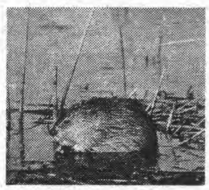
Canada Alberta Northwest Territories

Northern River Basins Study







NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 35

EMERGENT INSECT SAMPLING WITH LIGHT TRAPS

UPPER ATHABASCA RIVER, SEPTEMBER, 1993






Date Due

Prepared for the
Northern River Basins Study
under Project 2375-C1

by
Mark Dunnigan
R.L. & L. Environmental Services Ltd.

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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
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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 ____________________ 18 March 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 ____________________ 18 Mar 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**

Bev Burns ____________________ April 7/94 ____________
(Bev Burns, Co-chair) (Date)

Lucille Partington ____________________ April 7/94 ____________
(Lucille Partington, Co-chair) (Date)

EMERGENT INSECT SAMPLING WITH LIGHT TRAPS, UPPER ATHABASCA RIVER, SEPTEMBER, 1993

STUDY PERSPECTIVE

One of the major objectives of the Northern River Basins Study is to determine the degree to which the aquatic ecosystem has been affected by man related sources of contaminants. Because they form the basis of the food chain, benthic invertebrates are often used to give clues about contaminant levels in the aquatic environment. This includes a number of species of insects, such as stoneflies, mayflies and caddisflies, which inhabit the aquatic environment during the early stages of their lives. Collections of aquatic invertebrates, however, can often be very labour intensive and costly. Often too, a variety of life stages of a given invertebrate can exist at the same time in the aquatic environment resulting in variations in the length of contaminant exposure time. Another means of investigating contaminant levels in these invertebrates is to capture adult insects after they have left the aquatic environment. The Northern River Basins Study initiated a pilot project to evaluate the usefulness of light traps to capture winged adult insects as an alternative to collecting immature forms of invertebrates for the purpose of developing a biomonitoring tool.

Related Study Questions

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

4a) *Describe the contents and nature of the contaminants entering the system and describe their distribution and toxicity in the aquatic ecosystem with particular reference to water, sediments and biota.*

11) *Have the riparian vegetation, riparian wildlife and domestic livestock in the river basins been affected by exposure to organochlorines or other toxic compounds?*

Initially, adult and immature insects of three families of invertebrates (mayflies, caddisflies and stoneflies) were to be collected simultaneously from three sites along the upper Athabasca River during September 1993. However, collections were ultimately restricted to a site near the Obed Mountain Coal Bridge because of low trapping success of adult insects. Only adult caddisflies were collected at this site and in very small numbers. Immature caddisflies and stoneflies were also collected at the same time from the aquatic environment. The immature and adult caddisflies will be submitted for contaminant analyses to determine if adults can be used as an indicator for contaminant levels in the aquatic environment.

The low numbers of adult insects collected was attributable to the low temperatures during the collection period. The Northern River Basins Study is currently examining the potential of carrying out similar studies in late June or early July when weather conditions might be more optimal for the collection of adult insects.

REPORT SUMMARY

This report presents the results of a pilot study conducted to assess the feasibility of collecting adult aquatic insects from the Athabasca River for trace contaminant analyses. A primary objective was to evaluate the use and effectiveness of light trapping adult aquatic insects as compared to the collection of immature forms as a biomonitoring tool. The second objective of this project was to obtain tissue samples of immature aquatic insects and winged adults for organic contaminant (e.g., dioxins, furans, and polyaromatic hydrocarbons) and stable isotope (e.g., carbon and nitrogen) analyses.

Sampling was conducted at one site on the Athabasca River, near the Obed Mountain Coal Bridge, on 2 and 3 September 1993. Three taxa (mayflies, stoneflies, and caddisflies) were targeted for collection. Only adult caddisflies were collected, whereas immature caddisflies and stoneflies were collected. Adult mayflies, adult stoneflies, and immature mayflies were not present in sufficient densities to warrant collection (i.e., no adult stoneflies were observed). Of the tissues collected, complete complements for all trace contaminant analyses were not obtained because of low densities and time constraints. Conditions during the collection period and timing of collections (autumn) were not optimal for adult aquatic insects. Low temperature was probably the most important weather variable that limited adult insect catch. Maximum collection rates for adult aquatic insects has been reported during late June and early July in the temperate zone of the northern hemisphere.

