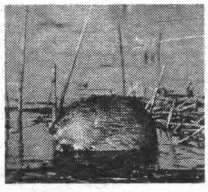
Canada Alberta Northwest Territories

Northern River Basins Study







NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 38

AQUATIC MACROINVERTEBRATE IDENTIFICATIONS

ON UNDER-ICE SAMPLES ATHABASCA RIVER, FEBRUARY AND MARCH, 1993






Date Due

Prepared for the
Northern River Basins Study
under Project 2371-C1

by

R.D. Saunders and Emil Dratnal

NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 38

AQUATIC MACROINVERTEBRATE IDENTIFICATIONS

ON UNDER-ICE SAMPLES ATHABASCA RIVER, FEBRUARY AND MARCH, 1993

Published by the
Northern River Basins Study
Edmonton, Alberta
June, 1994

CANADIAN CATALOGUING IN PUBLICATION DATA

Saunders, R. D.

Aquatic macroinvertebrate identifications on under-ice samples, Athabasca River, February and March, 1993

(Northern River Basins Study project report,
ISSN 1192-3571 ; no. 38)
Includes bibliographical references.
ISBN 0-662-22367-5
Cat. no. R71-49/3-38E

1. Aquatic invertebrates -- Effect of water pollution on -- Testing -- Alberta -- Athabasca River.
2. Organic water pollutants -- Alberta -- Athabasca River.
I. Dratnal, Emil.
II. Northern River Basins Study (Canada)
III. Series.

QH91.57A1S36 1994 592'.0526323'097123 C94-980238-7

PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

NORTHERN RIVER BASINS STUDY
PROJECT REPORT RELEASE FORM

This publication may be cited as:

Saunders, R.D. and Dratnal, Emil. 1994. ***Northern River Basins Study Project Report No. 38, Aquatic Macroinvertebrate Identifications on Under-ice Samples, Athabasca River, February and March, 1993.*** **Northern River Basins Study, Edmonton, Alberta.**

Whereas the above publication is the result of a project conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

F.J. Wrona — 8 June 94

(Dr. F.J. Wrona, Ph.D., Science Director) (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [ ] No

P.A. Larkin — 8 June 94

(Dr. P. A. Larkin, Ph.D., Chair) (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[ ] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

Lucille Partington — June 9, 94

(Lucille Partington, Co-chair) (Date)

_____ _____

(Date)

AQUATIC MACROINVERTEBRATE IDENTIFICATIONS ON UNDER-ICE SAMPLES, ATHABASCA RIVER, FEBRUARY AND MARCH, 1993

STUDY PERSPECTIVE

One of the major objectives of the Northern River Basins Study is to determine the degree to which the aquatic ecosystems of the Peace, Athabasca and Slave Rivers have been affected by developments within the basins. Benthic invertebrates are very sensitive to environmental change and are important components of food webs, therefore they are often used to monitor the state of aquatic environments. The abundance and types of benthic invertebrates present at a site can often indicate the extent to which the aquatic environment has been impacted by pollutants and the type of pollutant affecting the site.

Related Study Questions

1 a) How has the aquatic ecosystem, including fish and/or other aquatic organisms been affected by exposure to organochlorines or other toxic compounds?

2) What is the current state of water quality in the Peace, Athabasca and Slave river basins, including the Peace-Athabasca Delta?

5) Are the substances added to the rivers by natural and man-made discharges likely to cause deterioration of the water quality?

13 a) What are the cumulative effects of man-made discharges on the water and aquatic environment?

14) What long term monitoring programs and predictive models are required to provide an ongoing assessment of the state of the aquatic ecosystems. These programs must ensure that all stakeholders have the opportunity for input.

In February and March 1993, benthic invertebrates were collected under-ice cover from nine sites on the Athabasca River. Under this project, benthic invertebrates from this collection were identified, sorted and counted to determine the abundance and types of benthic invertebrates present at each site. This information will be evaluated and compared with similar information previously collected from sites along the Athabasca River to document changes in benthic invertebrate populations over time and to determine if populations have been impacted by man-made discharges to the river.

REPORT SUMMARY

Benthic invertebrates from ninety samples previously taken from the Athabasca River in February and March 1993 were sorted, identified and counted. The wet weight for each identified taxon was measured, and the incidence of parasitism in immature Chironomidae by mermithid nematodes was recorded. In addition, immature mayflies, stoneflies and caddisflies representative of the fauna that was sampled for tissue contaminant analyses were identified.

TABLE OF CONTENTS

1.0. INTRODUCTION

Ninety benthic invertebrate samples were taken from the Athabasca River in February and March 1993, using a modified Neill cylinder equipped with a collecting net of 210 microns mesh size. Ten replicate samples were taken at each of nine sites located between Entrance (upstream of Hinton) and Fort McMurray. In addition, five subsamples of specimens collected for tissue contaminant analyses were taken from five of the nine sites. The collection work is reported in Dunnigan and Millar (1993) under NRBS Project 2393-B1. Grid references (UTM coordinates) for the nine sites are given in Appendix A.

This report presents the results of the laboratory processing of those collections. Animals were identified, enumerated, and wet weight of each taxon was measured. Chironomid larvae parasitized by mermithid nematodes were also enumerated. The Terms of Reference for this project are contained in Appendix B.

Identification and enumeration of invertebrates followed procedures described in Alberta Environment (1990). All Quality Assurance/Quality Control procedures followed guidelines outlined in Environment Canada (1993).

2.0. METHOD AND RESULTS

2.1. Sorting

Benthic invertebrates were removed from the accompanying debris using a Zeiss dissecting microscope at no less than 10x magnification, and followed an established procedure. Rose Bengal stain was first added to the samples to improve sorting efficiency. Each sample was then poured into two sieves (mesh size: 1000 and 180 microns) and washed thoroughly. The contents of the 1000 micron sieves (coarse fraction) was transferred to a container to which a small amount of water was added. The contents of the 180 micron sieve (fine fraction) was transferred to another container. Warm water was added to the fine fraction, swirled and the water and organic matter decanted. This was repeated until all the organic matter was washed out of the sand. The organic material was transferred to another container. A small amount of the coarse fraction was placed on a grided petri dish, and examined grid by grid. Collected organisms were placed in labelled vials filled with 80% ethanol. Each petri dish was examined twice. The process was repeated until all the coarse fraction was examined. The sand was similarly examined, particularly for gastropods, and for chironomids and caddisflies which use sand grains for protective cases. The fine fraction was similarly examined unless subsampling was required. Subsampling was done according to the method outlined in Wrona et al. (1982), except for station 2. Owing to the large numbers of Orthocladiinae and the resulting difficulty of removing all of the other subfamilies, Chironomidae at station 2 were treated as a single taxon for subsampling purposes only. Five 50 mL subsamples (i.e. 1/4 of the total fine fraction) were examined.

Residue from the sorted samples was preserved in 80% ethanol. One randomly selected sample from each site (10% of total samples) was resorted to ensure a minimum recovery of 95% of the total organisms. The results of recovery efficiency are presented in Appendix C.

The benthic samples were sorted by Emil Dratnal and the residue of the QA/QC samples was resorted by R. D. Saunders.

2.2. Identification and enumeration

Invertebrates were identified using dissecting and compound microscopes. Identifications were performed to the genus level with some exceptions, following Terms of References. Microturbellaria, Nematoda, Collembola and Hydracarina were not identified beyond those taxonomic levels. Oligochaeta and some Diptera (Ceratopogonidae) were identified to family; Chironomidae to subfamily or tribe. In general ecologically important taxonomic groups were identified to genus level, if adequately developed stages were available. The following references were used: Allen and Edmunds (1962, 1976), Baumann (1975), Brinkhurst (1986), Brooks and Kelton (1967), Clarke (1973,1981), Clifford (1991), Currie (1986), Dosdall and Lehmkuhl (1979), Edmunds et al. (1976), Klemm (1985), Larsen (1975), Mackay (1978), McAlpine et al. (1981), McCafferty and Waltz (1990), Merritt and

Cummins (1984), Morihara and McCafferty (1979), Oliver and Roussel (1983), Pennak (1989), Steward and Stark (1988), Thorp and Covich (1991), Wiederholm (1983), Wiggins (1977), Zwick (1989).

A reference collection of identified taxa was completed and this was independently verified by Jack Zloty of the University of Calgary. Mr Zloty has a M.Sc. in entomology and is currently working towards Ph.D. at the University of Calgary. His major specialty is aquatic insects, in particular Ephemeroptera, Odonata and Diptera, and he is an author of major taxonomic revisions.

Appendix D contains the complete list of taxa identified. Numbers of specimens of each identified taxon in replicate Neill samples (0.1 m^2) presented in Appendix E are appropriately weighted for subsampled taxa. Counts of taxa in subsamples are presented in Appendix F.

2.3. Wet weight

The wet weight per sample for each identified taxon was measured using an electronic scale. The organisms were blotted on tissue paper and steady weight was measured with accuracy to 0.1 mg. Wet weight results appropriately weighted for subsampled taxa are presented in Appendix G.

2.4. Incidence parasitism by mermithid nematodes

The number of Chironomidae larvae parasitized by mermithid nematodes was recorded in each sample, using a dissecting microscope at 25x to 40x magnification. Examination was done under incident light and results were checked under transparent light. The results are presented in Appendix H.

2.5. Identification of representative fauna used for tissue contaminant analyses

Mayflies, stoneflies and caddisflies representative of the fauna that was sampled for tissue contaminant analyses were identified from five of the nine Athabasca River sites. The results are presented in Appendix I.

LITERATURE CITED

Alberta Environment. 1990. Selected methods for the monitoring of benthic invertebrates in Alberta rivers. Water Quality Branch, Pollution Division. 41 pp.

Allen, R.K. and G.F. Edmunds, Jr. 1962. A revision of the genus Ephemerella (Ephemeroptera: Ephemerellidae). V. The subgenus Drunella in North America. Misc. Publ. Ent. Soc. Amer. 3: 145-179.

Allen, R.K. and G.F. Edmunds, Jr. 1976. A revision of the genus Ametropus in North America (Ephemeroptera: Ametropodidae). J. Kansas Ent. Soc. 49: 625-635.

Baumann, R.W. 1975. Revision of the Stonefly Family Nemouridae (Plecoptera): a Study of the World Fauna at the Generic Level. Smithson. Contr. Zool. 211: 1-74.

Brinkhurst, R.O. 1986. Guide to the freshwater aquatic microdrile oligochaetes of North America. Can. Spec. Publ. Fish. Aquat. Sci. 84. 259 pp.

Brooks, A.R. and L.A. Kelton. 1967. Aquatic and semi-aquatic Heteroptera of Alberta, Saskatchewan, and Manitoba (Hemiptera). Mem. Ent. Soc. Can. 51. 92 pp.

Clarke, A.H. 1973. The freshwater molluscs of the Canadian interior basin. Malacologia 13: 1-509.

Clarke, A.H. 1981. The Freshwater Molluscs of Canada. National Museum of Natural Sciences. Natural Museums of Canada. Ottawa, Canada. 446 pp.

