
| BI Arthropods Only | 5.41 | 5.64 | 5.17 | 7.52 | 6.14 | 7.20 | 6.41 | 7.89 |
| BI Insects Only | 5.36 | 5.57 | 5.13 | 6.56 | 5.50 | 5.46 | 5.40 | 5.46 |
| Family Biotic Index (Modified) | 6.21 | 6.85 | 5.50 | 7.96 | 6.81 | 7.12 | 7.12 | 7.73 |
| FBI Arthropods only | 5.59 | 5.57 | 5.07 | 6.12 | 6.13 | 5.98 | 6.06 | 5.53 |
| FBI Insects Only | 5.61 | 5.58 | 5.07 | 6.28 | 6.13 | 5.95 | 5.98 | 5.51 |
| Number of Intolerant Taxa (0,1,2) | 9 | 8 | 9 | 0 | 2 | 3 | 3 | 0 |
| BMWP Score (Sensitivity) | 172 | 143 | 160 | 55 | 141 | 153 | 160 | 73 |
| Average Score Per Taxon (ASPT) | 5.38 | 5.30 | 5.33 | 4.23 | 4.55 | 4.78 | 4.44 | 4.06 |

# Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006)

## Cochrane

| Site | year | replicate | *Hydra* sp. | TURBELLARIA | Microturbellaria | *Dugesia tigrina* | *Polycelis coronata* | NEMATODA | NEMERTEA | TARDIGRADA | OLIGOCHAETA | Un - identified Oligochaeta | Enchytraeidae | Lumbricidae | Lumbriculidae | Naididae | Tubificidae | HIRUDINEA | Erpobdellidae (misc.) | *Dina sp.* | *Erpobdella* sp. | *Nephelopsis obscura* | *Mooreobdella* sp. | Glossiphonidae (misc.) | *Helobdella stagnalis* | *Glossiphonia* sp. | *Placobdella ornata* | Piscicolidae (misc.) | GASTROPODA | Lymnaeidae (misc.) | *Fossaria* sp. | *Lymnaea* sp. | *Ferrissia* sp. | Ancylidae (misc.) | Planorbidae (misc.) | *Gyraulus* sp. | *Helisoma* sp. | Physidae (misc.) | *Physa* sp. | PELECYPODA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cochrane** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | 127 | 6 | | | | 248 | | | 73 | | 0 | 7 | | 9808 | 0 | | | | | | | | | | | | | 17 | | | | | 1 | | | | | |
| | 1983 | Rep 2 | 103 | 11 | | | | 745 | | | 341 | | 124 | 77 | | 11804 | 0 | | | | | | | | | | | | | 29 | | | | | 0 | | | | | |
| | 1983 | Rep 3 | 116 | 51 | | | | 160 | | | 0 | | 36 | 26 | | 4160 | 0 | | | | | | | | | | | | | 1 | | | | | 2 | | | | | |
| | 1983 | Rep 4 | 12 | 3 | | | | 56 | | | 0 | | 28 | 1 | | 2116 | 0 | | | | | | | | | | | | | 6 | | | | | 0 | | | | | |
| | 1983 | Rep 5 | 42 | 1 | | | | 42 | | | 0 | | 28 | 1 | | 1248 | 2 | | | | | | | | | | | | | 0 | | | | | 0 | | | | | |
| | **1983** | **Average** | **80** | **14.4** | | | | **250.2** | | | **82.8** | | **43.2** | **22.4** | | **5827.2** | **0.4** | | | | | | | | | | | | | **10.6** | | | | | **0.6** | | | | | |
| | 1984 | Rep 1 | 99 | 1 | | | | 350 | | | | | 571 | 6 | 12 | 4263 | 160 | 0 | | | | | | | | | | | | 26 | | | 0 | | 0 | | | 0 | | |
| | 1984 | Rep 2 | 105 | 3 | | | | 426 | | | | | 97 | 9 | 5 | 2140 | 200 | 1 | | | | | | | | | | | | 36 | | | 2 | | 0 | | | 0 | | |
| | 1984 | Rep 3 | 20 | 2 | | | | 528 | | | | | 253 | 11 | 5 | 3853 | 324 | 0 | | | | | | | | | | | | 8 | | | 0 | | 2 | | | 0 | | |
| | 1984 | Rep 4 | 40 | 3 | | | | 542 | | | | | 499 | 6 | 10 | 1978 | 225 | 0 | | | | | | | | | | | | 17 | | | 3 | | 1 | | | 0 | | |
| | 1984 | Rep 5 | 61 | 3 | | | | 1519 | | | | | 885 | 16 | 44 | 4370 | 165 | 0 | | | | | | | | | | | | 26 | | | 0 | | 1 | | | 2 | | |
| | **1984** | **Average** | **65** | **2.4** | | | **0** | **673** | | | | **0** | **461** | **9.6** | **15.2** | **3320.8** | **214.8** | **0.2** | | | | | | | | | | | **0** | **22.6** | | **0** | **1** | | **0.8** | **0** | | **0.4** | **0** | |
| | 1985 | Rep 1 | 17 | 15 | | | | 84 | | | | | | 66 | 200 | 739 | 115 | | | | | | | | | | | | 0 | | | 0 | | | | 0 | | | 0 | |
| | 1985 | Rep 2 | 32 | 12 | | | | 83 | | | | | | 45 | 190 | 1078 | 9 | | | | | | | | | | | | 2 | | | 0 | | | | 0 | | | 2 | |
| | 1985 | Rep 3 | 40 | 17 | | | | 48 | | | | | | 54 | 137 | 1956 | 42 | | | | | | | | | | | | 1 | | | 1 | | | | 1 | | | 3 | |
| | 1985 | Rep 4 | 30 | 8 | | | | 63 | | | | | | 65 | 42 | 1018 | 33 | | | | | | | | | | | | 0 | | | 0 | | | | 0 | | | 1 | |
| | 1985 | Rep 5 | 9 | 31 | | | | 9 | | | | | | 139 | 222 | 1359 | 23 | | | | | | | | | | | | 5 | | | 0 | | | | 0 | | | 2 | |
| | **1985** | **Average** | **25.6** | **16.6** | | | **0** | **57.4** | | | | **0** | **0** | **73.8** | **158.2** | **1230** | **44.4** | **0** | | | | | | | | | | | **1.6** | **0** | | **0.2** | **0** | | **0** | **0.2** | | **0** | **1.6** | |
| | 1986 | Rep 1 | 27 | 12 | | | | 147 | | | | | 234 | 25 | 17 | 1052 | 7 | | | | | | | | | | | | | | | | | | 2 | | | | | |
| | 1986 | Rep 2 | 1 | 15 | | | | 149 | | | | | 109 | 18 | 4 | 709 | 0 | | | | | | | | | | | | | | | | | | 0 | | | | | |
| | 1986 | Rep 3 | 56 | 122 | | | | 65 | | | | | 158 | 27 | 80 | 2603 | 0 | | | | | | | | | | | | | | | | | | 1 | | | | | |
| | 1986 | Rep 4 | 32 | 16 | | | | 175 | | | | | 22 | 7 | 33 | 1188 | 0 | | | | | | | | | | | | | | | | | | 0 | | | | | |
| | 1986 | Rep 5 | 12 | 21 | | | | 203 | | | | | 20 | 31 | 47 | 1321 | 0 | | | | | | | | | | | | | | | | | | 0 | | | | | |
| | **1986** | **Average** | **25.6** | **37.2** | | | **0** | **147.8** | | | | **0** | **108.6** | **21.6** | **36.2** | **1374.6** | **1.4** | **0** | | | | | | | | | | | **0** | **0** | | **0** | **0** | | **0.6** | **0** | | **0** | **0** | |
| | 1987 | Rep 1 | 31 | | | | 2 | 17 | | | | 246 | 26 | | 86 | 425 | 0 | | | | | | | | | | | | | 0 | | | | | | | | | | |
| | 1987 | Rep 2 | 32 | | | | 4 | 51 | | | | 142 | 13 | | 83 | 1321 | 2 | | | | | | | | | | | | | 2 | | | | | | | | | | |
| | 1987 | Rep 3 | 38 | | | | 2 | 32 | | | | 208 | 33 | | 54 | 1159 | 0 | | | | | | | | | | | | | 0 | | | | | | | | | | |
| | 1987 | Rep 4 | 27 | | | | 7 | 8 | | | | 176 | 0 | | 51 | 413 | 0 | | | | | | | | | | | | | 0 | | | | | | | | | | |
| | 1987 | Rep 5 | 38 | | | | 2 | 24 | | | | 180 | 0 | | 29 | 502 | 2 | | | | | | | | | | | | | 0 | | | | | | | | | | |
| | **1987** | **Average** | **33.2** | **0** | | | **3.4** | **26.4** | | | | **190.4** | **14.4** | **0** | **60.6** | **764** | **0.8** | **0** | | | | | | | | | | | **0** | **0.4** | **0** | **0** | **0** | | **0** | **0** | | **0** | **0** | |
| | 1989 | Rep 1 | 24 | 35 | | | | 47 | | | | | 931 | 34 | 30 | 1437 | 57 | | | | | | | | | | | | | 12 | | | | | 9 | | | | | |
| | 1989 | Rep 2 | 7 | 34 | | | | 48 | | | | | 966 | 96 | 63 | 818 | 68 | | | | | | | | | | | | | 1 | | | | | 6 | | | | | |
| | 1989 | Rep 3 | 26 | 27 | | | | 56 | | | | | 82 | 13 | 16 | 624 | 1 | | | | | | | | | | | | | 1 | | | | | 1 | | | | | |
| | 1989 | Rep 4 | 39 | 34 | | | | 84 | | | | | 64 | 6 | 14 | 633 | 4 | | | | | | | | | | | | | 9 | | | | | 16 | | | | | |
| | 1989 | Rep 5 | 25 | 38 | | | | 110 | | | | | 468 | 16 | 22 | 1530 | 8 | | | | | | | | | | | | | 8 | | | | | 1 | | | | | |
| | **1989** | **Average** | **24.2** | **33.6** | | | **0** | **69** | | | | **0** | **502.2** | **33** | **29** | **1008.4** | **27.6** | **0** | | | | | | | | | | | **0** | **6.2** | **0** | **0** | **0** | | **6.6** | **0** | | **0** | **0** | |
| | 1993 | Rep 1 | 187 | 21 | | | | 31 | | | | | 31 | 11 | 1 | 240 | 1 | | | | | | | | | | | | 1 | 2 | | | | | | | | | | |
| | 1993 | Rep 2 | 223 | 29 | | | | 263 | | | | | 290 | 28 | 7 | 2298 | | | | | | | | | | | | | 1 | | | | | | 1 | | | | | |
| | 1993 | Rep 3 | 436 | 43 | | | | 90 | | | | | 316 | 71 | 6 | 729 | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| | 1993 | Rep 4 | 89 | 38 | | | | 47 | | | | | 540 | 60 | 14 | 549 | | | | | | | | | | | | | 1 | 2 | | | | | | | | | | |
| | 1993 | Rep 5 | 253 | 33 | | | | 102 | | | | | 247 | 17 | 6 | 1424 | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| | **1993** | **Average** | **237.6** | **32.8** | | | **0** | **106.6** | | | | **0** | **284.8** | **37.4** | **6.8** | **1048** | **0.2** | **0** | | | | | | | | | | | **0.8** | **0.8** | **0** | **0** | **0** | | **0.2** | **0** | | **0** | **0.2** | |
| | 2006 | Rep 1 | 8 | | 0 | | | 264 | | | | | 187 | 55 | | 58 | | | | | | | | | | | | | | | 7 | | | | | | | | | |
| | 2006 | Rep 2 | 0 | | 0 | | | 285 | | | | | 77 | 15 | | 28 | | | | | | | | | | | | | | | 0 | | | | | | | | | |
| | 2006 | Rep 3 | 28 | | 0 | | | 95 | | | | | 95 | 21 | | 16 | | | | | | | | | | | | | | | 0 | | | | | | | | | |
| | 2006 | Rep 4 | 17 | | 0 | | | 275 | | | | | 125 | 26 | | 83 | | | | | | | | | | | | | | | 0 | | | | | | | | | |
| | 2006 | Rep 5 | 12 | | 4 | | | 388 | | | | | 110 | 5 | | 69 | | | | | | | | | | | | | | | 0 | | | | | | | | | |
| | **2006** | **Average** | **13** | **0** | **0.8** | | **0** | **261** | | | **0** | **0** | **119** | **24** | **0** | **51** | **0** | **0** | | | | | | | | | | | **0** | **0** | **1** | **0** | **0** | | **0** | **0** | | **0** | **0** | |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

### Cochrane

| Site | year | replicate | *Pisidium* sp. | *Sphaerium* sp. | Sphaeriidae (misc.) | Hydracarina | Oribatei | CRUSTACEA | OSTRACODA | CLADOCERA | COPEPODA | AMPHIPODA | *Gammarus lacustris* | *Hyalella azteca* | *Orconectes virilis* | Collembola | Ephemeroptera | Baetidae (misc.) | *Baetis* sp. | *Dactylobaetis* sp. | *Caenis* sp. | Ephemerellidae (misc.) | *Ephemerella* sp. | *Drunella* sp. | *Serratella* sp. | *Ephemera* sp. | Heptageniidae (misc.) | *Epeorus* sp. | *Heptagenia* sp. | *Rhithrogena* sp. | *Stenonema* sp. | *Cinygma* sp. | Leptophlebiidae (misc.) | *Leptophlebia* sp. | *Paraleptophlebia* sp. | *Isonychia* sp. | *Ephoron* sp. | Siplonuridae misc. | *Ameletus* s p. | *Tricorythodes* sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cochrane | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | 1 | | | 7 | | | 0 | | 0 | | | | | | | | 8 | | | | 252 | | | | 4 | 8 | | 8 | | | | 3 | 1 | | | | | |
| | 1983 | Rep 2 | 1 | | | 14 | | | 13 | | 2 | | | | | | | | 1 | | | | 13 | | | | 0 | 1 | | 0 | | | | 0 | 0 | | | | | |
| | 1983 | Rep 3 | 2 | | | 146 | | | 50 | | 6 | | | | | | | | 164 | | | | 199 | | | | 0 | 31 | | 151 | | | | 0 | 8 | | | | | |
| | 1983 | Rep 4 | 2 | | | 8 | | | 0 | | 0 | | | | | | | | 11 | | | | 16 | | | | 0 | 7 | | 7 | | | | 0 | 0 | | | | | |
| | 1983 | Rep 5 | 0 | | | 1 | | | 2 | | 1 | | | | | | | | 2 | | | | 7 | | | | 0 | 0 | | 0 | | | | 0 | 0 | | | | | |
| | **1983** | **Average** | **1.2** | | | **35.2** | | | **13** | | **1.8** | | | | | | | | **37.2** | | | | **97.4** | | | | **0.8** | **9.4** | | **33.2** | | | | **0.6** | **1.8** | | | | | |
| | 1984 | Rep 1 | 1 | | | 37 | | | 42 | 301 | 369 | | | | | | | | 1 | | | | 1 | | | | | 0 | | 0 | | | | | | | | 0 | | |
| | 1984 | Rep 2 | 8 | | | 20 | | | 18 | 36 | 542 | | | | | | | | 2 | | | | 3 | | | | | 0 | | 0 | | | | | | | | 0 | | |
| | 1984 | Rep 3 | 4 | | | 110 | | | 15 | 55 | 350 | | | | | | | | 2 | | | | 0 | | | | | 1 | | 0 | | | | | | | | 0 | | |
| | 1984 | Rep 4 | 4 | | | 0 | | | 6 | 37 | 298 | | | | | | | | 0 | | | | 0 | | | | | 0 | | 1 | | | | | | | | 0 | | |
| | 1984 | Rep 5 | 4 | | | 0 | | | 54 | 54 | 1046 | | | | | | | | 1 | | | | 1 | | | | | 0 | | 0 | | | | | | | | 1 | | |
| | **1984** | **Average** | **4.2** | | **0** | **33.4** | | | **27** | **96.6** | **521** | | | | | | **0** | **0** | **1.2** | | | **0** | **1** | **0** | **0** | | **0** | **0.2** | **0** | **0.2** | | | **0** | | **0** | | | **0.2** | | **0** |
| | 1985 | Rep 1 | 1 | | | 51 | | | 1 | 0 | 2 | | | | | | 0 | 220 | 18 | | | | 29 | | | | 2 | 14 | 0 | 16 | | | | | 0 | | | | | |
| | 1985 | Rep 2 | 2 | | | 81 | | | 1 | 1 | 0 | | | | | | 0 | 85 | 7 | | | | 32 | | | | 0 | 2 | 0 | 19 | | | | | 5 | | | | | |
| | 1985 | Rep 3 | 1 | | | 178 | | | 3 | 0 | 0 | | | | | | 1 | 1297 | 70 | | | | 185 | | | | 8 | 196 | 0 | 30 | | | | | 24 | | | | | |
| | 1985 | Rep 4 | 1 | | | 49 | | | 4 | 1 | 6 | | | | | | 0 | 13 | 3 | | | | 9 | | | | 0 | 1 | 0 | 0 | | | | | 2 | | | | | |
| | 1985 | Rep 5 | 2 | | | 87 | | | 2 | 0 | 2 | | | | | | 0 | 306 | 28 | | | | 65 | | | | 5 | 64 | 4 | 11 | | | | | 17 | | | | | |
| | **1985** | **Average** | **1.4** | | **0** | **89.2** | | | **2.2** | **0.4** | **2** | | | | | | **0.2** | **384.2** | **25.2** | | | **0** | **64** | **0** | **0** | | **3** | **55.4** | **0.8** | **15.2** | | | **0** | | **9.6** | | | **0** | | **0** |
| | 1986 | Rep 1 | | | 11 | 243 | | | 7 | 0 | 1 | | | | | | 0 | 82 | 65 | | | | 37 | | | | 3 | | 0 | 41 | | | | | 1 | | | 1 | | |
| | 1986 | Rep 2 | | | 8 | 113 | | | 7 | 0 | 2 | | | | | | 0 | 89 | 63 | | | | 27 | | | | 4 | | 0 | 13 | | | | | 2 | | | 0 | | |
| | 1986 | Rep 3 | | | 2 | 246 | | | 11 | 0 | 1 | | | | | | 0 | 200 | 134 | | | | 62 | | | | 7 | | 1 | 51 | | | | | 0 | | | 0 | | |
| | 1986 | Rep 4 | | | 7 | 275 | | | 7 | 1 | 0 | | | | | | 2 | 281 | 117 | | | | 115 | | | | 14 | | 0 | 104 | | | | | 7 | | | 0 | | |
| | 1986 | Rep 5 | | | 5 | 226 | | | 23 | 0 | 0 | | | | | | 0 | 188 | 100 | | | | 94 | | | | 12 | | 0 | 44 | | | | | 4 | | | 0 | | |
| | **1986** | **Average** | **0** | | **6.6** | **221** | | | **11** | **0.2** | **0.8** | | | | | | **0.4** | **168** | **95.8** | | | **0** | **67** | **0** | **0** | | **8** | **0** | **0.2** | **50.6** | | | **0** | | **2.8** | | | **0.2** | | **0** |
| | 1987 | Rep 1 | 2 | | | 0 | | | 1 | 1 | 1 | | | | | | | | | | | | 1 | | | | | | | 0 | | | | | | | | | | |
| | 1987 | Rep 2 | 0 | | | 0 | | | 0 | 0 | 4 | | | | | | | | | | | | 2 | | | | | | | 1 | | | | | | | | | | |
| | 1987 | Rep 3 | 0 | | | 3 | | | 2 | 1 | 6 | | | | | | | | | | | | 2 | | | | | | | 0 | | | | | | | | | | |
| | 1987 | Rep 4 | 0 | | | 2 | | | 0 | 0 | 1 | | | | | | | | | | | | 0 | | | | | | | 0 | | | | | | | | | | |
| | 1987 | Rep 5 | 2 | | | 0 | | | 0 | 0 | 2 | | | | | | | | | | | | 1 | | | | | | | 1 | | | | | | | | | | |
| | **1987** | **Average** | **0.8** | | **0** | **1** | | | **0.6** | **0.4** | **2.8** | | | | | | **0** | **0** | **0** | | | **0** | **1.2** | **0** | **0** | | **0** | **0** | **0** | **0.4** | | | **0** | | **0** | | | **0** | | **0** |
| | 1989 | Rep 1 | | | 44 | 210 | | | 135 | | 21 | | | | | | | 624 | | | | | 532 | | | | | | | 93 | | | | | 4 | | | | | 2 |
| | 1989 | Rep 2 | | | 28 | 40 | | | 10 | | 28 | | | | | | | 204 | | | | | 302 | | | | | | | 118 | | | | | 6 | | | | | |
| | 1989 | Rep 3 | | | 17 | 120 | | | 84 | | 71 | | | | | | | 344 | | | | | 247 | | | | | | | 112 | | | | | 6 | | | | | |
| | 1989 | Rep 4 | | | 18 | 206 | | | 18 | | 29 | | | | | | | 432 | 2 | | | | 636 | | | | | | | 92 | | | | | 8 | | | | | |
| | 1989 | Rep 5 | | | 17 | 284 | | | 150 | | 76 | | | | | | | 576 | | | | | 512 | 1 | | | | | | 100 | | | | | | | | | | |
| | **1989** | **Average** | **0** | | **24.8** | **172** | | | **79.4** | **0** | **45** | | | | | | **0** | **436** | **0.4** | | | **0** | **445.8** | **0.2** | **0** | | **0** | **0** | **0** | **103** | | | **0** | | **4.8** | | | **0** | | **0.4** |
| | 1993 | Rep 1 | | | 21 | 123 | | | 64 | 2 | 11 | | | | | | 2 | 18 | 2 | | | 25 | | | 54 | | 3 | | | 30 | | | | | 1 | | | | | 4 |
| | 1993 | Rep 2 | | | 39 | 506 | | | 45 | | 243 | | | | | | 9 | 104 | 8 | | | 73 | | | 182 | | | 4 | | 13 | | | | | | | | | | 1 |
| | 1993 | Rep 3 | | | 94 | 419 | | | 129 | 2 | 220 | | | | | | 6 | 59 | 7 | | | 92 | 1 | 1 | 99 | | 6 | | | 34 | | | 4 | | 1 | | | | | |
| | 1993 | Rep 4 | | | 52 | 130 | | | 96 | 1 | 89 | | | | | | | 16 | 2 | | | 10 | | | 32 | | 2 | | | 52 | | | 2 | | 2 | | | | | |
| | 1993 | Rep 5 | | | 4 | 631 | | | 41 | 1 | 150 | | | | | | 6 | 124 | 2 | | | 50 | | 1 | 192 | | 1 | 2 | | 21 | | | | | 1 | | | | | |
| | **1993** | **Average** | **0** | | **42** | **362** | | | **75** | **1.2** | **142.6** | | | | | | **4.6** | **64.2** | **4.2** | | | **50** | **0.2** | **0.4** | **111.8** | | **2.4** | **1.2** | **0** | **30** | | | **1.2** | | **1** | | | **0** | | **1** |
| | 2006 | Rep 1 | | | | 0 | 12 | | 96 | 0 | 4 | | | | | | | | 4 | | | | 1 | | | | | | | | | | | | | | | | | |
| | 2006 | Rep 2 | | | | 4 | 0 | | 16 | 0 | 12 | | | | | | | | 4 | | | | 0 | | | | | | | | | | | | | | | | | |
| | 2006 | Rep 3 | | | | 0 | 4 | | 32 | 4 | 52 | | | | | | | | 4 | | | | 0 | | | | | | | | | | | | | | | | | |
| | 2006 | Rep 4 | | | | 0 | 0 | | 44 | 0 | 184 | | | | | | | | 0 | | | | 0 | | | | | | | | | | | | | | | | | |
| | 2006 | Rep 5 | | | | 24 | 0 | | 24 | 8 | 88 | | | | | | | | 0 | | | | 1 | | | | | | | | | | | | | | | | | |
| | **2006** | **Average** | **0** | | **0** | **6** | **3** | | **42** | **2** | **68** | | | | | | **0** | **0** | **2** | | | **0** | **0.4** | **0** | **0** | | **0** | **0** | **0** | **0** | | | **0** | **0** | **0** | | | **0** | | **0** |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Cochrane

| Site | year | replicate | **Plecoptera** | Capniidae (misc.) | Chloroperlidae (misc.) | *Sweltsa* sp. | *Suwallia* sp. | Perlidae (misc.) | *Claassenia* sp. | *Hesperoperla* sp. | *Perlesta* sp. | Perlodidae (misc.) | *Cultus* sp. | *Isogenoides* sp. | *Isoperla* sp. | *Skwala* sp. | *Pteronarcys* sp. | *Taenionema* sp. | *Oemopteryx* sp. | **Trichoptera** | *Brachycentrus* sp. | Glossosomatidae (misc.) | *Anagapetus* sp. | *Glossosoma* sp. | Helicopsychidae (misc.) | *Helicopsyche* sp. | Hydropsychidae (misc.) | *Arctopsyche* sp. | *Cheumatopsyche* sp. | *Hydropsyche* sp. | Hydroptilidae (misc.) | *Hydroptila* sp. | Leptoceridae (misc.) | *Ceraclea* sp. | *Mystacides* sp. | *Nectopsyche* sp. | *Oecetis* sp. | *Triaenodes* sp. | *Lepidostoma* sp. | Limnephilidae (misc.) | *Phryganea* sp. | Polycentropodidae (misc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cochrane** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1983 | Rep 1 | 0 |  | 0 |  |  | 0 |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 0 |  | 0 |  | 3 |  | 1 |  |  | 0 |  |  |  |  |  |
|  | 1983 | Rep 2 | 1 |  | 0 |  |  | 0 |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 0 |  | 0 |  | 1 |  | 1 |  |  | 1 |  |  |  |  |  |
|  | 1983 | Rep 3 | 0 |  | 83 |  |  | 1 |  |  |  |  |  | 12 |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 5 |  | 66 |  | 77 |  | 0 |  |  | 0 |  |  |  |  |  |
|  | 1983 | Rep 4 | 0 |  | 0 |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  | 2 | 0 |  | 3 |  | 3 |  | 0 |  |  | 0 |  |  |  |  |  |
|  | 1983 | Rep 5 | 0 |  | 0 |  |  | 0 |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0 |  | 0 |  | 1 |  | 0 |  |  | 0 |  |  |  |  |  |
|  | **1983** | **Average** | **0.2** |  | **16.6** |  |  | **0.4** |  |  |  |  |  | **2.6** |  |  |  |  |  |  |  |  |  |  |  |  | **0.8** | **1** |  | **13.8** |  | **17** |  | **0.4** |  |  | **0.2** |  |  |  |  |  |
|  | 1984 | Rep 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  | 1 | 3 |  | 5 |  |  |  |  |  |  |  |  |  |  |
|  | 1984 | Rep 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  | 8 | 11 |  | 4 |  |  |  |  |  |  |  |  |  |  |
|  | 1984 | Rep 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  | 2 | 3 |  | 1 |  |  |  |  |  |  |  |  |  |  |
|  | 1984 | Rep 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  | 0 | 0 |  | 2 |  |  |  |  |  |  |  |  |  |  |
|  | 1984 | Rep 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  | 0 | 1 |  | 3 |  |  |  |  |  |  |  |  |  |  |
|  | **1984** | **Average** | **0** |  | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |  |  | **0** | **0** | **0** |  |  | **0** | **0** |  | **0** |  |  |  | **0.4** | **0** | **2.2** | **3.6** | **0** | **3** |  | **0** |  |  |  |  | **0** |  |  |  |
|  | 1985 | Rep 1 | 0 |  | 3 | 7 |  | 0 | 4 | 4 | 5 | 2 |  |  | 4 | 14 |  |  |  |  |  |  |  |  |  |  | 11 | 18 | 41 | 28 |  | 0 |  | 0 |  |  |  |  | 0 |  |  |  |
|  | 1985 | Rep 2 | 0 |  | 4 | 8 |  | 14 | 3 | 0 | 0 | 0 |  |  | 1 | 14 |  |  |  |  |  |  |  |  |  |  | 1 | 4 | 19 | 2 |  | 55 |  | 5 |  |  |  |  | 3 |  |  |  |
|  | 1985 | Rep 3 | 1 |  | 10 | 16 |  | 32 | 6 | 5 | 4 | 0 |  |  | 11 | 26 |  |  |  |  |  |  |  |  |  |  | 33 | 15 | 104 | 167 |  | 36 |  | 1 |  |  |  |  | 12 |  |  |  |
|  | 1985 | Rep 4 | 0 |  | 1 | 2 |  | 12 | 0 | 0 | 0 | 0 |  |  | 0 | 2 |  |  |  |  |  |  |  |  |  |  | 1 | 0 | 25 | 0 |  | 29 |  | 0 |  |  |  |  | 0 |  |  |  |
|  | 1985 | Rep 5 | 0 |  | 0 | 28 |  | 17 | 7 | 2 | 3 | 0 |  |  | 7 | 15 |  |  |  |  |  |  |  |  |  |  | 28 | 5 | 61 | 6 |  | 129 |  | 8 |  |  |  |  | 5 |  |  |  |
|  | **1985** | **Average** | **0.2** |  | **3.6** | **12.2** | **0** | **15** | **4** | **2.2** | **2.4** | **0.4** |  |  | **4.6** | **14.2** | **0** |  |  | **0** | **0** |  | **0** |  |  |  | **14.8** | **8.4** | **50** | **40.6** | **0** | **49.8** |  | **2.8** |  |  |  |  | **4** |  |  |  |
|  | 1986 | Rep 1 | 0 |  | 2 |  |  | 0 | 1 | 0 |  | 3 |  |  |  | 3 |  |  |  |  | 1 |  |  |  |  |  | 8 | 4 | 0 | 0 |  | 14 |  |  |  |  |  |  | 2 |  |  |  |
|  | 1986 | Rep 2 | 1 |  | 1 |  |  | 1 | 1 | 0 |  | 3 |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 3 | 0 | 0 | 1 |  | 12 |  |  |  |  |  |  | 0 |  |  |  |
|  | 1986 | Rep 3 | 6 |  | 6 |  |  | 3 | 1 | 3 |  | 10 |  |  |  | 5 |  |  |  |  | 1 |  |  |  |  |  | 101 | 25 | 22 | 12 |  | 2 |  |  |  |  |  |  | 0 |  |  |  |
|  | 1986 | Rep 4 | 4 |  | 27 |  |  | 2 | 4 | 3 |  | 1 |  |  |  | 8 |  |  |  |  | 3 |  |  |  |  |  | 77 | 17 | 35 | 6 |  | 4 |  |  |  |  |  |  | 4 |  |  |  |
|  | 1986 | Rep 5 | 6 |  | 47 |  |  | 2 | 0 | 1 |  | 1 |  |  |  | 5 |  |  |  |  | 0 |  |  |  |  |  | 39 | 10 | 16 | 1 |  | 17 |  |  |  |  |  |  | 0 |  |  |  |
|  | **1986** | **Average** | **3.4** |  | **16.6** | **0** | **0** | **1.6** | **1.4** | **1.4** | **0** | **3.6** |  |  | **0** | **4.4** | **0** |  |  | **0** | **1.2** |  | **0** |  |  |  | **45.6** | **11.2** | **14.6** | **4** | **0** | **9.8** |  | **0** |  |  |  |  | **1.2** |  |  |  |
|  | 1987 | Rep 1 |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1987 | Rep 2 |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1987 | Rep 3 |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1987 | Rep 4 |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1987 | Rep 5 |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **1987** | **Average** | **0** |  | **0** | **0** | **0.2** | **0** | **0** | **0** | **0** | **0** |  |  | **0** | **0** | **0** |  |  | **0** | **0** |  | **0** |  |  |  | **0** | **0** | **0** | **0** | **0** | **0** |  | **0** |  |  |  |  | **0** |  |  |  |
|  | 1989 | Rep 1 |  |  | 40 |  |  |  |  | 1 |  | 2 |  |  |  | 4 |  |  |  |  |  |  |  |  |  |  | 7 |  |  | 1 |  | 664 |  | 2 |  |  |  |  | 7 |  |  |  |
|  | 1989 | Rep 2 |  |  | 15 |  |  |  |  |  |  |  |  |  |  | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  | 252 |  |  |  |  |  |  | 3 |  |  |  |
|  | 1989 | Rep 3 |  |  | 72 |  |  |  |  |  |  |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  | 1 |  |  |  |  | 327 |  |  |  |  |  |  | 3 |  |  |  |
|  | 1989 | Rep 4 |  |  | 100 |  |  | 1 |  |  |  | 2 |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  | 6 |  |  | 5 |  | 654 |  |  |  |  |  |  | 6 |  |  |  |
|  | 1989 | Rep 5 |  |  | 65 |  |  |  | 1 |  |  |  |  |  |  | 1 | 1 |  |  |  |  |  |  |  |  |  | 3 |  |  | 5 |  | 632 |  |  |  |  |  |  | 5 |  |  |  |
|  | **1989** | **Average** | **0** |  | **58.4** | **0** | **0** | **0.2** | **0.2** | **0.2** | **0** | **0.8** |  |  | **0** | **1.8** | **0.2** |  |  | **0** | **0** |  | **0** |  |  |  | **3.4** | **0** | **0** | **2.4** | **0** | **505.8** |  | **0.4** |  |  |  |  | **4.8** |  |  |  |
|  | 1993 | Rep 1 | 2 |  | 29 |  |  | 6 | 14 | 3 |  | 1 |  |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  |  |  | 4 |  |  |  |  |  |  |  |  | 1 |  |  |  |
|  | 1993 | Rep 2 |  |  | 13 |  |  | 11 | 5 | 2 |  | 2 |  |  |  |  | 1 |  |  | 1 |  |  | 1 |  |  |  | 47 |  |  | 44 |  | 5 |  |  |  |  |  |  | 1 |  |  |  |
|  | 1993 | Rep 3 |  |  | 76 |  |  | 11 | 12 | 1 |  | 2 |  |  |  |  |  |  |  |  |  |  | 1 |  |  |  | 13 |  |  | 3 |  | 1 |  | 1 |  |  |  |  | 2 |  |  |  |
|  | 1993 | Rep 4 |  |  | 78 |  |  | 5 | 11 | 1 |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 |  |  | 2 |  |  |  |  |  |  |  |  | 2 |  |  |  |
|  | 1993 | Rep 5 |  |  | 35 |  |  | 19 | 14 | 2 |  | 2 |  |  |  |  |  |  |  |  |  |  | 1 |  |  |  | 13 |  | 1 | 4 | 1 | 21 |  |  |  |  |  |  | 1 |  |  |  |
|  | **1993** | **Average** | **0.4** |  | **46.2** | **0** | **0** | **10.4** | **11.2** | **1.8** | **0** | **1.6** |  |  | **0** | **0.2** | **0.2** |  |  | **0.2** | **0** |  | **0.8** |  |  |  | **15.2** | **0** | **0.2** | **11.4** | **0.2** | **5.4** |  | **0.2** |  |  |  |  | **1.4** |  |  |  |
|  | 2006 | Rep 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |  | 1 |  |  |  |  | 0 |  |  |  |
|  | 2006 | Rep 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 |  | 0 |  |  |  |  | 0 |  |  |  |
|  | 2006 | Rep 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  | 0 |  |  |  |  | 0 |  |  |  |
|  | 2006 | Rep 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  | 0 |  |  |  |  | 1 |  |  |  |
|  | 2006 | Rep 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  | 0 |  |  |  |  | 0 |  |  |  |
|  | **2006** | **Average** | **0** |  | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |  | **0** | **0** | **0** | **0** |  |  | **0** | **0** |  | **0** |  |  |  | **0** | **0** | **0** | **0** | **0** | **1** |  | **0.2** |  |  | **0** |  | **0.2** |  |  |  |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