The collection efficiency of adult aquatic insects is dependent upon appropriate weather conditions as well as seasonality (i.e., timing of peak emergence). Collection of immature aquatic insects is less dependent upon weather conditions, but is much more labour intensive. One advantage to the collection of adults is that all specimens consist of only one life stage, alleviating potential problems associated with differential contaminant uptake due to variation in length of contaminant exposure time (i.e., immature specimens may be collected within a few weeks to two or more years after hatching).

When conducting monitoring studies that involve specimens with more than one life history stage, the advantages and disadvantages in sampling techniques must be considered when assessing objectives and cost-effectiveness.

ACKNOWLEDGEMENTS

The author would like to thank Dr. Anne-Marie Anderson, Alberta Environment, Technical Services and Monitoring Division, for providing information during the study. Field collections were conducted by Mr. Mark Dunnigan, Mr. Mike Braeuer, and Mr. Rob Stack of R.L. & L. Environmental Services Ltd. Ms. Frances Baker assisted with report production.

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INTRODUCTION

This report presents the results of a pilot study conducted to assess the feasibility of collecting adult aquatic insects from the Athabasca River for trace contaminant analyses.

In spring 1992 and late winter 1993 (R.L. & L. 1992, 1993) Northern River Basins Study (NRBS) collected immature forms of aquatic macroinvertebrates to help assess contaminant loadings in the aquatic food chain. However, adult aquatic insects may contribute significantly to the diet of terrestrial predators (e.g., birds, bats, rodents), thereby acting as a link between aquatic and terrestrial food chains (Menzie 1980, Jackson and Resh 1989).

Adult aquatic insects are nocturnally active and exhibit strong attraction to ultraviolet light (Nimmo 1966); thus, light traps are ideally suited for efficient collection of large numbers of these organisms during summer. Light traps have potential as a biomonitoring tool and can be an efficient, cost-effective, and practical alternative to sampling organisms directly within the aquatic environment (Kovats et al. 1991).

The major objective of the present study was to evaluate the use and effectiveness of light trapping adult aquatic insects as compared to the collection of immature forms as a biomonitoring tool (Terms of Reference, Appendix A). A second objective was to obtain samples of immature aquatic insects and winged adults from three sites in the Athabasca River. These samples were destined for organic contaminant and stable isotope analyses.

SECTION 2
METHODS

2.1 STUDY PERIOD AND AREA

Collections of aquatic insects were conducted on 2 and 3 September 1993. After consultation with NRBS, two of the original three sampling sites (near Entrance and Emerson Lakes Bridge), described in the Terms of Reference were not sampled because of time constraints. One sampling site was established on the Athabasca River at the Obed Mountain Coal Bridge. This site was located approximately 20 km downstream of the Town of Hinton and Weldwood of Canada Ltd.'s combined effluent discharge point. This location was surveyed in previous NRBS projects (R.L. & L. 1992, 1993). Photographs of the sampling site are presented in Appendix B.

2.2 GENERAL COLLECTION PROCEDURES

Attempts were made to collect sufficiently large numbers of immature and mature invertebrates from the sampling site to carry out analyses on individual taxa. Immature and mature specimens of hydropsychid caddisflies, mayflies, and stoneflies were the taxa selected for collection.

Tissues were collected for analysis of dioxins and furans, polyaromatic hydrocarbons (PAH's), and stable isotopes. Analytical laboratories required the following minimum amounts for analysis:

- dioxins and furans: 10 grams wet weight (ww)
- PAH's: 10 grams ww
- stable isotopes: 2 grams ww

Specimens for each analysis were kept in separate containers. Labels on containers displayed the following information: river, site, taxon, type of sample (immature or adult), date, number of replicate, wet weight in grams, and type of analysis (i.e., dioxins and furans, stable isotopes, etc.).

2.2.1 Handling and Quality Control

The following collection and handling procedures were employed to avoid contamination of samples.

1. To avoid contamination of stable isotope samples, liquids high in nitrogen, carbon or sulphur were not used.

2. All equipment that could potentially be in contact with samples for trace organic contaminants were first rinsed in ultra-pure acetone, then in ultra-pure (pesticide grade) hexane.

3. Aluminum foil was baked at 350°C for 6 to 12 h before being used to line lids and protect equipment.

4. Metal, Teflon® or glass equipment were used for trace organic contaminant samples.

5. All equipment was thoroughly cleaned between sites. This includes scrubbing all organic debris off sampling equipment prior to rinsing with acetone and hexane (for organics).