Clifford, H.F. 1991. Aquatic Invertebrates of Alberta. University of Alberta Press. Edmonton, Alberta. 538 pp.

Currie, D.C. 1986. An annotated list of and keys to the immature black flies of Alberta (Diptera: Simuliidae). Mem. Ent. Soc. Can. 134. 90 pp.

Dosdall, L.M. and D.M. Lehmkuhl. 1979. Stoneflies (Plecoptera) of Saskatchewan. Quaest. Ent. 15: 3-116.

Dunnigan, M. and S. Millar. 1993. Benthos Field Collections, Under-Ice Sampling, Athabasca River, February and March 1993. Northern River Basins Study, Project Report No. 23. R.L.&L. Environmental Services Ltd. Edmonton, Alberta.

Edmunds, J.F. Jr., S.L. Jensen and L. Berner. 1976. The Mayflies of North and Central America. Univ. of Minnesota Press. Minneapolis. 330 pp.

Environment Canada. 1993. Guidelines for monitoring benthos in freshwater environments. EVS Consultants. 81 pp.

Klemm, D.J. (ed.). 1985. A guide to the freshwater Annelida (Polychaeta, Naidid and Tubificid Oligochaeta, and Hirudinea) of North America. Kendall/Hunt Publ. Co. Dubuque, Iowa. 198 pp.

Larsen, D.J. 1975. The predaceous water beetles (Coleoptera: Dytiscidae) of Alberta: systematics, natural history and distribution. Quaest. Ent. 11: 245-498.

Mackay, R.J. 1978. Larval identification and instar association in some species of Hydropsyche and Cheumatopsyche (Trichoptera: Hydropsychidae). Ann. Ent. Soc. Amer. 71: 494-509.

Mc Alpine, J.F., B.V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Fockeroth, and D.M. Wood. (Eds). 1981. Manual of Nearctic Diptera. Vol. 1, Agriculture Canada. Monograph 27. 674 pp.

McCafferty, W.P. and R.D. Waltz. 1990. Revisionary Synopsis of the Baetidae (Ephemeroptera) of North and Middle America. Trans. Amer. Ent. Soc. 116: 769-799.

Merritt, R.W. and K.W. Cummins (Eds). 1984. An Introduction to the Aquatic Insects of North America, 2nd Ed. Kendall/Hunt Publ. Co. Dubuque, Iowa. 722 pp.

Morihara, D.K. and W.P. McCafferty. 1979. The Baetis Larvae of North America (Ephemeroptera: Baetidae). Trans. Amer. Ent. Soc. 105: 139-221.

Oliver, D.R. and M.E. Roussel. 1983. The Insects and Arachnids of Canada, Part 11. The Genera of Larval Midges of Canada. Diptera: Chironomidae. Agriculture Canada Publ. 1746. 263 pp.

Pennak, R.W. 1989. Freshwater Invertebrates of the United States, 3rd Ed. John Wiley and Sons, New York. 628 pp.

Stewart, K.W. and B.P. Stark. 1988. Nymphs of North American Stonefly Genera (Plecoptera). Thomas Say Foundation, Ent. Soc. Am., Vol.XII. 460 pp.

Thorp, J.H. and A.P. Covich (Eds). 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, Inc. San Diego, California. 911 pp.

Wiederholm, T. (Ed.). 1983. Chironomidae of the Holarctic region. Part 1. Larvae. Ent. Scand. Suppl. 19. 457 pp.

Wiggins, G.B. 1977. Larvae of the North American Caddisfly Genera (Trichoptera). University of Toronto Press, Toronto. 401 pp.

Wrona, F.J., J.M. Culp and R.W. Davies. 1982. Macroinvertebrate subsampling: a simplified apparatus and approach. Can. J. Fish. Aquat. Sci. 39: 1051-1054.

Zwick, P. 1989. Notes on Plecoptera (18). Skwala americana (Klapalek, 1912), comb. n., the valid name for Skwala parallela (Frison, 1936). Aquatic Insects 11: 181-182.

APPENDIX A:

UTM coordinates of the collection sites on the Athabasca River

Appendix A

UTM coordinates of the collection sites on the Athabasca River.

Site (sample)	Location	UTM coordinates
1	Near Maskuta Creek (Entrance)	11U 455000E 5914850N
2	Weldwood Haul Br.	11U 463150E 5919658N
3	Obed Mountain Coal Br.	11U 476450E 5930929N
4	Emerson Lakes Road Br.	11U 489010E 5959000N
5 (1- 5)	Blue Ridge	11U 605600E 6002450N
5 (6-10)		11U 606195E 6002500N
6 (1- 5)	D/S Athabasca Town	12U 353956E 6067400N
6 (6-10)		12U 353956E 6068500N
7	U/S Athabasca Town	12U 350900E 6068187N
8	Poacher's Landing	12U 394505E 6093795N
9	U/S Fort McMurray	12V 473500E 6285600N

APPENDIX B:

Terms of reference for Project 2371-C1:
Invertebrate Community analysis (Athabasca River) -
Sample Processing

NORTHERN RIVER BASINS STUDY

Terms of Reference

Project 2371-C1: Invertebrate Community Analysis (Athabasca River) - Sample Processing

I. Introduction

Ninety benthic invertebrate samples were taken from the Athabasca River in February and March 1993 using a modified Neill cylinder equipped with a collecting net (mesh size aperture: 0.210 mm). Ten replicate samples were taken at each of nine sites located between Entrance (upstream of Hinton) and Fort McMurray. In addition, five subsamples of specimens collected for tissue (contaminant) analyses were taken from five of these nine sites.

II. Requirements

The following points outline requirements for the processing of these samples:

1) Unless specified otherwise the identification and enumeration of aquatic invertebrates should follow procedures outlined in Alberta Environment (1990). All Quality Assurance/Quality Control (QA/QC) procedures must be documented at each phase of the sample processing according to Environment Canada (1993). Sorting will be completed by one person; identifications should also involve only one person per major taxonomic grouping. The contractor must provide the names and qualifications of the persons that will sort and identify samples. The person(s) who completed the QA/QC protocols must also be identified.

2) - Sorting must be performed under a dissecting microscope at no less than 6X magnification.
- Particularly abundant taxa may be sub-sampled according to methods outlined in Wrona et al. (1982). A minimum of five, 50 mL sub-samples are required. Sub-sampling is most accurate on screened sample fractions (i.e. that portion of the sample that passes through the sieve). The sample portion that remains on the screen or samples containing a lot of filamentous algae cannot be sub-sampled effectively and should be sorted in their entirety.
- Residue from the sorted samples (i.e., organic and inorganic material) and the unsorted portion of samples which were subsampled must be preserved in 80%

ethanol, labelled appropriately (i.e, on the outside and inside of sample jars) and returned to the Scientific Authority (see below) for this project.

3) - Identifications must be to genus when possible (i.e. for Ephemeroptera, Plecoptera, Trichoptera, Diptera except Chironomidae, and remaining groups). Chironomidae will be identified to sub-family.
- Individual genera of Ephemeroptera, Plecoptera, Trichoptera, Chironomidae identified to sub-family and remaining groups must be stored in separate vials indicating what sample portion they represent. All specimens must be returned to the Scientific Authority.

4) Measure the wet weight per sample for each genera of Ephemeroptera, Plecoptera, Trichoptera, and Diptera; for chironomid sub-families; and of remaining taxa as a group.

5) Record the incidence of parasitism in immature Chironomidae by mermithid nematodes.

6) Identify 20 immature mayflies, stoneflies, or caddisflies taken from additional samples from 5 of the 9 Athabasca River sites (i.e. 5 samples containing up to 60 sorted specimens). These specimens are representative of the fauna that was sampled for tissue contaminant analyses.

III. Reporting Requirements

1) The consultant is to prepare a comprehensive data report that includes the following information:

   a. invertebrate counts for each taxon appropriately weighted for sub-sampling volume;
   b. the portion of the sample sorted and counts of each taxa in each sub-sample;
   c. total wet weight per sample for each taxon, appropriately weighted for sub-sampling volume;
   d. incidence of mermithid parasitism per replicate sample;
   e. identification of representative specimens for tissue contaminant analyses; and
   f. details of QA/QC at all steps of the sample processing.

2) Ten copies of the draft report are to be submitted to the Component Coordinator by October 29th, 1993.

3) Three weeks after the receipt of review comments the consultant is to submit ten cerlox bound copies and two unbound, camera-ready originals of the final report to the Component Coordinator. An electronic copy of the report, in Word Perfect 5.1 format, is to be submitted to the Component Coordinator at the same time as the final report. Data presented in tables, figures appendices, etc. in the final report are also to be submitted in electronic form (dBase IV format or Lotus 1-2-3 compatible spreadsheet preferred) to the Component Coordinator. (The Northern River Basins Study may during the life of the contract specify a data reporting format for electronic data or provide the consultant with software for inputting electronic data). The final report is to contain a table of contents, list of figures, list of tables, acknowledgements, executive summary and an appendix containing the Terms of Reference for this contract. All sampling locations presented in the report and electronic format should be geo-referenced (lat./long. preferred).

IV. Project Administration

This project is being coordinated by the Nutrients Group of the Northern River Basins Study. This group is led by Dr. Patricia Chambers, National Hydrology Research Institute (NHRI), Saskatoon. Dr. Anne-Marie Anderson, Alberta Environmental Protection (phone (403)427-5893; fax (403)422-9714) has been designated as the scientific authority on this project and matters of a technical nature are to be referred to her. Greg Wagner (Office of the Science Director, Northern River Basins Study, 690 Standard Life Centre, 10405 Jasper Avenue, Edmonton, Alberta. T5J 3N4 - phone (403)427-1742; fax (403)422-3055) will act as the Component Coordinator for this project on behalf of the Northern River Basins Study. Matters relating to contract administration should be referred to him.

V. Literature Cited

Alberta Environment. 1990. Selected methods for the monitoring of benthic invertebrates in Alberta rivers. Water Quality Branch , Pollution Control Division. 41 pp.

Environment Canada. 1993. Guidelines for monitoring benthos in freshwater environments. Prepared by EVS Consultants. 81 pp.

Wrona, F.J., J.M. Culp, and R.W. Davies. 1982. Macroinvertebrate subsampling: a simplified apparatus and approach. Can. J. Fish. Aquat. Sci. 39: 1051-1054.

APPENDIX C:

Sorting efficiency

Appendix C

Number of organisms recovered from second sorting and recovery efficiency expressed as percent error of total organisms collected.