### Cochrane

| Site | year | replicate | *Neureclipsis* sp. | *Polycentropus* sp. | *Psychomyia* sp. | *Rhyacophila* sp. | **Anisoptera** | *Ophiogomphus* sp. | Coenagrionidae sp. | **Hemiptera** | Corixidae sp. | *Callicorixa* sp. | *Cenocorixa* sp. | *Corisella* sp. | *Palmacorixa* sp. | *Sigara* sp. | *Trichocorixa* sp. | **Coleoptera** | Dytiscidae (misc.) | *Colymbetes* sp. | *Hydroporus* sp. | *Liodessus* sp. | *Oreodytes* sp. | *Stictotarsus* sp. | Elmidae (misc.) | *Dubiraphia* sp. | *Optioservus* sp. | Gyrinidae (misc.) | Pyralidae (misc.) | *Petrophila* sp. | **Diptera** | *Atherix* sp. | Ceratopogonidae sp. | *Bezzia / Palpomyia* gp spp. | *Culicoides* sp. | *Rhaphium* sp. | Empididae (misc.) | *Chelifera* sp. | *Hemerodromia* sp. | *Wiedemannia* sp. | Simuliidae (misc.) | *Simulium* sp. | *Antocha* sp. | *Dicranota* sp. | *Hexatoma* sp. | *Tipula* sp. | **Chironomidae** | **Chironomini** | **Tanytarsini** | **Diamesinae** | **Orthocladiinae** | **Prodiamesinae** | **Tanypodinae** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cochrane** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | | | | 0 | | | | | 1 | | | | | | | | 9 | | | | | | | | | | | | | | 0 | | | | 19 | 0 | | | | | 8 | | | | 24 | 2 | 185 | | 1041 | 2 | 100 |
| | 1983 | Rep 2 | | | | 1 | | | | | 0 | | | | | | | | 0 | | | | | | | | | | | | | | 2 | | | | 11 | 4 | | | | | 2 | | | | 39 | 0 | 152 | | 1853 | 0 | 138 |
| | 1983 | Rep 3 | | | | 0 | | | | | 0 | | | | | | | | 0 | | | | | | | | | | | | | | 0 | | | | 46 | 0 | | | | | 93 | | | | 25 | 0 | 508 | | 3812 | 0 | 636 |
| | 1983 | Rep 4 | | | | 0 | | | | | 0 | | | | | | | | 0 | | | | | | | | | | | | | | 0 | | | | 8 | 0 | | | | | 2 | | | | 18 | 0 | 84 | | 380 | 0 | 60 |
| | 1983 | Rep 5 | | | | 0 | | | | | 0 | | | | | | | | 0 | | | | | | | | | | | | | | 0 | | | | 1 | 0 | | | | | 0 | | | | 2 | 0 | 32 | | 92 | 0 | 12 |
| | **1983** | **Average** | | | | **0.2** | | | | | **0.2** | | | | | | | | **2** | | | | | | | | | | | | | | **0** | | | | **17** | **1** | | | | | **21** | | | | **21.6** | **0.4** | **192.2** | | **1435.6** | **0** | **189** |
| | 1984 | Rep 1 | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | 0 | | | | 2 | | | | | | | | | | 11 | 22 | 7 | 41 | 143 | | 0 |
| | 1984 | Rep 2 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | 0 | | | | 1 | | | | | | | | | | 16 | 4 | 3 | 10 | 190 | | 3 |
| | 1984 | Rep 3 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | 0 | | | | 0 | | | | | | | | | | 10 | 0 | 4 | 12 | 48 | | 2 |
| | 1984 | Rep 4 | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | 0 | | | | 0 | | | | | | | | | | 6 | 6 | 27 | 0 | 136 | | 1 |
| | 1984 | Rep 5 | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | 2 | | | | | | | | | | 6 | 39 | 105 | 4 | 235 | | 4 |
| | **1984** | **Average** | | | **0.4** | | | | | | **0** | **0** | | **0** | **0** | | | **0** | **0** | | | | | | **0** | | **0** | | | **0.2** | **0** | **0** | **0** | | | | **1** | **0** | **0** | **0** | **0** | | **0** | **0** | | **0** | **9.8** | **14.2** | **29.2** | **13.4** | **150.4** | | **2** |
| | 1985 | Rep 1 | | | 1 | | | | | | 0 | | | | | | | 0 | 0 | | | | | | 1 | | | | | | | | | | | | | 0 | 0 | 2 | 1 | | 18 | | | 0 | 81 | 35 | 465 | | 378 | | 206 |
| | 1985 | Rep 2 | | | 5 | | | | | | 0 | | | | | | | 1 | 0 | | | | | | 1 | | | | | | | | | | | | | 1 | 1 | 2 | 0 | | 33 | | | 1 | 28 | 28 | 153 | | 484 | | 170 |
| | 1985 | Rep 3 | | | 4 | | | | | | 0 | | | | | | | 0 | 2 | | | | | | 4 | | | | | | | | | | | | | 1 | 0 | 8 | 0 | | 50 | | | 0 | 136 | 60 | 625 | | 977 | | 500 |
| | 1985 | Rep 4 | | | 0 | | | | | | 1 | | | | | | | 0 | 2 | | | | | | 0 | | | | | | | | | | | | | 1 | 0 | 4 | 2 | | 36 | | | 0 | 62 | 5 | 232 | | 345 | | 138 |
| | 1985 | Rep 5 | | | 0 | | | | | | 0 | | | | | | | 1 | 0 | | | | | | 1 | | | | | | | | | | | | | 4 | 0 | 11 | 0 | | 27 | | | 1 | 78 | 69 | 431 | | 899 | | 247 |
| | **1985** | **Average** | | | **2** | | | | | | **0.2** | **0** | | **0** | **0** | | | **0** | **1** | | | | | | **1** | | **0** | | | **0** | **0** | **0** | **0** | | | | **0** | **1** | **0** | **5.4** | **0.6** | | **33** | **0** | | **0.4** | **77** | **39.4** | **381.2** | **0** | **616.6** | | **252** |
| | 1986 | Rep 1 | | | 0 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 0 | | | | | 1 | 1 | 1 | 6 | 0 | | | 0 | | | 60 | 148 | 104 | | 1492 | | 7 |
| | 1986 | Rep 2 | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 0 | | | | | 0 | 3 | 0 | 3 | 0 | | | 0 | | | 32 | 65 | 57 | | 1092 | | 12 |
| | 1986 | Rep 3 | | | 0 | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | 0 | | | | | 0 | 1 | 0 | 4 | 8 | | | 1 | | | 1 | 525 | 205 | | 537 | | 69 |
| | 1986 | Rep 4 | | | 0 | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | 1 | | | | | 0 | 3 | 0 | 2 | 1 | | | 0 | | | 27 | 326 | 362 | | 902 | | 60 |
| | 1986 | Rep 5 | | | 1 | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | 0 | | | | | 0 | 1 | 0 | 2 | 3 | | | 0 | | | 40 | 331 | 250 | | 1435 | | 21 |
| | **1986** | **Average** | | | **0.4** | | | | | | **0** | **0** | | **0** | **0** | | | **0** | **0** | | | | | | **0** | | **0.4** | | | **0** | **0** | **0** | **0** | | | | **0** | **2** | **0** | **3.4** | **2.4** | | **0** | **0.2** | | **0** | **32** | **279** | **195.6** | **0** | **1091.6** | | **33.8** |
| | 1987 | Rep 1 | | | | | | | | | 7 | 8 | | 3 | 0 | | | | | | | | | | | | | | | | 1 | | | | | | | 0 | | | | | | | | | | | 0 | | 0 | | 0 |
| | 1987 | Rep 2 | | | | | | | | | 5 | 4 | | 0 | 1 | | | | | | | | | | | | | | | | 2 | | | | | | | 0 | | | | | | | | | | | 1 | | 6 | | 0 |
| | 1987 | Rep 3 | | | | | | | | | 4 | 0 | | 0 | 1 | | | | | | | | | | | | | | | | 2 | | | | | | | 1 | | | | | | | | | | | 0 | | 6 | | 2 |
| | 1987 | Rep 4 | | | | | | | | | 12 | 1 | | 7 | 0 | | | | | | | | | | | | | | | | 0 | | | | | | | 0 | | | | | | | | | | | 0 | | 3 | | 0 |
| | 1987 | Rep 5 | | | | | | | | | 7 | 0 | | 2 | 0 | | | | | | | | | | | | | | | | 0 | | | | | | | 0 | | | | | | | | | | | 0 | | 9 | | 1 |
| | **1987** | **Average** | | | **0** | | | | | | **7** | **2.6** | | **2.4** | **0.4** | | | **0** | **0** | | | | | | **0** | | **0** | | | **0** | **1** | **0** | **0** | | | | **0** | **0** | **0** | **0** | **0** | | **0** | **0** | | **0** | **0** | **0** | **0.2** | **0** | **4.8** | | **0.6** |
| | 1989 | Rep 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | 2 | 4 | | 11 | | | | 60 | 34 | 217 | | 3092 | | 168 |
| | 1989 | Rep 2 | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 64 | | 7 | | 1036 | | 148 |
| | 1989 | Rep 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | 1 | | | 5 | | | | 48 | 69 | 92 | 40 | 1608 | | 133 |
| | 1989 | Rep 4 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 2 | 2 | 4 | | 5 | | | | 44 | 8 | 219 | 8 | 1491 | | 95 |
| | 1989 | Rep 5 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | 6 | | 4 | | | 14 | 1 | | | 32 | 24 | 362 | 26 | 3354 | | 260 |
| | **1989** | **Average** | | | **0** | | | | | | **0.2** | **0** | | **0** | **0** | | | **0** | **0** | | | | | | **0** | | **0.4** | | | **0** | **0** | **0** | **0** | | | | **0** | **3** | **0** | **1.8** | **1.6** | | **7** | **0.2** | | **0** | **49.6** | **27** | **179.4** | **14.8** | **2116.2** | | **161** |
| | 1993 | Rep 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 4 | | 1 | | | 2 | | | | 1 | 22 | 99 | 1 | 32 | | 10 |
| | 1993 | Rep 2 | | | | | | | | | | | | | | | | | 1 | | | | | | 2 | | | | | | | | | | | | | 16 | | 21 | | | 62 | | | | 17 | 78 | 340 | | 723 | | 36 |
| | 1993 | Rep 3 | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | 2 | | | | | | 9 | | 8 | | | 20 | | | | 3 | 120 | 206 | 2 | 309 | | 137 |
| | 1993 | Rep 4 | | | | | | | | | 1 | | | | | | | | | | | | | | 1 | | | | | | | 1 | | | | | | 1 | 2 | 2 | | | 5 | | | | 3 | 86 | 83 | 1 | 143 | | 17 |
| | 1993 | Rep 5 | | | | | | | | | | | | | | | | | 1 | | | | | | 1 | | | | | | | | | | | | | 19 | | 12 | | | 45 | | | | 4 | 85 | 384 | | 479 | | 52 |
| | **1993** | **Average** | | | **0** | | | | | | **0.2** | **0** | | **0** | **0** | | | **0** | **0** | | | | | | **1** | | **0** | | | **0** | **0** | **1** | **0** | | | | **0** | **10** | **0** | **8.8** | **0** | | **27** | **0** | | **0** | **5.6** | **78.2** | **222.4** | **0.8** | **337.2** | | **50.4** |
| | 2006 | Rep 1 | | | | | | | | | | 31 | | | | 5 | | | | | | 17 | | | | | 2 | | | | | | | 4 | | | | | | | | | | 0 | | 1 | | 20 | 25 | 5 | 5 | | 9 |
| | 2006 | Rep 2 | | | | | | | | | | 12 | | | | 3 | | | | | | 5 | | | | | 0 | | | | | | | 0 | | | | | | | | | | 0 | | 1 | | 9 | 1 | 0 | 20 | | 0 |
| | 2006 | Rep 3 | | | | | | | | | | 1 | | | | 1 | | | | | | 0 | | | | | 0 | | | | | | | 0 | | | | | | | | | | 0 | | 0 | | 12 | 0 | 1 | 8 | | 4 |
| | 2006 | Rep 4 | | | | | | | | | | 27 | | | | 0 | | | | | | 4 | | | | | 0 | | | | | | | 0 | | | | | | | | | | 1 | | 0 | | 5 | 12 | 9 | 9 | | 5 |
| | 2006 | Rep 5 | | | | | | | | | | 0 | | | | 2 | | | | | | 0 | | | | | 0 | | | | | | | 0 | | | | | | | | | | 0 | | 0 | | 1 | 4 | 11 | 53 | | 6 |
| | **2006** | **Average** | | | **0** | **0** | | | | | **0** | **14** | | **0** | **0** | **2** | | **0** | **0** | | | **5** | | | **0** | | **0.4** | | | | | | | **0.8** | | | **0** | **0** | **0** | **0** | **0** | | **0** | **0.2** | | **0.4** | **0** | **9.4** | **8.4** | **5.2** | **19** | **0** | **5** |

# Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006)

## Stier's Ranch

| Site | year | replicate | *Hydra* sp. | TURBELLARIA | Microturbellaria | *Dugesia tigrina* | *Polycelis coronata* | NEMATODA | NEMERTEA | TARDIGRADA | OLIGOCHAETA | Un - identified Oligochaeta | Enchytraeidae | Lumbricidae | Lumbriculidae | Naididae | Tubificidae | HIRUDINEA | Erpobdellidae (misc.) | *Dina sp.* | *Erpobdella* sp. | *Nephelopsis obscura* | *Mooreobdella* sp. | Glossiphonidae (misc.) | *Helobdella stagnalis* | *Glossiphonia* sp. | *Placobdella ornata* | Piscicolidae (misc.) | GASTROPODA | Lymnaeidae (misc.) | *Fossaria* sp. | *Lymnaea* sp. | *Ferrissia* sp. | Ancylidae (misc.) | Planorbidae (misc.) | *Gyraulus* sp. | *Helisoma* sp. | Physidae (misc.) | *Physa* sp. | PELECYPODA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stier's Ranch** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | 2 | | | | | 11 | | | | | | 0 | 1 | 48 | 40 | 0 | | 3 | | | | | 0 | 0 | | | 1 | | | | | | 0 | 1 | | | 0 | |
| | 1985 | Rep 2 | 9 | | | | | 19 | | | | | | 1 | 1 | 184 | 159 | 0 | | 13 | | | | | 0 | 1 | | | 0 | | | | | | 0 | 16 | | | 0 | |
| | 1985 | Rep 3 | 6 | | | | | 37 | | | | | | 0 | 0 | 152 | 767 | 0 | | 11 | | | | | 1 | 0 | | | 0 | | | | | | 0 | 9 | | | 0 | |
| | 1985 | Rep 4 | 79 | | | | | 2 | | | | | | 0 | 0 | 121 | 33 | 0 | | 3 | | | | | 0 | 1 | | | 3 | | | | | | 0 | 9 | | | 1 | |
| | 1985 | Rep 5 | 8 | | | | | 24 | | | | | | 2 | 0 | 175 | 391 | 2 | | 2 | | | | | 0 | 0 | | | 0 | | | | | | 1 | 5 | | | 0 | |
| | **1985** | **Average** | **20.8** | **0** | | | | **18.6** | **0** | **0** | | | **0** | **0.6** | **0.4** | **136** | **278** | **0.4** | **0** | **6.4** | **0** | **0** | | | **0.2** | **0.4** | | | **0.8** | | | **0** | | | **0.2** | **8** | | | **0.2** | |
| | 1989 | Rep 1 | | | | | | 88 | 1 | | | | | 3 | | 2440 | 2400 | | 11 | | | 1 | | | | | | | | | | | | | 2 | | | | | |
| | 1989 | Rep 2 | | | | | | 167 | 1 | 20 | | | | 2 | | 1901 | 968 | | 18 | | | | | | | | | | | | | | | | 7 | | | | | |
| | 1989 | Rep 3 | | | | | | 77 | 1 | | | | 24 | 10 | | 904 | 427 | | 25 | | | | | | | | | | | | | | | | | | | | | |
| | 1989 | Rep 4 | 8 | | | | | 30 | | | | | 1 | 1 | | 539 | 463 | | 4 | | | | | | | | | | | | | | | | 7 | | | | | |
| | 1989 | Rep 5 | 7 | | | | | 41 | | | | | | | | 560 | 1696 | | 3 | | | 3 | | | | 1 | | | | | | | | | 9 | | | | | |
| | **1989** | **Average** | **3** | **0** | | | | **80.6** | **0.6** | **4** | | | **5** | **3.2** | **0** | **1268.8** | **1190.8** | **0** | **12.2** | **0** | **0** | **0.8** | **0** | | **0** | **0.2** | | | **0** | | | **0** | | | **5** | **0** | | | **0** | |
| | 1993 | Rep 1 | 5 | | | | | 27 | | | | | 14 | 5 | | 785 | 1118 | | 7 | | | | | | | | | | 45 | | | | | | 35 | | | | 3 | |
| | 1993 | Rep 2 | 9 | | | | | 18 | | | | | 3 | 2 | | 786 | 886 | | 13 | | | | | | | | | | 28 | | | | | | 39 | | | | 1 | |
| | 1993 | Rep 3 | 8 | 1 | | | | 41 | | | | | 4 | 10 | | 1072 | 1507 | | | | | | | | | | | | 26 | | | | | | 43 | | | | 3 | |
| | 1993 | Rep 4 | 7 | 2 | | | | 23 | | | | | 9 | 2 | 1 | 1119 | 1562 | | 9 | | 1 | | | | | | | | 27 | | | 1 | | | 62 | | | | 1 | |
| | 1993 | Rep 5 | 8 | 2 | | | | 40 | | | | | 35 | 2 | | 608 | 1358 | | 1 | | | | | | | | | | 13 | | | | | | 18 | | | | 2 | |
| | **1993** | **Average** | **7.4** | **1** | | | | **29.8** | **0** | **0** | | | **13** | **4.2** | **0.2** | **874** | **1286.2** | **0** | **6** | **0** | **0.2** | **0** | | | **0** | **0** | | | **27.8** | | | **0.2** | | | **39.4** | **0** | | | **2** | |
| | 2006 | Rep 1 | 0 | | 0 | 1 | | 359 | | | | | 1 | 2 | | 131 | 216 | | 0 | 0 | 0 | 0 | | | | 0 | | | | | 0 | | | | | 1 | | | 181 | |
| | 2006 | Rep 2 | 0 | | 20 | 4 | | 1170 | | | | | 20 | 2 | | 60 | 1250 | | 0 | 0 | 0 | 9 | | | | 0 | | | | | 0 | | | | | 0 | | | 330 | |
| | 2006 | Rep 3 | 10 | | 40 | 0 | | 1441 | | | | | 31 | 8 | | 70 | 1202 | | 0 | 0 | 1 | 2 | | | | 0 | | | | | 0 | | | | | 1 | | | 418 | |
| | 2006 | Rep 4 | 0 | | 0 | 8 | | 424 | | | | | 160 | 1 | | 40 | 914 | | 0 | 1 | 1 | 0 | | | | 1 | | | | | 0 | | | | | 1 | | | 904 | |
| | 2006 | Rep 5 | 40 | | 0 | 0 | | 5998 | | | | | 0 | 0 | | 40 | 1447 | | 0 | 0 | 1 | 1 | | | | 0 | | | | | 0 | | | | | 0 | | | 340 | |
| | **2006** | **Average** | **10** | | **16** | **3** | | **2112** | | **0** | | | **46** | **3** | | **80** | **1256** | | **0** | **0.2** | **0.6** | **4** | | | **0** | **0.2** | | | | | **0** | | **0** | | | **0.6** | | | **501** | |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

### Stier's Ranch

| Site | year | replicate | *Pisidium* sp. | *Sphaerium* sp. | Sphaeriidae (misc.) | **Hydracarina** | **Oribatei** | **CRUSTACEA** | **OSTRACODA** | **CLADOCERA** | **COPEPODA** | **AMPHIPODA** | *Gammarus lacustris* | *Hyalella azteca* | *Orconectes virilis* | **Collembola** | **Ephemeroptera** | Baetidae (misc.) | *Baetis* sp. | *Dactylobaetis* sp. | *Caenis* sp. | Ephemerellidae (misc.) | *Ephemerella* sp. | *Drunella* sp. | *Serratella* sp. | *Ephemera* sp. | Heptageniidae (misc.) | *Epeorus* sp. | *Heptagenia* sp. | *Rhithrogena* sp. | *Stenonema* sp. | *Cinygma* sp. | Leptophlebiidae (misc.) | *Leptophlebia* sp. | *Paraleptophlebia* sp. | *Isonychia* sp. | *Ephoron* sp. | Siplonuridae misc. | *Ameletus* sp. | *Tricorythodes* sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stier's Ranch** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | 4 | 1 | | 10 | | | 0 | 0 | 1 | | | 2 | | | 0 | 35 | 99 | | | | 7 | | | | | 0 | 2 | 0 | 0 | | | | 2 | | | | | 4 |
| | 1985 | Rep 2 | 4 | 0 | | 2 | | | 7 | 0 | 24 | | | 2 | | | 1 | 15 | 24 | | | | 9 | | | | | 0 | 6 | 1 | 0 | | | | 6 | | | | | 4 |
| | 1985 | Rep 3 | 8 | 0 | | 4 | | | 6 | 1 | 40 | | | 2 | | | 0 | 18 | 27 | | | | 4 | | | | | 2 | 1 | 0 | 1 | | | | 1 | | | | | 8 |
| | 1985 | Rep 4 | 0 | 0 | | 35 | | | 2 | 0 | 232 | | | 3 | | | 0 | 164 | 163 | | | | 89 | | | | | 0 | 2 | 0 | 0 | | | | 9 | | | | | 37 |
| | 1985 | Rep 5 | 3 | 0 | | 4 | | | 13 | 0 | 317 | | | 1 | | | 0 | 6 | 53 | | | | 5 | | | | | 0 | 0 | 0 | 1 | | | | 0 | | | | | 3 |
| | **1985** | **Average** | **3.8** | **0.2** | **0** | **11** | | | **5.6** | **0.2** | **122.8** | | **0** | **2** | | **0** | **0.2** | **47.6** | **73.2** | | | **0** | **22.8** | | **0** | | **0** | **0.4** | **2.2** | **0.2** | **0.4** | | **0** | **0** | **3.6** | | | | | **11.2** |
| | 1989 | Rep 1 | | | 45 | 168 | | | 330 | 7 | 156 | | | | | | | 208 | | | | | 201 | | | | | | 10 | | 1 | | | | 23 | | | | | 14 |
| | 1989 | Rep 2 | | | 25 | 63 | | | 122 | 4 | 380 | | | | | | | 119 | | | | | 117 | | | | | 1 | 6 | 1 | | | | | 1 | | | | | 13 |
| | 1989 | Rep 3 | | | 28 | 244 | | | 65 | | 212 | | | | | | | 196 | | | | | 880 | | | | | | 7 | 2 | | | | | 96 | | | | | 16 |
| | 1989 | Rep 4 | | | 21 | 207 | | | 215 | 13 | 139 | | | | | | | 202 | | | | | 302 | | | | | | 13 | | | | | | 27 | | | | | 28 |
| | 1989 | Rep 5 | | | 43 | 116 | | | 488 | | 120 | | | | | | | 68 | | | | | 109 | | | | | | 4 | | | | | | 4 | | | | | 10 |
| | **1989** | **Average** | **0** | **0** | **32.4** | **160** | | | **244** | **4** | **201.4** | | **0** | **0** | | **0** | **0** | **158.6** | **0** | | | **0** | **321.8** | | **0** | | **0** | **0.2** | **8** | **0.6** | **0.2** | | **0** | **0** | **30.2** | | | | | **16.2** |
| | 1993 | Rep 1 | | | 22 | 56 | | | 120 | 2 | 44 | | | 1 | | 1 | 1 | 444 | 6 | | | 78 | | | 413 | | 4 | | 9 | 1 | | | 54 | | 39 | | | | | 24 |
| | 1993 | Rep 2 | | | 26 | 40 | | | 95 | 5 | 25 | | | | | | 2 | 391 | 5 | | | 30 | | | 332 | | | | 14 | 2 | | | 10 | | 17 | | | | | 7 |
| | 1993 | Rep 3 | 9 | | 16 | 100 | | | 233 | 1 | 176 | | 3 | | | | 1 | 708 | 12 | | | 134 | | | 406 | | 4 | | 9 | 4 | | | 29 | | 88 | | | | | 8 |
| | 1993 | Rep 4 | 5 | | 56 | 105 | | | 111 | | 121 | | | | | | 1 | 920 | 9 | | | 47 | | | 1050 | | | | 7 | 7 | | | 15 | 1 | 59 | | | | | 5 |
| | 1993 | Rep 5 | | | 23 | 70 | | | 79 | | 74 | | | | | | | 489 | 6 | | | 30 | 3 | | 495 | | 1 | | 12 | 9 | | | 8 | | 73 | | | | | 4 |
| | **1993** | **Average** | **2.8** | **0** | **28.6** | **74.2** | | | **127.6** | **1.5** | **88** | | **0.6** | **0.2** | | **0.2** | **1** | **590.4** | **7.6** | | | **63.8** | **0.6** | | **539.2** | | **1.8** | **0** | **10.2** | **4.6** | **0** | | **23.2** | **0.2** | **55.2** | | | | | **9.6** |
| | 2006 | Rep 1 | 0 | | | 100 | 0 | | 90 | | 40 | | 0 | 0 | | | | | 107 | | 0 | | 163 | | | | | 71 | 12 | 1 | 0 | | | 0 | 8 | | | | | |
| | 2006 | Rep 2 | 0 | | | 40 | 0 | | 60 | | 260 | | 1 | 15 | | | | | 167 | | 0 | | 70 | | | | | 0 | 1 | 1 | 0 | | | 0 | 4 | | | | | |
| | 2006 | Rep 3 | 0 | | | 80 | 0 | | 100 | | 330 | | 0 | 0 | | | | | 220 | | 0 | | 126 | | | | | 46 | 30 | 0 | 0 | | | 0 | 8 | | | | | |
| | 2006 | Rep 4 | 20 | | | 40 | 0 | | 280 | | 120 | | 4 | 1 | | | | | 396 | | 0 | | 390 | | | | | 60 | 1 | 0 | 0 | | | 0 | 16 | | | | | |
| | 2006 | Rep 5 | 0 | | | 40 | 0 | | 240 | | 80 | | 0 | 0 | | | | | 506 | | 0 | | 211 | | | | | 0 | 0 | 0 | 0 | | | 0 | 5 | | | | | |
| | **2006** | **Average** | **4** | **0** | | **68** | **0** | | **166** | | **166.0** | | **1** | **6** | **0** | **0** | | | **313** | | **0** | | **206** | | | **0** | | **35** | **9** | **0.6** | **0** | | | **0** | **9** | | | | | **0** |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Stier's Ranch

| Site | year | replicate | **Plecoptera** | Capniidae (misc.) | Chloroperlidae (misc.) | *Sweltsa* sp. | *Suwallia* sp. | Perlidae (misc.) | *Claassenia* sp. | *Hesperoperla* sp. | *Perlesta* sp. | Perlodidae (misc.) | *Cultus* sp. | *Isogenoides* sp. | *Isoperla* sp. | *Skwala* sp. | *Pteronarcys* sp. | *Taenionema* sp. | *Oemopteryx* sp. | **Trichoptera** | *Brachycentrus* sp. | Glossosomatidae (misc.) | *Anagapetus* sp. | *Glossosoma* sp. | Helicopsychidae (misc.) | *Helicopsyche* sp. | Hydropsychidae (misc.) | *Arctopsyche* sp. | *Cheumatopsyche* sp. | *Hydropsyche* sp. | Hydroptilidae (misc.) | *Hydroptila* sp. | Leptoceridae (misc.) | *Ceraclea* sp. | *Mystacides* sp. | *Nectopsyche* sp. | *Oecetis* sp. | *Triaenodes* sp. | *Lepidostoma* sp. | Limnephilidae (misc.) | *Phryganea* sp. | Polycentropodidae (misc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stier's Ranch** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | | | | | | | | | | | | | 0 | | | | | 0 | 0 | | | | | | 29 | | 2 | 148 | | 1 | | 0 | | | 0 | | 1 | | | |
| | 1985 | Rep 2 | | | | | | | | | | | | | 1 | | | | | 0 | 1 | | | | | | 32 | | 21 | 297 | | 0 | | 1 | | | 0 | | 5 | | | |
| | 1985 | Rep 3 | | | | | | | | | | | | | 0 | | | | | 0 | 0 | | | | | | 89 | | 3 | 215 | | 0 | | 1 | | | 0 | | 2 | | | |
| | 1985 | Rep 4 | | | | | | | | | | | | | 5 | | | | | 1 | 0 | | | | | | 236 | | 12 | 392 | | 0 | | 0 | | | 2 | | 32 | | | |
| | 1985 | Rep 5 | | | | | | | | | | | | | 0 | | | | | 0 | 2 | | | | | | 6 | | 1 | 78 | | 0 | | 1 | | | 0 | | 0 | | | |
| | **1985** | **Average** | | | | | | **0** | | | | **0** | | | **1.2** | | | | | **0.2** | **0.6** | | **0** | | | | **78.4** | | **7.8** | **226** | | **0.2** | | **0.6** | | | **0.4** | | **8** | | | |
| | 1989 | Rep 1 | | | | | | | | | | | | | | | | | | | | | | | | | 200 | | | 31 | | | | 5 | | | 1 | | 39 | | | |
| | 1989 | Rep 2 | | | | | | | | | | 1 | | | | | | | | | | | | | | | 100 | | | 10 | | | | | | | 1 | | 35 | | | |
| | 1989 | Rep 3 | | | | | | | | | | 3 | | | | | | | | | | | | | | | 204 | | 12 | 76 | | | | 13 | | | | | 120 | | | |
| | 1989 | Rep 4 | | | | | | | | | | | | | | | | | | | | | | | | | 106 | | 7 | 23 | | | | | | | 8 | | 59 | | | |
| | 1989 | Rep 5 | | | | | | | | | | | | | | | | | | | | | | | | | 45 | | | 4 | | | | 7 | | | 1 | | 17 | | | |
| | **1989** | **Average** | | | | | | **0** | | | | **0.8** | | | **0** | | | | | **0** | **0** | | **0** | | | | **131** | | **3.8** | **28.8** | | **0** | | **5** | | | **2.2** | | **54** | | | |
| | 1993 | Rep 1 | | | | | | 3 | | | | 13 | | | 3 | | | | | 1 | 2 | | | | | | 62 | | 7 | 485 | | | | | | | | | 88 | | | |
| | 1993 | Rep 2 | | | | | | 1 | | | | 3 | | | 4 | | | | | 6 | 2 | | 1 | | | | 100 | | 16 | 577 | | | | 2 | | | | | 40 | | | |
| | 1993 | Rep 3 | | | | | | 1 | | | | 22 | | | 3 | | | | | | 8 | | | | | | 258 | | 33 | 1132 | | | | | | | 3 | | 171 | | | |
| | 1993 | Rep 4 | | | | | | 2 | | | | 10 | | | | | | | | 1 | 1 | | | | | | 157 | | 25 | 971 | | | | | | | | | 79 | | | |
| | 1993 | Rep 5 | | | | | | | | | | 12 | | | | | | | | | | | 1 | | | | 175 | | 28 | 1086 | | | | | | | | | 56 | | | |
| | **1993** | **Average** | | | | | | **1.4** | | | | **12** | | | **2** | | | | | **1.6** | **2.6** | | **0.4** | | | | **150.4** | | **21.8** | **850.2** | | **0** | | **0.4** | | | **0.6** | | **86.8** | | | |
| | 2006 | Rep 1 | | | | | | | 0 | | | | | | 0 | | | | | 0 | 0 | | | | | | | | 65 | 2269 | | | | 5 | | | 0 | | 1 | | | |
| | 2006 | Rep 2 | | | | | | | 0 | | | | | | 0 | | | | | 0 | 0 | | | | | | | | 4 | 547 | | | | 65 | | | 2 | | 4 | | | |
| | 2006 | Rep 3 | | | | | | | 3 | | | | | | 0 | | | | | 0 | 5 | | | | | | | | 40 | 2199 | | | | 60 | | | 1 | | 1 | | | |
| | 2006 | Rep 4 | | | | | | | 1 | | | | | | 0 | | | | | 0 | 16 | | | | | | | | 150 | 2826 | | | | 10 | | | 5 | | 9 | | | |
| | 2006 | Rep 5 | | | | | | | 0 | | | | | | 1 | | | | | 0 | 1 | | | | | | | | 7 | 759 | | | | 0 | | | 0 | | 0 | | | |
| | **2006** | **Average** | | | | | | | **0.8** | | | | **0** | **0** | **0.2** | **0** | | **0** | | | **4** | | | | | **0** | | | **54** | **1829** | | **0** | | **41** | | **0** | **2** | | **4** | | | |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