6. All samples were stored in clean containers (glass jars with lids lined with treated aluminum foil for organic and stable isotope analyses). Precautions were taken to keep samples out of direct light (e.g., placed in a box/cooler). During transport and storage, all samples were kept frozen (-20°C).

7. Precautions were taken so that samples were not contaminated during sample or sample preparation. Combustion exhaust from running motors, smoke, dust, paper products, etc. were avoided.

8. Where possible, additional sets (duplicates) of all types of samples were collected.

9. All residual chemical solutions (i.e., acetone, hexane, acid) were collected, stored and disposed of in a manner consistent with the Alberta Occupational Health and Safety Act.

2.3 COLLECTION OF IMMATURE AQUATIC MACRO-INVERTEBRATES

Sampling methods for the collection of instream immature insects were identical to those employed during a survey of the same study area conducted in April 1992 and late winter 1993 (R.L. & L. 1992, 1993) and are outlined below.

Macroinvertebrate tissue samples for trace contaminant analyses were collected from erosional habitats. To collect invertebrate tissue samples, a coarse mesh (1.55 mm) barrier net (aluminum mesh fastened between two wooden dowels) was used. The barrier was positioned downstream of a person overturning stones with their feet. Dislodged animals were then swept by the river current into the barrier mesh (same principle as a kick net). Animals were transferred from the mesh to a small glass jar containing some river water, and subsequently into a glass tray where they were sorted into taxonomic groups and separated from organic debris and fine sediments. Samples were then placed in appropriately prepared containers (scintillation vials that had lids lined with treated aluminum foil), fully labelled and frozen on dry ice immediately after collection. Teflon® coated forceps were used to transfer specimens among sampling equipment/containers. Samples were kept frozen at all times. At least two people collected immature aquatic insects for a minimum period of 5 h on each of 2 and 3 September 1993.

A representative sub-sample of approximately 10-20 organisms from each taxonomic group was collected for identification at each site. These samples were preserved in 4% formaldehyde, labelled appropriately, and analyzed in the laboratory at a later date.

2.4 COLLECTION OF ADULT AQUATIC MACROINVERTEBRATES

Sampling of adult stages of aquatic macroinvertebrates were carried out with light traps following basic methods outlined in Kovats et al. (1991). Four modified Pennsylvania-type light traps (Frost 1957), where the glass killing jar was replaced with a cylindrical reservoir made of Teflon® and where dry ice was used as a killing and preserving agent, were used (see Photographs in Appendix B). These traps were constructed of metal, Teflon®, and glass so that specimens were not exposed to any plastic materials.

Light trapping began prior to dusk (at approximately 2100 h) at suitable locations (open, unforested area approximately 10 to 20 m from shore) near water at each of the sampling sites. The times ultraviolet lights were switched on and off (dependent on capture rate) were recorded, together with air and water temperatures. Wind velocity (anemometer), wind direction, and humidity (psychrometer) also were determined. Sampling was scheduled on evenings with little or no wind to ensure that the traps functioned properly and that the insects collected had emerged in the sampling area and were not transported from elsewhere by the wind.

The following morning, after storage on ice overnight, the contents of the traps were transferred into a properly prepared (acetone and hexane rinsed) stainless steel or glass tray. Stainless steel or Teflon® coated forceps were used to sort insects into taxonomic groups and place specimens in appropriately prepared and labelled containers (20 mL glass scintillation vials that had lids lined with aluminum foil or Teflon®).

A representative sub-sample of approximately 10-20 adult organisms from each taxonomic group was collected for identification. These samples were preserved in 70% ethanol, labelled appropriately, and analyzed in the laboratory at a later date.

SECTION 3
RESULTS

Adult macroinvertebrate tissue samples for trace contaminant analyses were collected from the Athabasca River near Obed Mountain Coal Bridge (Table 3.1). No adult stoneflies (Plecoptera) were observed and only a few, small adult mayflies (Ephemeroptera) were present at the time of sampling. The adult mayflies were too small, in size and number, to warrant collection for contaminant analyses. Adult caddisflies were collected during the two sampling nights (2 and 3 September 1993; however, only 5 g of tissue were accumulated. This was considerably less than the 22 g required for a complete complement of contaminant analyses.

Light traps are passive traps (i.e., animals fly into the traps) and as such, attract all flying invertebrates. Considerable numbers of adult moths (Lepidoptera), ants and wasps (Hymenoptera) and true flies (Diptera; craneflies, no-see-ums, and midges) were also collected.