	Site - sample								
Taxa	1-10	2-3	3-4	4-10	5-9	6-10	7-3	8-1	9-7
Microturbellaria	1								
Nematoda	2		8	1		2	3	3	
Aeolosomatidae	1								
Naididae					2	2	1	1	1
Tubificidae		1							
Hydracarina	1	2	3	2	3	1			
Baetis	1	2			1	1	3		
Ephemerella		8	9	1	1				
Rhithrogena		1						1	
Chloroperlidae		2							
Isoperla								2	
Cheumatopsyche								1	
Chelifera				1	1				
Hemerodromia				3				2	2
Orthocladiinae	3	16	5	12		3	2	2	
Tanytarsini	2	4		8	1	1	3	1	11
Chironomini						2	1		1
Tanypodinae						1			
Prodiamesinae	1								
Total organisms	12	36	25	28	9	13	13	10	24
Initial sort	339	4659	704	1267	408	657	644	367	781
Percent error	3.4	0.8	3.4	2.2	2.2	1.9	2.0	2.7	3.0

APPENDIX D:

List of taxa collected from nine sites on the Athabasca River
in February and March 1993

Appendix D

List of taxa collected from nine sites on the Athabasca River in February and March 1993.

Phyllum, class or order	Family, subfamily or tribe	Genus, species
Microturbellaria		
Nematoda		
Aphanoneura	Aeolosomatidae	
Oligochaeta	Enchytraeidae	
	Naididae	
	Tubificidae	
	Lumbriculidae	
Gastropoda	Lymnaeidae	*Stagnicola*
	Ancylidae	*Ferrissia*
Hydracarina		
Ostracoda	Candonidae	*Candona*
Collembola		
Ephemeroptera	Ametropodidae	*Ametropus neavei*
	Baetidae	*Acerpenna*
		Baetis
	Ephemerellidae	*Drunella doddsi*
		Ephemerella
	Heptageniidae	*Cinygmula*
		Epeorus (Iron)
		Heptagenia
		Rhithrogena
		Stenonema
	Leptophlebiidae	*Leptophlebia*
	Siphlonuridae	*Ameletus*
	Tricorythidae	*Tricorythodes*

Appendix D

Phyllum, class or order	Family, subfamily or tribe	Genus, species
Odonata	Gomphidae	*Ophiogomphus columbrinus*
Plecoptera	Capniidae	*Capnia*
	Chloroperlidae	*Sweltsa*
	Leuctridae	*Paraleuctra*
	Nemouridae	*Prostoia*
		Shipsa
		Zapada cinctipes
	Perlidae	*Acroneuria*
		Claassenia sabulosa
		Hesproperla pacifica
	Perlodidae	*Cultus*
		Isogenoides
		Isoperla
		Skwala americana
	Pteronarcyidae	*Pteronarcella*
		Pteronarcys
	Taeniopterygidae	*Oemopteryx*
		Taenionema
Trichoptera	Brachycentridae	*Brachycentrus*
	Glossosomatidae	*Glossosoma*
	Hydropsychidae	*Arctopsyche*
		Cheumatopsyche
		Hydropsyche
	Hydroptilidae	*Hydroptila*
	Lepidostomatidae	*Lepidostoma*
	Leptoceridae	*Oecetis*
	Limnephilidae	*Apatania*
	Psychomyiidae	*Psychomyia*
	Rhyacophilidae	*Rhyacophila*
Heteroptera	Corixidae	*Cenocorixa dakotensis*
		Sigara decoratella
		Sigara solensis
Coleoptera	Dytiscidae	*Oreodytes*
	Elmidae	

Appendix D

Phyllum, class or order	Family, subfamily or tribe	Genus, species
Diptera	Athericidae	*Atherix*
	Blephariceridae	*Bibiocephala*
	Ceratopogonidae	
	Chironomidae	
	Chironominae	
	Chironomini	
	Tanytarsini	
	Diamesinae	
	Orthocladiinae	
	Prodiamesinae	
	Tanypodinae	
	Empididae	*Chelifera*
		Hemerodromia
		Wiedemannia
	Simuliidae	*Simulium*
	Tipulidae	*Hexatoma*

APPENDIX E:

Numbers of benthic invertebrates per replicate Neill sample (0.1 m^2) collected from nine sites on the Athabasca River (counts appropriately weighted for subsampled taxa)

Appendix E

Numbers of benthic invertebrates per replicate Neill sample (0.1 sq. m) collected from nine sites on the Athabasca River (counts appropriately weighted for subsampled taxa).

Site 1.

Taxa	Sample Number									
	1	3	4	6	7	8	10	11	12	13
NEMATODA	1	1	2	1		2		1		2
APHANONEURA										
Aeolosomatidae	1									
OLIGOCHAETA										
Enchytraeidae				1		1	2			
Lumbriculidae								5	4	2
HYDRACARINA	3	4	2		1	1	6	3	3	5
EPHEMEROPTERA										
Baetidae										
Baetis	12	47	69	28	16	52	48	37	82	100
Ephemerellidae										
Drunella			1					1	1	5
Ephemerella	1	1	20		5	3			1	26
Heptageniidae										
Rhithrogena		6	9	5	1		2	4	17	24
PLECOPTERA										
Chloroperlidae										
early nymphs	15	34	17	17	5	21	8	6	6	23
Leuctridae										
Paraleuctra									2	
Perlidae										
Claassenia		1			1			1	1	3
Perlodidae										
Isogenoides					1				2	
Taeniopterygidae										
Taenionema		1	4		3	9			3	5
TRICHOPTERA										
Brachycentridae										
Brachycentrus							1	6		1
Glossosomatidae										
Glossosoma								1		

Appendix E

Site 1, ctd.

Taxa	Sample Number 1	3	4	6	7	8	10	11	12	13
Hydropsychidae										
Hydropsyche	4	1	3		1	2	2		1	3
DIPTERA										
Athericidae										
Atherix									1	
Chironomidae										
Chironominae										
Chironomini	3	1			2	2	8		1	10
Tanytarsini	96	78	45	11	72	76	168	14	11	93
Diamesinae	1									
Orthocladiinae	64	60	57	9	97	60	79	37	35	105
Prodiamesinae	5	3			2	2	6	3	3	7
Tanypodinae	1				1		1			
Empididae										
Chelifera	1	2	1		3	3	6			1
Hemerodromia			1			1	1			
Wiedemannia						2	1			
Total organisms	208	240	236	71	209	235	339	119	174	415
Total taxa	14	14	13	7	15	15	15	13	17	17

Appendix E

Site 2.

Taxa	Sample Number									
	1	2	3	4	5	6	7	9	11	13
MICROTURBELLARIA							2			
NEMATODA	68	60	40	89	96	72	243	83	85	134
APHANONEURA										
Aeolosomatidae	1			1				2	2	42
OLIGOCHAETA										
Enchytraeidae	30	28	12	19	21	17	74	31	21	58
Naididae	3	5	1	5		1	2			33
Tubificidae	32	49	39	57	12	30	28	53	6	7
HYDRACARINA	20	30	10	23	14	19	22	19	92	113
OSTRACODA										
Candonidae										
Candona									1	1
EPHEMEROPTERA										
Baetidae										
Baetis	1195	1226	1211	2664	1027	857	967	1181	136	114
Ephemerellidae										
Drunella	5	1	4	4	4	3	2		1	
Ephemerella	106	159	56	197	159	155	195	187	312	569
Heptageniidae										
Cinygmula							1			
Heptagenia							1			
Rhithrogena	10	9	19	16	19	15	28	18	20	4
Siphlonuridae										
Ameletus		1				2	2			1
PLECOPTERA										
Capniidae										
Capnia			1	2	2		2	1	2	4
Chloroperlidae										
Sweltsa							1			
early nymphs		5	14	11	21	12	27	48	2	
Nemouridae										
Prostoia	1						1	1	1	

Appendix E

Site 2, ctd.

Taxa	Sample Number 1	2	3	4	5	6	7	9	11	13
Perlidae										
Claassenia	3	6	5	7	8	11	12	9	5	
Hesperoperla	1									
Perlodidae										
Isogenoides	2	6	3	19	8	8	9	2	1	
Isoperla	1	4	6	13	4	1	2	4	1	
Taeniopterygidae										
Taeniopteryx	5	7	6	11		2	1	4	1	
TRICHOPTERA										
Brachycentridae										
Brachycentrus	1							1	2	1
Glossosomatidae										
Glossosoma			1	2			1		1	1
Hydropsychidae										
Arctopsyche	1			1						
Cheumatopsyche					1					
Hydropsyche	20	24	21	45	17	7	22	23	3	12
DIPTERA										
Athericidae										
Atherix							1		3	3
Blepharoceridae										
Bibiocephala		1	1							
Chironomidae										
Chironominae										
Chironomini	4	8		12	8	4	5	20	14	47
Tanytarsini	20	40	22	20	32	36	140	159	49	99
Diamesinae	2		5	1		1	3	3		3
Orthocladiinae	4119	3916	3180	6978	3597	2394	3729	3875	2066	3359
Prodiamesinae	12			4			1	2	17	22
Tanypodinae	5	2		21	4	1	7	7	5	20
Empididae										
Chelifera	3		2	4	1	1	3	4	14	19
Hemerodromia		1		1	1		1	1	7	10
Wiedemannia									2	7
Tipulidae										
Hexatoma	1				1		1	4	5	7
Total organisms	5671	5588	4659	1022	5057	3649	5536	5742	2877	4690
Total taxa	27	22	22	27	22	22	33	26	30	26

Appendix E

Site 3.

Taxa	Sample Number									
	4	5	6	7	8	9	10	11	12	13
MICROTURBELLARIA				1		1				
NEMATODA	68	84	48	81	115	79	122	51	220	112
APHANONEURA										
Aeolosomatidae						1				
OLIGOCHAETA										
Enchytraeidae	23	73	82	39	69	60	67	35	89	38
Naididae		1			1			1	1	1
Tubificidae	1				2	1	1	1	1	1
HYDRACARINA	9	11	9	12	14	14	13	5	18	14
EPHEMEROPTERA										
Baetidae										
Baetis		1			4	3	1			
Ephemerellidae										
Drunella			1							
Ephemerella	41	50	76	108	222	150	195	133	187	186
Heptageniidae										
Rhithrogena	3		5	3	3	12	4	6	1	4
Siphlonuridae										
Ameletus					1	1				
PLECOPTERA										
Capniidae										
Capnia										1
Chloroperlidae										
early nymphs	1				1		5			
Perlidae										
Claassenia	1				3	6	4	1		2
Hesperoperla							1			1
Perlodidae										
Cultus			1							
Isogenoides	1	2			3	4	3		1	
Isoperla					1					
TRICHOPTERA										
Brachycentridae										
Brachycentrus	11	4	1		7	2	3	3	1	

Appendix E

Site 3, ctd.