### Stier's Ranch

| Site | year | replicate | *Neureclipsis* sp. | *Polycentropus* sp. | *Psychomyia* sp. | *Rhyacophilia* sp. | **Anisoptera** | *Ophiogomphus* sp. | Coenagrionidae sp. | **Hemiptera** | Corixidae sp. | *Callicorixa* sp. | *Cenocorixa* sp. | *Corisella* sp. | *Palmacorixa* sp. | *Sigara* sp. | *Trichocorixa* sp. | **Coleoptera** | Dytiscidae (misc.) | *Colymbetes* sp. | *Hydroporus* sp. | *Liodessus* sp. | *Oreodytes* sp. | *Stictotarsus* sp. | Elmidae (misc.) | *Dubiraphia* sp. | *Optioservus* sp. | Gyrinidae (misc.) | Pyralidae (misc.) | *Petrophila* sp. | **Diptera** | *Atherix* sp. | Ceratopogonidae sp. | *Bezzia / Palpomyia* gp spp. | *Culicoides* sp. | *Rhaphium* sp. | Empididae (misc.) | *Chelifera* sp. | *Hemerodromia* sp. | *Wiedemannia* sp. | Simulidae (misc.) | *Simulium* sp. | *Antocha* sp. | *Dicranota* sp. | *Hexatoma* sp. | *Tipula* sp. | **Chironomidae** | **Chironomini** | **Tanytarsini** | **Diamesinae** | **Orthocladiinae** | **Prodiamesinae** | **Tanypodinae** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stier's Ranch** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | | | 0 | | | | | | | | | | | | | 0 | 0 | | | | | | 1 | | | | | | | | | | | | | | | 8 | 40 | | | | | | | 33 | 0 | 6 | 344 | | 25 |
| | 1985 | Rep 2 | | | 2 | | | | | | | | | | | | | 1 | 2 | | | | | | 2 | | | | | | | | | | | | | | | 36 | 2 | | | | | | | 146 | 16 | 12 | 233 | | 112 |
| | 1985 | Rep 3 | | | 0 | | | | | | | | | | | | | 0 | 0 | | | | | | 0 | | | | | | | | | | | | | | | 12 | 21 | | | | | | | 58 | 16 | 0 | 120 | | 67 |
| | 1985 | Rep 4 | | | 41 | | | | | | | | | | | | | 0 | 1 | | | | | | 0 | | | | | | | | | | | | | | | 51 | 4 | | | | | | | 42 | 6 | 16 | 584 | | 310 |
| | 1985 | Rep 5 | | | 2 | | | | | | | | | | | | | 0 | 0 | | | | | | 1 | | | | | | | | | | | | | | | 16 | 4 | | | | | | | 36 | 4 | 1 | 214 | | 50 |
| | **1985** | **Average** | | | **9** | | | | | **0** | **0** | | | | | | | **0** | **1** | | | | | | **1** | | **0** | | | | **0** | **0** | **0** | | | | | **0** | | **24.6** | **14** | | **0** | | | | **0** | **63** | **8.4** | **7** | **299** | | **113** |
| | 1989 | Rep 1 | | | 4 | | | | | | | | | | | | | | | | | | | | | | 9 | | | | | | | | | | | | | | 69 | | | | | | 17 | 1396 | 124 | 88 | 1364 | | 112 |
| | 1989 | Rep 2 | | | 28 | | | | | | 3 | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | 11 | | | | | | 17 | 1586 | 104 | 72 | 2445 | | 136 |
| | 1989 | Rep 3 | | | 68 | | | | | | | | | | | | | | | | | | | | 2 | | 52 | | | | | | | | | | | 2 | | | 49 | | | | | | 36 | 2048 | 56 | 8 | 984 | | 220 |
| | 1989 | Rep 4 | | | 14 | | | | | | | | | | | | | | | | | | | | 1 | | 12 | | | | | | | | | | | | | | 97 | | | | | | 4 | 1067 | 59 | 14 | 397 | | 136 |
| | 1989 | Rep 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 115 | | | | | | | 748 | 28 | 32 | 1068 | | 68 |
| | **1989** | **Average** | | | **22.8** | | | | | **0** | **0.6** | | | | | | | **0** | **0** | | | | | | **1** | | **14.8** | | | | **0** | **0** | **0** | | | | | **0** | | **0** | **68** | | **0** | | | | **14.8** | **1369** | **74.2** | **42.8** | **1251.6** | | **134** |
| | 1993 | Rep 1 | | | 36 | | | | | 1 | 4 | | | | | | | | | | | | | | 15 | | | | | | | | | | | | | 3 | | | 2 | | 1 | | | | 25 | 1500 | 34 | 4 | 949 | | 230 |
| | 1993 | Rep 2 | | | 43 | | | | | | | | | | | | | | | | | | | | 21 | | | | | | | 1 | | | | | | 1 | | | 17 | | 1 | | | | 30 | 669 | 28 | 2 | 726 | | 85 |
| | 1993 | Rep 3 | | | 23 | | | | | | | | | | | | | | 1 | | | | | | 18 | | | | | | | | | | | | | | | | 36 | | | | | | 43 | 1508 | 82 | 8 | 1117 | | 59 |
| | 1993 | Rep 4 | | | 49 | | | | | | | | | | | | | | | | | | | | 33 | | | | | | | | 1 | | | | | | | | 17 | | | | | | 21 | 1266 | 50 | | 1076 | | 124 |
| | 1993 | Rep 5 | | | 15 | | | | | | | | | | | | | | | | | | | | 17 | | | | | | | | | | | | | | | | 31 | | | | | | 21 | 1448 | 21 | | 702 | | 46 |
| | **1993** | **Average** | | | **33.2** | | | | | **0.2** | **0.8** | | | | | | | **0** | **0** | | | | | | **21** | | **0** | | | | **0** | **0** | **0** | | | | | **1** | | **0** | **21** | | **0.4** | | | | **28** | **1278.2** | **43** | **2.8** | **914** | | **109** |
| | 2006 | Rep 1 | 1 | | 13 | | | | | 0 | | 6 | 0 | | | 0 | | 0 | | | | 0 | 0 | 0 | | | 876 | | | | | | | | | | | | 9 | | | 53 | | | | | | 1127 | 71 | 1 | 1026 | | 832 |
| | 2006 | Rep 2 | 5 | | 4 | | | | | 0 | | 5 | 1 | | | 1 | | 0 | | | | 8 | 0 | 0 | | | 409 | | | | | | | | | | | | 4 | | | 1952 | | | | | | 1542 | 229 | 259 | 1611 | | 839 |
| | 2006 | Rep 3 | 1 | | 2 | | | | | 0 | | 0 | 0 | | | 3 | | 0 | | | | 1 | 0 | 0 | | | 1232 | | | | | | | | | | | | 13 | | | 1900 | | | | | | 1826 | 255 | 227 | 2672 | | 1530 |
| | 2006 | Rep 4 | 3 | | 0 | | | | | 0 | | 650 | 0 | | | 0 | | 0 | | | | 0 | 1 | 4 | | | 723 | | | | | | | | | | | | 8 | | | 456 | | | | | | 1260 | 96 | 321 | 1372 | | 1294 |
| | 2006 | Rep 5 | 0 | | 0 | | | | | 0 | | 18 | 0 | | | 1 | | 0 | | | | 0 | 0 | 0 | | | 105 | | | | | | | | | | | | 0 | | | 2560 | | | | | | 1625 | 50 | 160 | 430 | | 479 |
| | **2006** | **Average** | **3** | **0** | **5** | | | **0** | **0** | | **0** | **137** | **0.4** | | | **1** | **0** | | | **0** | | **3** | **0.2** | **0.8** | | **0** | **751** | | | **0** | | **0** | **0** | **0** | **0** | **0** | | **0** | **8** | | | **1775** | **0** | **0** | **0** | **0** | | **1784.4** | **186** | **245** | **1744.4** | **0** | **1163** |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006)

## Carseland

| Site | year | replicate | *Hydra* sp. | TURBELLARIA | Microturbellaria | *Dugesia tigrina* | *Polycelis coronata* | NEMATODA | NEMERTEA | TARDIGRADA | OLIGOCHAETA | Un - identified Oligochaeta | Enchytraeidae | Lumbricidae | Lumbriculidae | Naididae | Tubificidae | HIRUDINEA | Erpobdellidae (misc.) | *Dina* sp. | *Erpobdella* sp. | *Nephelopsis obscura* | *Mooreobdella* sp. | Glossiphonidae (misc.) | *Helobdella stagnalis* | *Glossiphonia* sp. | *Placobdella ornata* | Piscicolidae (misc.) | GASTROPODA | Lymnaeidae (misc.) | *Fossaria* sp. | *Lymnaea* sp. | *Ferrissia* sp. | Ancylidae (misc.) | Planorbidae (misc.) | *Gyraulus* sp. | *Helisoma* sp. | Physidae (misc.) | *Physa* sp. | PELECYPODA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carseland** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | 33 | | | | | 25 | | | | | 5 | 4 | | 809 | 758 | | 9 | 0 | | | 2 | | | | | | | 0 | | | 8 | | 52 | | | 7 | | |
| | 1983 | Rep 2 | 30 | | | | | 269 | | | | | 0 | 0 | | 1044 | 223 | | 1 | 0 | | | 0 | | | | | | | 0 | | | 13 | | 82 | | | 3 | | |
| | 1983 | Rep 3 | 28 | | | | | 188 | | | | | 20 | 0 | | 1756 | 1680 | | 14 | 0 | | | 0 | | | | | | | 0 | | | 9 | | 54 | | | 20 | | |
| | 1983 | Rep 4 | 86 | | | | | 252 | | | | | 60 | 0 | | 1192 | 1455 | | 26 | 0 | | | 0 | | | | | | | 6 | | | 4 | | 290 | | | 21 | | |
| | 1983 | Rep 5 | 102 | | | | | 316 | | | | | 160 | 0 | | 1648 | 172 | | 3 | 0 | | | 0 | | | | | | | 0 | | | 2 | | 68 | | | 13 | | |
| | **1983** | **Average** | **55.8** | **0** | | | | **210** | | | | **0** | **49** | **0.8** | **0** | **1289.8** | **857.6** | **0** | **10.6** | **0** | **0** | **0** | **0.4** | **0** | **0** | **0** | | **0** | **0** | **1.2** | | | **7.2** | | **109.2** | **0** | | **12.8** | **0** | |
| | 1984 | Rep 1 | 128 | | | | | 209 | | | | | 0 | 0 | | 755 | 826 | | 1 | 0 | | | | 0 | | | | 1 | | 11 | | | 11 | | 115 | | | 5 | | |
| | 1984 | Rep 2 | 69 | | | | | 70 | | | | | 13 | 2 | | 688 | 283 | | 2 | 0 | | | | 1 | | | | 0 | | 26 | | | 44 | | 55 | | | 10 | | |
| | 1984 | Rep 3 | 40 | | | | | 200 | | | | | 0 | 2 | | 791 | 291 | | 5 | 0 | | | | 1 | | | | 0 | | 22 | | | 31 | | 70 | | | 0 | | |
| | 1984 | Rep 4 | 128 | | | | | 110 | | | | | 0 | 3 | | 940 | 183 | | 4 | 0 | | | | 4 | | | | 0 | | 39 | | | 26 | | 61 | | | 2 | | |
| | 1984 | Rep 5 | 87 | | | | | 292 | | | | | 13 | 5 | | 737 | 75 | | 4 | 0 | | | | 1 | | | | 0 | | 30 | | | 10 | | 45 | | | 5 | | |
| | **1984** | **Average** | **90.4** | **0** | | | | **176.2** | | | | **0** | **5.2** | **2.4** | **0** | **782.2** | **331.6** | **0** | **3.2** | **0** | **0** | **0** | **0** | **1.4** | **0** | **0** | | **0.2** | **0** | **25.6** | | | **24.4** | | **69.2** | **0** | | **4.4** | **0** | |
| | 1985 | Rep 1 | 2 | 1 | | | | 1596 | | | | | | 43 | | 360 | 1341 | | | 6 | | | | | 1 | 2 | | | | | | | 0 | | | 0 | | | | |
| | 1985 | Rep 2 | 0 | 0 | | | | 1888 | | | | | | 91 | | 980 | 1074 | | | 6 | | | | | 0 | 0 | | | | | | | 0 | | | 0 | | | | |
| | 1985 | Rep 3 | 0 | 0 | | | | 1304 | | | | | | 36 | | 410 | 433 | | | 5 | | | | | 0 | 2 | | | | | | | 2 | | | 1 | | | | |
| | 1985 | Rep 4 | 0 | 0 | | | | 1396 | | | | | | 141 | | 552 | 1081 | | | 7 | | | | | 0 | 5 | | | | | | | 0 | | | 0 | | | | |
| | 1985 | Rep 5 | 0 | 0 | | | | 325 | | | | | | 15 | | 153 | 1698 | | | 24 | | | | | 0 | 3 | | | | | | | 14 | | | 0 | | | | |
| | **1985** | **Average** | **0.4** | **0.2** | | | | **1301.8** | | | | **0** | **0** | **65.2** | **0** | **491** | **1125.4** | **0** | **0** | **9.6** | **0** | **0** | **0** | **0** | **0.2** | **2.4** | | **0** | **0** | **0** | | | **3.2** | | **0** | **0.2** | | **0** | **0** | |
| | 1986 | Rep 1 | 2 | | | | | 816 | | | | | 508 | 124 | | 322 | 74 | | 2 | 0 | 1 | 0 | | | 1 | 0 | | | | | | | 7 | | | | | | | |
| | 1986 | Rep 2 | 2 | | | | | 570 | | | | | 35 | 24 | | 275 | 130 | | 0 | 0 | 0 | 0 | | | 0 | 2 | | | | | | | 2 | | | | | | | |
| | 1986 | Rep 3 | 1 | | | | | 840 | | | | | 254 | 64 | | 80 | 87 | | 1 | 0 | 3 | 2 | | | 0 | 3 | | | | | | | 0 | | | | | | | |
| | 1986 | Rep 4 | 1 | | | | | 339 | | | | | 434 | 81 | | 666 | 99 | | 0 | 0 | 0 | 3 | | | 0 | 0 | | | | | | | 3 | | | | | | | |
| | 1986 | Rep 5 | 0 | | | | | 423 | | | | | 75 | 5 | | 178 | 76 | | 1 | 0 | 0 | 1 | | | 0 | 0 | | | | | | | 0 | | | | | | | |
| | **1986** | **Average** | **1.2** | **0** | | | | **597.6** | | | | **0** | **261.2** | **59.6** | **0** | **304.2** | **93.2** | **0** | **0.8** | **0** | **0.8** | **1.2** | **0** | **0** | **0.2** | **1** | | **0** | **0** | **0** | | | **2.4** | | **0** | **0** | | **0** | **0** | |
| | 1987 | Rep 1 | 10 | | | | | 70 | | | | 54 | | | 0 | 287 | 135 | 2 | | 0 | | | | | | 1 | | | | | | | 11 | | | | | 0 | | |
| | 1987 | Rep 2 | 5 | | | | | 13 | | | | 52 | | | 0 | 319 | 139 | 4 | | 1 | | | | | | 1 | | | | | | | 18 | | | | | 0 | | |
| | 1987 | Rep 3 | 15 | | | | | 16 | | | | 50 | | | 1 | 319 | 465 | 6 | | 0 | | | | | | 0 | | | | | | | 7 | | | | | 0 | | |
| | 1987 | Rep 4 | 10 | | | | | 18 | | | | 53 | | | 1 | 596 | 206 | 2 | | 0 | | | | | | 0 | | | | | | | 0 | | | | | 0 | | |
| | 1987 | Rep 5 | 12 | | | | | 75 | | | | 106 | | | 3 | 680 | 316 | 1 | | 1 | | | | | | 0 | | | | | | | 7 | | | | | 1 | | |
| | **1987** | **Average** | **10.4** | **0** | | | | **38.4** | | | | **63** | **0** | **0** | **1** | **440.2** | **252.2** | **3** | **0** | **0.4** | **0** | **0** | **0** | **0** | **0** | **0.4** | | **0** | **0** | **0** | | | **8.6** | | **0** | **0** | | **0.2** | **0** | |
| | 1993 | Rep 1 | 7 | 6 | | | | 120 | | | | | 30 | 8 | | 222 | 1627 | | 3 | 0 | | 1 | | | | | | | 3 | | | | | | 1 | | | | | |
| | 1993 | Rep 2 | 2 | 10 | | | | 176 | | | | | 52 | 11 | 1 | 383 | 860 | | 7 | 0 | 2 | 2 | | | | | | | | 3 | | | | | | | | | 2 | |
| | 1993 | Rep 3 | 2 | 10 | | | | 228 | | | | | 38 | 3 | | 253 | 1949 | | 2 | 0 | 2 | 1 | | | | | | | 1 | 2 | | | | | 2 | | | | 1 | |
| | 1993 | Rep 4 | 2 | 7 | | | | 221 | | | | | 63 | 9 | | 347 | 798 | | 4 | 0 | | 2 | | | | | | | | | | | | | | | | | | |
| | 1993 | Rep 5 | 5 | 20 | | | | 298 | | | | | 42 | 13 | 4 | 527 | 981 | | 3 | 0 | 3 | | | | | | | | 3 | 3 | | | | | 1 | | | 5 | 1 | |
| | **1993** | **Average** | **3.6** | **10.6** | | | | **208.6** | | | | **0** | **45** | **8.8** | **1** | **346.4** | **1243** | **0** | **3.8** | **0** | **1.4** | **1.2** | **0** | **0** | **0** | **0** | | **0** | **1.4** | **1.6** | | | **0** | | **0.8** | **0** | | **1** | **0.8** | |
| | 2006 | Rep 1 | 60 | | 0 | 0 | | 849 | | | | | 20 | 0 | | 1826 | 94 | | | | 1 | 0 | | | | | | | | | 0 | | | | | 0 | | | 62 | |
| | 2006 | Rep 2 | 20 | | 0 | 0 | | 310 | | | | | 0 | 0 | | 883 | 28 | | | | 0 | 1 | | | | | | | | | 0 | | | | | 0 | | | 4 | |
| | 2006 | Rep 3 | 140 | | 0 | 0 | | 516 | | | | | 0 | 0 | | 1042 | 40 | | | | 0 | 0 | | | | | | | | | 0 | | | | | 0 | | | 21 | |
| | 2006 | Rep 4 | 80 | | 20 | 2 | | 183 | | | | | 1 | 0 | | 1849 | 51 | | | | 1 | 0 | | | | | | | | | 0 | | | | | 0 | | | 1 | |
| | 2006 | Rep 5 | 100 | | 40 | 0 | | 88 | | | | | 0 | 0 | | 2090 | 28 | | | | 0 | 0 | | | | | | | | | 0 | | | | | 1 | | | 0 | |
| | **2006** | **Average** | **80** | | **12** | **0** | | **389** | | **0** | | | **4** | **0** | | **1538** | **48** | | **0** | **0** | **0.4** | **0.2** | | | **0** | **0** | | | | | **0** | | **0** | | | **0.2** | | | **18** | |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Carseland

| Site | year | replicate | *Pisidium* sp. | *Sphaerium* sp. | Sphaeriidae (misc.) | **Hydracarina** | **Oribatei** | **CRUSTACEA** | **OSTRACODA** | **CLADOCERA** | **COPEPODA** | **AMPHIPODA** | *Gammarus lacustris* | *Hyalella azteca* | *Orconectes virilis* | **Collembola** | **Ephemeroptera** | Baetidae (misc.) | *Baetis* sp. | *Dactylobaetis* sp. | *Caenis* sp. | Ephemerellidae (misc.) | *Ephemerella* sp. | *Drunella* sp. | *Serratella* sp. | *Ephemera* sp. | Heptageniidae (misc.) | *Epeorus* sp. | *Heptagenia* sp. | *Rhithrogena* sp. | *Stenonema* sp. | *Cinygma* sp. | Leptophlebiidae (misc.) | *Leptophlebia* sp. | *Paraleptophlebia* sp. | *Isonychia* sp. | *Ephoron* sp. | Siplonuridae misc. | *Ameletus* s p. | *Tricorythodes* sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carseland** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | 23 | | | | | | 461 | | 1 | | | 0 | | | | | 18 | | | | 25 | | | | 0 | | | 0 | | 0 | | | 2 | | | | | 0 |
| | 1983 | Rep 2 | 17 | | | | | | 20 | | 2 | | | 0 | | | | | 63 | | | | 22 | | | | 1 | | | 1 | | 9 | | | 0 | | | | | 1 |
| | 1983 | Rep 3 | 34 | | | | | | 112 | | 0 | | | 2 | | | | | 30 | | | | 30 | | | | 0 | | | 2 | | 0 | | | 0 | | | | | 1 |
| | 1983 | Rep 4 | 26 | | | | | | 132 | | 16 | | | 2 | | | | | 2 | | | | 0 | | | | 0 | | | 0 | | 14 | | | 0 | | | | | 2 |
| | 1983 | Rep 5 | 11 | | | | | | 80 | | 20 | | | 0 | | | | | 74 | | | | 20 | | | | 3 | | | 1 | | 14 | | | 0 | | | | | 0 |
| | **1983** | **Average** | **22.2** | | **0** | **0** | | | **161** | **0** | **7.8** | | | **0.8** | | **0** | **0** | **0** | **37.4** | | **0** | **0** | **19.4** | | **0** | **0** | **0.8** | **0** | **0** | **0.8** | **0** | **7.4** | **0** | | **0.4** | | | | | **0.8** |
| | 1984 | Rep 1 | 40 | | | 27 | | | 189 | 386 | 378 | | | 46 | | | | | 112 | | | | 63 | | | | 0 | | 1 | 0 | 0 | | | | 0 | | | | | 26 |
| | 1984 | Rep 2 | 17 | | | 82 | | | 54 | 26 | 85 | | | 2 | | | | | 216 | | | | 106 | | | | 0 | | 10 | 2 | 2 | | | | 0 | | | | | 41 |
| | 1984 | Rep 3 | 13 | | | 82 | | | 81 | 0 | 36 | | | 3 | | | | | 174 | | | | 97 | | | | 0 | | 0 | 0 | 0 | | | | 2 | | | | | 18 |
| | 1984 | Rep 4 | 32 | | | 122 | | | 112 | 121 | 155 | | | 1 | | | | | 119 | | | | 161 | | | | 2 | | 2 | 0 | 5 | | | | 0 | | | | | 77 |
| | 1984 | Rep 5 | 28 | | | 81 | | | 40 | 27 | 323 | | | 3 | | | | | 318 | | | | 55 | | | | 0 | | 10 | 2 | 10 | | | | 0 | | | | | 15 |
| | **1984** | **Average** | **26** | | **0** | **78.8** | | | **95.2** | **112** | **195.4** | | | **11** | | **0** | **0** | **0** | **187.8** | | **0** | **0** | **96.4** | | **0** | **0** | **0.4** | **0** | **4.6** | **0.8** | **3.4** | **0** | **0** | | **0.4** | | | | | **35.4** |
| | 1985 | Rep 1 | 0 | | | 0 | | | 5 | | 14 | | | 6 | | | | 52 | 242 | | 1 | | 6 | | | | 1 | 4 | 12 | 1 | 0 | | | | 0 | | | | | 16 |
| | 1985 | Rep 2 | 3 | | | 0 | | | 7 | | 0 | | | 2 | | | | 4 | 16 | | 0 | | 0 | | | | 1 | 0 | 2 | 1 | 3 | | | | 1 | | | | | 2 |
| | 1985 | Rep 3 | 9 | | | 7 | | | 6 | | 19 | | | 4 | | | | 117 | 390 | | 0 | | 79 | | | | 0 | 0 | 1 | 1 | 14 | | | | 7 | | | | | 15 |
| | 1985 | Rep 4 | 16 | | | 1 | | | 13 | | 12 | | | 0 | | | | 8 | 24 | | 0 | | 4 | | | | 0 | 0 | 1 | 0 | 0 | | | | 0 | | | | | 1 |
| | 1985 | Rep 5 | 5 | | | 4 | | | 6 | | 7 | | | 6 | | | | 8 | 291 | | 0 | | 33 | | | | 1 | 6 | 12 | 0 | 5 | | | | 2 | | | | | 7 |
| | **1985** | **Average** | **6.6** | | **0** | **2.4** | | | **7.4** | **0** | **10.4** | | | **3.6** | | **0** | **0** | **37.8** | **192.6** | | **0.2** | **0** | **24.4** | | **0** | **0** | **0.6** | **2** | **5.6** | **0.6** | **4.4** | **0** | **0** | | **2** | | | | | **8.2** |
| | 1986 | Rep 1 | | | 4 | 12 | | | 2 | | 1 | | | | | | 4 | 230 | 57 | | | | 565 | | | 0 | 0 | | 6 | 8 | 5 | | 4 | | 0 | | | | | 64 |
| | 1986 | Rep 2 | | | 2 | 23 | | | 5 | | 7 | | | | | | 0 | 555 | 92 | | | | 1376 | | | 0 | 7 | | 23 | 0 | 1 | | 21 | | 2 | | | | | 84 |
| | 1986 | Rep 3 | | | 1 | 8 | | | 1 | | 1 | | | | | | 0 | 88 | 7 | | | | 413 | | | 1 | 1 | | 0 | 0 | 5 | | 0 | | 0 | | | | | 35 |
| | 1986 | Rep 4 | | | 4 | 7 | | | 0 | | 2 | | | | | | 0 | 177 | 36 | | | | 615 | | | 0 | 4 | | 0 | 8 | 0 | | 0 | | 4 | | | | | 16 |
| | 1986 | Rep 5 | | | 4 | 9 | | | 1 | | 2 | | | | | | 0 | 193 | 31 | | | | 340 | | | 0 | 1 | | 1 | 0 | 1 | | 0 | | 3 | | | | | 0 |
| | **1986** | **Average** | **0** | | **3** | **11.8** | | | **1.8** | **0** | **2.6** | | | **0** | | **0** | **0.8** | **248.6** | **44.6** | | **0** | **0** | **661.8** | | **0** | **0.2** | **2.6** | **0** | **6** | **3.2** | **2.4** | **0** | **5** | | **1.8** | | | | | **39.8** |
| | 1987 | Rep 1 | 0 | | | 14 | | | 0 | | 26 | | | | | | | 229 | 18 | | | | 155 | | | | 2 | 0 | 1 | 7 | 3 | | | | 6 | | | | | 0 |
| | 1987 | Rep 2 | 2 | | | 2 | | | 1 | | 16 | | | | | | | 271 | 18 | | | | 149 | | | | 1 | 2 | 5 | 9 | 2 | | | | 9 | | | | | 3 |
| | 1987 | Rep 3 | 0 | | | 0 | | | 0 | | 4 | | | | | | | 399 | 13 | | | | 63 | | | | 3 | 0 | 7 | 20 | 4 | | | | 8 | | | | | 0 |
| | 1987 | Rep 4 | 0 | | | 10 | | | 0 | | 6 | | | | | | | 1079 | 3 | | | | 146 | | | | 0 | 0 | 3 | 2 | 3 | | | | 1 | | | | | 5 |
| | 1987 | Rep 5 | 0 | | | 10 | | | 0 | | 26 | | | | | | | 730 | 12 | | | | 149 | | | | 0 | 0 | 3 | 6 | 5 | | | | 0 | | | | | 13 |
| | **1987** | **Average** | **0.4** | | **0** | **7.2** | | | **0.2** | **0** | **15.6** | | | **0** | | **0** | **0** | **541.6** | **12.8** | | **0** | **0** | **132.4** | | **0** | **0** | **1.2** | **0.4** | **3.8** | **8.8** | **3.4** | **0** | **0** | | **4.8** | | | | | **4.2** |
| | 1993 | Rep 1 | | | 10 | 20 | | | 14 | | 3 | | | | | 1 | 2 | 59 | 0 | | | 16 | | | 89 | | 34 | | 6 | 32 | | | 4 | | 11 | | | | | 20 |
| | 1993 | Rep 2 | | | 9 | 28 | | | 31 | | 6 | | | | | | | 71 | 4 | | | 20 | | | 183 | | 19 | | 4 | 57 | | | | | 26 | | | | | 28 |
| | 1993 | Rep 3 | | | 10 | 54 | | | 14 | | 1 | | | | | | 1 | 116 | 8 | | | 57 | 3 | | 221 | | 41 | 4 | 5 | 74 | | | 1 | | 18 | | | | | 55 |
| | 1993 | Rep 4 | | | 4 | 28 | | | 7 | | 1 | | | | | | | 128 | 3 | | | 15 | | | 109 | | 16 | | | 90 | | | 2 | | 51 | | | | | 14 |
| | 1993 | Rep 5 | | | 6 | 79 | | | 67 | | 9 | | | | | 1 | | 52 | 2 | | | 22 | | | 176 | | 26 | | 3 | 64 | | | 4 | | 28 | | | | | 20 |
| | **1993** | **Average** | **0** | | **7.8** | **41.8** | | | **26.6** | **0** | **4** | | | **0** | | **0.4** | **0.6** | **85.2** | **3.4** | | **0** | **26** | **0.6** | | **155.6** | **0** | **27.2** | **0.8** | **3.6** | **63.4** | **0** | **0** | **2.2** | | **26.8** | | | | | **27.4** |
| | 2006 | Rep 1 | 0 | | | 20 | | | 40 | 100 | 180 | | 0 | 1 | | | | | 65 | | 0 | | 13 | | | | | 0 | 0 | 1 | 0 | | | | 2 | | | | | 0 |
| | 2006 | Rep 2 | 0 | | | 0 | | | 40 | 0 | 50 | | 0 | 0 | | | | | 134 | | 1 | | 13 | | | | | 0 | 0 | 2 | 0 | | | | 0 | | | | | 1 |
| | 2006 | Rep 3 | 1 | | | 20 | | | 0 | 0 | 200 | | 0 | 0 | | | | | 772 | | 0 | | 25 | | | | | 0 | 26 | 17 | 1 | | | | 5 | | | | | 1 |
| | 2006 | Rep 4 | 1 | | | 20 | | | 0 | 40 | 120 | | 0 | 0 | | | | | 121 | | 0 | | 4 | | | | | 0 | 3 | 8 | 1 | | | | 0 | | | | | 0 |
| | 2006 | Rep 5 | 0 | | | 40 | | | 0 | 20 | 160 | | 0 | 0 | | | | | 104 | | 0 | | 3 | | | | | 0 | 4 | 7 | 0 | | | | 3 | | | | | 0 |
| | **2006** | **Average** | **0.4** | **0** | | **20** | **0** | | **16** | **32** | **142.0** | | **0** | **0.2** | **0** | **0** | | | **239** | | **0.2** | | **12** | | | **0** | | **0** | **7** | **7** | **0.4** | | | **0** | **2** | | | | | **0.4** |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Carseland