Table 3.1 Summary of aquatic insect trace contaminant tissue samples collected from the Athabasca River near Obed mountain Coal Bridge, 2 and 3 September 1993.

Taxon	Wet Weight* (g)	
	Adults	Immatures
Ephemeroptera (mayflies)		<1 <1 <1
Plecoptera (stoneflies)		2 6 10
Trichoptera (caddisflies)	2 3	4 5 6
Remaining Taxa (mostly terrestrial)	26 40	

* Each weight represents one vial.

Immature forms of mayflies, stoneflies, and caddisflies also were collected from substrates in the Athabasca River near Obed Mountain Coal Bridge (Table 3.1). Stoneflies and caddisflies were relatively more abundant than mayflies. The relative amount of tissue collected reflected each taxon's abundance; 18 g of stoneflies, 15 g of caddisflies, and <1 g sampled of mayflies.

Light traps were operated for over 3 h, from approximately 2030 through 2400 h, on each night of sampling. During the first night of trapping, the sky was clear (there was a full moon), and winds were calm (Table 3.2). Temperatures dropped to 12°C by 2200 h and to 7.5°C by 2300 h. The second night was cloudy with intermittent light rain showers and winds were calm. Temperatures dropped to 13°C by 2200 h and remained there throughout the sampling period. Sampling terminated at approximately 2415 h when moderate precipitation occurred.

Table 3.2 Summary of weather conditions measured in the field during the collection of adult invertebrates.

Date	Wind Velocity (km/h)	Relative Humidity	Temperature (°C)	General Comments
Night of 02/09/93	0-10 @ 2000 h	56% @ 2000 h	27 @ 1700 h 18 @ 2000 h 12 @ 2200 h 7.5 @ 2300 h 8.0 @ 0140 h	Winds out of west. Calm, clear night with a near full moon. Water temperature was 23.5°C at 1700 h
Night of 03/09/93	0-4 @ 1830 h	54% @ 1830 h	21 @ 1830 h 18 @ 2100 h 13.5 @ 2200 h 13.0 @ 2300 h 13.0 @ 2400 h	Calm, overcast night, light rain from 2130 to 2145 h, and 2240 to 2300 h. Moderate rain at 2415 h. Water temperature was 14°C at 1830 h.

Table 3.3 summarizes the taxonomic identifications of representative specimens collected for trace contaminant analyses. No adult stoneflies were collected; however immature *Isogenoides* (Perlodidae), and *Pteronarcella* (Pternonarcyidae) were collected. Immature *Ephemerella* (Ephemeroptera: Ephemerellidae) were collected while only adult *Baetis* (Ephemeroptera: Baetidae) were attracted to the light traps. Only immature hydropsychids (*Hydropsyche* and *Arctopsyche*) were collected, whereas adult caddisflies included the hydropsychid *Hydropsyche* and the limnephilid *Hesperophylax*. There was an approximate ratio of 12 adult *Hydropsyche* to one adult *Hesperophylax* captured.

Table 3.3 Taxonomic list of specimens collected for trace contaminant analysis from the Athabasca River near Obed Mountain Coal Bridge, 2 and 3 September 1993.

Immatures	Adults
INSECTA	INSECTA
EPHEMEROPTERA	EPHEMEROPTERA
Ephemerellidae	Baetidae
Ephemerella	*Baetis*
PLECOPTERA	TRICHOPTERA
Perlodidae	Hydropsychidae
Isogenoides	*Hydropsyche*
Pteronarcyidae	Limnephilidae
Pteronarcella	*Hesperophylax*
TRICHOPTERA	
Hydropsychidae	
Artopsyche	
Hydropsyche	

SECTION 4
DISCUSSION

Four modified Pennsylvania light traps were used to collect adult aquatic insects from the Athabasca River during two sampling nights. A total of five grams of tissue for one of three taxa was collected. Conditions during the collection period and the timing of collections (autumn) were not optimal for adult aquatic insects.