Taxa	Sample Number									
	4	5	6	7	8	9	10	11	12	13
Hydropsychidae										
Arctopsyche										1
Hydropsyche	33	10	29	10	92	14	36	25	16	33
DIPTERA										
Athericidae										
Atherix	1									
Chironomidae										
Chironominae										
Chironomini	5	5	7	4	10	11	6	8	22	8
Tanytarsini	59	48	44	73	75	41	40	43	90	29
Orthocladiinae	435	187	386	713	541	613	432	375	591	438
Prodiamesinae	1	6	4		8	6	5	3	3	4
Tanypodinae	7	5	11	9	12	11	11	7	6	10
Empididae										
Chelifera	3	15	10	16	19	18	15	15	10	6
Hemerodromia	1		1	1			2		1	5
Tipulidae										
Hexatoma				1			1		1	
Total organisms	704	502	715	1071	1203	1048	967	712	1259	894
Total taxa	19	15	16	14	21	20	21	16	18	19

Appendix E

Site 4.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA		1		3			2		1	4
NEMATODA	98	56	98	63	41	77	197	48	59	67
APHANONEURA										
Aeolosomatidae			2	1		2	5		2	1
OLIGOCHAETA										
Enchytraeidae	49	75	66	31	33	83	93	35	24	29
Naididae	44	145	115	82	131	72	89	162	63	80
Tubificidae	2	9	8	5	8	10	17	4	3	2
GASTROPODA										
Lymnaeidae										
Stagnicola	1		2							
HYDRACARINA	81	30	34	22	43	15	12	123	65	137
OSTRACODA										
Candonidae										
Candona					2			2		
COLLEMBOLA			1					1		
EPHEMEROPTERA										
Ametropodidae										
Ametropus										1
Baetidae										
Baetis	18	39	42	17	20	28	23	25	27	17
Ephemerellidae										
Drunella		1	4			1	1	2	4	3
Ephemerella	324	260	280	181	122	145	74	244	127	230
Heptageniidae										
Cinygmula								1		
Epeorus (Iron)		4		4			1	2	2	1
Heptagenia						1	1			
Rhithrogena	162	267	342	141	123	124	78	63	100	79
Siphlonuridae										
Ameletus	6	2		1		1	4	2		

Appendix E

Site 4, ctd.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
PLECOPTERA										
Capniidae										
Capnia	21	19	24	4	9	4	3	1		3
Chloroperlidae										
Sweltsa	1	1	3					1		
early nymphs	54	75	25	22	21	12	29	10	14	24
Nemouridae										
Prostoia	1	1	1							
Zapada			1							
Perlidae										
Claassenia	16	8	15	9	5	4	7	6	6	13
Hesperoperla			2		1	3	4		2	2
Perlodidae										
Cultus	1	1			1	3	2	6	3	4
Isogenoides	9	8	3	2	5	1	2	2	5	
Isoperla	13	21	21	11	11	12	8	5	6	4
Pteronarcyidae										
Pteronarcella	1								1	
Taeniopterygidae										
Taenionema	2	5	7	8	4	3	3	5	5	3
TRICHOPTERA										
Brachycentridae										
Brachycentrus	1		4	1		1		8	4	3
Glossosomatidae										
Glossosoma	1				1		1			2
Hydropsychidae										
Arctopsyche			1	2	2			2		1
Hydropsyche	102	57	118	99	143	101	75	54	50	29
Lepidostomatidae										
Lepidostoma	2							1		1
Leptoceridae										
Oecetis	4				1					1
Limnephilidae										
Apatania				1						
Rhyacophilidae										
Rhyacophila						1				
COLEOPTERA										
Elmidae								1	1	

Appendix E

Site 4, ctd.

Taxa	Sample Number 1	2	3	4	5	6	7	8	9	10
DIPTERA										
Athericidae										
Atherix	1	6	3		1	1		1	2	2
Ceratopogonidae	1									
Chironomidae										
Chironominae										
Chironomini	10	12	19	14	8	16	18	9	6	7
Tanytarsini	268	187	150	110	243	141	139	136	75	146
Diamesinae	1		1					2	4	
Orthocladiinae	511	382	347	276	421	348	388	209	184	180
Prodiamesinae			1			1		1		
Tanypodinae	68	61	68	29	22	24	36	75	36	77
Empididae										
Chelifera	40	49	54	24	17	13	20	44	21	63
Hemerodromia	18	22	15	8	9	3	1	35	21	50
Wiedemannia	1									
Tipulidae										
Antocha	1									
Hexatoma		1								1
Total organisms	1934	1805	1877	1171	1448	1251	1333	1328	923	1267
Total taxa	36	30	34	28	28	31	30	36	31	34

Appendix E

Site 5.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA				1						
NEMATODA	4	7	7	7	8	6	5	16	6	8
APHANONEURA										
Aeolosomatidae	1	2	1	4	4				1	
OLIGOCHAETA										
Enchytraeidae	35	47	85	82	54	38	34	26	18	18
Naididae	12	31	37	27	28	48	108	17	84	31
Tubificidae	2	1				2	2	2	1	4
HYDRACARINA	36	22	26	22	24	23	58	14	12	7
EPHEMEROPTERA										
Ametropodidae										
Ametropus		1								
Baetidae										
Baetis	10	10	17	16	3	49	18	25	37	26
Ephemerellidae										
Ephemerella	109	104	134	110	117	24	14	7	15	7
Heptageniidae										
Heptagenia	1				2					
Rhithrogena	57	23	46	29	36	111	63	47	38	55
PLECOPTERA										
Chloroperlidae										
early nymphs	2	13	9	3	6				1	
Perlidae										
Claassenia	2	3	1	1	4	2		1	2	
Perlodidae										
Cultus	2	1		5	1	2				
Isogenoides	5	3	8	3	4	13	7	2	1	2
Isoperla	1	2	2	2	1	4	2	1	6	
Pteronarcyidae										
Pteronarcys						1		1		
Taeniopterygidae										
Taenionema	2			2	1	8	9	2	9	5

Appendix E

Site 5, ctd.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
TRICHOPTERA										
Brachycentridae										
Brachycentrus	36	32	50	30	27	88	31	12	11	39
Glossosomatidae										
Glossosoma									3	
Hydropsychidae										
Arctopsyche	1		1			4			1	
Hydropsyche	24	23	33	31	33	14	24	2	18	4
Lepidostomatidae										
Lepidostoma	1	2								
Leptoceridae										
Oecetis		1	1	1		1			1	
Limnephilidae										
Apatania								3	2	
DIPTERA										
Ceratopogonidae					1					
Chironomidae										
Chironominae										
Chironomini	27	35	42	33	28	1	2		3	
Tanytarsini	1141	1412	1408	1431	2019	108	78	36	71	25
Diamesinae						1				
Orthocladiinae	435	512	579	466	629	103	89	38	55	31
Prodiamesinae	3	2	1	2	1					
Tanypodinae	26	35	46	50	40	2	10	3	3	1
Empididae										
Chelifera	13	17	11	13	15	5	6	4	5	3
Hemerodromia	17	24	24	14	9	10	6	3	4	2
Tipulidae										
Hexatoma			1			1				
Total organisms	2005	2365	2570	2385	3095	669	566	262	408	268
Total taxa	27	26	24	25	25	26	19	21	26	17

Appendix E

Site 6.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA	64	70	11	68	74	18	12	20	17	14
NEMATODA	351	137	251	379	227	62	160	96	88	85
APHANONEURA										
Aeolosomatidae									1	
OLIGOCHAETA										
Enchytraeidae	19			4	31	5	1	1	3	4
Naididae	450	489	239	494	445	109	92	162	171	147
Tubificidae	4				1					
GASTROPODA										
Ancylidae										
Ferrissia						2		1		1
HYDRACARINA	24	48	65	43	85	19	11	17	12	12
OSTRACODA										
Candonidae										
Candona						1				
EPHEMEROPTERA										
Baetidae										
Acerpenna	2	1	2	7	6		2	4	1	6
Baetis	160	180	218	371	490	29	35	18	20	20
Ephemerellidae										
Ephemerella	13	18	5	14	36	7	8	7	5	9
Heptageniidae										
Heptagenia	21	17	11	40	12	15	13	11	10	21
Rhithrogena	27	29	22	45	23	26	40	19	24	21
Stenonema					1					
Leptophlebiidae										
Leptophlebia										1
Tricorythidae										
Tricorythodes						1				
ODONATA										
Gomphidae										
Ophiogomphus		1			1					1

Appendix E

Site 6, ctd.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
PLECOPTERA										
Chloroperlidae										
early nymphs			1	1			1		1	
Nemouridae										
Shipsa	2	1	1	3	7	10	15	10	7	10
Perlidae										
Acroneuria		1		1	1					
Perlodidae										
Cultus		1			2		2	2		
Isogenoides				2		1				
Isoperla	5	7	5	7	8	10	6	7	10	4
Taeniopterygidae										
Oemopteryx						1	2	1	1	
Taenionema	4	8	1	9	8	1	5	5	2	1
TRICHOPTERA										
Brachycentridae										
Brachycentrus	1		1		1					
Glossosomatidae										
Glossosoma						1			1	
Hydropsychidae										
Cheumatopsyche	35	40	9	46	149	45	27	50	40	50
Hydropsyche	8	13	12	11	31	14	8	7	3	11
Hydroptilidae										
Hydroptila	36	47	28	45	59	8	18	14	7	16
Lepidostomatidae										
Lepidostoma				1						1
Leptoceridae										
Oecetis	5	19	33	18	40	32	12	16	4	5
HETEROPTERA										
Corixidae										
Cenocorixa									1	
Sigara						1				
COLEOPTERA										
Dytiscidae										
Oreodytes	2							1	1	
Elmidae		1		1						
DIPTERA										
Ceratopogonidae									1	

Appendix E

Site 6, ctd.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
Chironomidae										
Chironominae										
Chironomini	136	110	65	111	161	43	47	34	33	27
Tanytarsini	66	121	63	84	197	45	71	55	61	63
Diamesinae	9	25	19	14	25		4		3	1
Orthocladiinae	263	331	383	439	603	115	163	87	98	109
Tanypodinae	26	36	28	32	99	4	18	19	10	7
Empididae										
Hemerodromia	19	20	6	20	45	10	7	14	10	9
Simuliidae										
Simulium	1	1	1	1	2		1			1
Total organisms	1753	1772	1480	2311	2870	635	781	678	646	657
Total taxa	27	27	25	29	30	28	27	26	30	28

Appendix E

Site 7.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA	19	29	16	31	31		7	18	11	33
NEMATODA	146	147	88	75	79	89	12	183	47	76
OLIGOCHAETA										
Enchytraeidae	8	10	7	9	5	1	10	14	5	6
Naididae	116	46	64	72	56	53	37	116	87	106
GASTROPODA										
Ancylidae										
Ferrissia			1			1				
HYDRACARINA	6	4	1	3	4	9	8	8	7	18
EPHEMEROPTERA										
Baetidae										
Acerpenna	1			1	1		2			
Baetis	199	204	138	172	136	186	167	213	207	105
Ephemerellidae										
Ephemerella	12	5	11	5	8	21	18	15	15	7
Heptageniidae										
Heptagenia	1	2			3	8	8	4	2	3
Rhithrogena	14	21	24	3	15	20	53	17	24	40
ODONATA										
Gomphidae										
Ophiogomphus		1								
PLECOPTERA										
Chloroperlidae										
early nymphs	1		1							1
Nemouridae										
Shipsa			2			1	2	2		
Perlidae										
Acroneuria						1				
Perlodidae										
Cultus					1			1		1
Isogenoides	2	4	1	1	1	1	4	6		2
Isoperla	3	9	3	4	5	2	9	10	5	5

Appendix E

Site 7, ctd.