| Site | year | replicate | **Plecoptera** | Capniidae (misc.) | Chloroperlidae (misc.) | *Sweltsa* sp. | *Suwallia* sp. | Perlidae (misc.) | *Claassenia* sp. | *Hesperoperla* sp. | *Perlesta* sp. | Perlodidae (misc.) | *Cultus* sp. | *Isogenoides* sp. | *Isoperla* sp. | *Skwala* sp. | *Pteronarcys* sp. | *Taenionema* sp. | *Oemopteryx* sp. | **Trichoptera** | *Brachycentrus* sp. | Glossosomatidae (misc.) | *Anagapetus* sp. | *Glossosoma* sp. | Helicopsychidae (misc.) | *Helicopsyche* sp. | Hydropsychidae (misc.) | *Arctopsyche* sp. | *Cheumatopsyche* sp. | *Hydropsyche* sp. | Hydroptilidae (misc.) | *Hydroptila* sp. | Leptoceridae (misc.) | *Ceraclea* sp. | *Mystacides* sp. | *Nectopsyche* sp. | *Oecetis* sp. | *Triaenodes* sp. | *Lepidostoma* sp. | Limnephilidae (misc.) | *Phryganea* sp. | Polycentropodidae (misc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carseland** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | | | | | | 0 | | | | | | | | | | | | 0 | 0 | | | | | 258 | 2 | | 1 | | 27 | | | | | | | | 1 | 7 | | |
| | 1983 | Rep 2 | | | | | | 2 | | | | | | | | | | | | 1 | 2 | | | | | 670 | 125 | | 8 | | 37 | | | | | | | | 2 | 0 | | |
| | 1983 | Rep 3 | | | | | | 4 | | | | | | | | | | | | 0 | 0 | | | | | 777 | 128 | | 37 | | 55 | | | | | | | | 5 | 0 | | |
| | 1983 | Rep 4 | | | | | | 0 | | | | | | | | | | | | 0 | 0 | | | | | 104 | 7 | | 0 | | 200 | | | | | | | | 0 | 0 | | |
| | 1983 | Rep 5 | | | | | | 1 | | | | | | | | | | | | 0 | 1 | | | | | 235 | 80 | | 14 | | 74 | | | | | | | | 2 | 0 | | |
| | **1983** | **Average** | **0** | **0** | **0** | | | **1.4** | **0** | | | **0** | **0** | **0** | **0** | | | | | **0.2** | **0.6** | **0** | **0** | **0** | | **408.8** | **68.4** | | **12** | | **78.6** | **0** | **0** | **0** | | | **0** | | **2** | **1.4** | **0** | |
| | 1984 | Rep 1 | | | | | | | 0 | | | 0 | | | | | | | | 2 | | | | | | 51 | 8 | | 11 | | | 32 | | 7 | | | 14 | | 36 | | 1 | |
| | 1984 | Rep 2 | | | | | | | 1 | | | 0 | | | | | | | | 4 | | | | | | 445 | 129 | | 259 | | | 313 | | 9 | | | 9 | | 47 | | 0 | |
| | 1984 | Rep 3 | | | | | | | 0 | | | 1 | | | | | | | | 0 | | | | | | 881 | 206 | | 245 | | | 360 | | 16 | | | 13 | | 32 | | 0 | |
| | 1984 | Rep 4 | | | | | | | 0 | | | 1 | | | | | | | | 6 | | | | | | 359 | 45 | | 204 | | | 377 | | 7 | | | 10 | | 53 | | 0 | |
| | 1984 | Rep 5 | | | | | | | 0 | | | 2 | | | | | | | | 4 | | | | | | 517 | 243 | | 275 | | | 250 | | 47 | | | 4 | | 24 | | 0 | |
| | **1984** | **Average** | **0** | **0** | **0** | | | **0** | **0.2** | | | **0.8** | **0** | **0** | **0** | | | | | **3.2** | **0** | **0** | **0** | **0** | | **450.6** | **126.2** | | **198.8** | | **0** | **266.4** | **0** | **17.2** | | | **10** | | **38.4** | **0** | **0.2** | |
| | 1985 | Rep 1 | | | | | | | | | | | | | 2 | | | | | | 0 | | | | | 11 | 6 | | 4 | | | 17 | | 29 | | | 0 | | 11 | | | |
| | 1985 | Rep 2 | | | | | | | | | | | | | 1 | | | | | | 0 | | | | | 11 | 5 | | 25 | | | 1 | | 8 | | | 0 | | 19 | | | |
| | 1985 | Rep 3 | | | | | | | | | | | | | 3 | | | | | | 1 | | | | | 84 | 118 | | 79 | | | 63 | | 17 | | | 1 | | 60 | | | |
| | 1985 | Rep 4 | | | | | | | | | | | | | 3 | | | | | | 0 | | | | | 10 | 1 | | 0 | | | 16 | | 9 | | | 3 | | 14 | | | |
| | 1985 | Rep 5 | | | | | | | | | | | | | 5 | | | | | | 2 | | | | | 131 | 155 | | 276 | | | 57 | | 46 | | | 3 | | 54 | | | |
| | **1985** | **Average** | **0** | **0** | **0** | | | **0** | **0** | | | **0** | **0** | **0** | **2.8** | | | | | **0** | **0.6** | **0** | **0** | **0** | | **49.4** | **57** | | **76.8** | | **0** | **30.8** | **0** | **21.8** | | | **1.4** | | **31.6** | **0** | **0** | |
| | 1986 | Rep 1 | 1 | | | | | 0 | 1 | | | 8 | | 0 | | | | | | 0 | 0 | | | | | 317 | 786 | | 174 | | | 4 | | 0 | | | | | 0 | | | |
| | 1986 | Rep 2 | 0 | | | | | 0 | 2 | | | 1 | | 1 | | | | | | 1 | 3 | | | | | 910 | 808 | | 310 | | | 0 | | 13 | | | | | 16 | | | |
| | 1986 | Rep 3 | 0 | | | | | 0 | 0 | | | 0 | | 0 | | | | | | 2 | 4 | | | | | 390 | 185 | | 75 | | | 4 | | 0 | | | | | 0 | | | |
| | 1986 | Rep 4 | 0 | | | | | 1 | 1 | | | 5 | | 3 | | | | | | 0 | 2 | | | | | 361 | 576 | | 199 | | | 8 | | 4 | | | | | 4 | | | |
| | 1986 | Rep 5 | 0 | | | | | 3 | 0 | | | 1 | | 0 | | | | | | 0 | 0 | | | | | 1487 | 546 | | 280 | | | 0 | | 1 | | | | | 4 | | | |
| | **1986** | **Average** | **0.2** | **0** | **0** | | | **0.8** | **0.8** | | | **3** | **0** | **0.8** | **0** | | | | | **0.6** | **1.8** | **0** | **0** | **0** | | **693** | **580.2** | | **207.6** | | **0** | **3.2** | **0** | **3.6** | | | **0** | | **4.8** | **0** | **0** | |
| | 1987 | Rep 1 | | | | | | | 1 | | | | 0 | | | | | | | | | 0 | | 2 | | 1110 | 16 | | 88 | | | | | | | | | | 0 | | | |
| | 1987 | Rep 2 | | | | | | | 1 | | | | 2 | | | | | | | | | 2 | | 0 | | 800 | 18 | | 14 | | | | | | | | | | 2 | | | |
| | 1987 | Rep 3 | | | | | | | 2 | | | | 2 | | | | | | | | | 0 | | 2 | | 734 | 0 | | 32 | | | | | | | | | | 0 | | | |
| | 1987 | Rep 4 | | | | | | | 0 | | | | 4 | | | | | | | | | 0 | | 3 | | 1436 | 20 | | 44 | | | | | | | | | | 0 | | | |
| | 1987 | Rep 5 | | | | | | | 6 | | | | 0 | | | | | | | | | 0 | | 0 | | 480 | 34 | | 24 | | | | | | | | | | 6 | | | |
| | **1987** | **Average** | **0** | **0** | **0** | | | **0** | **2** | | | **0** | **1.6** | **0** | **0** | | | | | **0** | **0** | **0.4** | **0** | **1.4** | | **912** | **17.6** | | **40.4** | | **0** | **0** | **0** | **0** | | | **0** | | **1.6** | **0** | **0** | |
| | 1993 | Rep 1 | | 1 | 1 | | | 15 | | | | 14 | | | | | | | | 5 | | | 3 | | | 220 | 126 | | 5 | | | | 3 | | | | 3 | | 27 | | | |
| | 1993 | Rep 2 | | | | | | 37 | 5 | | | 17 | | | | | | | | 15 | | | | | | 317 | 114 | | 3 | | | | | 11 | | | | | 68 | | | |
| | 1993 | Rep 3 | | | 4 | | | 31 | 4 | | | 21 | | 1 | 1 | | | | | | | | 2 | | | 566 | 331 | | 3 | | | | | | | | | | 56 | | | |
| | 1993 | Rep 4 | | 1 | 4 | | | 43 | 2 | | | 19 | | | | | | | | 40 | | | 1 | | | 510 | 345 | | 8 | | | | | | | | | | 52 | | | |
| | 1993 | Rep 5 | | | 2 | | | 34 | 2 | | | 33 | | 1 | | | | | | 4 | | | | | | 370 | 194 | | 1 | | | | | 12 | | | 4 | | 21 | | | |
| | **1993** | **Average** | **0** | **0.4** | **2.2** | | | **32** | **2.6** | | | **20.8** | **0** | **0.4** | **0.2** | | | | | **12.8** | **0** | **0** | **1.2** | **0** | | **396.6** | **222** | | **4** | | **0** | **0** | **0.6** | **4.6** | | | **1.4** | | **44.8** | **0** | **0** | |
| | 2006 | Rep 1 | | | | | | | 0 | | | | | 0 | 1 | 0 | | | | | 1 | | | | | 1 | | | 2 | 99 | | | | 9 | | | 20 | | 3 | | | |
| | 2006 | Rep 2 | | | | | | | 0 | | | | | 0 | 5 | 0 | | | | | 1 | | | | | 0 | | | 1 | 704 | | | | 0 | | | 3 | | 1 | | | |
| | 2006 | Rep 3 | | | | | | | 3 | | | | | 1 | 10 | 0 | | | | | 7 | | | | | 1 | | | 12 | 1708 | | | | 2 | | | 3 | | 0 | | | |
| | 2006 | Rep 4 | | | | | | | 1 | | | | | 0 | 0 | 0 | | | | | 1 | | | | | 0 | | | 1 | 113 | | | | 23 | | | 2 | | 0 | | | |
| | 2006 | Rep 5 | | | | | | | 0 | | | | | 0 | 2 | 1 | | | | | 1 | | | | | 0 | | | 0 | 63 | | | | 20 | | | 2 | | 0 | | | |
| | **2006** | **Average** | | | | | | | **0.8** | | | | **0** | **0.2** | **4** | **0.2** | | **0** | | | **2** | | | | | **0.4** | | | **3** | **537** | | **0** | | **11** | | **0** | **6** | | **0.8** | | | |

# Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Carseland

| Site | year | replicate | *Neureclipsis* sp. | *Polycentropus* sp. | *Psychomyia* sp. | *Rhyacophilia* sp. | **Anisoptera** | *Ophiogomphus* sp. | Coenagrionidae sp. | **Hemiptera** | Corixidae sp. | *Callicorixa* sp. | *Cenocorixa* sp. | *Corisella* sp. | *Palmacorixa* sp. | *Sigara* sp. | *Trichocorixa* sp. | **Coleoptera** | Dytiscidae (misc.) | *Colymbetes* sp. | *Hydroporus* sp. | *Liodessus* sp. | *Oreodytes* sp. | *Stictotarsus* sp. | Elmidae (misc.) | *Dubiraphia* sp. | *Optioservus* sp. | Gyrinidae (misc.) | Pyralidae (misc.) | *Petrophila* sp. | **Diptera** | *Atherix* sp. | Ceratopogonidae sp. | *Bezzia / Palpomyia* gp spp. | *Culicoides* sp. | *Rhaphium* sp. | Empididae (misc.) | *Chelifera* sp. | *Hemerodromia* sp. | *Wiedemannia* sp. | Simulidae (misc.) | *Simulium* sp. | *Antocha* sp. | *Dicranota* sp. | *Hexatoma* sp. | *Tipula* sp. | **Chironomidae** | **Chironomini** | **Tanytarsini** | **Diamesinae** | **Orthocladiinae** | **Prodiamesinae** | **Tanypodinae** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carseland** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | | | 57 | | | | | | 3 | | | | | | | 0 | 1 | | | | | | 15 | | | | | | 0 | | | | | | 1 | | | | 17 | | | | | | 6 | 154 | 149 | | 121 | | 395 |
| | 1983 | Rep 2 | | | 43 | | | | | | 2 | | | | | | | 1 | 1 | | | | | | 34 | | | | | | 0 | | | | | | 0 | | | | 74 | | | | | | 19 | 93 | 60 | | 113 | | 648 |
| | 1983 | Rep 3 | | | 47 | | | | | | 3 | | | | | | | 0 | 0 | | | | | | 22 | | | | | | 0 | | | | | | 0 | | | | 150 | | | | | | 14 | 128 | 68 | | 260 | | 416 |
| | 1983 | Rep 4 | | | 137 | | | | | | 6 | | | | | | | 0 | 1 | | | | | | 10 | | | | | | 1 | | | | | | 1 | | | | 5 | | | | | | 3 | 348 | 304 | | 80 | | 192 |
| | 1983 | Rep 5 | | | 45 | | | | | | 0 | | | | | | | 0 | 0 | | | | | | 12 | | | | | | 0 | | | | | | 0 | | | | 53 | | | | | | 13 | 248 | 152 | | 164 | | 452 |
| | **1983** | **Average** | | | **65.8** | | | | | | **2.8** | | | | | | | **0** | **1** | | **0** | | | | **19** | | **0** | | | **0** | **0** | **0** | | | | | **0** | **0** | **0** | **0** | **60** | **0** | | | | **0** | **11** | **194.2** | **146.6** | **0** | **147.6** | | **421** |
| | 1984 | Rep 1 | | | 1 | | | | | | 0 | | | | | | | | 0 | | | | | | 16 | | | | | 0 | | | | | | | | | | | 14 | | | | | | 34 | 937 | 429 | 21 | 421 | | 519 |
| | 1984 | Rep 2 | | | 45 | | | | | | 0 | | | | | | | | 1 | | | | | | 73 | | | | | 0 | | | | | | | | | | | 28 | | | | | | 12 | 443 | 411 | 32 | 455 | | 973 |
| | 1984 | Rep 3 | | | 74 | | | | | | 3 | | | | | | | | 0 | | | | | | 26 | | | | | 1 | | | | | | | | | | | 46 | | | | | | 23 | 948 | 382 | 9 | 1252 | | 824 |
| | 1984 | Rep 4 | | | 45 | | | | | | 0 | | | | | | | | 0 | | | | | | 53 | | | | | 1 | | | | | | | | | | | 7 | | | | | | 6 | 1051 | 723 | 56 | 878 | | 1268 |
| | 1984 | Rep 5 | | | 57 | | | | | | 0 | | | | | | | | 1 | | | | | | 80 | | | | | 0 | | | | | | | | | | | 2 | | | | | | 24 | 651 | 258 | 70 | 791 | | 941 |
| | **1984** | **Average** | | | **44.4** | | | | | | **0.6** | | | | | | | **0** | **0** | | **0** | | | | **50** | | **0** | | | **0.4** | **0** | **0** | | | | | **0** | **0** | **0** | **0** | **19** | **0** | | | | **0** | **19.8** | **806** | **440.6** | **37.6** | **759.4** | | **905** |
| | 1985 | Rep 1 | | | 16 | | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | | | 82 | | | | | 1 | 115 | 725 | 122 | 66 | 774 | | 366 |
| | 1985 | Rep 2 | | | 0 | | | | | | | | | | | | | | | | | | | | 12 | | | | | | | | | | | | | | | | 9 | | | | | 0 | 13 | 256 | 20 | 8 | 121 | | 31 |
| | 1985 | Rep 3 | | | 55 | | | | | | | | | | | | | | | | | | | | 24 | | | | | | | | | | | | | | | | 88 | | | | | 0 | 49 | 566 | 111 | 16 | 589 | | 146 |
| | 1985 | Rep 4 | | | 14 | | | | | | | | | | | | | | | | | | | | 6 | | | | | | | | | | | | | | | | 48 | | | | | 0 | 61 | 278 | 102 | 8 | 294 | | 83 |
| | 1985 | Rep 5 | | | 34 | | | | | | | | | | | | | | | | | | | | 18 | | | | | | | | | | | | | | | | 33 | | | | | 0 | 81 | 1466 | 159 | 7 | 602 | | 449 |
| | **1985** | **Average** | | | **23.8** | | | | | | **0** | | | | | | | **0** | **0** | | **0** | | | | **13** | | **0** | | | **0** | **0** | **0** | | | | | **0** | **0** | **0** | **0** | **52** | **0** | | | | **0.2** | **63.8** | **658.2** | **102.8** | **21** | **476** | | **215** |
| | 1986 | Rep 1 | | | 170 | | | | | | | | | | | | | | 0 | | | | | | 2 | | 58 | | | | | 1 | | | | | | | | | 8 | | | | | | 205 | 925 | 7 | 0 | 2617 | | 34 |
| | 1986 | Rep 2 | | | 293 | | | | | | | | | | | | | | 0 | | | | | | 6 | | 133 | | | | | 1 | | | | | | | | | 4 | | | | | | 201 | 2410 | 13 | 13 | 2680 | | 163 |
| | 1986 | Rep 3 | | | 402 | | | | | | | | | | | | | | 0 | | | | | | 4 | | 92 | | | | | 1 | | | | | | | | | 12 | | | | | | 185 | 813 | 13 | 13 | 3189 | | 73 |
| | 1986 | Rep 4 | | | 99 | | | | | | | | | | | | | | 0 | | | | | | 2 | | 81 | | | | | 0 | | | | | | | | | 10 | | | | | | 197 | 1547 | 0 | 0 | 1931 | | 68 |
| | 1986 | Rep 5 | | | 81 | | | | | | | | | | | | | | 1 | | | | | | 9 | | 48 | | | | | 2 | | | | | | | | | 2 | | | | | | 85 | 1281 | 0 | 0 | 1234 | | 66 |
| | **1986** | **Average** | | | **209** | | | | | | **0** | | | | | | | **0** | **0** | | **0** | | | | **4.6** | | **82.4** | | | **0** | **0** | **1** | | | | | **0** | **0** | **0** | **0** | **7.2** | **0** | | | | **0** | **174.6** | **1395.2** | **6.6** | **5.2** | **2330.2** | | **80.8** |
| | 1987 | Rep 1 | | | 9 | | | | | | | | | | | | | | | | 0 | | | | 65 | | 37 | | | | 6 | | | | | | | | | | 6 | 0 | | | | | 86 | 144 | 40 | | 927 | | 29 |
| | 1987 | Rep 2 | | | 6 | | | | | | | | | | | | | | | | 0 | | | | 68 | | 34 | | | | 0 | | | | | | | | | | 0 | 0 | | | | | 156 | 217 | 1 | | 362 | | 34 |
| | 1987 | Rep 3 | | | 12 | | | | | | | | | | | | | | | | 0 | | | | 27 | | 16 | | | | 0 | | | | | | | | | | 8 | 0 | | | | | 162 | 103 | 15 | | 922 | | 20 |
| | 1987 | Rep 4 | | | 26 | | | | | | | | | | | | | | | | 1 | | | | 64 | | 25 | | | | 1 | | | | | | | | | | 60 | 22 | | | | | 226 | 98 | 0 | | 1043 | | 66 |
| | 1987 | Rep 5 | | | 20 | | | | | | | | | | | | | | | | 0 | | | | 42 | | 13 | | | | 7 | | | | | | | | | | 2 | 0 | | | | | 236 | 124 | 20 | | 647 | | 59 |
| | **1987** | **Average** | | | **14.6** | | | | | | **0** | | | | | | | **0** | **0** | | **0** | | | | **53** | | **25** | | | **0** | **3** | **0** | | | | | **0** | **0** | **0** | **0** | **15** | **4.4** | | | | **0** | **173.2** | **137.2** | **15.2** | **0** | **780.2** | | **41.6** |
| | 1993 | Rep 1 | | | 250 | | | | | | | | | | | | | | | | | | | | 11 | | | | | | 1 | | | | | | | | | | | | | | | | 34 | 386 | 116 | | 2106 | | 53 |
| | 1993 | Rep 2 | | | 264 | | | | | | | | | | | | | | | | | | | | 30 | | | | | | | | | | | | | | 2 | | | | | | | | 117 | 873 | 162 | 1 | 2933 | | 17 |
| | 1993 | Rep 3 | | | 207 | | | | | | | | | | | | | | 1 | | | | | | 23 | | | | | | 1 | | | | | | | | 1 | 1 | | | | | | | 51 | 676 | 155 | | 2787 | | 155 |
| | 1993 | Rep 4 | | | 290 | | | | | | | | | | | | | | | | | | | | 6 | | | | | | | | | | | | | 1 | 1 | | 1 | | | | | | 79 | 446 | 283 | 1 | 2282 | | 50 |
| | 1993 | Rep 5 | | | 242 | | | | | | | | | | | | | | | | | | | | 8 | | | | | | 1 | | | | | | | | | | | | | | | | 28 | 577 | 76 | 1 | 3107 | | 15 |
| | **1993** | **Average** | | | **250.6** | | | | | | **0** | | | | | | | **0** | **0** | | **0** | | | | **16** | | **0** | | | **0** | **1** | **0** | | | | | **0** | **0** | **1** | **0.2** | **0.2** | **0** | | | | **0** | **61.8** | **591.6** | **158.4** | **0.6** | **2643** | | **58** |
| | 2006 | Rep 1 | | 1 | 12 | | | 0 | | | | 0 | 0 | | | 1 | 0 | | | 0 | | 2 | 0 | 0 | | | 138 | | | | | 0 | | 0 | | | | | 0 | | | 3 | | | 0 | 1 | | 3047 | 1906 | 140 | 2031 | | 258 |
| | 2006 | Rep 2 | | 0 | 5 | | | 0 | | | | 0 | 0 | | | 1 | 0 | | | 0 | | 0 | 0 | 0 | | | 287 | | | | | 1 | | 0 | | | | | 0 | | | 0 | | | 0 | 2 | | 2497 | 702 | 55 | 1435 | | 322 |
| | 2006 | Rep 3 | | 0 | 11 | | | 0 | | | | 0 | 0 | | | 0 | 0 | | | 1 | | 0 | 0 | 0 | | | 396 | | | | | 2 | | 0 | | | | | 0 | | | 20 | | | 1 | 0 | | 1896 | 327 | 69 | 2342 | | 575 |
| | 2006 | Rep 4 | | 0 | 5 | | | 0 | | | | 0 | 0 | | | 0 | 0 | | | 0 | | 1 | 0 | 0 | | | 198 | | | | | 1 | | 0 | | | | | 0 | | | 0 | | | 0 | 0 | | 849 | 1638 | 187 | 1884 | | 55 |
| | 2006 | Rep 5 | | 0 | 5 | | | 0 | | | | 0 | 0 | | | 0 | 0 | | | 0 | | 0 | 0 | 0 | | | 167 | | | | | 0 | | 0 | | | | | 0 | | | 0 | | | 0 | 0 | | 597 | 460 | 134 | 2610 | | 165 |
| | **2006** | **Average** | **0** | **0.2** | **8** | | | **0** | **0** | | **0** | **0** | **0** | | | **0.4** | **0** | | | **0.2** | | **0.6** | **0** | **0** | | **0** | **237** | | | **0** | | **0.8** | **0** | **0** | **0** | **0** | | **0** | **0** | | | **5** | **0** | **0** | **0.2** | **0.6** | | **1777.2** | **1006.6** | **117** | **2060.4** | | **275** |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006)

### Cluny

| Site | **year** | replicate | *Hydra* sp. | **TURBELLARIA** | Microturbellaria | *Dugesia tigrina* | *Polycelis coronata* | **NEMATODA** | **NEMERTEA** | **TARDIGRADA** | **OLIGOCHAETA** | Un - identified Oligochaeta | Enchytraeidae | Lumbricidae | Lumbriculidae | Naididae | Tubificidae | **HIRUDINEA** | Erpobdellidae (misc.) | *Dina sp.* | *Erpobdella* sp. | *Nephelopsis obscura* | *Mooreobdella* sp. | Glossiphonidae (misc.) | *Helobdella stagnalis* | *Glossiphonia* sp. | *Placobdella ornata* | Piscicolidae (misc.) | **GASTROPODA** | Lymnaeidae (misc.) | *Fossaria* sp. | *Lymnaea* sp. | *Ferrissia* sp. | Ancylidae (misc.) | Planorbidae (misc.) | *Gyraulus* sp. | *Helisoma* sp. | Physidae (misc.) | *Physa* sp. | **PELECYPODA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cluny** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | | | | | | 562 | | | | | | 0 | | 99 | 1256 | | | 1 | | | | | 0 | 1 | | | | | | 0 | 1 | | | 0 | | | 1 | |
| | 1985 | Rep 2 | | | | | | 1249 | | | | | | 0 | | 142 | 929 | | | 3 | | | | | 0 | 0 | | | | | | 0 | 0 | | | 0 | | | 0 | |
| | 1985 | Rep 3 | | | | | | 1681 | | | | | | 4 | | 88 | 1829 | | | 11 | | | | | 5 | 1 | | | | | | 0 | 0 | | | 0 | | | 1 | |
| | 1985 | Rep 4 | | | | | | 1081 | | | | | | 0 | | 253 | 1085 | | | 3 | | | | | 1 | 0 | | | | | | 0 | 0 | | | 0 | | | 0 | |
| | 1985 | Rep 5 | | | | | | 1019 | | | | | | 0 | | 155 | 2230 | | | 1 | | | | | 1 | 0 | | | | | | 1 | 0 | | | 2 | | | 1 | |
| | **1985** | **Average** | | **0** | | | | **1118.4** | | | | | **0** | **0.8** | | **147.4** | **1465.8** | | **0** | **3.8** | **0** | **0** | | | **1.4** | **0.4** | | | | | | **0.2** | **0.2** | | | **0.4** | | **0** | **0.6** | |
| | 1993 | Rep 1 | | | | | | 124 | | | | | 32 | | | 475 | 770 | | 4 | | 2 | | | | | | | | | | | | | | | | | | | |
| | 1993 | Rep 2 | | 1 | | | | 279 | | | | | 24 | | | 413 | 1440 | | 4 | | | | | | | | | | | | | | | | | | | | | |
| | 1993 | Rep 3 | | | | | | 432 | | | | | 195 | 2 | | 3151 | 807 | | | | | | | | | | | | | | | | | | | | | | | |
| | 1993 | Rep 4 | | | | | | 149 | | | | | 48 | | | 895 | 297 | | 2 | | 2 | | | | | | | | | | | | | | | | | 1 | | |
| | 1993 | Rep 5 | | | | | | 302 | | | | | 66 | | | 1033 | 895 | | | | 1 | 2 | | | | | | | | | | | | | | | | 1 | | |
| | **1993** | **Average** | | **0.2** | | | | **257.2** | | | | | **73** | **0.4** | | **1193.4** | **841.8** | | **2** | **0** | **1** | **0.4** | | | **0** | **0** | | | | | | **0** | **0** | | | **0** | | **0.4** | **0** | |
| | 2006 | Rep 1 | 0 | | 0 | 2 | | 381 | | | | | 0 | 2 | | 451 | 0 | | | | 0 | 0 | | | | | | | | | | | | | | | | | 0 | |
| | 2006 | Rep 2 | 0 | | 0 | 2 | | 273 | | | | | 0 | 34 | | 963 | 0 | | | | 0 | 1 | | | | | | | | | | | | | | | | | 0 | |
| | 2006 | Rep 3 | 0 | | 8 | 8 | | 298 | | | | | 250 | 4 | | 857 | 0 | | | | 0 | 0 | | | | | | | | | | | | | | | | | 0 | |
| | 2006 | Rep 4 | 0 | | 0 | 0 | | 430 | | | | | 93 | 12 | | 1325 | 1 | | | | 0 | 0 | | | | | | | | | | | | | | | | | 0 | |
| | 2006 | Rep 5 | 0 | | 0 | 0 | | 249 | | | | | 24 | 5 | | 1168 | 1 | | | | 0 | 1 | | | | | | | | | | | | | | | | | 0 | |
| | **2006** | **Average** | **0** | | **2** | **2** | | **326** | | **0** | | | **73** | **11** | | **953** | **0.4** | | **0** | **0** | **0** | **0.4** | | | **0** | **0** | | | | | **0** | | **0** | | | **0** | | | **0** | |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Cluny