Weather conditions greatly affect adult invertebrate catches. Warm, calm, humid nights are ideal for collecting adult insects (Kovats and Ciborowski 1989; Kovats 1990). Kovats (1990) identified air temperature as being the most important single factor influencing collection sizes. Maximum sample sizes were collected at temperatures around 25°C. In this study temperatures quickly dropped to 13.5°C or less by 2200 h and were 18°C near the onset of light trapping (2000 h and 2100 h on 2 and 3 September, respectively). Wind velocities greater than 15 km/h greatly reduce catches (Kovats and Ciborowski 1989; Kovats 1990). In the present study, wind velocities were generally 10 km/h or less. In general, larger samples are collected on humid nights (Kovats and Cibrowski 1989) and may have limited capture rates in this survey as the relative humidity was 56% or less. Temperature was probably the most important weather variable that limited insect catches on the Athabasca River on 2 and 3 September 1993.

Capture rates of adult aquatic insects vary with the time of year. Mid-summer appears to be the optimum time to collect adult insects. At the Detroit River, catch rates steadily increased from the end of May through June 1987 (Kovats and Cibrowski 1989; Kovats 1990). Other temperate zone, northern hemisphere studies have documented optimal sampling efficiency from large rivers in late May through August (Corbet et al. 1966; Waringer 1989). In general, maximum collection rates, up to 250 g wet weight/trap/2 h, occur in late June and early July (Kovats 1990).

Light traps passively capture adult insects and require minimal effort to set up, maintain, and dismantle. During the collection of immature aquatic insects, at least two people expended 10 or more hours actively collecting specimens; therefore, physical energy expended during the collection of adult aquatic insects is minimal relative to the collection of immature forms. Based on physical effort, light traps are less demanding; however, capture success is less reliable. Caddisflies were the only aquatic taxon captured in substantial quantities with the use of light traps whereas considerable amounts of immature caddisflies and stoneflies were collected. Seasonality in emergence of adult forms of aquatic insects can account for this observed difference. No adult stoneflies were present at the time of sampling. To capture adult stoneflies, and possibly mayflies, timing of the collections must coincide with emergence periods. If the objective is to collect adults of two or more taxa during one sampling event, the window of opportunity may be very narrow.

One problem associated with the collection of immature insects is variation in length of exposure to potential contaminants. Depending on the length of time a species requires for development, aquatic insects may be collected within a few weeks to two or more years after hatching. Collecting adults ensures all specimens of a given species have had an equal amount of time exposed to potential contaminants. Variability in resultant trace contaminant tissue analyses may be reduced if adults are collected over immatures.

In summary, light traps are suited for the collection of large numbers of adult aquatic invertebrates for trace contaminant analyses during summer (late May to early July). Collection efficiency is dependent upon appropriate weather conditions as well as seasonality of adult forms (i.e., timing of peak emergence). Collection of immature aquatic insects for trace contaminant analyses is less dependent upon weather conditions and seasonality (samples have been collected year-round; R.L. & L. 1992, 1993); however, it is much more labour intensive. One advantage to the collection of adults is that all specimens consist of only one life stage, alleviating problems associated with differential contaminant uptake due to variation in length of contaminant exposure time.

The advantages and disadvantages of each sampling technique must be considered when assessing objectives and cost-effectiveness in monitoring studies of this type.

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APPENDIX A

TERMS OF REFERENCE

SCHEDULE A - TERMS OF REFERENCE

Project 2375-C1 Emergent Insect Sampling With Light Traps

I. GENERAL OBJECTIVES

The objective is to obtain samples of immature aquatic insects and winged adults from three sites in the Athabasca River. These samples will be analyzed for organic contaminants and stable isotopes.

II. REQUIREMENTS

1. The study area stretches approximately from the Highway #40 bridge to Whitecourt. See attached Northern River study map of the Upper Athabasca River. Sampling sites should be chosen for their suitability, but should be located in the vicinity of the following sites:

   - near entrance (near Highway 40)
   - Obed Mountain Coal Bridge
   - Emerson Lake Bridge

   Sampling should be conducted in August when insects still emerge.

2. Sufficiently large numbers of immature and mature invertebrates should be collected from each sampling site to carry out analyses on individual taxa. Hydropsychid caddisflies, mayflies, or stoneflies are likely to be selected. Up to 24 samples would be collected (i.e., 3 taxa, 3 sites, water and air, one survey, duplicates at one site). Ideally samples of immature and mature insects should comprise the same taxa.

   The analytical laboratories require the following minimum amounts for analysis:

   - dioxins and furans: 10 grams wet weight (ww)
   - PAH's: 10 grams ww
   - stable isotopes: 2 grams ww

   Specimens for each analysis must be kept in separate containers.