Taxa	Sample Number 1	2	3	4	5	6	7	8	9	10
Taeniopterygidae										
Taenionema	6	4	5	8	3	2	6	3	1	1
TRICHOPTERA										
Brachycentridae										
Brachycentrus					1		1			1
Glossosomatidae										
Glossosoma	3	1	2	1	1				2	1
Hydropsychidae										
Cheumatopsyche	57	41	42	48	51	92	67	65	52	72
Hydropsyche	9	8	4	1	4	15	5	4	7	12
Hydroptilidae										
Hydroptila	2	1		5	3	1		2	2	1
Leptoceridae										
Oecetis	1	3	3		7	12	5	6	3	4
Psychomyiidae										
Psychomyia								1		
DIPTERA										
Chironomidae										
Chironominae										
Chironomini	30	34	13	25	20	25	24	21	40	30
Tanytarsini	71	34	46	48	51	201	103	164	170	182
Diamesinae	8	4	3	6	6	12	1	11	16	8
Orthocladiinae	231	121	152	124	237	332	129	259	403	287
Tanypodinae	18	7	10	4	4	12	4	15	2	2
Empididae										
Hemerodromia	14	6	6	5	6	15	6	8	7	12
Simuliidae										
Simulium			1			1	1	3	1	
Total organisms	978	746	644	651	739	1113	689	1169	1116	1016
Total taxa	25	24	25	22	26	25	25	26	23	26

Appendix E

Site 8.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA	1	1		1	2			1		
NEMATODA	4	10	9	15	9	12	23	11	9	24
APHANONEURA										
Aeolosomatidae	5	2		2	1					
OLIGOCHAETA										
Enchytraeidae	14	8	14	5	1	2	1	3	3	1
Naididae	34	11	10	7	15	12	63	40	33	24
HYDRACARINA		1		5	3	1	1			2
EPHEMEROPTERA										
Baetidae										
Acerpenna				1						
Baetis	20	20	13	16	20	2	21	17	10	7
Ephemerellidae										
Ephemerella	5	7	9	7	5		5	9	9	4
Heptageniidae										
Heptagenia	2	1								1
Rhithrogena	21	8	43	71	42	2	2	4	5	3
ODONATA										
Gomphidae										
Ophiogomphus					1					
PLECOPTERA										
Chloroperlidae										
early nymphs		1	3							
Nemouridae										
Shipsa			3	2	2		4	3	2	6
Perlodidae										
Isogenoides	1		4	2	1					
Isoperla	15	11	30	26	22	2	15	4	13	5
Pteronarcyidae										
Pteronarcys		1								
Taeniopterygidae										
Taenionema	2	1	2	4	2		2		3	

Appendix E

Site 8, ctd.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
TRICHOPTERA										
Brachycentridae										
Brachycentrus			2	1				1		
Hydropsychidae										
Cheumatopsyche	142	114	100	89	96	31	148	146	98	61
Hydropsyche	2	7	3	7	6		2	6		1
Hydroptilidae										
Hydroptila									1	
Leptoceridae										
Oecetis		1	5		1	1	2	7		
HETEROPTERA										
Corixidae										
Sigara					1					
DIPTERA										
Chironomidae										
Chironominae										
Chironomini	16	17	14	18	36	11	22	7	17	25
Tanytarsini	7	14	10	6	7	11	29	17	14	27
Diamesinae	1	3	1	2	1	1	9	6	2	4
Orthocladiinae	44	104	69	26	36	85	200	172	124	164
Tanypodinae	16	9	14	9	11	4	52	20	26	11
Empididae										
Hemerodromia	15	16	18	9	12	5	16	13	14	19
Simuliidae										
Simulium			2	2	1					1
Total organisms	367	368	378	333	334	182	617	487	383	390
Total taxa	20	23	22	24	25	15	19	19	17	19

Appendix E

Site 9.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
NEMATODA	6	3	11	5	5	16	1	9	3	3
OLIGOCHAETA										
Enchytraeidae	3			2	1	1	3			
Naididae	1	1		2	1		2		5	3
Tubificidae		1			1					
HYDRACARINA	1		8	14	6	33	25	8	9	15
EPHEMEROPTERA										
Baetidae										
Baetis	44	62	99	104	41	50	51	51	39	34
Ephemerellidae										
Ephemerella	11	19	20	19	8	7	15	13	5	19
Heptageniidae										
Heptagenia	5		2	9	9	1	15	5	6	20
Rhithrogena	21	44	28	34	31	52	80	78	47	142
ODONATA										
Gomphidae										
Ophiogomphus						1				
PLECOPTERA										
Chloroperlidae										
early nymphs	2		1			1	1		3	2
Perlidae										
Claassenia			1	1			1			5
Perlodidae										
Isogenoides	5		3	5		4	6	1	2	11
Isoperla	11	14	11	18	14	10	13	15	7	33
Pteronarcyidae										
Pteronarcys										1
Taeniopterygidae										
Taenionema										1
TRICHOPTERA										
Glossosomatidae										
Glossosoma						1	2		2	
Hydropsychidae										
Cheumatopsyche		7					3	1	1	7
Hydropsyche	12	52	15	12	13	24	44	17	22	80

Appendix E

Site 9, ctd.

Taxa	Sample Number									
	1	2	3	4	5	6	7	8	9	10
Hydroptilidae										
Hydroptila						2				
Leptoceridae										
Oecetis					1	1				
Psychomyiidae										
Psychomyia	9	10	6	15	3	15	4	3	5	2
DIPTERA										
Ceratopogonidae							1		1	
Chironomidae										
Chironominae										
Chironomini	22	11	12	5	4	10	15	14	11	6
Tanytarsini	93	64	143	121	112	196	88	114	115	103
Diamesinae			1					1		1
Orthocladiinae	133	202	399	389	128	661	393	232	209	266
Tanypodinae	5	10	4	7	3	9	7	14	4	26
Empididae										
Hemerodromia	15	12	25	8	6	9	11	11	11	19
Total organisms	399	512	789	770	387	1104	781	587	507	799
Total taxa	18	15	18	18	18	21	22	17	20	22

APPENDIX F:

Counts of taxa in five 1/20 (50 mL) subsamples
(1/4 of the total fine fraction)

Appendix F

Counts of taxa in five 1/20 (50 mL) subsamples (1/4 of the total fine fraction).

Site 2 sample 1

	Subsample					
Taxa	1	2	3	4	5	Total
Baetis	46	66	58	59	64	293
Chironomini		1				1
Tanytarsini	1	1	2		1	5
Orthocladiinae	196	198	199	186	224	1003
Prodiamesinae	1				2	3
Tanypodinae	3				2	5

Site 2 sample 2

	Subsample					
Taxa	1	2	3	4	5	Total
Baetis	72	56	67	56	51	302
Chironomini		1		1		2
Tanytarsini	1	2		4	3	10
Orthocladiinae	182	214	193	183	173	945

Site 2 sample 3

	Subsample					
Taxa	1	2	3	4	5	Total
Baetis	60	71	45	42	56	274
Tanytarsini	1	1				2
Orthocladiinae	138	135	114	169	131	687

Appendix F

Site 2 sample 4

	Subsample					
Taxa	1	2	3	4	5	Total
Baetis	123	126	124	127	134	634
Chironomini			1		2	3
Tanytarsini	1		2		2	5
Orthocladiinae	296	333	339	330	358	1656
Prodiamesinae		1				1
Tanypodinae		1	2	1		4

Site 2 sample 13

	Subsample					
Taxa	1	2	3	4	5	Total
Ephemerella	17	25	31	21	22	116
Chironomini	3	5	6	3	4	21
Tanytarsini	2	7	2	6	7	24
Orthocladiinae	173	138	188	148	162	809
Prodiamesinae	1		1	2		4
Tanypodinae	1	2	1	1		5

Site 5 sample 2

	Subsample					
Taxa	1	2	3	4	5	Total
Tanytarsini	47	45	52	44	43	231
Orthocladiinae	26	23	16	14	22	101

Appendix F

Site 5 sample 3

	Subsample					
Taxa	1	2	3	4	5	Total
Tanytarsini	39	53	45	32	33	202
Orthocladiinae	19	19	26	15	30	109

Site 5 sample 4

	Subsample					
Taxa	1	2	3	4	5	Total
Tanytarsini	61	51	49	63	59	283
Orthocladiinae	17	21	20	19	26	103

Site 5 sample 5

	Subsample					
Taxa	1	2	3	4	5	Total
Tanytarsini	86	59	61	65	64	334
Orthocladiinae	31	32	22	22	27	134

APPENDIX G:

Wet weights (mg) of benthic invertebrates per replicate Neill sample (0.1 m^2) collected from nine sites on the Athabasca River (weights appropriately weighted for subsampled taxa)

Appendix G

Wet weights (mg) of benthic invertebrates per replicate Neill sample (0.1 sq. m) collected from nine sites on the Athabasca River (weights appropriately weighted for subsampled taxa).

Site 1. *<0.1 mg.

Taxa	Sample number									
	1	3	4	6	7	8	10	11	12	13
NEMATODA	*	*	*	0.1		*		*		*
APHANONEURA										
Aeolosomatidae	*									
OLIGOCHAETA										
Enchytraeidae				*		*	*			
Lumbriculidae								2.7	2.1	0.7
HYDRACARINA	*	0.4	*		*	*	0.1	0.1	0.2	0.1
EPHEMEROPTERA										
Baetidae										
Baetis	0.2	1.6	3.2	1.3	0.3	4.4	1.9	1.1	6.2	2.8
Ephemerellidae										
Drunella			13.9					8.1	11.5	54.0
Ephemerella	*	*	0.6		*	*			0.2	*
Heptageniidae										
Rhithrogena		11.7	13.5	0.5	*		0.1	1.6	4.7	24.5
PLECOPTERA										
Chloroperlidae										
early nymphs	0.9	2.1	2.7	0.9	0.1	1.9	0.3	0.4	0.1	2.1
Leuctridae										
Paraleuctra									0.4	
Perlidae										
Claassenia		*			*			0.1	0.1	*

Appendix G

Site 1, ctd.

Taxa	Sample number									
	1	3	4	6	7	8	10	11	12	13
Perlodidae										
Isogenoides					35.7				31.3	
Taeniopterygidae										
Taenionema		1.2	7.8		4.8	22.6			4.6	13.4
TRICHOPTERA										
Brachycentridae										
Brachycentrus							3.6	43.5		3.6
Glossosomatidae										
Glossosoma								1.6		
Hydropsychidae										
Hydropsyche	2.6	9.1	1.3		0.2	2.3	3.2		0.1	1.2
DIPTERA										
Athericidae										
Atherix									*	
Chironomidae										
Chironominae										
Chironomini	*	*			*	0.1	0.1		*	0.1
Tanytarsini	0.4	0.2	*	*	*	0.2	0.2	*	*	0.1
Diamesinae	*									
Orthocladiinae	3.0	2.2	2.3	0.1	1.3	1.8	3.5	1.9	0.1	2.6
Prodiamesinae	*	*			*	*	0.1	0.1	*	*
Tanypodinae	*				*		*			
Empididae										
Chelifera	*	*	*		0.1	*	0.1			*
Hemerodromia			*			*	*			
Wiedemannia						0.1	*			

Appendix G

Site 2. *<0.1 mg.