| Site | year | replicate | *Pisidium* sp. | *Sphaerium* sp. | Sphaeriidae (misc.) | Hydracarina | Oribatei | CRUSTACEA | OSTRACODA | CLADOCERA | COPEPODA | AMPHIPODA | *Gammarus lacustris* | *Hyalella azteca* | *Orconectes virilis* | Collembolla | Ephemeroptera | Baetidae (misc.) | *Baetis* sp. | *Dactylobaetis* sp. | *Caenis* sp. | Ephemerellidae (misc.) | *Ephemerella* sp. | *Drunella* sp. | *Serratella* sp. | *Ephemera* sp. | Heptageniidae (misc.) | *Epeorus* sp. | *Heptagenia* sp. | *Rhithrogena* sp. | *Stenonema* sp. | *Cinygma* sp. | Leptophlebiidae (misc.) | *Leptophlebia* sp. | *Paraleptophlebia* sp. | *Isonychia* sp. | *Ephoron* sp. | Siplonuridae misc. | *Ameletus* s p. | *Tricorythodes* sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cluny | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | 3 | | | 12 | | | 3 | | 1 | | | 1 | | | | 0 | 14 | | | | | | | 0 | 1 | | 4 | | 51 | | | | | | | | | 22 |
| | 1985 | Rep 2 | 5 | | | 21 | | | 2 | | 6 | | | 11 | | | | 12 | 35 | | | | | | | 0 | 1 | | 0 | | 18 | | | | | | | | | 33 |
| | 1985 | Rep 3 | 5 | | | 3 | | | 0 | | 0 | | | 36 | | | | 8 | 29 | | | | | | | 0 | 1 | | 0 | | 17 | | | | | | | | | 28 |
| | 1985 | Rep 4 | 9 | | | 2 | | | 0 | | 0 | | | 5 | | | | 4 | 20 | | | | | | | 0 | 1 | | 0 | | 9 | | | | | | | | | 10 |
| | 1985 | Rep 5 | 9 | | | 17 | | | 0 | | 0 | | | 0 | | | | 8 | 7 | | | | | | | 1 | 1 | | 1 | | 53 | | | | | | | | | 22 |
| | **1985** | **Average** | **6.2** | | **0** | **11** | | | **1** | | **1.4** | | | **10.6** | | | **0** | **6.4** | **21** | | | **0** | | | **0** | **0.2** | **1** | | **1** | **0** | **29.6** | | **0** | **0** | | | **0** | | | **23** |
| | 1993 | Rep 1 | 1 | | 8 | 221 | | | 1 | | 0 | | | 1 | | | | 4231 | 59 | | | 36 | | | 119 | | 15 | | 1 | 1 | | | | | | | | | | 2160 |
| | 1993 | Rep 2 | 5 | | 6 | 126 | | | 1 | | 0 | | | 1 | | | 3 | 2403 | 76 | | | 2 | | | 110 | | 5 | | 5 | 1 | 1 | | | 1 | | | | | | 1441 |
| | 1993 | Rep 3 | | | 5 | 156 | | | 2 | | 0 | | | | | | | 3803 | 62 | | | 35 | | | 148 | | 2 | | | | 1 | | | | | | | | | 1806 |
| | 1993 | Rep 4 | | | 14 | 323 | | | 3 | | 0 | | | 1 | | | 3 | 3572 | 66 | | | 11 | | | 198 | | 23 | | 8 | 1 | | | 16 | 1 | | | | | | 1438 |
| | 1993 | Rep 5 | | | 10 | 116 | | | 1 | | 0 | | | 1 | | | | 3205 | 69 | | | 23 | | | 205 | | 9 | | 3 | | 3 | | | | | | 1 | | | 2224 |
| | **1993** | **Average** | **1.2** | | **8.6** | **188** | | | **1.6** | | **0** | | | **0.8** | | | **1.2** | **3442.8** | **66.4** | | | **21.4** | | | **156** | **0** | **10.8** | | **3.4** | **0.6** | **1** | | **3.2** | **0.4** | | | **0.2** | | | **1813.8** |
| | 2006 | Rep 1 | 0 | | | 60 | | | 20 | 0 | 30 | | | 0 | | | | | 246 | | 0 | | 1 | | | | | 0 | 46 | 68 | 89 | | | | 0 | | | | | 44 |
| | 2006 | Rep 2 | 0 | | | 60 | | | 20 | 0 | 20 | | | 0 | | | | | 464 | | 0 | | 0 | | | | | 0 | 26 | 35 | 32 | | | | 1 | | | | | 12 |
| | 2006 | Rep 3 | 1 | | | 24 | | | 56 | 0 | 16 | | | 0 | | | | | 41 | | 0 | | 0 | | | | | 0 | 0 | 1 | 30 | | | | 0 | | | | | 3 |
| | 2006 | Rep 4 | 0 | | | 0 | | | 30 | 0 | 50 | | | 0 | | | | | 6 | | 2 | | 0 | | | | | 0 | 10 | 2 | 60 | | | | 0 | | | | | 4 |
| | 2006 | Rep 5 | 0 | | | 1 | | | 20 | 0 | 30 | | | 0 | | | | | 151 | | 0 | | 0 | | | | | 0 | 11 | 3 | 103 | | | | 0 | | | | | 36 |
| | **2006** | **Average** | **0.2** | **0** | | **29** | **0** | | **29.2** | **0** | **29.2** | | **0** | **0** | **0** | **0** | | | **182** | | **0.4** | | **0.2** | | | **0** | | **0** | **19** | **22** | **63** | | | **0** | **0.2** | | | | | **20** |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't))

## Cluny

| Site | year | replicate | Plecoptera | Capniidae (misc.) | Chloroperlidae (misc.) | *Sweltsa* sp. | *Suwallia* sp. | Perlidae (misc.) | *Claassenia* sp. | *Hesperoperla* sp. | *Perlesta* sp. | Perlodidae (misc.) | *Cultus* sp. | *Isogenoides* sp. | *Isoperla* sp. | *Skwala* sp. | *Pteronarcys* sp. | *Taenionema* sp. | *Oemopteryx* sp. | Trichoptera | *Brachycentrus* sp. | Glossosomatidae (misc.) | *Anagapetus* sp. | *Glossosoma* sp. | Helicopsychidae (misc.) | *Helicopsyche* sp. | Hydropsychidae (misc.) | *Arctopsyche* sp. | *Cheumatopsyche* sp. | *Hydropsyche* sp. | Hydroptilidae (misc.) | *Hydroptila* sp. | Leptoceridae (misc.) | *Ceraclea* sp. | *Mystacides* sp. | *Nectopsyche* sp. | *Oecetis* sp. | *Triaenodes* sp. | *Lepidostoma* sp. | Limnephilidae (misc.) | *Phryganea* sp. | Polycentropodidae (misc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cluny** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | | | | | | | | | | | | | 2 | | | | | | 2 | | | | | | 12 | | 2 | 384 | | 1 | | | | 0 | 18 | | | | | |
| | 1985 | Rep 2 | | | | | | | | | | | | | 1 | | | | | | 0 | | | | | | 16 | | 4 | 510 | | 14 | | | | 20 | 20 | | | | | |
| | 1985 | Rep 3 | | | | | | | | | | | | | 2 | | | | | | 0 | | | | | | 5 | | 4 | 223 | | 0 | | | | 37 | 4 | | | | | |
| | 1985 | Rep 4 | | | | | | | | | | | | | 0 | | | | | | 2 | | | | | | 2 | | 0 | 134 | | 0 | | | | 41 | 2 | | | | | |
| | 1985 | Rep 5 | | | | | | | | | | | | | 0 | | | | | | 1 | | | | | | 7 | | 3 | 202 | | 0 | | | | 17 | 9 | | | | | |
| | **1985** | **Average** | **0** | | | | | **0** | **0** | | | **0** | | **0** | **1** | | | | **0** | **0** | **1** | | | | | **0** | **8.4** | | **2.6** | **290.6** | **0** | **3** | **0** | | | **23** | **10.6** | | **0** | | | |
| | 1993 | Rep 1 | 1 | | | | | | 1 | | | 41 | | | 5 | | | | 1 | | 16 | | | | | 6 | 112 | | 6 | 569 | 5 | 22 | | | | 2 | 38 | | 2 | | | |
| | 1993 | Rep 2 | | | | | | 1 | | | | 21 | | | 1 | | | | | | 42 | | | | | 13 | 121 | | 2 | 480 | 8 | 15 | | | | 2 | 51 | | 4 | | | |
| | 1993 | Rep 3 | | | | | | | | | | 43 | | | 2 | | | | | 5 | 27 | | | | | 5 | 253 | | 7 | 1148 | 2 | 38 | | | | | 18 | | 11 | | | |
| | 1993 | Rep 4 | | | | | | 1 | | | | 54 | | | 3 | | | | | 1 | 10 | | | | | 6 | 218 | | 9 | 692 | 7 | 15 | 2 | | | 3 | 53 | | 11 | | | |
| | 1993 | Rep 5 | | | | | | | | | | 34 | | 1 | 1 | | | | | 1 | 9 | | | | | 10 | 127 | | 2 | 434 | 4 | 34 | | | | 5 | 47 | | 1 | | | |
| | **1993** | **Average** | **0.2** | | | | | **0.4** | **0.2** | | | **38.6** | | **0.2** | **2.4** | | | | **0.2** | **1.4** | **20.8** | | | | | **8** | **166.2** | | **5.2** | **664.6** | **5.2** | **24.8** | **0.4** | | | **2.4** | **41.4** | | **5.8** | | | |
| | 2006 | Rep 1 | | | | | | | 4 | | | | | 1 | 28 | 0 | | | | | 1 | | | | | 3 | | | 79 | 168 | | 0 | | | | 0 | 5 | | 0 | | | |
| | 2006 | Rep 2 | | | | | | | 2 | | | | | 0 | 73 | 0 | | | | | 13 | | | | | 9 | | | 92 | 357 | | 0 | | | | 0 | 4 | | 0 | | | |
| | 2006 | Rep 3 | | | | | | | 0 | | | | | 0 | 2 | 0 | | | | | 0 | | | | | 8 | | | 22 | 19 | | 0 | | | | 0 | 2 | | 0 | | | |
| | 2006 | Rep 4 | | | | | | | 1 | | | | | 0 | 9 | 0 | | | | | 13 | | | | | 4 | | | 39 | 42 | | 0 | | | | 3 | 27 | | 1 | | | |
| | 2006 | Rep 5 | | | | | | | 0 | | | | | 0 | 22 | 0 | | | | | 5 | | | | | 26 | | | 46 | 121 | | 0 | | | | 3 | 25 | | 1 | | | |
| | **2006** | **Average** | | | | | | | **1** | | | | **0** | **0.2** | **27** | **0** | | **0** | | | **6** | | | | | **10** | | | **56** | **141** | | **0** | | **0** | | **1** | **13** | | **0.4** | | | |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

### Cluny

| Site | year | replicate | *Neureclipsis* sp. | *Polycentropus* sp. | *Psychomyia* sp. | *Rhyacophilia* sp. | **Anisoptera** | *Ophiogomphus* sp. | Coenagrionidae sp. | **Hemiptera** | Corixidae sp. | *Callicorixa* sp. | *Cenocorixa* sp. | *Corisella* sp. | *Palmacorixa* sp. | *Sigara* sp. | *Trichocorixa* sp. | **Coleoptera** | Dytiscidae (misc.) | *Colymbetes* sp. | *Hydroporus* sp. | *Liodessus* sp. | *Oreodytes* sp. | *Stictotarsus* sp. | Elmidae (misc.) | *Dubiraphia* sp. | *Optioservus* sp. | Gyrinidae (misc.) | Pyralidae (misc.) | *Petrophila* sp. | **Diptera** | *Atherix* sp. | Ceratopogonidae sp. | *Bezzia / Palpomyia* gp spp. | *Culicoides* sp. | *Rhaphium* sp. | Empididae (misc.) | *Chelifera* sp. | *Hemerodromia* sp. | *Wiedemannia* sp. | Simulidae (misc.) | *Simulium* sp. | *Antocha* sp. | *Dicranota* sp. | *Hexatoma* sp. | *Tipula* sp. | **Chironomidae** | **Chironomini** | **Tanytarsini** | **Diamesinae** | **Orthocladiinae** | **Prodiamesinae** | **Tanypodinae** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cluny** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1985 | Rep 1 | | | 0 | | | | | | | | | | | | | | 0 | | | | | | 3 | | | | | | | | 0 | | | | | | 0 | | 0 | | | | | | 20 | 3870 | 126 | 0 | 110 | | 135 |
| | 1985 | Rep 2 | | | 1 | | | | | | | | | | | | | | 1 | | | | | | 11 | | | | | | | | 2 | | | | | | 0 | | 13 | | | | | | 24 | 4324 | 222 | 0 | 159 | | 155 |
| | 1985 | Rep 3 | | | 0 | | | | | | | | | | | | | | 0 | | | | | | 10 | | | | | | | | 0 | | | | | | 0 | | 23 | | | | | | 20 | 3739 | 64 | 7 | 118 | | 70 |
| | 1985 | Rep 4 | | | 0 | | | | | | | | | | | | | | 0 | | | | | | 5 | | | | | | | | 0 | | | | | | 0 | | 18 | | | | | | 7 | 2650 | 37 | 0 | 92 | | 118 |
| | 1985 | Rep 5 | | | 3 | | | | | | | | | | | | | | 0 | | | | | | 7 | | | | | | | | 0 | | | | | | 1 | | 19 | | | | | | 7 | 2597 | 27 | 0 | 88 | | 162 |
| | **1985** | **Average** | | | **0.8** | | | **0** | | | | | | | | | | | **0** | | | | | | **7.2** | | | | | | **0** | | **0** | | | | **0** | **0** | **0** | | **15** | | | | | | **15.6** | **3436** | **95.2** | **1.4** | **113.4** | | **128** |
| | 1993 | Rep 1 | | | 14 | | | | | | | | | | | | | | | | | | | | 197 | | | | | | | | | | | | | | 5 | | 3 | | | | | | 4 | 159 | 66 | 8 | 517 | | 44 |
| | 1993 | Rep 2 | | | 8 | | | 1 | | | | | | | | | | | | | | | | | 162 | | | | | | | | | | | | | 2 | 2 | | 11 | | | | | | 20 | 245 | 98 | 9 | 478 | | 20 |
| | 1993 | Rep 3 | | | 10 | | | | | | | | | | | | | | 1 | | | | | | 128 | | | | | | | | | | | | | 1 | 9 | | 4 | | | | | | 15 | 501 | 168 | 9 | 1061 | | 64 |
| | 1993 | Rep 4 | | | 10 | | | | | | | | | | | | | | 3 | | | | | | 114 | | | | | | | | | | | | 1 | | 5 | | 6 | | | | | | 16 | 135 | 93 | 11 | 594 | | 34 |
| | 1993 | Rep 5 | | | 20 | | | | | | | | | | | | | | 3 | | | | | | 162 | | | | | | 1 | | | | | | | 1 | 9 | | 8 | | | | | | 18 | 440 | 140 | 14 | 682 | | 42 |
| | **1993** | **Average** | | | **12.4** | | | **0.2** | | | | | | | | | | | **1** | | | | | | **153** | | | | | | **0** | | **0** | | | | **0** | **1** | **6** | | **6.4** | | | | | | **14.6** | **296** | **113** | **10.2** | **666.4** | | **40.8** |
| | 2006 | Rep 1 | 0 | | 1 | | | 0 | | | | 0 | 0 | | | 0 | 0 | | | | | 0 | | 1 | | 0 | 512 | | | | | 0 | | 0 | | | | | 15 | | | 0 | | 1 | 1 | | | 293 | 1079 | 0 | 958 | | 265 |
| | 2006 | Rep 2 | 0 | | 0 | | | 0 | | | | 1 | 0 | | | 0 | 0 | | | | | 0 | | 0 | | 0 | 304 | | | | | 0 | | 0 | | | | | 62 | | | 10 | | 0 | 0 | | | 110 | 574 | 10 | 1274 | | 136 |
| | 2006 | Rep 3 | 0 | | 0 | | | 0 | | | | 0 | 0 | | | 0 | 0 | | | | | 1 | | 0 | | 0 | 130 | | | | | 0 | | 10 | | | | | 21 | | | 0 | | 2 | 0 | | | 330 | 524 | 0 | 748 | | 126 |
| | 2006 | Rep 4 | 14 | | 11 | | | 0 | | | | 0 | 0 | | | 1 | 0 | | | | | 0 | | 0 | | 1 | 274 | | | | | 0 | | 3 | | | | | 23 | | | 0 | | 1 | 0 | | | 533 | 854 | 0 | 506 | | 260 |
| | 2006 | Rep 5 | 7 | | 1 | | | 0 | | | | 0 | 0 | | | 0 | 0 | | | | | 0 | | 0 | | 0 | 204 | | | | | 0 | | 0 | | | | | 2 | | | 0 | | 0 | 0 | | | 343 | 532 | 0 | 540 | | 284 |
| | **2006** | **Average** | **4** | **0** | **3** | | | **0** | **0** | | **0** | **0.2** | **0** | | | **0.2** | **0** | | | **0** | | **0.2** | **0** | **0.2** | | **0.2** | **285** | | | **0** | | **0** | **0** | **3** | **0** | **0** | | **0** | **25** | | | **2** | **0** | **0.8** | **0.2** | **0** | | **321.8** | **712.6** | **2** | **805.2** | **0** | **214** |

# Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con’t)

## Ronalane

| Site | year | replicate | *Hydra* sp. | TURBELLARIA | Microturbellaria | *Dugesia tigrina* | *Polycelis coronata* | NEMATODA | NEMERTEA | TARDIGRADA | OLIGOCHAETA | Un - identified Oligochaeta | Enchytraeidae | Lumbricidae | Lumbriculidae | Naididae | Tubificidae | HIRUDINEA | Erpobdellidae (misc.) | *Dina sp.* | *Erpobdella* sp. | *Nephelopsis obscura* | *Mooreobdella* sp. | Glossiphonidae (misc.) | *Helobdella stagnalis* | *Glossiphonia* sp. | *Placobdella ornata* | Piscicolidae (misc.) | GASTROPODA | Lymnaeidae (misc.) | *Fossaria* sp. | *Lymnaea* sp. | *Ferrissia* sp. | Ancylidae (misc.) | Planorbidae (misc.) | *Gyraulus* sp. | *Helisoma* sp. | Physidae (misc.) | *Physa* sp. | PELECYPODA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ronalane** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | 4 | | | | | 96 | | | 480 | | | | | | | 7 | | | | | | | | | | | | | | | 36 | | | | 9 | 6 | | 64 |
| | 1983 | Rep 2 | 0 | | | | | 16 | | | 200 | | | | | | | 7 | | | | | | | | | | | | | | | 85 | | | | 0 | 5 | | 32 |
| | 1983 | Rep 3 | 0 | | | | | 96 | | | 432 | | | | | | | 11 | | | | | | | | | | | | | | | 56 | | | | 4 | 8 | | 44 |
| | 1983 | Rep 4 | 0 | | | | | 48 | | | 592 | | | | | | | 28 | | | | | | | | | | | | | | | 36 | | | | 4 | 12 | | 32 |
| | 1983 | Rep 5 | 0 | | | | | 80 | | | 224 | | | | | | | 11 | | | | | | | | | | | | | | | 52 | | | | 0 | 12 | | 0 |
| | **1983** | **Average** | **0.8** | | | | | **67.2** | | | **385.6** | **0** | **0** | **0** | | **0** | **0** | **12.8** | | **0** | **0** | | | | **0** | **0** | **0** | | **0** | **0** | | **0** | **53** | **0** | **0** | **0** | **3.4** | **8.6** | **0** | **34.4** |
| | 1984 | Rep 1 | 0 | | | | | 46 | | | | | 10 | 0 | | 56 | 51 | | | | | | | | | | | | | 0 | | | 12 | | 1 | | | 0 | | |
| | 1984 | Rep 2 | 1 | | | | | 59 | | | | | 0 | 0 | | 155 | 33 | | | | | | | | | | | | | 0 | | | 23 | | 6 | | | 0 | | |
| | 1984 | Rep 3 | 2 | | | | | 49 | | | | | 0 | 0 | | 38 | 56 | | | | | | | | | | | | | 0 | | | 21 | | 7 | | | 0 | | |
| | 1984 | Rep 4 | 20 | | | | | 77 | | | | | 2 | 1 | | 163 | 91 | | | | | | | | | | | | | 0 | | | 34 | | 1 | | | 0 | | |
| | 1984 | Rep 5 | 1 | | | | | 120 | | | | | 1 | 0 | | 71 | 64 | | | | | | | | | | | | | 1 | | | 20 | | 2 | | | 1 | | |
| | **1984** | **Average** | **4.8** | | | | | **70.2** | | | **0** | **0** | **2.6** | **0.2** | | **96.6** | **59** | **0** | | **0** | **0** | | | | **0** | **0** | **0** | | **0** | **0.2** | | **0** | **22** | **0** | **3.4** | **0** | **0** | **0.2** | **0** | **0** |
| | 1985 | Rep 1 | 1 | | | | | 495 | | | | | | | | 25 | 811 | | | 2 | | | | | 20 | 0 | | | 0 | | | 0 | 8 | | | 2 | | | 0 | |
| | 1985 | Rep 2 | 5 | | | | | 432 | | | | | | | | 62 | 1102 | | | 7 | | | | | 41 | 2 | | | 4 | | | 1 | 1 | | | 4 | | | 2 | |
| | 1985 | Rep 3 | 0 | | | | | 315 | | | | | | | | 29 | 1015 | | | 8 | | | | | 26 | 1 | | | 0 | | | 1 | 6 | | | 1 | | | 1 | |
| | 1985 | Rep 4 | 0 | | | | | 224 | | | | | | | | 50 | 1267 | | | 2 | | | | | 22 | 2 | | | 1 | | | 0 | 6 | | | 0 | | | 1 | |
| | 1985 | Rep 5 | 0 | | | | | 95 | | | | | | | | 57 | 825 | | | 12 | | | | | 53 | 0 | | | 0 | | | 0 | 11 | | | 0 | | | 1 | |
| | **1985** | **Average** | **1.2** | | | | | **312.2** | | | **0** | **0** | **0** | **0** | | **44.6** | **1004** | **0** | | **6.2** | **0** | | | | **32.4** | **1** | **0** | | **1** | **0** | | **0.4** | **6.4** | **0** | **0** | **1.4** | **0** | **0** | **1** | **0** |
| | 1987 | Rep 1 | | | | | | 168 | | | | 4 | | | | 3 | 88 | 1 | | 0 | | | | | 11 | 1 | | | | | | | 10 | | | 3 | | 1 | | |
| | 1987 | Rep 2 | | | | | | 167 | | | | 0 | | | | 0 | 91 | 0 | | 0 | | | | | 11 | 0 | | | | | | | 19 | | | 3 | | 5 | | |
| | 1987 | Rep 3 | | | | | | 206 | | | | 26 | | | | 0 | 467 | 2 | | 0 | | | | | 3 | 0 | | | | | | | 42 | | | 1 | | 1 | | |
| | 1987 | Rep 4 | | | | | | 146 | | | | 33 | | | | 6 | 812 | 0 | | 0 | | | | | 10 | 1 | | | | | | | 18 | | | 0 | | 3 | | |
| | 1987 | Rep 5 | | | | | | 201 | | | | 0 | | | | 6 | 1008 | 0 | | 5 | | | | | 4 | 0 | | | | | | | 54 | | | 0 | | 2 | | |
| | **1987** | **Average** | **0** | | | | | **177.6** | | | **0** | **12.6** | **0** | **0** | | **3** | **493.2** | **0.6** | | **1** | **0** | | | | **7.8** | **0.4** | **0** | | **0** | **0** | | **0** | **28.6** | **0** | **0** | **1.4** | **0** | **2.4** | **0** | **0** |
| | 1993 | Rep 1 | | | | | | 151 | | | | | 381 | | | 1360 | 630 | | | | 1 | | | | | | | | | | | | 10 | 9 | | | | 1 | | |
| | 1993 | Rep 2 | | | | | | 145 | | | | | 652 | | | 2879 | 344 | | | | | | | | | | | | | | | | | 11 | | | | 1 | 2 | |
| | 1993 | Rep 3 | | | | | | 103 | | | | | 387 | | | 1263 | 378 | | | | | | | | | | | | | | | | 5 | 10 | | | | 2 | | |
| | 1993 | Rep 4 | | | | | | 99 | | | | | 216 | | | 1049 | 439 | | | | | | | | | | 1 | | | | | | 5 | 5 | | | | 2 | | |
| | 1993 | Rep 5 | | | | | | 128 | | | | | 482 | | | 1805 | 446 | | | | | | | | | | | | | | | | 4 | 9 | | | | 3 | | |
| | **1993** | **Average** | **0** | | | | | **125.2** | | | **0** | **0** | **423.6** | **0** | | **1671.2** | **447.4** | **0** | | **0** | **0.2** | | | | **0** | **0** | **0.2** | | **0** | **0** | | **0** | **4.8** | **8.8** | **0** | **0** | **0** | **1.8** | **0.4** | **0** |
| | 2006 | Rep 1 | 0 | | 20 | 161 | | 576 | | | | | 0 | 0 | | 1947 | 161 | | | | | 0 | | | 0 | | | | | | 0 | | 0 | | | | | | 0 | |
| | 2006 | Rep 2 | 0 | | 100 | 22 | | 241 | | | | | 0 | 0 | | 2220 | 708 | | | | | 1 | | | 0 | | | | | | 0 | | 0 | | | | | | 0 | |
| | 2006 | Rep 3 | 20 | | 40 | 120 | | 223 | | | | | 0 | 0 | | 2471 | 137 | | | | | 0 | | | 0 | | | | | | 0 | | 0 | | | | | | 1 | |
| | 2006 | Rep 4 | 0 | | 50 | 91 | | 293 | | | | | 0 | 0 | | 1216 | 142 | | | | | 0 | | | 0 | | | | | | 0 | | 1 | | | | | | 0 | |
| | 2006 | Rep 5 | 0 | | 80 | 97 | | 122 | | | | | 40 | 0 | | 2488 | 324 | | | | | 0 | | | 0 | | | | | | 0 | | 0 | | | | | | 1 | |
| | **2006** | **Average** | **4** | | **58** | **98** | | **291** | | **0** | | | **8** | **0** | | **2068** | **294** | | **0** | **0** | **0** | **0.2** | | | **0** | **0** | | | | | **0** | | **0.2** | | | **0** | | | **0.4** | |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Ronalane

| Site | year | replicate | *Pisidium* sp. | *Sphaerium* sp. | Sphaeriidae (misc.) | **Hydracarina** | **Oribatei** | **CRUSTACEA** | **OSTRACODA** | **CLADOCERA** | **COPEPODA** | **AMPHIPODA** | *Gammarus lacustris* | *Hyalella azteca* | *Orconectes virilis* | **Collembola** | **Ephemeroptera** | Baetidae (misc.) | *Baetis* sp. | *Dactylobaetis* sp. | *Caenis* sp. | Ephemerellidae (misc.) | *Ephemerella* sp. | *Drunella* sp. | *Serratella* sp. | *Ephemera* sp. | Heptageniidae (misc.) | *Epeorus* sp. | *Heptagenia* sp. | *Rhithrogena* sp. | *Stenonema* sp. | *Cinygma* sp. | Leptophlebiidae (misc.) | *Leptophlebia* sp. | *Paraleptophlebia* sp. | *Isonychia* sp. | *Ephoron* sp. | Siplonuridae misc. | *Ameletus* sp. | *Tricorythodes* sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ronalane** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | | | | | | | 8 | 0 | 4 | | 6 | | | | 0 | | 4 | | | | 17 | | | 11 | | | 216 | | | | | | | | | | 0 | 4 |
| | 1983 | Rep 2 | | | | | | | 0 | 0 | 32 | | 1 | | | | 48 | | 0 | | | | 8 | | | 11 | | | 336 | | | | | | | | | | 0 | 96 |
| | 1983 | Rep 3 | | | | | | | 12 | 0 | 8 | | 6 | | | | 0 | | 0 | | | | 0 | | | 25 | | | 184 | | | | | | | | | | 0 | 32 |
| | 1983 | Rep 4 | | | | | | | 8 | 0 | 16 | | 36 | | | | 0 | | 1 | | | | 1 | | | 8 | | | 112 | | | | | | | | | | 1 | 0 |
| | 1983 | Rep 5 | | | | | | | 64 | 16 | 60 | | 13 | | | | 0 | | 4 | | | | 4 | | | 17 | | | 320 | | | | | | | | | | 0 | 24 |
| | **1983** | **Average** | **0** | | **0** | **0** | | | **18.4** | **3.2** | **24** | | **12.4** | **0** | | **0** | **9.6** | **0** | **1.8** | **0** | **0** | **0** | **6** | | **0** | **14.4** | **0** | | **233.6** | | **0** | | **0** | **0** | **0** | **0** | **0** | | **0.2** | **31.2** |
| | 1984 | Rep 1 | 1 | | | 289 | | | 27 | 0 | 18 | | | 2 | | | | | 394 | | | | 10 | | | 4 | 65 | | 3 | | 340 | | | | 8 | | | | 0 | 168 |
| | 1984 | Rep 2 | 5 | | | 209 | | | 45 | 9 | 76 | | | 24 | | | | | 158 | | | | 16 | | | 2 | 46 | | 0 | | 255 | | | | 0 | | | | 0 | 193 |
| | 1984 | Rep 3 | 14 | | | 154 | | | 36 | 9 | 9 | | | 4 | | | | | 223 | | | | 4 | | | 18 | 78 | | 1 | | 354 | | | | 0 | | | | 4 | 174 |
| | 1984 | Rep 4 | 1 | | | 327 | | | 36 | 9 | 82 | | | 5 | | | | | 285 | | | | 40 | | | 6 | 58 | | 0 | | 395 | | | | 0 | | | | 0 | 181 |
| | 1984 | Rep 5 | 6 | | | 100 | | | 72 | 0 | 36 | | | 3 | | | | | 259 | | | | 25 | | | 5 | 66 | | 0 | | 276 | | | | 0 | | | | 0 | 180 |
| | **1984** | **Average** | **5.4** | | **0** | **216** | | | **43.2** | **5.4** | **44.2** | | **0** | **7.6** | | **0** | **0** | **0** | **263.8** | **0** | **0** | **0** | **19** | | **0** | **7** | **62.6** | | **0.8** | | **324** | | **0** | **0** | **1.6** | **0** | **0** | | **0.8** | **179.2** |
| | 1985 | Rep 1 | 10 | | | 27 | | | 8 | 1 | 14 | | | 187 | | | 0 | 13 | 12 | | 6 | | 8 | | | 27 | 4 | | | | 31 | | | | | | | | | 66 |
| | 1985 | Rep 2 | 7 | | | 36 | | | 2 | 0 | 13 | | | 286 | | | 1 | 4 | 18 | | 38 | | 1 | | | 12 | 0 | | | | 46 | | | | | | | | | 42 |
| | 1985 | Rep 3 | 16 | | | 72 | | | 7 | 0 | 8 | | | 231 | | | 0 | 3 | 0 | | 11 | | 0 | | | 10 | 2 | | | | 36 | | | | | | | | | 41 |
| | 1985 | Rep 4 | 9 | | | 30 | | | 6 | 0 | 6 | | | 266 | | | 0 | 0 | 0 | | 18 | | 0 | | | 10 | 2 | | | | 23 | | | | | | | | | 32 |
| | 1985 | Rep 5 | 10 | | | 74 | | | 7 | 0 | 6 | | | 296 | | | 0 | 1 | 1 | | 17 | | 0 | | | 20 | 0 | | | | 21 | | | | | | | | | 24 |
| | **1985** | **Average** | **10.4** | | **0** | **47.8** | | | **6** | **0.2** | **9.4** | | **0** | **253.2** | | **0** | **0.2** | **4.2** | **6.2** | **0** | **18** | **0** | **1.8** | | **0** | **15.8** | **1.6** | | **0** | | **31.4** | | **0** | **0** | **0** | **0** | **0** | | **0** | **41** |
| | 1987 | Rep 1 | 1 | | | 68 | | | 4 | | 0 | | 1 | 13 | | | | 100 | 9 | | | | 0 | | | 9 | 2 | | 0 | | 34 | | | | | | | | | 108 |
| | 1987 | Rep 2 | 3 | | | 44 | | | 0 | | 4 | | 0 | 8 | | | | 56 | 4 | | | | 0 | | | 8 | 1 | | 1 | | 29 | | | | | | | | | 108 |
| | 1987 | Rep 3 | 14 | | | 70 | | | 1 | | 0 | | 0 | 7 | | | | 176 | 3 | | | | 2 | | | 5 | 0 | | 0 | | 33 | | | | | | | | | 187 |
| | 1987 | Rep 4 | 6 | | | 70 | | | 0 | | 0 | | 0 | 7 | | | | 22 | 4 | | | | 0 | | | 10 | 0 | | 0 | | 29 | | | | | | | | | 176 |
| | 1987 | Rep 5 | 13 | | | 92 | | | 4 | | 2 | | 2 | 25 | | | | 146 | 6 | | | | 0 | | | 15 | 2 | | 0 | | 54 | | | | | | | | | 182 |
| | **1987** | **Average** | **7.4** | | **0** | **68.8** | | | **1.8** | **0** | **1.2** | | **0.6** | **12** | | **0** | **0** | **100** | **5.2** | **0** | **0** | **0** | **0.4** | | **0** | **9.4** | **1** | | **0.2** | | **35.8** | | **0** | **0** | **0** | **0** | **0** | | **0** | **152.2** |
| | 1993 | Rep 1 | | | 1 | 137 | | | 4 | | 0 | | | 1 | | 6 | 1 | 539 | 58 | 39 | | | 1 | | 30 | 5 | 27 | | 1 | | 108 | | 4 | 2 | | | 35 | | | 289 |
| | 1993 | Rep 2 | 2 | | 6 | 186 | | | 15 | | 1 | | 1 | 6 | | 8 | 1 | 457 | 58 | 28 | | 3 | | | 45 | 1 | 21 | | | | 35 | | 1 | 1 | | | 8 | | | 316 |
| | 1993 | Rep 3 | | | 7 | 137 | | | 11 | | 0 | | 1 | 3 | | 2 | | 805 | 50 | 30 | | 13 | | | 44 | | 56 | | 16 | | 59 | | | 7 | | 1 | 47 | | | 254 |
| | 1993 | Rep 4 | 2 | | 1 | 99 | | | 3 | | 0 | | 1 | 3 | | 1 | 5 | 201 | 50 | 37 | | 7 | | | 10 | 4 | 16 | | | | 98 | | | 14 | | | 32 | | | 247 |
| | 1993 | Rep 5 | 2 | | 1 | 197 | | | 1 | | 0 | | 1 | 1 | | | | 426 | 56 | 24 | | 49 | 4 | | 9 | 1 | 42 | | 2 | | 70 | | | 3 | | | 26 | | | 311 |
| | **1993** | **Average** | **1.2** | | **3.2** | **151** | | | **6.8** | **0** | **0.2** | | **0.8** | **2.8** | | **3.4** | **1.4** | **485.6** | **54.4** | **31.6** | **0** | **14.4** | **1** | | **27.6** | **2.2** | **32.4** | | **3.8** | | **74** | | **1** | **5.4** | **0** | **0.2** | **29.6** | | **0** | **283.4** |
| | 2006 | Rep 1 | 30 | 0 | | 80 | | | 800 | 120 | 220 | | 0 | 42 | 1 | 0 | | | 0 | | 0 | | 0 | | | 3 | | 0 | 0 | | 23 | | | 0 | | | | | | 9 |
| | 2006 | Rep 2 | 6 | 0 | | 0 | | | 720 | 70 | 110 | | 0 | 49 | 0 | 0 | | | 10 | | 0 | | 0 | | | 0 | | 0 | 1 | | 0 | | | 0 | | | | | | 0 |
| | 2006 | Rep 3 | 3 | 0 | | 20 | | | 940 | 100 | 280 | | 0 | 23 | 0 | 0 | | | 0 | | 0 | | 0 | | | 2 | | 0 | 0 | | 1 | | | 0 | | | | | | 3 |
| | 2006 | Rep 4 | 2 | 3 | | 0 | | | 490 | 30 | 100 | | 0 | 4 | 0 | 0 | | | 1 | | 0 | | 0 | | | 1 | | 0 | 0 | | 0 | | | 0 | | | | | | 0 |
| | 2006 | Rep 5 | 2 | 14 | | 20 | | | 1360 | 140 | 300 | | 1 | 5 | 0 | 0 | | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 | | 0 | | | 0 | | | | | | 0 |
| | **2006** | **Average** | **9** | **3** | | **24** | **0** | | **862.0** | **92.0** | **202.0** | | **0.2** | **25** | **0.2** | **0** | | | **2** | | **0** | | **0** | | | **1** | | **0** | **0** | **0** | **5** | | | **0** | **0** | | | | | **2** |

## Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Ronalane

| Site | year | replicate | **Plecoptera** | Capniidae (misc.) | Chloroperlidae (misc.) | *Sweltsa* sp. | *Suwallia* sp. | Perlidae (misc.) | *Claassenia* sp. | *Hesperoperla* sp. | *Perlesta* sp. | Perlodidae (misc.) | *Cultus* sp. | *Isogenoides* sp. | *Isoperla* sp. | *Skwala* sp. | *Pteronarcys* sp. | *Taenionema* sp. | *Oemopteryx* sp. | **Trichoptera** | *Brachycentrus* sp. | Glossosomatidae (misc.) | *Anagapetus* sp. | *Glossosoma* sp. | Helicopsychidae (misc.) | *Helicopsyche* sp. | Hydropsychidae (misc.) | *Arctopsyche* sp. | *Cheumatopsyche* sp. | *Hydropsyche* sp. | Hydroptilidae (misc.) | *Hydroptila* sp. | Leptoceridae (misc.) | *Ceraclea* sp. | *Mystacides* sp. | *Nectopsyche* sp. | *Oecetis* sp. | *Triaenodes* sp. | *Lepidostoma* sp. | Limnephilidae (misc.) | *Phryganea* sp. | Polycentropodidae (misc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ronalane** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | | | | | | | | | | | | | | | | | | 24 | | | | | 12 | | | | 64 | 68 | | 16 | 92 | | 1 | | | | | | | 0 |
| | 1983 | Rep 2 | | | | | | | | | | | | | | | | | | 80 | | | | | 10 | | | | 8 | 49 | | 96 | 9 | | 0 | | | | | | | 0 |
| | 1983 | Rep 3 | | | | | | | | | | | | | | | | | | 32 | | | | | 0 | | | | 0 | 24 | | 32 | 76 | | 3 | | | | | | | 8 |
| | 1983 | Rep 4 | | | | | | | | | | | | | | | | | | 16 | | | | | 20 | | | | 0 | 12 | | 0 | 68 | | 5 | | | | | | | 0 |
| | 1983 | Rep 5 | | | | | | | | | | | | | | | | | | 64 | | | | | 0 | | | | 16 | 116 | | 25 | 56 | | 1 | | | | | | | 4 |
| | **1983** | **Average** | | | | | | | | | | **0** | | | | | | | | **43.2** | **0** | **0** | **0** | | **8.4** | **0** | **0** | | **17.6** | **53.8** | **0** | **33.8** | **60.2** | | **2** | **0** | **0** | **0** | **0** | | | **2.4** |
| | 1984 | Rep 1 | | | | | | | | | | 1 | | | | | | | | | | | 4 | | | 104 | 67 | | 65 | 210 | | 59 | | | | | 29 | | | | | |
| | 1984 | Rep 2 | | | | | | | | | | 0 | | | | | | | | | | | 5 | | | 202 | 40 | | 31 | 70 | | 71 | | | | | 89 | | | | | |
| | 1984 | Rep 3 | | | | | | | | | | 0 | | | | | | | | | | | 27 | | | 35 | 29 | | 38 | 66 | | 127 | | | | | 21 | | | | | |
| | 1984 | Rep 4 | | | | | | | | | | 2 | | | | | | | | | | | 4 | | | 84 | 101 | | 80 | 64 | | 126 | | | | | 26 | | | | | |
| | 1984 | Rep 5 | | | | | | | | | | 0 | | | | | | | | | | | 4 | | | 2 | 38 | | 37 | 32 | | 41 | | | | | 29 | | | | | |
| | **1984** | **Average** | | | | | | | | | | **0.6** | | | | | | | | **0** | **0** | **0** | **8.8** | | **0** | **85.4** | **55** | | **50.2** | **88.4** | **0** | **84.8** | **0** | | **0** | **0** | **38.8** | **0** | **0** | | | **0** |
| | 1985 | Rep 1 | | | | | | | | | | | | | | | | | | | | | | | | 0 | 10 | | 2 | 15 | | 247 | | | 0 | | 8 | | | | | |
| | 1985 | Rep 2 | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | | 2 | 5 | | 310 | | | 0 | | 12 | | | | | |
| | 1985 | Rep 3 | | | | | | | | | | | | | | | | | | | | | | | | 0 | 3 | | 1 | 17 | | 144 | | | 0 | | 8 | | | | | |
| | 1985 | Rep 4 | | | | | | | | | | | | | | | | | | | | | | | | 1 | 4 | | 2 | 3 | | 124 | | | 1 | | 6 | | | | | |
| | 1985 | Rep 5 | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | | 0 | 5 | | 119 | | | 1 | | 5 | | | | | |
| | **1985** | **Average** | | | | | | | | | | **0** | | | | | | | | **0** | **0** | **0** | **0** | | **0** | **0.2** | **3.4** | | **1.4** | **9** | **0** | **188.8** | **0** | | **0.4** | **0** | **7.8** | **0** | **0** | | | **0** |
| | 1987 | Rep 1 | | | | | | | | | | | | | | | | | | | 1 | 0 | | | | 29 | 24 | | 17 | 43 | 108 | | | | | | 9 | | | | | |
| | 1987 | Rep 2 | | | | | | | | | | | | | | | | | | | 0 | 4 | | | | 129 | 74 | | 25 | 63 | 16 | | | | | | 11 | | | | | |
| | 1987 | Rep 3 | | | | | | | | | | | | | | | | | | | 0 | 18 | | | | 133 | 42 | | 30 | 107 | 66 | | | | | | 16 | | | | | |
| | 1987 | Rep 4 | | | | | | | | | | | | | | | | | | | 0 | 0 | | | | 16 | 6 | | 11 | 45 | 108 | | | | | | 3 | | | | | |
| | 1987 | Rep 5 | | | | | | | | | | | | | | | | | | | 0 | 6 | | | | 60 | 88 | | 24 | 53 | 60 | | | | | | 3 | | | | | |
| | **1987** | **Average** | | | | | | | | | | **0** | | | | | | | | **0** | **0.2** | **5.6** | **0** | | **0** | **73.4** | **46.8** | | **21.4** | **62.2** | **71.6** | **0** | **0** | | **0** | **0** | **8.4** | **0** | **0** | | | **0** |
| | 1993 | Rep 1 | | | | | | | | | | 12 | | | | | | | | 3 | | | 3 | | | 18 | 14 | | 115 | 103 | 2 | 20 | | | | 6 | 9 | | | | | |
| | 1993 | Rep 2 | | | | | | | | | | 10 | | | | | | | | 1 | 3 | | 1 | | | 18 | 12 | | 44 | 107 | | 20 | 1 | | | 46 | 12 | 1 | 1 | | | |
| | 1993 | Rep 3 | | | | | | | | | | 15 | | | | | | | | | | | 5 | | | 11 | 26 | | 164 | 196 | 3 | 21 | | | | 4 | 13 | | | | | |
| | 1993 | Rep 4 | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | 23 | 12 | | 15 | 20 | 1 | 33 | | | | 9 | 12 | | | | | |
| | 1993 | Rep 5 | | | | | | | | | | 20 | | | | | | | | | 2 | | 4 | | | 2 | 15 | | 54 | 139 | 1 | 10 | | | | 59 | 11 | | | | | |
| | **1993** | **Average** | | | | | | | | | | **11.4** | | | | | | | | **0.8** | **1** | **0.2** | **2.8** | | **0** | **14.4** | **15.8** | | **78.4** | **113** | **1.4** | **20.8** | **0.2** | | **0** | **24.8** | **11.4** | **0.2** | **0.2** | | | **0** |
| | 2006 | Rep 1 | | | | | | | 0 | | | | | | 0 | | | | | | | | | | | 0 | | | 5 | 1 | | 63 | | | | 0 | 2 | | | | | |
| | 2006 | Rep 2 | | | | | | | 0 | | | | | | 0 | | | | | | | | | | | 0 | | | 0 | 1 | | 10 | | | | 0 | 0 | | | | | |
| | 2006 | Rep 3 | | | | | | | 0 | | | | | | 0 | | | | | | | | | | | 0 | | | 1 | 2 | | 40 | | | | 1 | 0 | | | | | |
| | 2006 | Rep 4 | | | | | | | 0 | | | | | | 0 | | | | | | | | | | | 0 | | | 0 | 0 | | 0 | | | | 0 | 0 | | | | | |
| | 2006 | Rep 5 | | | | | | | 0 | | | | | | 0 | | | | | | | | | | | 0 | | | 0 | 0 | | 40 | | | | 0 | 0 | | | | | |
| | **2006** | **Average** | | | | | | | **0** | | | | **0** | **0** | **0** | **0** | | **0** | | | **0** | | | | | **0** | | | **1** | **0.8** | | **31** | | **0** | | **0.2** | **0.4** | | **0** | | | |

# Appendix 5 Benthic invertebrate data collected with a Neill cylinder sampler from the Bow River (1983 to 2006) (con't)

## Ronalane

| Site | year | replicate | *Neureclipsis* sp. | *Polycentropus* sp. | *Psychomyia* sp. | *Rhyacophilia* sp. | **Anisoptera** | *Ophiogomphus* sp. | Coenagrionidae sp. | **Hemiptera** | Corixidae sp. | *Callicorixa* sp. | *Cenocorixa* sp. | *Corisella* sp. | *Palmacorixa* sp. | *Sigara* sp. | *Trichocorixa* sp. | **Coleoptera** | Dytiscidae (misc.) | *Colymbetes* sp. | *Hydroporus* sp. | *Liodessus* sp. | *Oreodytes* sp. | *Stictotarsus* sp. | Elmidae (misc.) | *Dubiraphia* sp. | *Optioservus* sp. | Gyrinidae (misc.) | Pyralidae (misc.) | *Petrophila* sp. | **Diptera** | *Atherix* sp. | Ceratopogonidae sp. | *Bezzia / Palpomyia* gp spp. | *Culicoides* sp. | *Rhaphium* sp. | Empididae (misc.) | *Chelifera* sp. | *Hemerodromia* sp. | *Wiedemannia* sp. | Simulidae (misc.) | *Simulium* sp. | *Antocha* sp. | *Dicranota* sp. | *Hexatoma* sp. | *Tipula* sp. | **Chironomidae** | **Chironomini** | **Tanytarsini** | **Diamesinae** | **Orthocladiinae** | **Prodiamesinae** | **Tanypodinae** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ronalane | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1983 | Rep 1 | | | | | | | | 1 | 2 | | | | | | | 1 | | | | | | | 28 | | | | 0 | | | | | | | | | | | | | | | | | | 3344 | 160 | 16 | | | | 96 |
| | 1983 | Rep 2 | | | | | | | | 0 | 7 | | | | | | | 0 | | | | | | | 10 | | | | 24 | | | | | | | | | | | | | | | | | | 5953 | 200 | 0 | | | | 112 |
| | 1983 | Rep 3 | | | | | | | | 0 | 23 | | | | | | | 0 | | | | | | | 20 | | | | 14 | | | | | | | | | | | | | | | | | | 6880 | 160 | 0 | | | | 112 |
| | 1983 | Rep 4 | | | | | | | | 0 | 8 | | | | | | | 5 | | | | | | | 16 | | | | 16 | | | | | | | | | | | | | | | | | | 4432 | 144 | 0 | | | | 48 |
| | 1983 | Rep 5 | | | | | | | | 0 | 3 | | | | | | | 0 | | | | | | | 8 | | | | 28 | | | | | | | | | | | | | | | | | | 6832 | 112 | 0 | | | | 128 |
| | **1983** | **Average** | **0** | **0** | **0** | | **0** | **0** | **0** | **0.2** | **8.6** | | | | | | | **1** | **0** | | **0** | | | | **16** | | **0** | **0** | **16** | **0** | **0** | | **0** | | | | | | | | **0** | | | | | | **5488.2** | **155.2** | **3.2** | **0** | **0** | | **99.2** |
| | 1984 | Rep 1 | 1 | | 14 | | 0 | | | | 0 | | | | | | | | 0 | | | | | | 57 | | | | | 39 | | | | | | | | | | | 15 | | | | | | 0 | 216 | 278 | | 848 | | 279 |
| | 1984 | Rep 2 | 0 | | 21 | | 1 | | | | 1 | | | | | | | | 0 | | | | | | 0 | | | | | 33 | | | | | | | | | | | 0 | | | | | | 0 | 505 | 786 | | 693 | | 282 |
| | 1984 | Rep 3 | 0 | | 14 | | 3 | | | | 0 | | | | | | | | 0 | | | | | | 17 | | | | | 35 | | | | | | | | | | | 22 | | | | | | 13 | 318 | 345 | | 1129 | | 262 |
| | 1984 | Rep 4 | 1 | | 5 | | 0 | | | | 0 | | | | | | | | 0 | | | | | | 6 | | | | | 13 | | | | | | | | | | | 1 | | | | | | 5 | 205 | 301 | | 1021 | | 331 |
| | 1984 | Rep 5 | 0 | | 32 | | 0 | | | | 0 | | | | | | | | 1 | | | | | | 14 | | | | | 33 | | | | | | | | | | | 2 | | | | | | 2 | 562 | 334 | | 519 | | 202 |
| | **1984** | **Average** | **0.4** | **0** | **17.2** | | **0.8** | **0** | **0** | **0** | **0.2** | | | | | | | **0** | **0** | | **0** | | | | **19** | | **0** | **0** | **0** | **30.6** | **0** | | **0** | | | | | | | | **8** | | | | | | **4** | **361.2** | **408.8** | **0** | **842** | | **271** |
| | 1985 | Rep 1 | | 17 | 3 | | | | 0 | | 0 | | | | | | | 0 | | | | | | | 3 | | | 0 | 8 | | | | 0 | | | | | | | | 0 | | | | | | 134 | 843 | 579 | 20 | 130 | | 312 |
| | 1985 | Rep 2 | | 25 | 1 | | | | 0 | | 0 | | | | | | | 1 | | | | | | | 8 | | | 0 | 1 | | | | 1 | | | | | | | | 3 | | | | | | 49 | 529 | 380 | 27 | 243 | | 321 |
| | 1985 | Rep 3 | | 18 | 17 | | | | 0 | | 0 | | | | | | | 0 | | | | | | | 4 | | | 0 | 12 | | | | 0 | | | | | | | | 0 | | | | | | 123 | 1078 | 480 | 7 | 611 | | 475 |
| | 1985 | Rep 4 | | 12 | 3 | | | | 1 | | 0 | | | | | | | 1 | | | | | | | 3 | | | 0 | 5 | | | | 0 | | | | | | | | 0 | | | | | | 38 | 425 | 364 | 20 | 365 | | 136 |
| | 1985 | Rep 5 | | 24 | 21 | | | | 1 | | 1 | | | | | | | 0 | | | | | | | 6 | | | 1 | 6 | | | | 0 | | | | | | | | 0 | | | | | | 165 | 1118 | 668 | 220 | 730 | | 487 |
| | **1985** | **Average** | **0** | **19.2** | **9** | | **0** | **0** | **0.4** | **0** | **0.2** | | | | | | | **0** | **0** | | **0** | | | | **4.8** | | **0** | **0** | **6** | **0** | **0** | | **0** | | | | | | | | **0.6** | | | | | | **101.8** | **798.6** | **494.2** | **58.8** | **415.8** | | **346** |
| | 1987 | Rep 1 | 9 | 0 | 25 | | | | | | 0 | | | | | | | | | | 0 | | | | 0 | | 9 | | | 27 | | | | | | | | | | | | | | | | | 146 | 249 | 320 | | 662 | | 164 |
| | 1987 | Rep 2 | 2 | 0 | 6 | | | | | | 0 | | | | | | | | | | 0 | | | | 4 | | 1 | | | 40 | | | | | | | | | | | | | | | | | 165 | 330 | 20 | | 346 | | 192 |
| | 1987 | Rep 3 | 4 | 1 | 12 | | | | | | 0 | | | | | | | | | | 1 | | | | 0 | | 6 | | | 43 | | | | | | | | | | | | | | | | | 433 | 541 | 73 | | 541 | | 409 |
| | 1987 | Rep 4 | 0 | 2 | 15 | | | | | | 0 | | | | | | | | | | 0 | | | | 0 | | 8 | | | 27 | | | | | | | | | | | | | | | | | 246 | 553 | 186 | | 680 | | 308 |
| | 1987 | Rep 5 | 0 | 2 | 14 | | | | | | 1 | | | | | | | | | | 0 | | | | 0 | | 10 | | | 34 | | | | | | | | | | | | | | | | | 280 | 571 | 166 | | 488 | | 221 |
| | **1987** | **Average** | **3** | **1** | **14.4** | | **0** | **0** | **0** | **0** | **0.2** | | | | | | | **0** | **0** | | **0** | | | | **0.8** | | **6.8** | **0** | **0** | **34.2** | **0** | | **0** | | | | | | | | **0** | | | | | | **254** | **448.8** | **153** | **0** | **543.4** | | **259** |
| | 1993 | Rep 1 | | | 55 | | | | | | 1 | | | | | | | | 1 | | | | | | 14 | | | | | 18 | 4 | | | | | | | | | | 18 | | | | | | 6 | 211 | 154 | | 408 | | 49 |
| | 1993 | Rep 2 | | | 15 | | | | | | | | | | | | | | | | | | | | 9 | | | | | 5 | | | | | | | | | | | 15 | | | | | | 8 | 168 | 353 | 1 | 482 | | 46 |
| | 1993 | Rep 3 | | | 47 | | | | | | | | | | | | | | | | | | | | 22 | | | | | 16 | 2 | | | | | | | | | | 21 | | | | | | 12 | 33 | 315 | | 343 | | 30 |
| | 1993 | Rep 4 | | | 7 | | | | | | 2 | | | | | | | | | | | | | | 5 | | | | | 29 | 2 | | | | | | | | | | 1 | | | | | | 20 | 166 | 265 | | 580 | | 50 |
| | 1993 | Rep 5 | | | 30 | | | 1 | | | | | | | | | | | | | | | | | 11 | | | | | 20 | | | 1 | | | | | | | | 12 | | | | | | 18 | 108 | 228 | | 836 | | 87 |
| | **1993** | **Average** | **0** | **0** | **30.8** | | **0** | **0.2** | **0** | **0** | **0.6** | | | | | | | **0** | **0** | | **0** | | | | **12** | | **0** | **0** | **0** | **17.6** | **2** | | **0** | | | | | | | | **13** | | | | | | **12.8** | **137.2** | **263** | **0.2** | **529.8** | | **52.4** |
| | 2006 | Rep 1 | | 0 | | | | 2 | 0 | | 0 | 0 | 0 | | | 1 | 0 | | | | | 3 | | | | 0 | 10 | | | 1 | | | 0 | 46 | 81 | 0 | | | | | | 20 | | 0 | | 0 | | 670 | 5005 | 0 | 1495 | | 192 |
| | 2006 | Rep 2 | | 0 | | | | 0 | 0 | | 0 | 0 | 0 | | | 0 | 0 | | | | | 0 | | | | 0 | 2 | | | 0 | | | 0 | 32 | 50 | 0 | | | | | | 0 | | 0 | | 0 | | 82 | 744 | 0 | 226 | | 20 |
| | 2006 | Rep 3 | | 0 | | | | 0 | 0 | | 0 | 0 | 0 | | | 0 | 1 | | | | | 3 | | | | 21 | 26 | | | 0 | | | 0 | 2 | 0 | 0 | | | | | | 0 | | 0 | | 0 | | 411 | 4003 | 0 | 1434 | | 131 |
| | 2006 | Rep 4 | | 0 | | | | 0 | 0 | | 0 | 0 | 0 | | | 0 | 0 | | | | | 0 | | | | 1 | 11 | | | 0 | | | 0 | 3 | 20 | 0 | | | | | | 0 | | 0 | | 0 | | 139 | 392 | 0 | 169 | | 3 |
| | 2006 | Rep 5 | | 1 | | | | 0 | 0 | | 0 | 0 | 0 | | | 2 | 0 | | | | | 1 | | | | 1 | 22 | | | 0 | | | 0 | 2 | 60 | 1 | | | | | | 0 | | 0 | | 1 | | 121 | 720 | 0 | 374 | | 60 |
| | **2006** | **Average** | **0** | **0.2** | **0** | | | **0.4** | **0** | | **0** | **0** | **0** | | | **1** | **0.2** | | | **0** | | **1** | **0** | **0** | | **5** | **14** | | | **0.2** | | **0** | **0** | **17** | **42** | **0.2** | | **0** | **0** | | | **4** | **0** | **0** | **0** | **0.2** | | **284.6** | **2172.8** | **0** | **739.6** | | **81** |

## Appendix 6 Summary of results of the Bootstrap assessment of differences among sampling approaches

**Abundance**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 667 | ± | 214.15 | 667 | **2112 (1)** | **337** |
| | Stiers Ranch | 12616.4 | ± | 3332.8 | 14811 | **36240** | **18438** |
| | Carseland | 8622.6 | ± | 1852.58 | 8623 | **73675** | **16571** |
| | Cluny | 4396.2 | ± | 616.81 | 4396 | **24854** | **8272** |
| | Ronalane | 7447.4 | ± | 3587.68 | 7447 | **35176** | **26898** |

**Richness**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 21.4 | ± | 2.7 | **43** | **39** | **39** |
| | Stiers Ranch | 47.6 | ± | 8.02 | **70** | 45 | 45 |
| | Carseland | 47.8 | ± | 4.66 | **75** | **68** | **56** |
| | Cluny | 39 | ± | 3.32 | **65** | 41 | **44** |
| | Ronalane | 38.4 | ± | 6.19 | **68** | **54** | **57** |

**Ratio Hydropsychid to Trichoptera**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | *no analysis due to zero counts for all methods* | | | | | |
| | Stiers Ranch | 0.964 | ± | 0.052 | **0.97** | **0.997** | 0.992 |
| | Carseland | 0.827 | ± | 0.151 | **0.951** | **0.969** | **0.958** |
| | Cluny | 0.789 | ± | 0.18 | 0.84 | **0.951** | **0.615** |
| | Ronalane | 0.049 | ± | 0.045 | 0.06 | 0.068 | **0.667** |

**Proportion EPT**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.008 | ± | 0.0062 | 0.007 | 0.008 | **0.092** |
| | Stiers Ranch | 0.199 | ± | 0.119 | 0.17 | **0.314** | **0.353** |
| | Carseland | 0.092 | ± | 0.099 | 0.098 | 0.059 | **0.186** |
| | Cluny | 0.124 | ± | 0.079 | 0.129 | 0.091 | **0.32** |
| | Ronalane | 0.005 | ± | 0.003 | 0.006 | 0.007 | 0.007 |

**Ratio EPT to Chironomidae**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.121 | ± | 0.101 | 0.098 | 0.128 | **0.554** |
| | Stiers Ranch | 0.588 | ± | 0.303 | 0.491 | 0.621 | **1.808** |
| | Carseland | 0.164 | ± | 0.196 | 0.161 | 0.124 | 0.318 |
| | Cluny | 0.271 | ± | 0.184 | 0.276 | 0.269 | **0.739** |
| | Ronalane | 0.016 | ± | 0.011 | 0.013 | 0.044 | 0.024 |

**Contribution by dominant family (insects only)**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.673 | ± | 0.194 | 0.644 | 0.682 | **0.384** |
| | Stiers Ranch | 0.644 | ± | 0.167 | 0.699 | 0.604 | **0.456** |
| | Carseland | 0.843 | ± | 0.127 | 0.829 | 0.871 | 0.738 |
| | Cluny | 0.728 | ± | 0.109 | 0.71 | 0.731 | **0.524** |
| | Ronalane | 0.976 | ± | 0.013 | 0.981 | **0.944** | **0.954** |

**Ratio Scraper to Filterer**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.256 | ± | 0.356 | 0.143 | 0.095 | 0.444 |
| | Stiers Ranch | 0.38 | ± | 0.139 | 0.362 | 0.278 | 0.324 |
| | Carseland | 0.186 | ± | 0.1 | 0.157 | 0.258 | 0.255 |
| | Cluny | 0.387 | ± | 0.098 | 0.404 | **0.284** | **1.463** |
| | Ronalane | 0.025 | ± | 0.016 | 0.02 | 0.025 | **0.047** |

**Proportion with Depositonal preferences**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.08 | ± | 0.048 | 0.094 | **0.327** | 0.099 |
| | Stiers Ranch | 0.083 | ± | 0.063 | 0.089 | **0.01** | 0.046 |
| | Carseland | 0.111 | ± | 0.064 | 0.114 | 0.084 | **0.053** |
| | Cluny | 0.137 | ± | 0.085 | 0.126 | **0.056** | 0.085 |
| | Ronalane | 0.597 | ± | 0.045 | 0.61 | **0.489** | **0.662** |

**Proportion with Erosional Preferences**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.498 | ± | 0.2733 | 0.43 | **0.177** | **0.291** |
| | Stiers Ranch | 0.703 | ± | 0.024 | **0.658** | 0.715 | **0.58** |
| | Carseland | 0.6 | ± | 0.089 | 0.551 | 0.604 | **0.669** |
| | Cluny | 0.598 | ± | 0.117 | 0.552 | **0.782** | 0.664 |
| | Ronalane | 0.318 | ± | 0.044 | 0.306 | **0.384** | **0.209** |

**Proportion Erosional to Depositional preferences**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.103 | ± | 0.0911 | 0.163 | 0.077 | **0.233** |
| | Stiers Ranch | 0.077 | ± | 0.045 | **0.125** | **0.13** | **0.236** |
| | Carseland | 0.047 | ± | 0.015 | **0.084** | **0.095** | **0.118** |
| | Cluny | 0.142 | ± | 0.027 | **0.204** | **0.1** | **0.218** |
| | Ronalane | 0.027 | ± | 0.015 | 0.021 | 0.036 | **0.065** |

**Proportion with Lentic Preference**

| Variable | Site | Neill mean ± SD | | | "Total" Neill | Kick Samples (210 µm mesh) | Kick Samples (400 µm mesh) |
|---|---|---|---|---|---|---|---|
| | Cochrane | 0.317 | ± | 0.1795 | 0.31 | 0.407 | 0.349 |
| | Stiers Ranch | 0.114 | ± | 0.039 | 0.108 | 0.104 | 0.128 |
| | Carseland | 0.192 | ± | 0.08 | 0.202 | 0.18 | **0.101** |
| | Cluny | 0.092 | ± | 0.053 | 0.088 | 0.072 | **0.027** |
| | Ronalane | 0.031 | ± | 0.025 | 0.047 | **0.006** | **0.01** |