3. Sampling methods for the collection of instream immature insects should be similar to those employed during the survey carried out in April 1992 (RL & L 1992).

   Sampling of aerial stages should be carried out with light traps following methods outlined in Kovats et al. (1991). The recommended light trap is a modified Pennsylvania-type light trap (Frost 1957) where the glass killing jar is replaced with a cylindrical reservoir made of aluminum hardware cloth and where dry ice is used as killing and preserving agent. The standard collection time of 2 hrs, starting at sunset, may be adjusted according to the quantitative and qualitative composition of the samples.

Specimens must be placed in appropriate, fully labelled containers and frozen on dry ice immediately after collection. Samples must remain frozen at all time until they are analyzed. Sample labels must include river, site, and taxon, name, date, number of replicate, type of analysis required.

4. A representative sub-sample of 10 to 20 organisms from each sample should be retained for taxonomic identification. Preserve samples of immature insects in 4% formaldehyde, those of winged adults in 70% ethanol, label appropriately. Identify specimens to genus or species level.

5. Sampling and sample handling procedures must be appropriate for trace organic compounds and trace metals. Precautions must be taken at all times to avoid contamination of the samples, namely:

- To avoid contamination of stable isotope samples, liquids high in nitrogen, carbon or sulphur must not be used.
- Clean all equipment that will contact the samples for trace organics by rinsing first in ultra-pure acetone then in ultra-pure (pesticide grade) hexane.
- Soak equipment that will contact the samples for trace metal analysis in an acid bath made of high grade acid.
- Bake aluminum foil at 350 C for 6 to 12 hours before using it to line lids or protect equiment.
- Use metal or teflon coated equipment for trace organic samples and plastic or teflon coated equipment for trace metal samples.
- Clean equipment between sites.
- Store tissue samples in clean containers (glass jars with teflon lids for trace organics and stable isotopes: teflon coated or plastic containers for trace metals).
- Ensure that samples do not get contaminated during sampling or sample preparation especially by combustion sources such as running motors; smoke, dust, and paper products may also contribute contaminants.

6. Collect samples for quality control and assurance.

- Blank tissue samples will be provided by the Project Manager and should be subjected to routine handling procedures.
- At least two additional sets (i.e., a sample for each group of contaminants) should be obtained from a taxon which is easiest to sample. These samples will be used as replicates or for spiking as directed by the Project Manager.

III. REPORTING REQUIREMENTS

1) Ten copies of the draft report are to be submitted to the Component Coordinator by December 1st, 1993. The draft report should contain a listing of samples, locations, dates, pertinent observations regarding sampling and field conditions, and comparative comments regarding the ease of sampling of immature versus mature insects.

2) Three weeks after the receipt of review comments on the draft report, the contractor is to submit ten cerlox bound copies and two unbound, camera-ready originals or the final report to the Component Coordinator. Test in the final report is to be presented in 12 point Times Roman font. An electronic copy of the report, in Word Perfect 5.1 format, is to be submitted to the Component Coordinator along with the final report. The final report is to contain a table of contents, list of figures (if appropriate) list of tables, acknowledgements, executive summary and an appendix containing the Terms of Reference for this contract. Data presented in tables, figures or appendices of the report are also to be submitted in an electronic spreadsheet (Quattro Pro preferred) or database. Any figures presented in the report should be reproducable in black and white. If photos are to be presented in the report, they should be high contrast black and white.

IV. PROJECT ADMINISTRATION

The Scientific Authority for this project will be:

Dr. Anne-Marie Anderson
Alberta Environmental Protection
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Edmonton, Alberta
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fax: (403) 422-9714

All questions of a technical nature should be directed to her.

The NRBS Study Office Component Coordinator for this project is:

Greg Wagner
Office of the Science Director
Northern River Basins Study
690 Standard Life Centre
10405 Jasper Avenue
Edmonton, Alberta
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phone: (403) 427-1742
fax: (403) 422-3055

Administrative questions related to this project should be directed to him.

V. LITERATURE CITED

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Frost. S.W. 1957. The Pennsylvania light trap. J. Econ. Entomol. 50: 287 - 292.