Taxa	Sample number									
	1	2	3	4	5	6	7	9	11	13
MICROTURBELLARIA							*			
NEMATODA	0.9	0.3	1.1	1.3	1.7	0.5	1.7	0.4	2.6	2.5
APHANONEURA										
Aeolosomatidae	*			*				*	*	0.1
OLIGOCHAETA										
Enchytraeidae	0.1	*	*	0.1	0.1	0.1	0.4	0.7	0.1	0.2
Naididae	*	*	*	*		*	*			*
Tubificidae	0.1	0.3	0.2	0.5	*	0.7	0.7	1.0	*	0.1
HYDRACARINA	0.6	1.5	0.4	1.2	1.3	4.3	4.3	2.0	12.6	14.0
OSTRACODA										
Candonidae										
Candona									*	*
EPHEMEROPTERA										
Baetidae										
Baetis	63.9	71.8	84.5	198.9	60.7	88.8	747.6	97.5	22.3	9.6
Ephemerellidae										
Drunella	134.9	26.1	107.5	88.4	115.0	77.4	44.4		11.9	
Ephemerella	16.2	53.9	8.3	26.2	18.6	17.2	19.7	27.1	74.1	180.5
Heptageniidae										
Cinygmula							0.7			
Heptagenia							2.6			
Rhithrogena	49.9	22.6	62.3	12.7	47.0	25.5	81.4	32.4	53.0	16.6

Appendix G

Site 2, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	9	11	13
Siphlonuridae										
Ameletus		*				28.2	38.7			20.7
PLECOPTERA										
Capniidae										
Capnia			*	0.1	0.1		*	0.8	0.9	8.7
Chloroperlidae										
Sweltsa							2.8			
early nymphs		0.4	1.2	0.6	1.5	0.8	1.3	4.4	2.7	
Nemouridae										
Prostoia	*						*	0.1	*	
Perlidae										
Claassenia	4.0	3.3	0.1	102.1	7.2	9.1	2.5	4.3	0.8	
Hesperoperla	1.0									
Perlodidae										
Isogenoides	110.2	414.0	133.5	1149.1	405.3	348.1	478.0	108.4	1.5	
Isoperla	1.3	3.3	3.5	9.0	4.2	*	2.2	4.2	0.7	
Taeniopterygidae										
Taenionema	23.0	36.8	30.0	51.6		5.3	1.4	18.2	7.0	
TRICHOPTERA										
Brachycentridae										
Brachycentrus	23.4							19.0	12.8	1.6
Glossosomatidae										
Glossosoma			10.4	0.9			*		*	*
Hydropsychidae										
Arctopsyche	120.7			9.9						
Cheumatopsyche					0.1					
Hydropsyche	25.7	50.2	49.5	51.1	10.5	37.1	5.5	11.1	8.5	29.0

Appendix G

Site 2, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	9	11	13
DIPTERA										
Athericidae										
Atherix							1.1		4.7	3.5
Blepharoceridae										
Bibiocephala		49.8	73.6							
Chironomidae										
Chironominae										
Chironomini	*	*		*	*	*	0.3	0.6	0.1	1.6
Tanytarsini	*	*	*	*	*	*	0.1	0.1	*	*
Diamesinae	6.9		15.1	5.2		5.4	5.7	7.9		8.4
Orthocladiinae	539.0	484.6	443.6	670.9	422.9	262.5	421.7	464.0	221.3	298.6
Prodiamesinae	0.2			0.1			*	0.3	0.1	1.3
Tanypodinae	0.1	*		0.1	*	*	*	1.0	0.1	0.8
Empididae										
Chelifera	0.1		*	0.2	*	*	0.3	0.8	3.0	4.5
Hemerodromia		*		*	*		0.1	*	0.2	0.9
Wiedemannia									3.1	8.1
Tipulidae										
Hexatoma	0.5				*		1.0	38.8	18.6	11.8

Appendix G

Site 3. *<0.1 mg.

Taxa	Sample number									
	4	5	6	7	8	9	10	11	12	13
MICROTURBELLARIA				*		*				
NEMATODA	0.4	0.8	0.4	0.3	0.6	0.5	0.9	0.6	2.8	2.2
APHANONEURA										
Aeolosomatidae						*				
OLIGOCHAETA										
Enchytraeidae	0.1	0.1	0.2	*	0.2	0.2	0.2	*	0.1	0.1
Naididae		*			*			*	*	*
Tubificidae	*				0.2	*	*	*	0.1	0.2
HYDRACARINA	1.7	1.0	1.0	1.3	1.9	1.3	1.3	0.3	1.0	1.0
EPHEMEROPTERA										
Baetidae										
Baetis		*			1.9	1.8	*			
Ephemerellidae										
Drunella			12.6							
Ephemerella	10.2	4.5	10.8	12.3	26.2	18.3	32.5	12.8	23.2	30.0
Heptageniidae										
Rhithrogena	1.5		4.8	0.8	1.0	4.0	1.6	2.1	0.1	0.5
Siphlonuridae										
Ameletus					23.0	31.7				
PLECOPTERA										
Capniidae										
Capnia										0.8

Appendix G

Site 3, ctd.

Taxa	Sample number									
	4	5	6	7	8	9	10	11	12	13
Chloroperlidae										
early nymphs	1.2				1.2		2.7			
Perlidae										
Claassenia	0.1				0.7	286.9	9.2	*		*
Hesperoperla							5.7			0.1
Perlodidae										
Cultus			*							
Isogenoides	37.0	63.0			99.6	134.4	147.7		41.1	
Isoperla					4.3					
TRICHOPTERA										
Brachycentridae										
Brachycentrus	149.2	30.7	9.4		114.1	26.0	61.0	39.8	15.4	
Hydropsychidae										
Arctopsyche										28.6
Hydropsyche	142.6	3.8	185.3	10.1	424.3	64.8	262.3	61.1	36.6	64.2
DIPTERA										
Athericidae										
Atherix	63.4									
Chironomidae										
Chironominae										
Chironomini	0.7	0.1	*	*	0.6	0.5	0.2	0.3	1.1	*
Tanytarsini	0.5	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.1
Orthocladiinae	17.2	20.8	27.0	26.1	24.3	27.9	23.9	23.1	21.6	23.0
Prodiamesinae	*	0.1	0.2		0.4	0.3	0.2	0.1	*	0.1
Tanypodinae	0.6	0.8	1.3	1.7	2.0	1.1	2.0	0.2	0.1	0.2

Appendix G

Site 3, ctd.

Taxa	Sample number									
	4	5	6	7	8	9	10	11	12	13
Empididae										
Chelifera	*	1.9	1.4	2.2	2.0	2.0	1.8	1.7	1.2	0.6
Hemerodromia	*		*	*			*		*	0.1
Tipulidae										
Hexatoma				13.0			1.9		7.9	

Appendix G

Site 4. *<0.1 mg.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA		*		*			*		*	*
NEMATODA	0.1	0.1	0.2	*	*	*	0.5	*	0.1	0.1
APHANONEURA										
Aeolosomatidae			*	*		*	*		*	*
OLIGOCHAETA										
Enchytraeidae	*	0.1	*	*	*	*	0.1	*	0.1	*
Naididae	*	0.3	0.2	0.1	0.2	0.1	0.4	0.7	0.2	0.3
Tubificidae	0.1	0.2	0.3	0.1	0.1	2.0	4.1	0.1	0.3	0.4
GASTROPODA										
Lymnaeidae										
Stagnicola	22.0		2.4							
HYDRACARINA	2.6	1.4	1.3	0.8	1.0	0.8	0.4	6.3	2.9	11.7
OSTRACODA										
Candonidae										
Candona					*			*		
COLLEMBOLA			*					*		
EPHEMEROPTERA										
Ametropodidae										
Ametropus										28.0
Baetidae										
Baetis	2.4	3.8	4.5	2.3	2.1	2.3	1.9	3.3	3.3	1.1

Appendix G

Site 4, ctd.

Taxa	Sample number 1	2	3	4	5	6	7	8	9	10
Ephemerellidae										
Drunella		*	5.7			*	*	20.6	36.4	31.3
Ephemerella	115.1	86.9	90.1	51.1	31.3	32.0	18.3	88.5	42.0	60.1
Heptageniidae										
Cinygmula								0.5		
Epeorus (Iron)		*		*			*	*	*	*
Heptagenia						0.5	*			
Rhithrogena	69.8	66.6	213.9	58.9	63.0	38.1	27.6	7.0	41.9	19.0
Siphlonuridae										
Ameletus	117.1	*		32.8		20.2	14.9	41.8		
PLECOPTERA										
Capniidae										
Capnia	16.0	17.0	19.7	2.4	5.8	3.7	2.0	0.1		1.4
Chloroperlidae										
Sweltsa	9.7	4.4	15.6					4.4		
early nymphs	31.4	22.6	8.6	12.3	5.9	6.1	11.4	2.9	4.6	2.8
Nemouridae										
Prostoia	*	0.1	*							
Zapada			4.7							
Perlidae										
Claassenia	110.0	14.8	51.3	197.6	49.0	159.4	139.1	5.5	7.1	1.8
Hesperoperla			146.1		3.0	165.4	118.4		1.2	4.3
Perlodidae										
Cultus	*	*			*	0.8	2.5	10.1	1.9	1.5
Isogenoides	255.1	214.5	8.8	128.0	160.5	43.7	86.5	15.3	88.8	
Isoperla	3.7	11.3	9.6	5.6	2.0	4.6	1.0	9.2	0.9	0.3
Pteronarcyidae										
Pteronarcella	30.2								*	

Appendix G

Site 4, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
Taeniopterygidae										
Taenionema	10.4	18.0	26.2	31.0	15.5	11.1	15.5	18.5	21.5	10.6
TRICHOPTERA										
Brachycentridae										
Brachycentrus	8.1		34.0	12.4		*		60.2	40.9	31.9
Glossosomatidae										
Glossosoma	1.0				4.3		5.0			9.9
Hydropsychidae										
Arctopsyche			51.2	215.0	54.7			22.0		9.8
Hydropsyche	413.0	194.8	516.0	331.1	429.1	297.0	113.0	158.0	270.4	87.0
Lepidostomatidae										
Lepidostoma	0.3							*		*
Leptoceridae										
Oecetis	*				*					*
Limnephilidae										
Apatania				7.5						
Rhyacophilidae										
Rhyacophila						0.6				
COLEOPTERA										
Elmidae								*	*	
DIPTERA										
Athericidae										
Atherix	1.0	8.1	3.3		0.1	1.2		1.3	4.4	4.1
Ceratopogonidae	*									