**(1)** numbers that are bold and underlined identify a significant difference with the Neill sample mean ± SD

## Appendix 7 Summary of ANOVAS performed on 2006 benthic invertebrate data to assess longitudinal trends in the Bow River

| Test | p for ANOVA | Bonferroni (p<0.05) | | | | |
|---|---|---|---|---|---|---|
| Metric Tested | | Cochrane | Stiers Ranch | Carseland | Cluny | Ronalane |
| Abundance | 0.000 | | | (1) | | |
| Richness | 0.000 | | | | | |
| Simpson Diversity Index | 0.017 | | | | | |
| Shannon Diversity Index | 0.000 | | | | | |
| EPT genera | 0.000 | | | | | |
| EPT to chironomid ratio | 0.000 | | | | | |
| Contribution by Dominant order (insect) | 0.000 | | | | | |
| Number of Filter Taxa | 0.000 | | | | | |
| Proportion of Filterers | 0.000 | | | | | |
| Proportion of Gatherers | 0.000 | | | | | |
| Proportion of Shredders | 0.427 | no significant differences | | | | |
| Proportion Scrapers | 0.000 | | | | | |
| Proportion Predators | 0.000 | | | | | |
| Proporation Swimmers | 0.000 | | | | | |
| Number of Clinger Taxa | 0.000 | | | | | |

## Appendix 7 Summary of ANOVAS performed on 2006 Benthic Invertebrate Data to Assess Longitudinal Trends in the Bow River(con't)

| Test | p for ANOVA | Bonferroni (p<0.05) | | | | | |
|---|---|---|---|---|---|---|---|
| Metric Tested | | | Cochrane | Stiers Ranch | Carseland | Cluny | Ronalane |
| Number of Clinger Taxa | 0.000 | | | | | | |
| Proportion Sprawlers | 0.005 | | | | | | |
| Number of Burrower Taxa | 0.000 | | | | | | |
| Proportion Burrowers | 0.000 | | | | | | |
| Proportion with Depositional Preference (Historic Data) | 0.000 | | | | | | |
| Number of Pollution Intolerant Taxa | 0.000 | | | | | | |
| Family Biotic Index | 0.000 | | | | | | |
| Sensitivity (BWMP) Score | 0.000 | | | | | | |
| Average Score per Taxon | 0.000 | | | | | | |

*(1) Horizontal lines join 2 sites that differ significantly (p<0.05)*

## Appendix 8 Summary of results of Step-wise Discriminant Analysis on historical benthic invertebrate Neill cylinder data for the Bow River

| Function | Eigenvalue | % of Variance | Cumulative % | Canonical Correlation |
|---|---|---|---|---|
| 1 | 12.934 | 43.4 | 43.4 | 0.963 |
| 2 | 8.872 | 29.8 | 73.2 | 0.948 |
| 3 | 6.845 | 23.0 | 96.2 | 0.934 |
| 4 | 1.142 | 3.8 | 100.0 | 0.730 |

**Correlations for individual taxa by function**

| Taxon | Function -1 | Function -2 | Function -3 | Function -4 |
|---|---|---|---|---|
| Chironomini | 0.33 | 0.001 | 0.043 | -0.011 |
| Tubificidae | 0.248 | -0.04 | -0.024 | 0.109 |
| Simulidae | 0.203 | -0.108 | -0.175 | -0.062 |
| Coleoptera | 0.185 | -0.024 | 0.098 | -0.154 |
| Tanypodinae | 0.163 | -0.001 | 0.009 | 0.115 |
| Hydropsychidae | 0.121 | -0.09 | -0.005 | -0.005 |
| Stenonema | 0.122 | 0.271 | 0.191 | 0.115 |
| Hydra | -0.208 | -0.255 | -0.053 | 0.022 |
| Tricorythodes | 0.211 | 0.218 | 0.136 | -0.027 |
| Ephemerellidae | 0.068 | -0.162 | -0.027 | -0.117 |
| Orthocladiinae | 0.078 | -0.091 | -0.013 | -0.063 |
| Helicopsychidae | 0.192 | -0.201 | 0.36 | 0.23 |
| Hydracarina | -0.026 | 0.067 | -0.088 | -0.006 |
| Tanytarsini | 0.038 | 0.06 | 0.077 | -0.005 |
| Naididae | -0.074 | -0.135 | -0.013 | -0.337 |
| Hydroptilidae | -0.042 | 0.099 | 0.163 | 0.329 |
| Hydropsyche | 0.187 | 0.235 | -0.239 | -0.324 |
| Chironomidae | 0.014 | 0.003 | 0.123 | 0.259 |
| Psychomyia | 0.226 | -0.175 | 0.127 | 0.23 |
| NEMATODA | 0.045 | 0.002 | 0.124 | -0.22 |
| Baetidae | 0.112 | -0.061 | -0.03 | -0.208 |
| OSTRACODA | 0.024 | -0.007 | -0.124 | 0.188 |
| COPEPODA | 0.022 | -0.057 | -0.15 | 0.165 |
| Enchytraeidae | -0.124 | -0.036 | -0.001 | -0.164 |

*Variables ordered by absolute size of correlation within function.*

*Highlighted numbers indicate the largest absolute correlation between each variable and any discriminant function*

## Appendix 9 Discussion on the influence of discharge on variability in the historical benthic invertebrate data from the Bow River

CONSIDERATIONS ABOUT THE INFLUENCE OF RIVER FLOW ON BENTHIC INVERTEBRATE DISTRIBUTION

Differences in benthic fauna among years may be the result of changes to water quality over time. However, the effect of flow on invertebrate community structure must be considered as well. Hydrometric data which correspond to the period studied are available from the Water Survey of Canada on-line archives for a limited number of Bow River sites. Bow River below Bearspaw Dam (05BH009), downstream of Carseland Dam (05BM002), and near the mouth (at the confluence of the Oldman River) (05BN012) were chosen to represent flow conditions over the range of sites where invertebrates were collected. These stations roughly correspond to the Cochrane, Carseland, and Ronalane sampling locations.

Flows from the dates sampled ranged from 45 to 103 $m^3/s$ downstream from the Bearspaw Dam. Downstream from the Carseland Dam, daily flows on the sample dates ranged more widely, between 41 and 155 $m^3/s$. Near the confluence with the Oldman River, samples were collected over the greatest range of flows, between 13 and 143 $m^3/s$. In all cases, the highest flows were in September of 1993, while the date of the lowest flow was different for all sites (Figure A9-1). The highest daily flow for each site occurred in the sample month with the highest mean monthly flows. However, the lowest mean monthly flows did not correspond to lowest daily flows (Figure A9-2).

Hydrometric conditions prior to the day or month in which the invertebrates were sampled can have an important effect on the benthic invertebrate community. The scouring action of high flows may reduce invertebrate abundance and diversity in the short-term, but by removing algal over-growth and sediments may leave a substrate that is more favourable for colonization by clinging and sprawling taxa that are associated with “cleaner” water conditions. Daily flows for April through October for the years sampled are graphed in the Appendix (Figures A 9-3). These data were examined for incidents of “high” flow, arbitrarily defined as flows over 300 $m^3/s$. The first such peak occurred downstream of the Carseland Dam and near the confluence with the Oldman River in mid-September of 1985, just two weeks before invertebrate sampling occurred. On this occasion, flows rose from 40 $m^3/s$ to about 330 $m^3/s$ over one day. In early June of 1986, spring flows peaked at over 400 $m^3/s$ at all three hydrometric stations. Flows in 1993 were generally high; measurements over 300 $m^3/s$ occurred numerous times at the two downstream stations throughout June, July and August. The maximum daily flow downstream of the Carseland Dam was 490 $m^3/s$ during this period, while flows near the mouth peaked at 477 $m^3/s$. The highest levels of all the years sampled occurred in 2006, when, in mid-June, maximum flows reached 820 $m^3/s$ downstream of the Carseland Dam and 778 $m^3/s$ near the confluence.

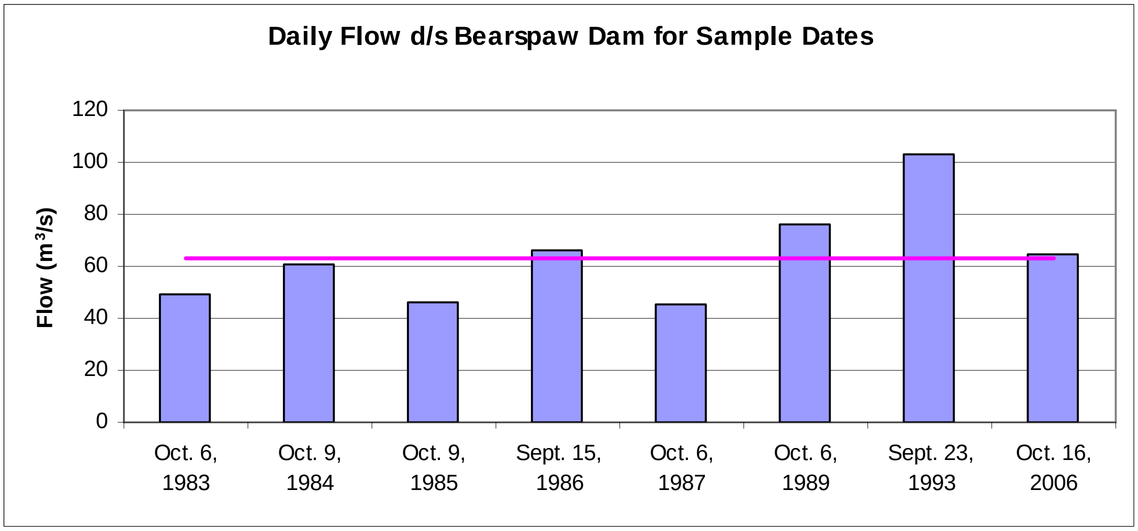
Although no benthic samples were collected in 2005, it is important to note that in June of that year, the Bow River experienced a significant flood event. No flows are available from the station below the Bearspaw Dam, but the highest daily flow downstream at Calgary (05BH004) was 602 $m^3/s$. Flows were highest downstream of the Carseland Dam, reaching 1710 $m^3/s$. Near the mouth of the Bow River, the maximum daily flow was 1530 $m^3/s$. Flows of these magnitudes would be expected to cause physical alteration to the bed and banks of the river, decimation of macrophyte and algae populations, and significant drift and displacement of benthic invertebrates.

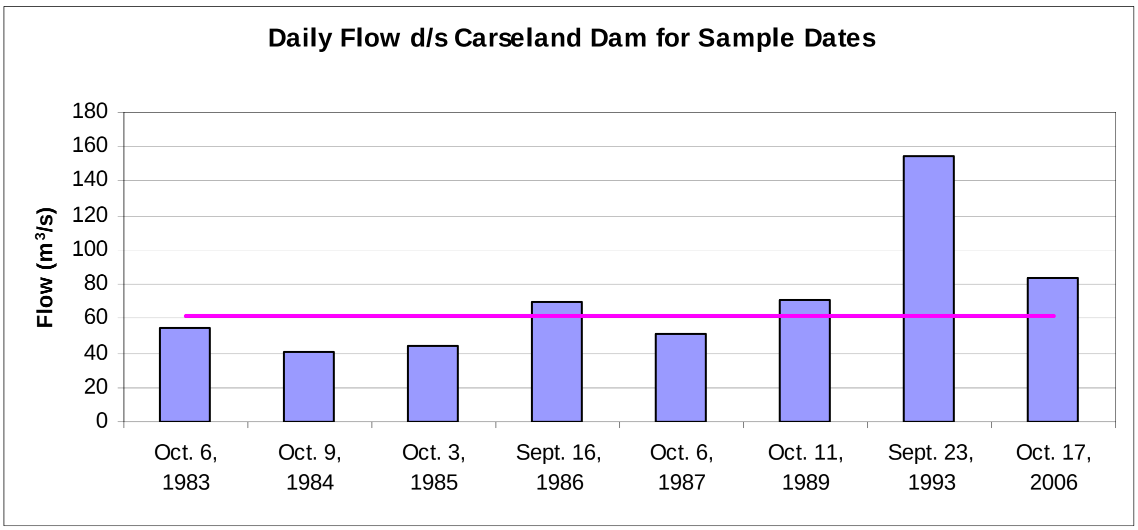
Ecological conditions in the Bow River in the fall of 2004 and 2005 were compared in a project by University of Calgary Environmental Sciences students (ENSC502 2006). From an examination of four sites within the City of Calgary, they concluded that while epilithic algae had already begun to recover to pre-flood levels, aquatic macrophyte biomass, sediment nutrient levels, and benthic invertebrate diversity (richness) were all lower than in the previous year. Given the relatively short life-spans of most benthic invertebrates, recovery should be expected by the following year (*i.e.* by the 2006 sampling dates). Indeed, anecdotal reports from fly-fishermen claim that the trout fishery between Calgary and Carseland was excellent in 2006 (Big Rock Fly Guides 2007), suggesting an adequate supply of invertebrate prey.

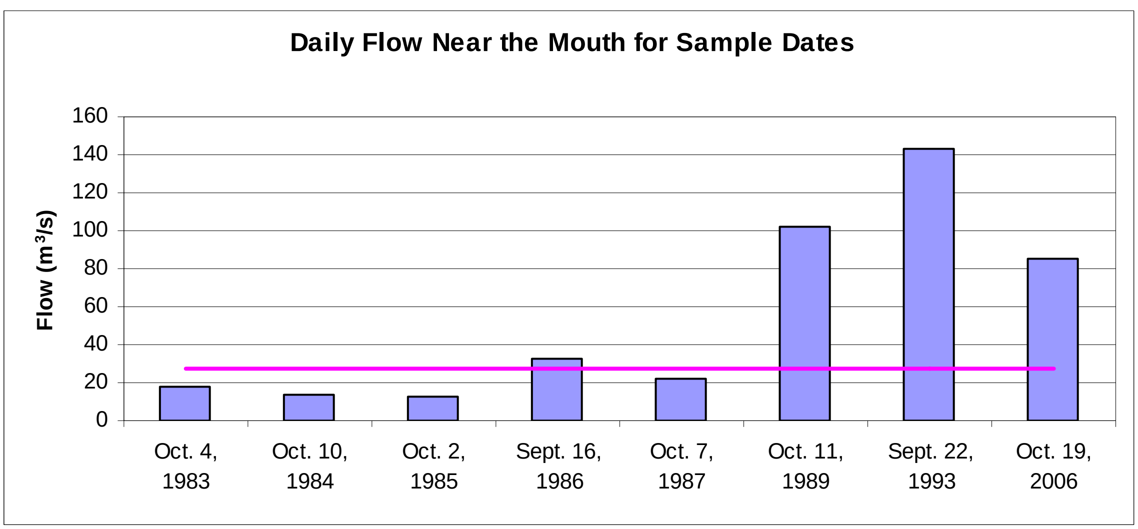
Literature Cited

Big Rock Fly Guides 2007. Web Archives. January 22, 2007. http://www.bigrockflyguides.com/

Environmental Sciences 502. 2006. Bow River Ecological Changes Following the 2005 Flood. *In* Flood 2005: Lessons Learned. Presented by K. Carter and R. Willson, June 14, 2006. http://www.ucalgary.ca/ensc/files/ensc/ENSC502%2005-06%20Living%20with%20Our%20Rivers%20BRBC%20Combined.pdf