Appendix G

Site 4, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
Chironomidae										
Chironominae										
Chironomini	0.1	0.1	0.2	0.2	0.1	1.0	1.2	0.3	0.1	*
Tanytarsini	5.6	2.9	3.0	2.3	5.2	2.8	2.0	0.9	0.5	1.6
Diamesinae	*		*					2.8	1.0	
Orthocladiinae	21.0	14.1	14.0	12.3	19.7	18.1	18.0	7.0	6.9	7.2
Prodiamesinae			*			*		*		
Tanypodinae	11.2	11.3	12.0	2.8	2.2	2.2	6.2	12.7	6.2	12.5
Empididae										
Chelifera	3.9	2.3	4.7	2.6	1.3	1.0	1.9	4.0	3.2	8.9
Hemerodromia	1.8	1.9	0.3	0.2	0.1	*	*	2.1	1.4	3.1
Wiedemannia	*									
Tipulidae										
Antocha	*									
Hexatoma		1.7								1.1

Appendix G

Site 5. *<0.1 mg

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA				*						
NEMATODA	*	*	0.1	*	*	*	*	*	0.1	*
APHANONEURA										
Aeolosomatidae	*	*	*	*	*				*	
OLIGOCHAETA										
Enchytraeidae	*	*	*	0.1	*	*	0.2	*	*	*
Naididae	0.1	*	*	*	*	*	0.3	*	0.2	*
Tubificidae	*	*				0.1	*	*	*	0.2
HYDRACARINA	3.9	3.3	3.6	3.3	2.9	1.9	3.8	0.2	0.5	0.1
EPHEMEROPTERA										
Ametropodidae										
Ametropus		27.2								
Baetidae										
Baetis	2.9	1.1	3.0	2.2	0.3	2.2	2.1	2.1	2.4	2.1
Ephemerellidae										
Ephemerella	33.2	28.7	38.1	31.9	31.3	7.3	2.3	1.2	2.3	1.1
Heptageniidae										
Heptagenia	0.9				1.2					
Rhithrogena	50.1	11.5	30.7	49.2	82.2	22.3	14.1	24.3	6.8	17.4
PLECOPTERA										
Chloroperlidae										
early nymphs	0.7	2.7	2.8	0.6	1.2				0.1	

Appendix G

Site 5, ctd.

Taxa	Sample number 1	2	3	4	5	6	7	8	9	10
Perlidae										
Claassenia	0.1	2.9	*	0.1	3.7	1.4		0.1	0.7	
Perlodidae										
Cultus	2.1	3.2		6.3	1.2	2.9				
Isogenoides	180.1	119.2	203.0	39.5	83.9	650.0	347.0	125.7	24.0	55.0
Isoperla	*	3.3	2.0	0.4	0.2	0.9	*	0.1	7.4	
Pteronarcyidae										
Pteronarcys						32.2		24.5		
Taeniopterygidae										
Taenionema	8.9			9.9	5.2	32.2	37.1	8.1	38.0	25.0
TRICHOPTERA										
Brachycentridae										
Brachycentrus	402.0	377.0	512.1	325.0	242.1	566.0	144.1	67.3	59.3	245.4
Glossosomatidae										
Glossosoma									22.2	
Hydropsychidae										
Arctopsyche	61.0		15.7			184.9			33.3	
Hydropsyche	67.7	51.7	190.0	51.1	30.2	66.1	87.3	2.7	92.0	20.6
Lepidostomatidae										
Lepidostoma	0.5	1.8								
Leptoceridae										
Oecetis		0.4	*	*		0.5			*	
Limnephilidae										
Apatania								24.5	17.4	
DIPTERA										
Ceratopogonidae					*					

Appendix G

Site 5, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
Chironomidae										
Chironominae										
Chironomini	*	0.1	0.6	0.3	0.4	*	0.1		*	
Tanytarsini	42.5	61.0	70.5	58.7	100.2	1.9	1.3	0.6	1.1	0.5
Diamesinae						*				
Orthocladiinae	23.9	24.2	25.2	12.1	30.5	3.0	2.7	0.8	2.8	1.3
Prodiamesinae	*	*	*	*	*					
Tanypodinae	1.9	2.4	3.7	4.0	3.2	1.5	1.9	0.4	0.1	*
Empididae										
Chelifera	1.8	1.6	1.0	1.2	1.3	0.2	0.4	0.2	0.3	0.3
Hemerodromia	0.9	2.4	2.2	1.1	0.6	0.6	0.3	0.1	0.1	0.1
Tipulidae										
Hexatoma			10.4			8.7				

Appendix G

Site 6. *<0.1 mg.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA	0.1	0.1	*	0.1	0.1	*	*	*	*	*
NEMATODA	*	0.1	0.1	0.1	*	*	*	*	*	*
APHANONEURA										
Aeolosomatidae									*	
OLIGOCHAETA										
Enchytraeidae	0.1			*	*	*	*	*	*	*
Naididae	0.1	0.2	0.2	0.5	0.3	*	*	*	0.1	0.4
Tubificidae	0.2				0.1					
GASTROPODA										
Ancylidae										
Ferrissia						16.2		11.9		6.5
HYDRACARINA	0.4	0.6	0.7	0.3	1.0	0.2	*	0.1	0.1	0.2
OSTRACODA										
Candonidae										
Candona						*				
EPHEMEROPTERA										
Baetidae										
Acerpenna	*	*	*	0.2	0.2		*	*	*	0.2
Baetis	24.0	24.3	2.8	51.7	89.3	9.7	4.7	5.8	5.1	5.0
Ephemerellidae										
Ephemerella	16.1	23.3	5.4	20.2	41.2	7.8	9.3	2.9	5.3	5.6

Appendix G

Site 6, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
Heptageniidae										
Heptagenia	14.3	15.8	14.4	37.1	21.0	35.8	17.3	9.6	18.2	11.7
Rhithrogena	10.0	10.8	7.7	26.2	12.7	17.5	43.3	8.9	32.9	8.4
Stenonema					2.4					
Leptophlebiidae										
Leptophlebia										1.4
Tricorythidae										
Tricorythodes						*				
ODONATA										
Gomphidae										
Ophiogomphus		13.6			3.9					304.0
PLECOPTERA										
Chloroperlidae										
early nymphs			*	*			*		*	
Nemouridae										
Shipsa	2.5	1.6	1.5	3.9	10.0	22.6	29.6	27.3	9.6	21.4
Perlidae										
Acroneuria		0.1		7.0	5.5					
Perlodidae										
Cultus		0.8			1.6		3.9	1.9		
Isogenoides				91.9		37.2				
Isoperla	2.5	3.9	1.8	6.1	6.8	7.2	3.7	1.8	4.5	3.6
Taeniopterygidae										
Oemopteryx						15.9	26.4	17.5	12.6	
Taenionema	26.1	50.0	4.8	45.6	36.9	5.8	25.6	19.3	10.4	4.2

Appendix G

Site 6, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
TRICHOPTERA										
Brachycentridae										
Brachycentrus	10.2		14.5		11.3					
Glossosomatidae										
Glossosoma						*			1.0	
Hydropsychidae										
Cheumatopsyche	41.6	41.5	12.4	72.8	229.1	56.1	38.0	63.0	48.1	76.0
Hydropsyche	71.3	184.2	86.5	103.6	181.1	81.5	72.5	68.8	14.6	169.0
Hydroptilidae										
Hydroptila	1.2	1.5	1.0	1.4	1.8	*	0.4	*	*	*
Lepidostomatidae										
Lepidostoma				2.2						*
Leptoceridae										
Oecetis	0.6	2.5	9.7	2.4	11.9	10.0	4.4	4.5	0.6	1.0
HETEROPTERA										
Corixidae										
Cenocorixa									9.4	
Sigara						4.9				
COLEOPTERA										
Dytiscidae										
Oreodytes	1.1							0.1	0.1	
Elmidae		0.1		*						
DIPTERA										
Ceratopogonidae									*	
Chironomidae										

Appendix G

Site 6, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
Chironominae										
Chironomini	0.5	0.2	0.1	0.4	0.6	*	0.1	*	*	*
Tanytarsini	0.9	0.8	0.8	0.9	2.7	0.3	0.3	0.6	0.2	*
Diamesinae	1.3	6.7	5.7	4.9	8.0		0.2		*	0.4
Orthocladiinae	61.9	84.1	89.1	80.9	174.0	9.2	11.0	12.9	17.9	18.5
Tanypodinae	1.8	2.5	2.1	2.1	5.7	*	0.4	0.3	0.1	0.2
Empididae										
Hemerodromia	1.6	2.2	0.5	2.1	3.7	0.1	0.3	1.9	1.8	1.9
Simuliidae										
Simulium	0.1	*	*	*	0.1		3.2			*

Appendix G

Site 7. *<0.1 mg.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA	*	*	*	*	*		*	*	*	*
NEMATODA	*	0.1	*	*	*	*	*	0.1	*	*
OLIGOCHAETA										
Enchytraeidae	*	*	*	*	*	*	*	0.1	*	*
Naididae	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.8	0.6	1.0
GASTROPODA										
Ancylidae										
Ferrissia			*			6.8				
HYDRACARINA	0.1	0.1	*	*	0.2	*	*	*	0.3	0.2
EPHEMEROPTERA										
Baetidae										
Acerpenna	*			*	*		*			
Baetis	32.9	41.3	19.5	25.4	28.2	24.1	26.3	34.1	19.8	11.3
Ephemerellidae										
Ephemerella	13.2	3.3	8.4	6.0	8.3	17.7	9.2	13.2	10.1	3.3
Heptageniidae										
Heptagenia	*	0.2			0.1	5.7	1.1	0.4	*	*
Rhithrogena	1.4	24.4	41.0	12.7	8.3	2.6	21.0	27.7	14.6	6.9
ODONATA										
Gomphidae										
Ophiogomphus		13.9								

Appendix G

Site 7, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
PLECOPTERA										
Chloroperlidae										
early nymphs	*		0.1							*
Nemouridae										
Shipsa			3.1			0.1	3.0	2.4		
Perlidae										
Acroneuria						8.6				
Perlodidae										
Cultus					0.9			*		1.9
Isogenoides	82.9	106.3	57.4	11.8	48.7	46.4	179.0	345.0		93.0
Isoperla	0.9	3.8	1.0	2.4	1.6	1.6	4.2	6.8	3.4	2.1
Taeniopterygidae										
Taenionema	50.5	15.1	24.0	43.4	18.0	7.4	30.0	11.3	4.5	4.6
TRICHOPTERA										
Brachycentridae										
Brachycentrus					15.9		17.7			2.6
Glossosomatidae										
Glossosoma	0.1	*	3.2	*	*				0.1	10.2
Hydropsychidae										
Cheumatopsyche	72.9	51.4	49.4	67.0	68.1	111.0	59.2	80.0	65.1	77.0
Hydropsyche	155.1	2.6	50.7	4.7	61.5	118.0	32.4	38.6	46.9	109.4
Hydroptilidae										
Hydroptila	*	*		*	*	*		0.3	*	*
Leptoceridae										
Oecetis	0.1	0.4	0.6		1.6	5.5	1.9	2.6	1.3	1.8
Psychomyiidae										
Psychomyia								*		