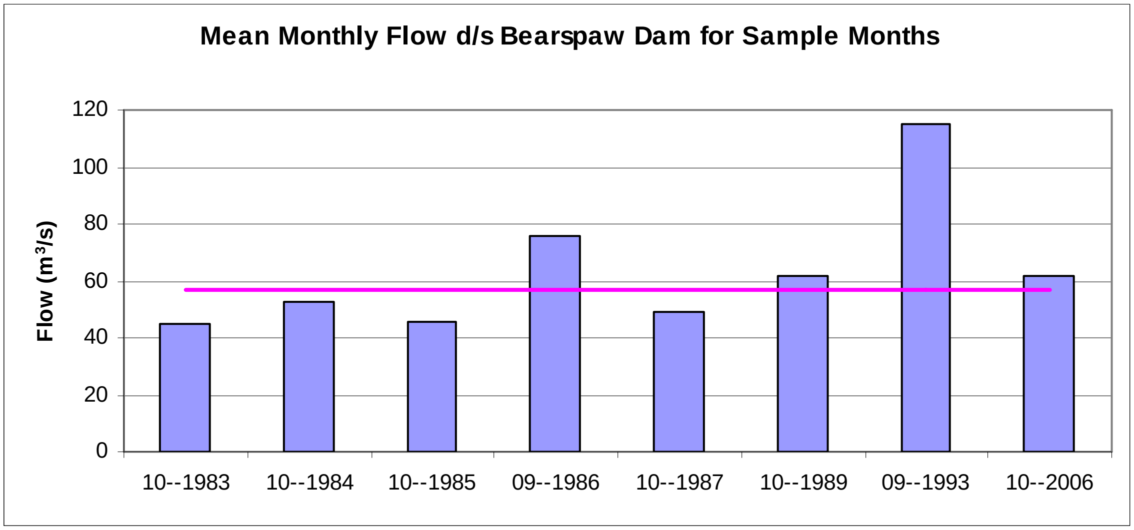


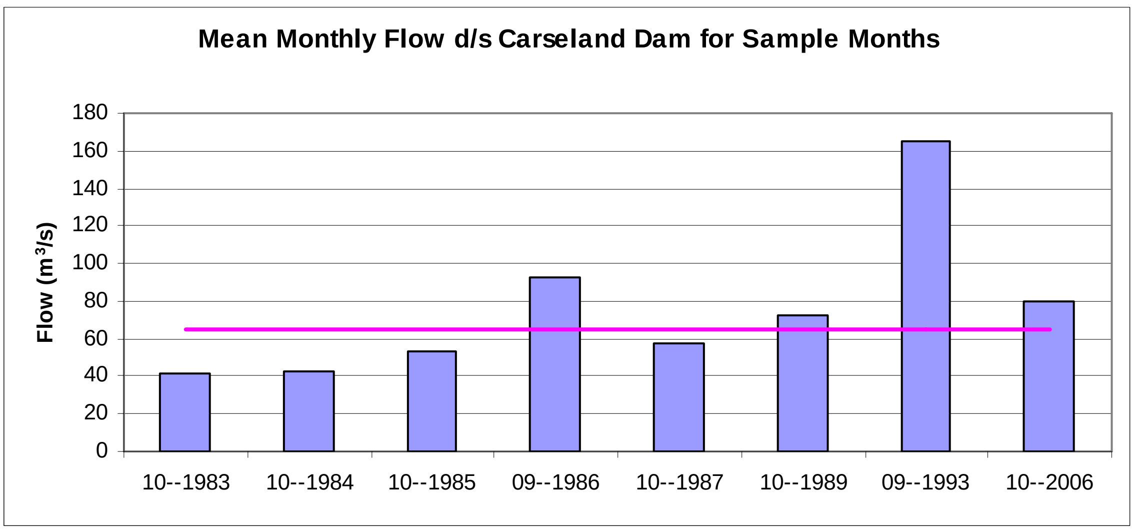



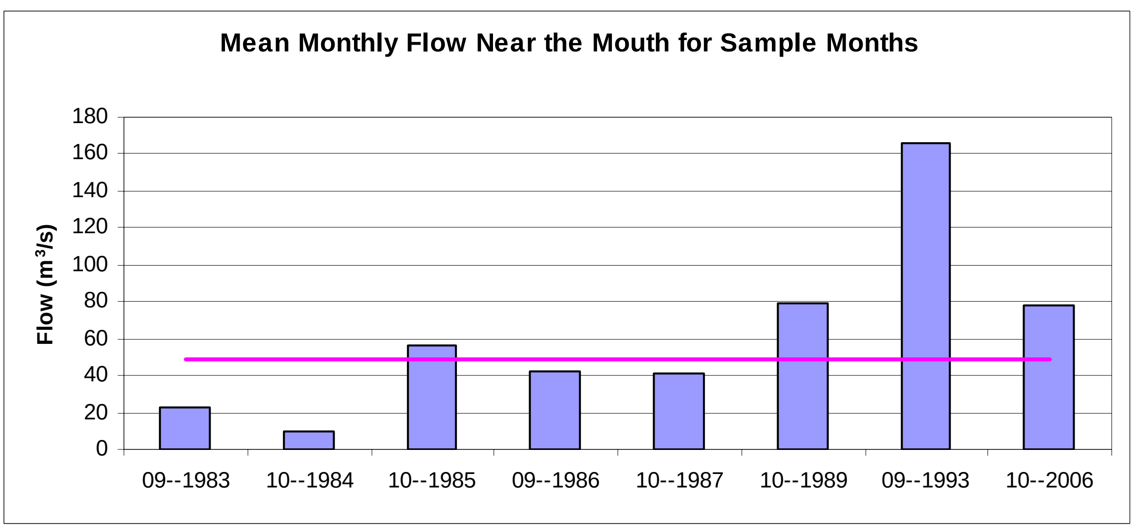




Line indicates median

**Figure A 9-1 Daily flows in the Bow River which correspond to benthic invertebrate sampling dates, 1983-2006**

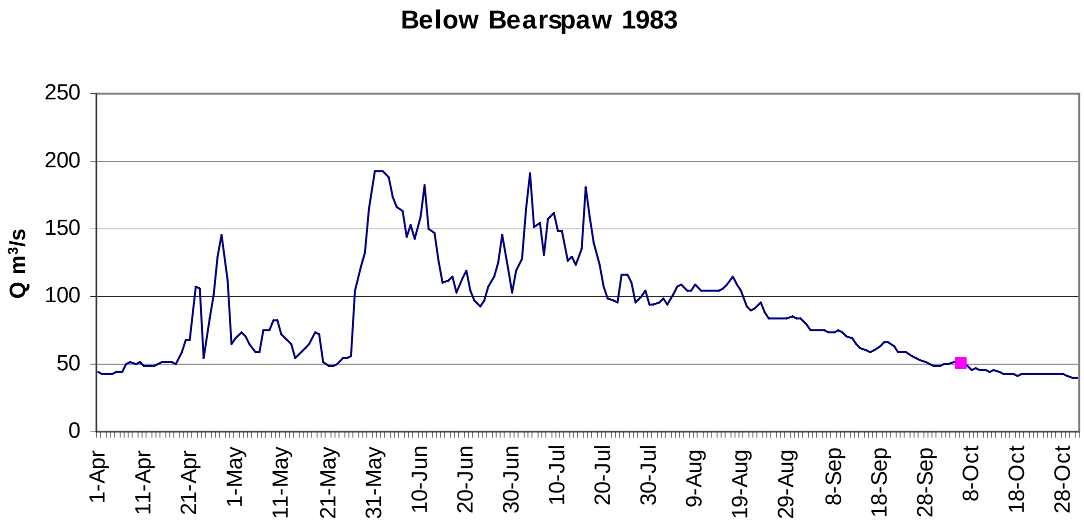


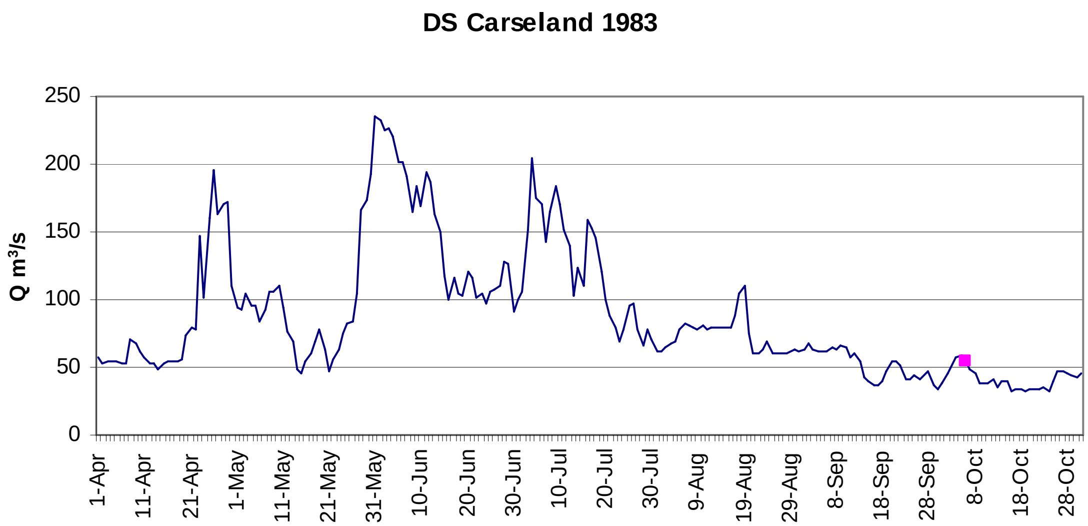



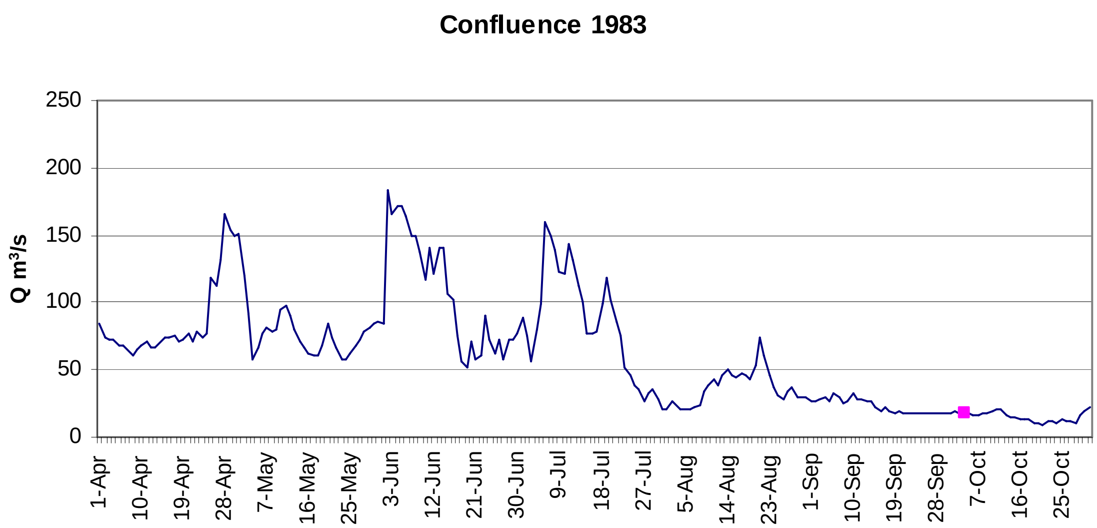




Line indicates median

**Figure A 9-2 Monthly flows in the Bow River which correspond to benthic invertebrate sampling months, 1983-2006**

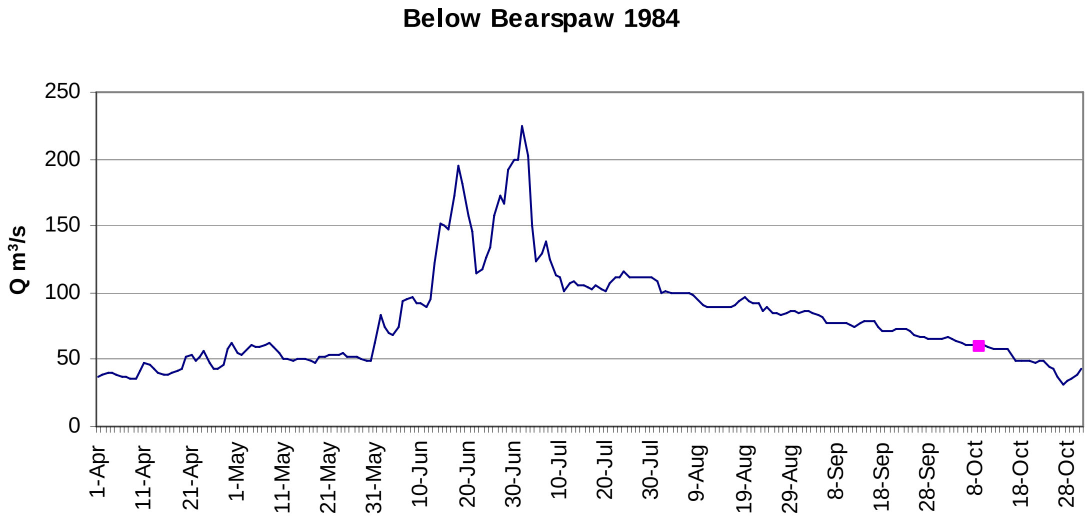


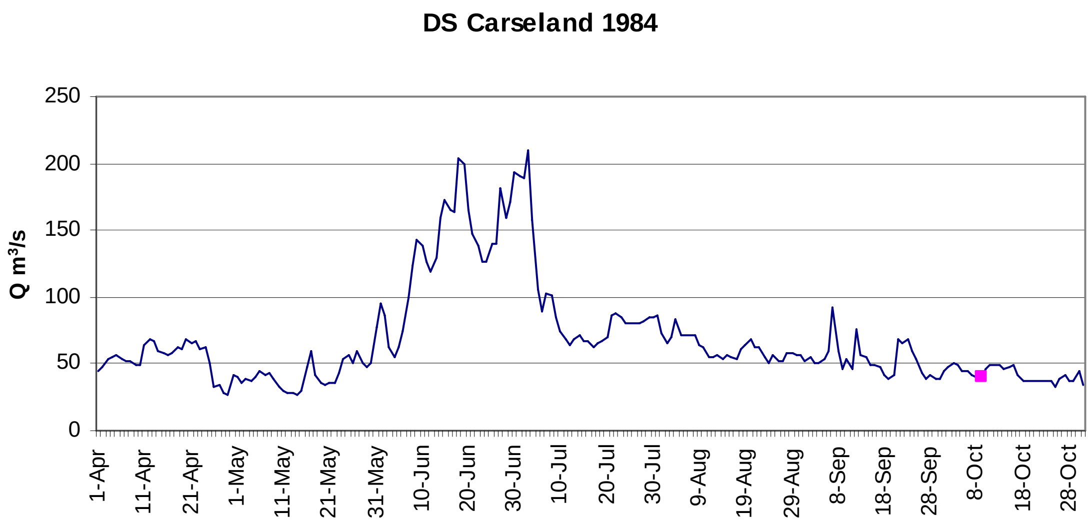



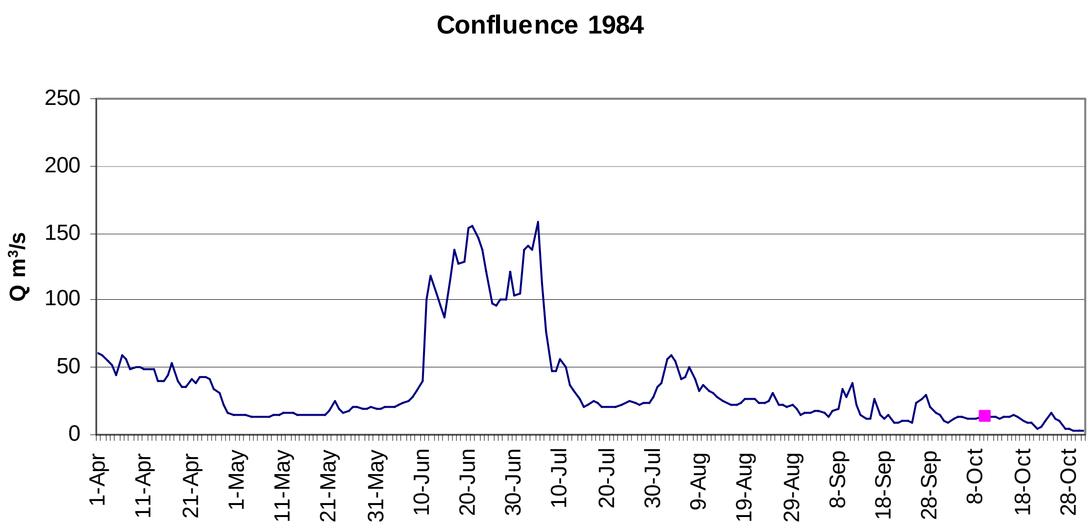




Pink square indicates benthic invertebrate sampling day

**Figure A 9-3 Daily Flows at several locations in the Bow River**



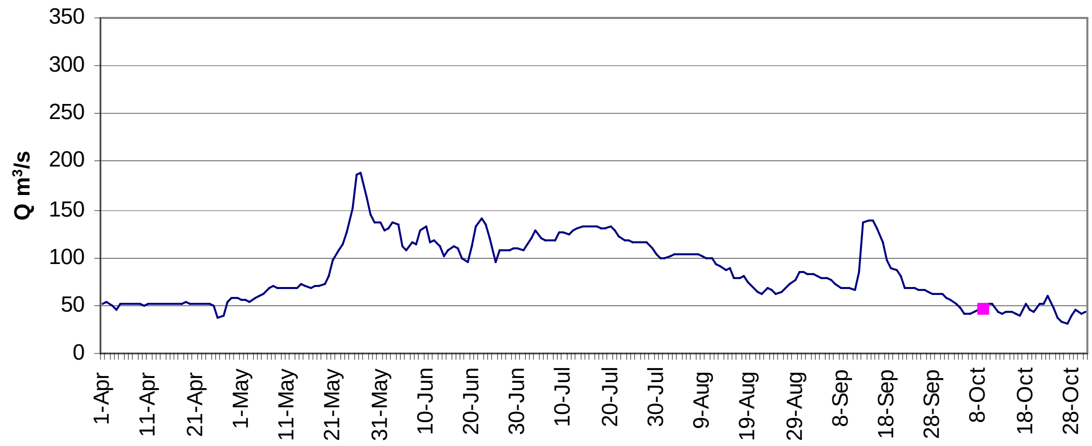



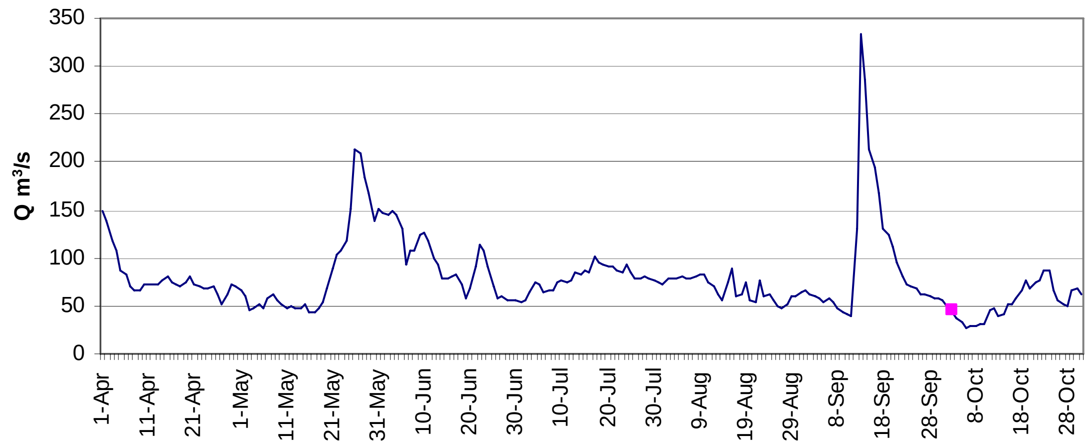

Pink square indicates benthic invertebrate sampling day

**Figure A 9-3 Daily Flows at several locations in the Bow River (con't)**

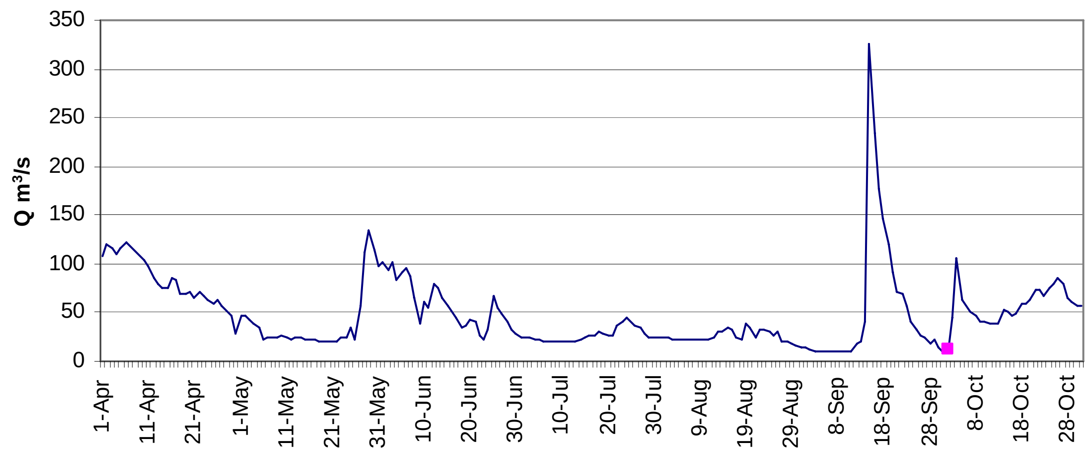
Below Bearspaw 1985




DS Carseland 1985

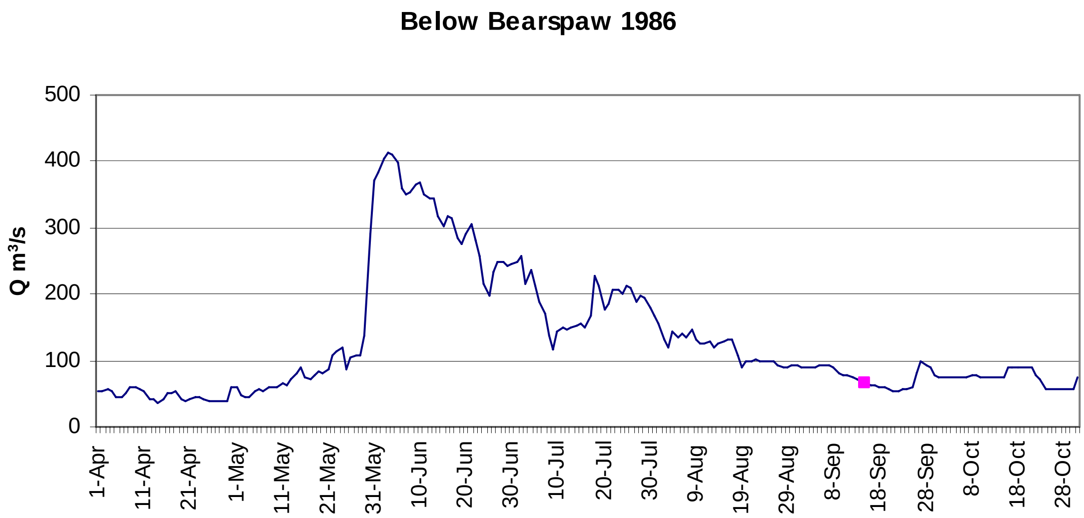


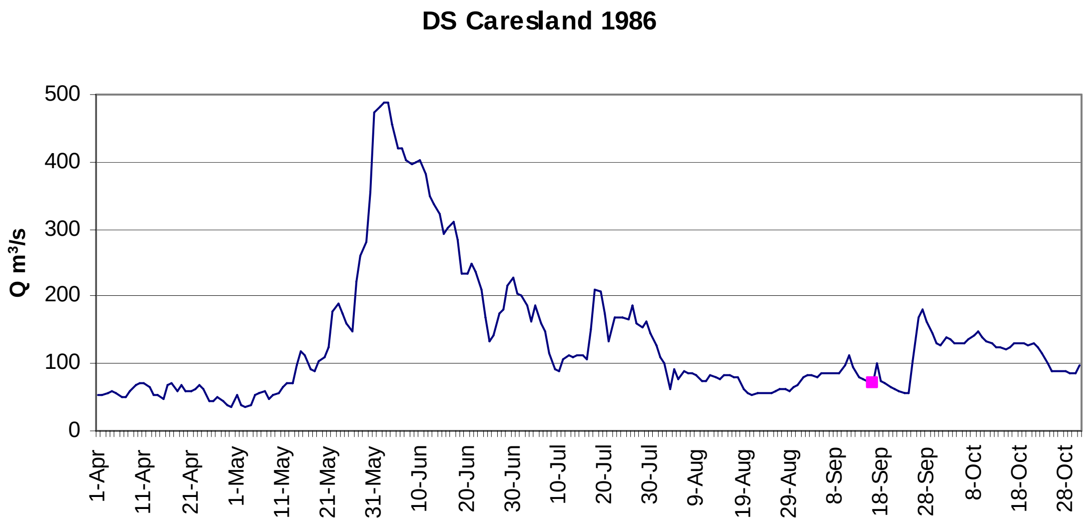

Confluence 1985

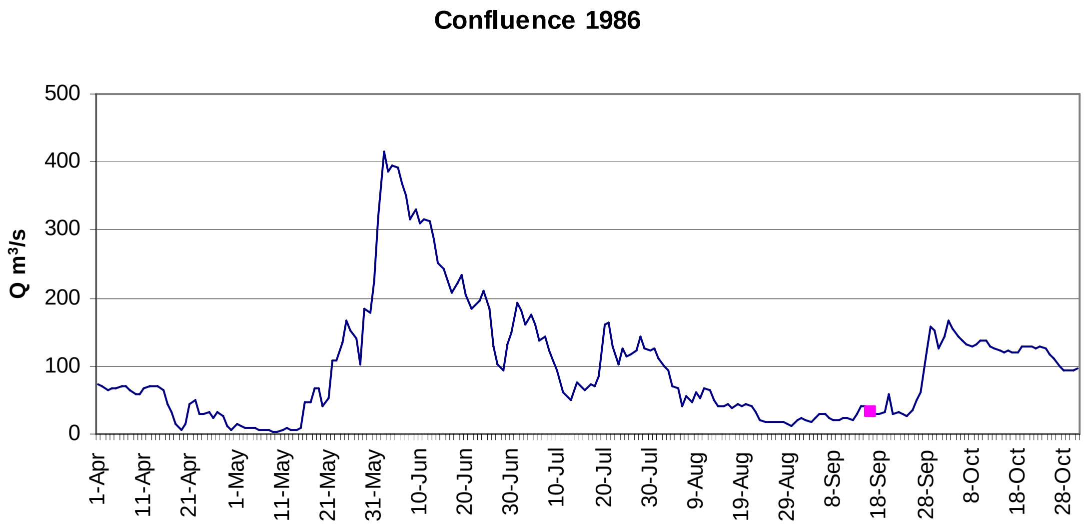



Pink square indicates benthic invertebrate sampling day

**Figure A 9-3 Daily Flows at several locations in the Bow River (con't)**



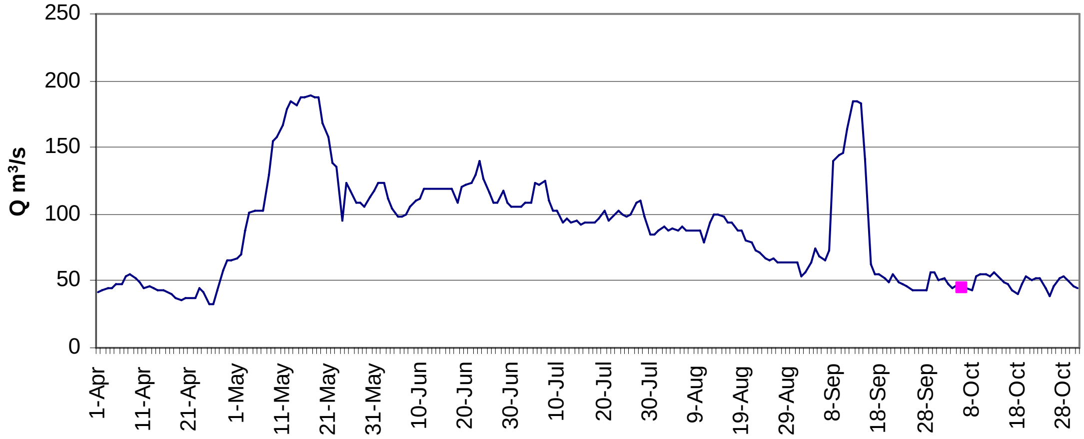



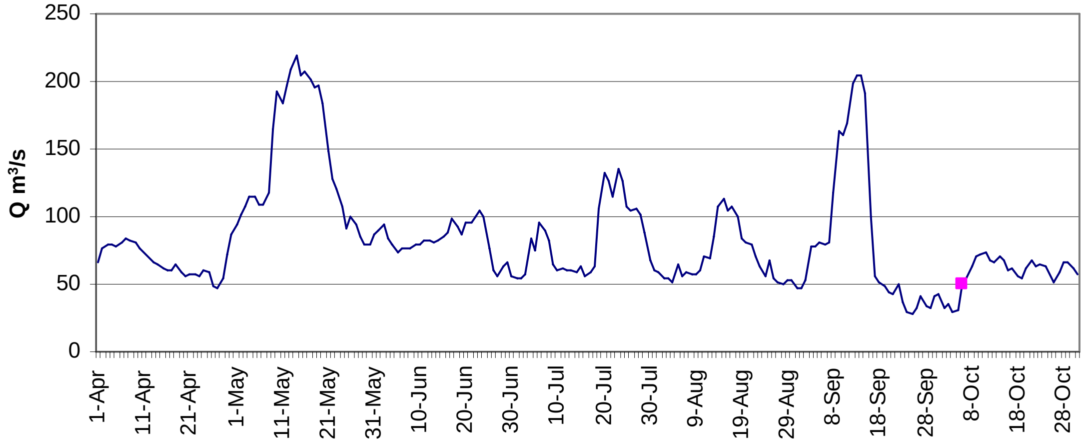

Pink square indicates benthic invertebrate sampling day

**Figure A 9-3 Daily Flows at several locations in the Bow River (con't)**

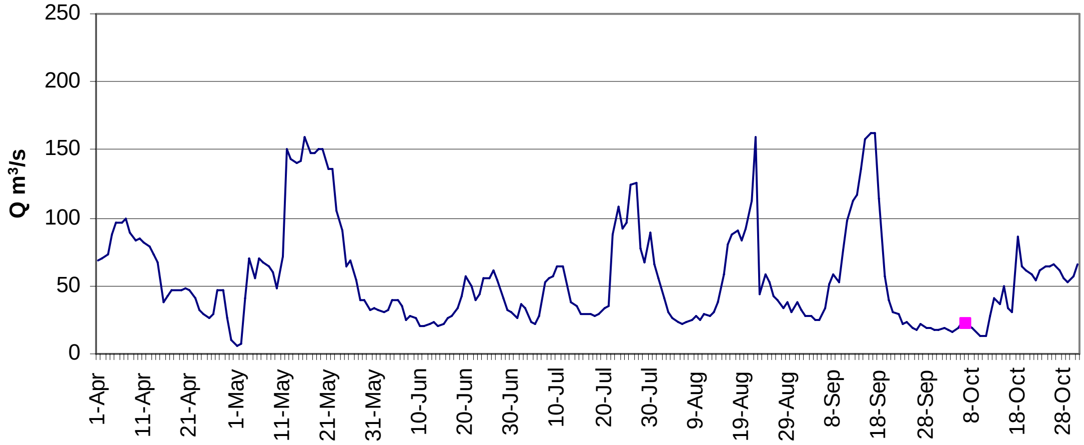
**Below Bearspaw 1987**




**DS Carseland 1987**



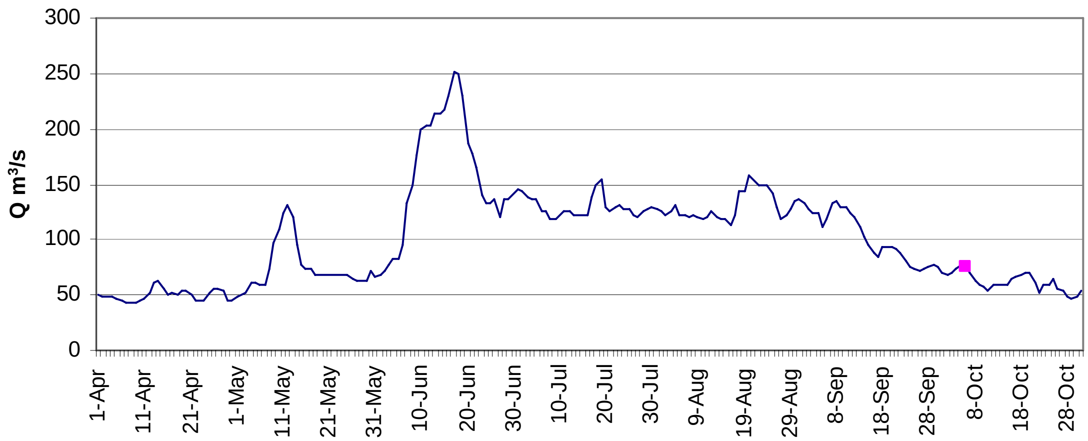

**Confluence 1987**



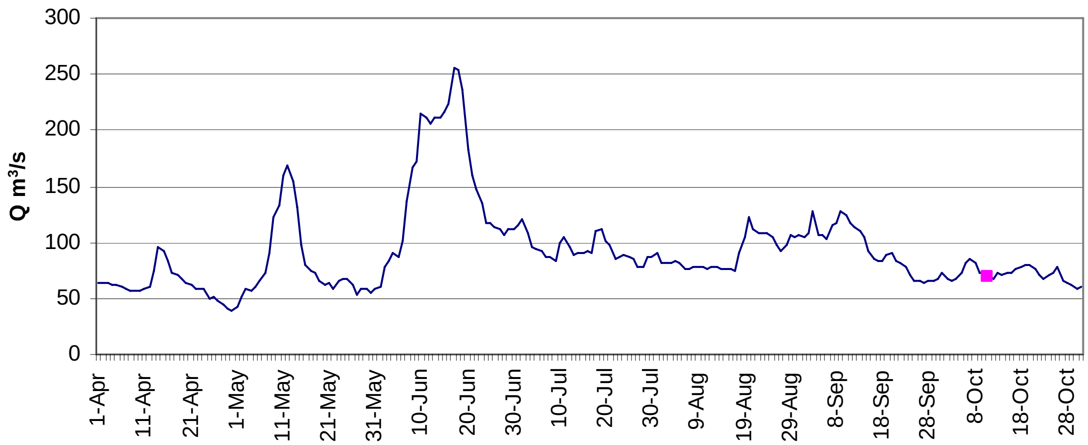

Pink square indicates benthic invertebrate sampling day

## Figure A 9-3 Daily Flows at several locations in the Bow River (con't)

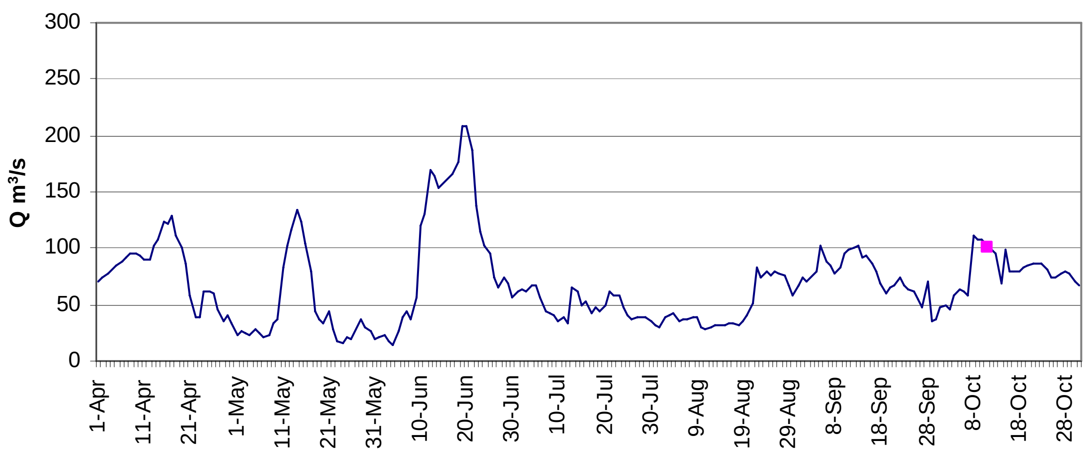
**Below Bearspaw 1989**




**DS Carseland 1989**

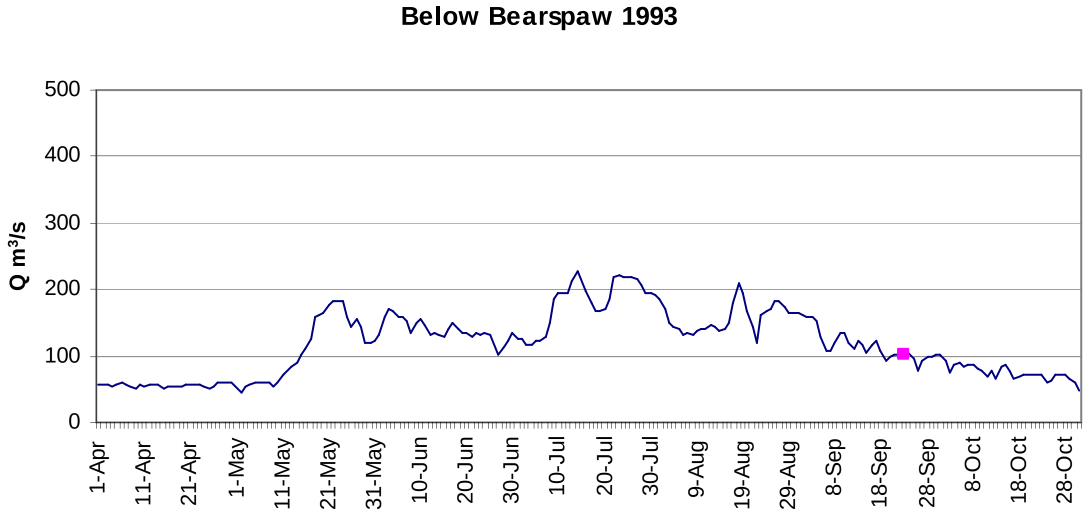


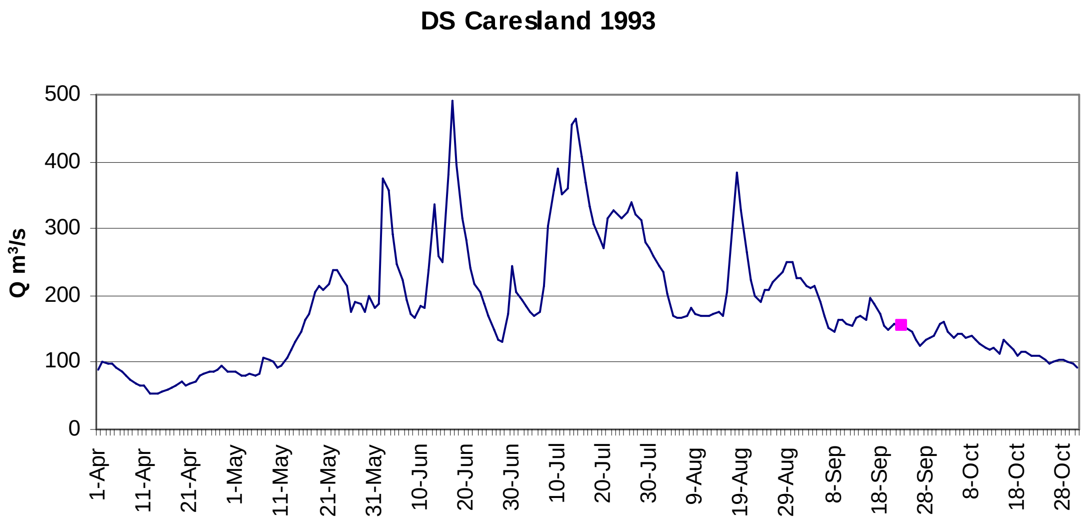

**Confluence 1989**

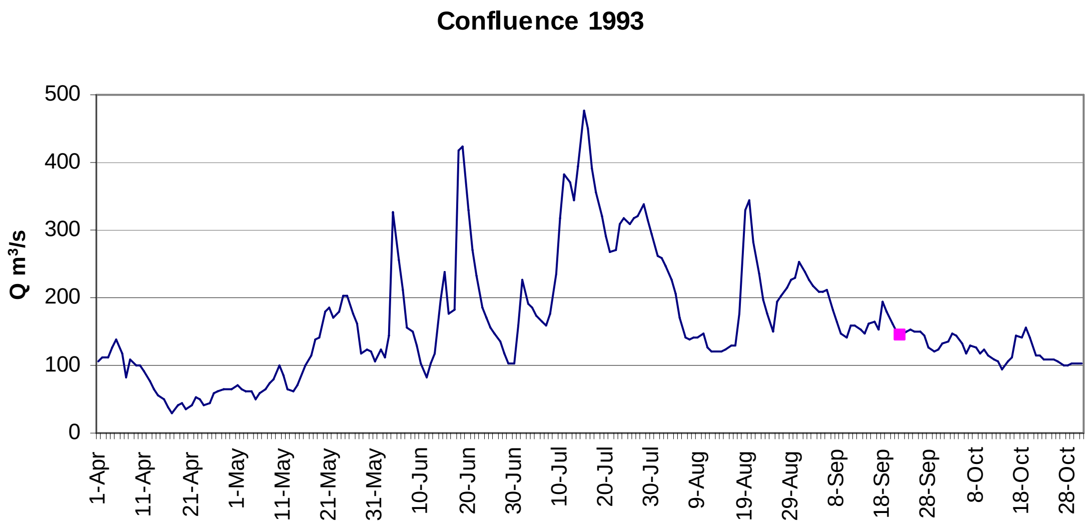



Pink square indicates benthic invertebrate sampling day

**Figure A 9-3 Daily Flows at several locations in the Bow River (con't)**

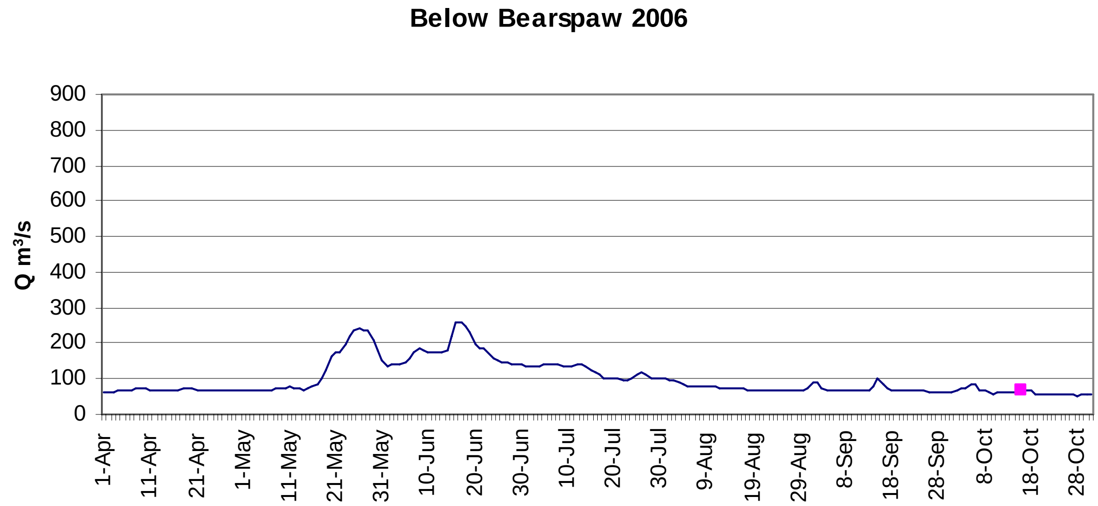


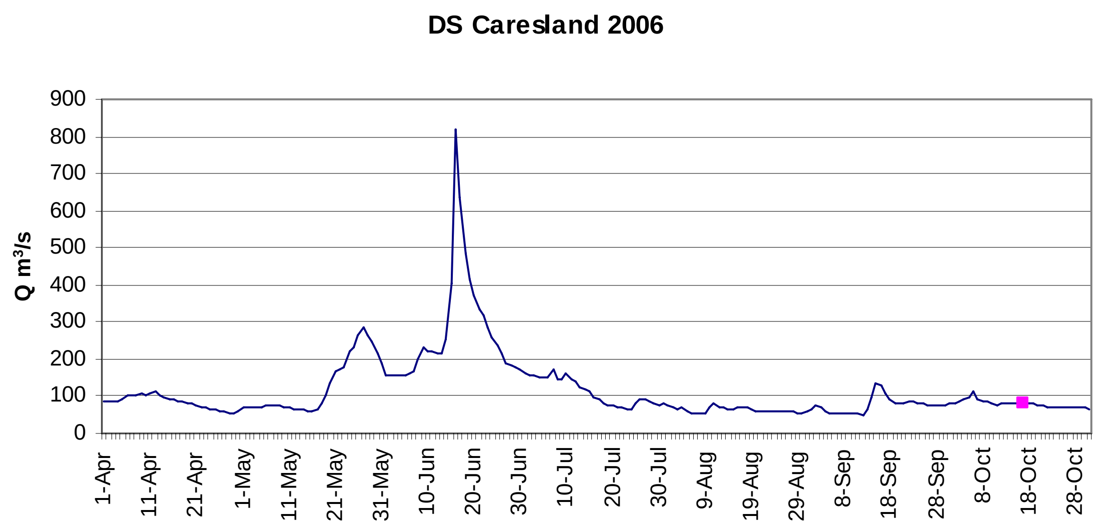



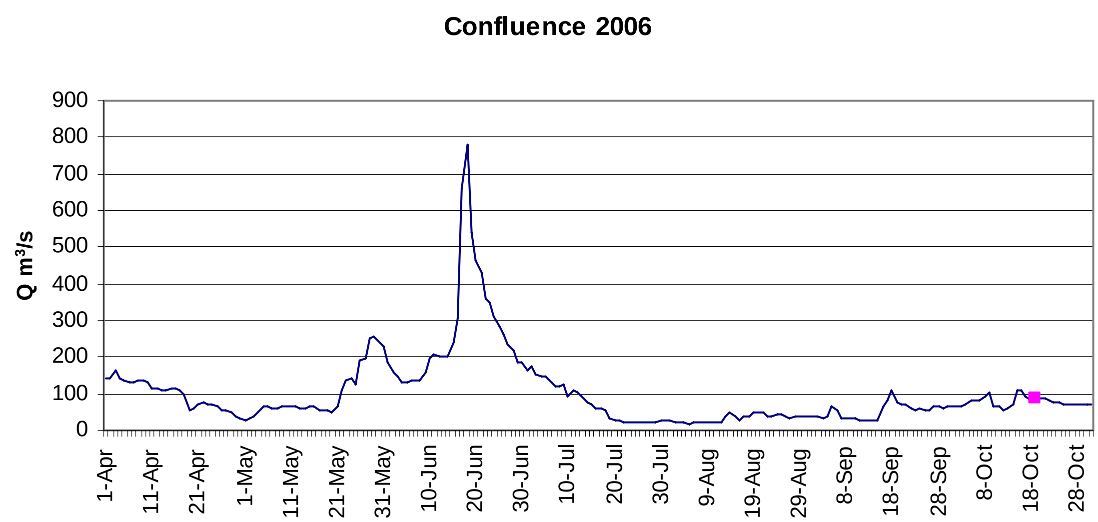




Pink square indicates benthic invertebrate sampling day

**Figure A 9-3 Daily Flows at several locations in the Bow River (con't)**




Pink square indicates benthic invertebrate sampling day

**Figure A 9-3 Daily Flows at several locations in the Bow River (con't)**

## Appendix 10 Comparisons among years: examples of results of Bonferroni test performed on samples collected in 1985, 1993, and 2006

*Example applies to selected metrics from Stier's Ranch*

| **Metric Tested** | **1985** | **1993** | **2006** |
|---|---|---|---|
| Abundance | | | |
| Richness | | | |
| Simpson Diversity Index | | | |
| Shannon Diversity Index | | | |
| No. Predatory Taxa | | | |
| No. Scraper Taxa | | | |
| No. Shredder taxa | | | |
| No. Filter Taxa | | | |
| No. Gatherer Taxa | | | |
| No. Clinger Taxa | | | |
| No. Climbing Taxa | | | |
| No. Burrowing Taxa | | | |
| No. Sprawling Taxa | | | |
| No. Swimming Taxa | | | |
| No. Erosional Taxa | | | |
| No. Lentic Taxa | | | |
| No. Intolerant Taxa | | | |
| Total No. Families | | | |
| No. Ephemeroptera Genera | | | |
| No. Plecoptera Genera | | | |
| No. Trichoptera Genera | | | |

*Full line joins years significantly (p<0.05) different*