Appendix G

Site 7, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
DIPTERA										
Chironomidae										
Chironominae										
Chironomini	0.1	0.3	*	*	*	0.2	0.1	0.9	0.1	*
Tanytarsini	0.6	0.2	0.4	0.7	0.7	5.9	2.6	1.0	5.7	5.8
Diamesinae	0.5	*	0.2	3.9	*	1.3	*	0.4	1.6	*
Orthocladiinae	29.2	15.9	16.1	18.7	38.4	74.6	11.7	44.3	64.4	45.0
Tanypodinae	0.4	0.1	0.2	0.1	0.4	0.1	0.6	0.4	*	*
Empididae										
Hemerodromia	0.9	0.1	0.4	0.2	0.5	1.9	0.5	0.8	0.8	1.6
Simuliidae										
Simulium			0.2			0.1	*	1.7	*	

Appendix G

Site 8. *<0.1 mg.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
MICROTURBELLARIA	*	*		*	*			*		
NEMATODA	*	*	*	*	*	*	*	*	*	*
APHANONEURA										
Aeolosomatidae	*	*		*	*					
OLIGOCHAETA										
Enchytraeidae	*	*	*	*	*	*	*	*	*	*
Naididae	*	*	*	*	*	*	0.2	0.1	*	*
HYDRACARINA		*		0.3	0.1	*	*			*
EPHEMEROPTERA										
Baetidae										
Acerpenna				*						
Baetis	12.1	4.0	2.7	7.0	5.9	0.1	3.3	4.8	1.6	2.3
Ephemerellidae										
Ephemerella	1.4	5.8	7.0	3.8	2.4		2.6	5.3	9.9	2.9
Heptageniidae										
Heptagenia	0.6	*								*
Rhithrogena	8.1	0.7	38.5	28.0	11.9	0.1	0.2	1.0	0.9	0.2
ODONATA										
Gomphidae										
Ophiogomphus					3.8					

Appendix G

Site 8, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
PLECOPTERA										
Chloroperlidae										
early nymphs		*	0.8							
Nemouridae										
Shipsa			6.4	1.8	2.0		3.5	4.0	1.1	7.0
Perlodidae										
Isogenoides	44.0		128.6	78.2	70.4					
Isoperla	5.0	4.2	6.5	6.9	5.9	0.1	4.0	0.4	4.5	1.7
Pteronarcyidae										
Pteronarcys		9.5								
Taeniopterygidae										
Taenionema	9.5	4.6	10.1	23.4	8.3		11.5		13.8	
TRICHOPTERA										
Brachycentridae										
Brachycentrus			24.1	23.0				5.3		
Hydropsychidae										
Cheumatopsyche	132.0	164.5	119.3	135.0	140.1	33.5	211.1	206.2	98.2	74.8
Hydropsyche	4.8	20.9	52.8	69.0	74.1		20.4	68.1		3.0
Hydroptilidae										
Hydroptila									*	
Leptoceridae										
Oecetis		0.4	1.2		0.2	0.1	0.2	1.2		
HETEROPTERA										
Corixidae										
Sigara					16.9					

Appendix G

Site 8, ctd.

Taxa	Sample number									
	1	2	3	4	5	6	7	8	9	10
DIPTERA										
Chironomidae										
Chironominae										
Chironomini	*	0.1	0.1	0.2	0.3	0.1	0.6	*	*	*
Tanytarsini	*	*	*	*	*	0.2	0.1	0.1	0.1	0.2
Diamesinae	*	*	*	*	*	*	0.1	0.1	0.1	*
Orthocladiinae	2.7	15.8	6.8	2.2	2.7	12.8	37.8	40.0	27.8	30.1
Tanypodinae	0.6	0.1	0.1	0.1	0.3	*	1.4	0.9	0.2	0.2
Empididae										
Hemerodromia	0.7	1.0	0.9	0.5	0.5	0.3	1.3	1.2	1.7	1.7
Simuliidae										
Simulium			1.0	*	*					0.1

Appendix G

Site 9. *<0.1 mg.

Taxa	Sample number 1	2	3	4	5	6	7	8	9	10
NEMATODA	*	*	*	*	*	*	*	*	*	*
OLIGOCHAETA										
Enchytraeidae	*			*	*	*	*			
Naididae	*	*		*	*		*		*	*
Tubificidae		*			*					
HYDRACARINA	*		0.2	0.5	0.1	0.9	0.3	0.2	0.4	0.7
EPHEMEROPTERA										
Baetidae										
Baetis	2.4	6.6	7.3	8.4	1.6	2.4	2.2	2.4	2.1	3.6
Ephemerellidae										
Ephemerella	3.6	5.3	12.1	8.0	3.4	5.8	3.0	4.1	0.8	5.9
Heptageniidae										
Heptagenia	0.8		1.6	1.6	1.5	*	3.2	0.1	*	8.2
Rhithrogena	7.4	46.0	9.3	41.4	18.9	73.9	51.0	69.1	44.0	83.0
ODONATA										
Gomphidae										
Ophiogomphus						181.9				
PLECOPTERA										
Chloroperlidae										
early nymphs	0.1		*			*	*		0.3	*
Perlidae										
Claassenia			4.1	1.2			3.4			20.7
Perlodidae										
Isogenoides	210.1		125.0	46.2		111.2	171.2	35.4	33.2	323.2

Appendix G

Site 9, ctd.

Taxa	Sample number 1	2	3	4	5	6	7	8	9	10
Isoperla	3.7	3.9	3.3	7.7	3.5	2.5	3.2	3.4	1.1	10.0
Pteronarcyidae										
Pteronarcys										355.7
Taeniopterygidae										
Taenionema										3.5
TRICHOPTERA										
Glossosomatidae										
Glossosoma						*	4.2		*	
Hydropsychidae										
Cheumatopsyche		11.6					9.3	4.8	0.8	23.9
Hydropsyche	19.0	180.0	38.0	80.3	52.0	88.0	202.9	40.6	59.2	287.9
Hydroptilidae										
Hydroptila						*				
Leptoceridae										
Oecetis					*	0.1				
Psychomyiidae										
Psychomyia	4.1	8.7	2.3	6.9	1.3	6.2	1.2	1.0	2.1	0.1
DIPTERA										
Ceratopogonidae							*		*	
Chironomidae										
Chironominae										
Chironomini	0.4	0.1	*	*	*	*	*	*	*	*
Tanytarsini	1.1	2.1	5.0	3.0	1.9	9.4	1.7	1.9	1.5	2.0
Diamesinae			*					*		*
Orthocladiinae	5.2	16.9	19.6	14.8	3.9	30.4	17.0	11.3	7.7	15.4
Tanypodinae	*	0.4	*	*	*	*	0.4	0.7	0.1	1.8
Empididae										
Hemerodromia	2.5	1.7	2.9	0.2	0.1	0.1	0.1	1.0	0.9	1.6

APPENDIX H:

The incidence of parasitism in Chironomidae larvae by mermithid nematodes per replicate Neill sample (0.1 m^2) at nine sites of the Athabasca River (counts appropriately weighted for subsampled taxa)

Appendix H

The incidence of parasitism in Chironomidae larvae by mermithid nematodes per replicate Neill sample (0.1 m^2) at nine sites of the Athabasca River (counts appropriately weighted for subsampled taxa).

Site 1	Sample number									
	1	3	4	6	7	8	10	11	12	13
Total Chironomidae	170	142	102	20	174	214	262	54	50	215
Total parasitized	0	0	0	0	0	0	0	0	0	0
Percent parasitism	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site 2	Sample number									
	1	2	3	4	5	6	7	9	11	13
Total Chironomidae	4162	3966	3207	7037	3641	2436	3885	4066	2151	3550
Total parasitized	74	15	53	41	26	34	37	56	13	9
Percent parasitism	1.8	0.4	1.7	0.6	0.7	1.4	1.0	1.4	0.6	0.3

Site 3	Sample number									
	4	5	6	7	8	9	10	11	12	13
Total Chironomidae	507	251	452	799	646	682	494	436	712	489
Total parasitized	2	2	2	5	8	4	3	1	4	5
Percent parasitism	0.4	0.8	0.4	0.6	1.2	0.6	0.6	0.2	0.6	1.0

Appendix H

Site 4	Sample number									
	1	2	3	4	5	6	7	8	9	10
Total Chironomidae	858	642	586	429	694	530	581	432	305	410
Total parasitized	1	1	0	0	0	0	2	1	0	0
Percent parasitism	0.1	0.2	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0

Site 5	Sample number									
	1	2	3	4	5	6	7	8	9	10
Total Chironomidae	1632	1996	2076	1982	2717	215	179	77	132	57
Total parasitized	2	0	0	0	0	0	0	0	0	0
Percent parasitism	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site 6	Sample number									
	1	2	3	4	5	6	7	8	9	10
Total Chironomidae	500	623	558	680	1085	207	303	195	205	207
Total parasitised	0	0	0	2	0	1	0	0	1	1
Percent parasitism	0.0	0.0	0.0	0.3	0.0	0.5	0.0	0.0	0.5	0.5

Appendix H

Site 7	Sample number									
	1	2	3	4	5	6	7	8	9	10
Total Chironomidae	385	200	224	207	318	582	261	470	631	509
Total parasitized	0	0	0	0	0	0	0	0	0	0
Percent parasitism	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site 8	Sample number									
	1	2	3	4	5	6	7	8	9	10
Total Chironomidae	84	147	108	61	91	112	312	222	183	231
Total parasitized	0	0	0	0	0	0	0	0	0	0
Percent parasitism	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site 9	Sample number									
	1	2	3	4	5	6	7	8	9	10
Total Chironomidae	253	287	559	522	247	876	503	375	339	402
Total parasitized	0	0	0	0	0	0	0	0	0	0
Percent parasitism	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX I:

Numbers of representative mayflies, stoneflies and caddisflies taken from five of the nine Athabasca River sites for tissue contaminant analyses

Appendix I

Numbers of representative mayflies, stoneflies and caddisflies taken from five of the nine Athabasca River sites for tissue contaminant analyses.

Taxa	Site 1	Site 2	Site 4	Site 5	Site 9
EPHEMEROPTERA					
Ameletus			3	1	
Ametropus neavei				1	
Baetis		1			
Drunella doddsi		4	17		
Ephemerella	1		3		
Heptagenia					1
Rhithrogena		4	19	8	10
PLECOPTERA					
Sweltsa			2		
Cultus			1		
Isogenoides		12	30	5	21
Skwala americana			2		
Claassenia sabulosa		2	7	1	5
Hesperoperla pacifica			2		
Pteronarcella		3	1	2	
Pteronarcys					1
Taenionema		1	3		
TRICHOPTERA					
Brachycentrus				1	
Arctopsyche	12	1	5	2	
Cheumatopsyche					3
Hydropsyche		5	35	7	38