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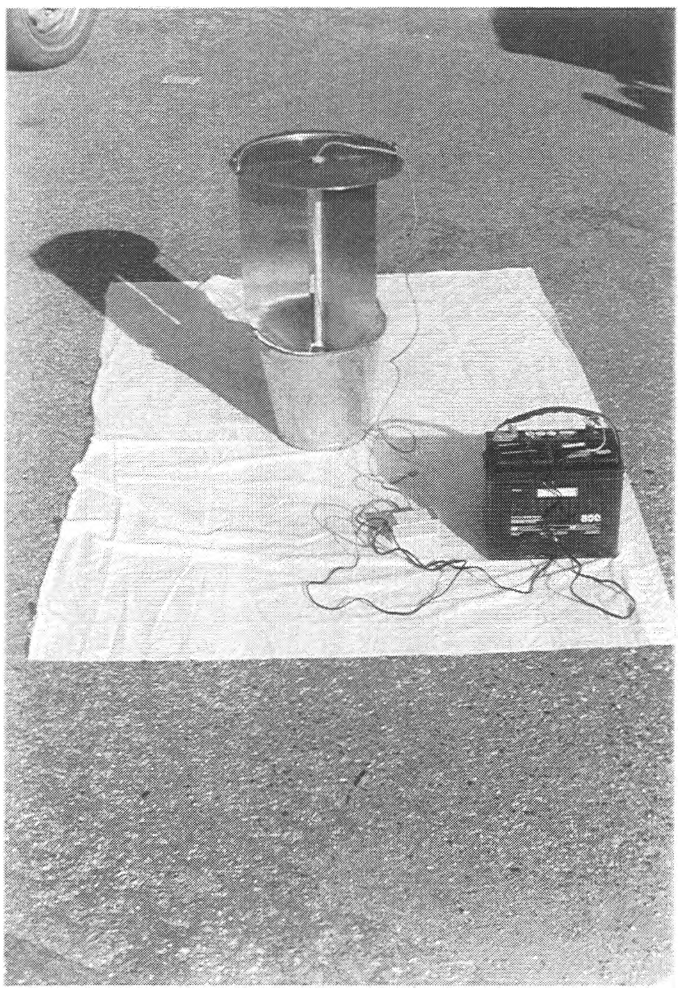
APPENDIX B

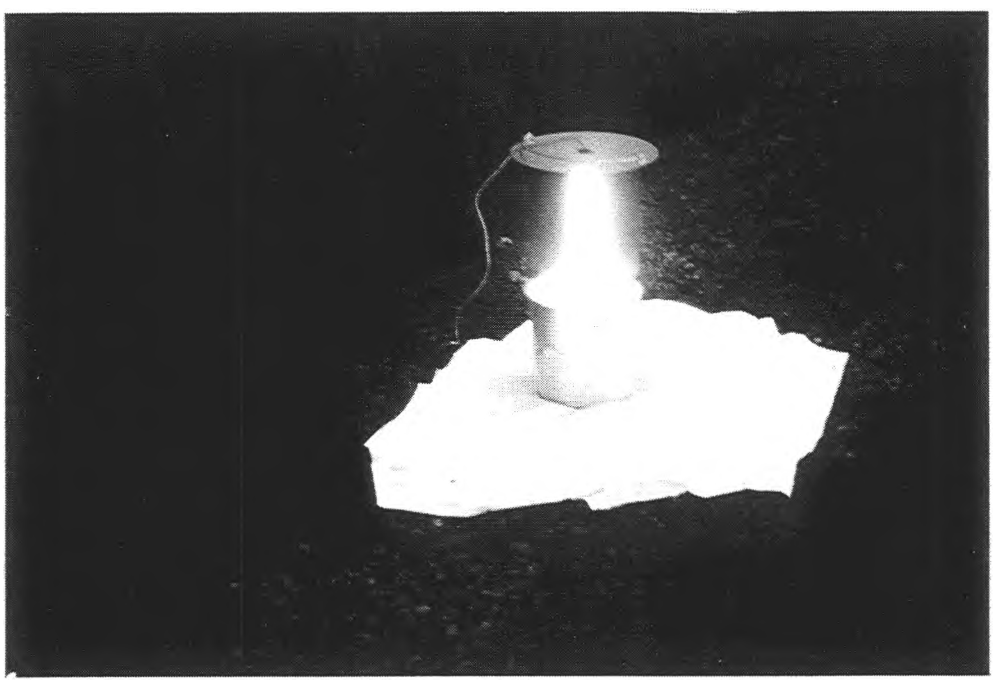
PHOTOGRAPHIC PLATES

A modified Pennsylvania light trap - unassembled.



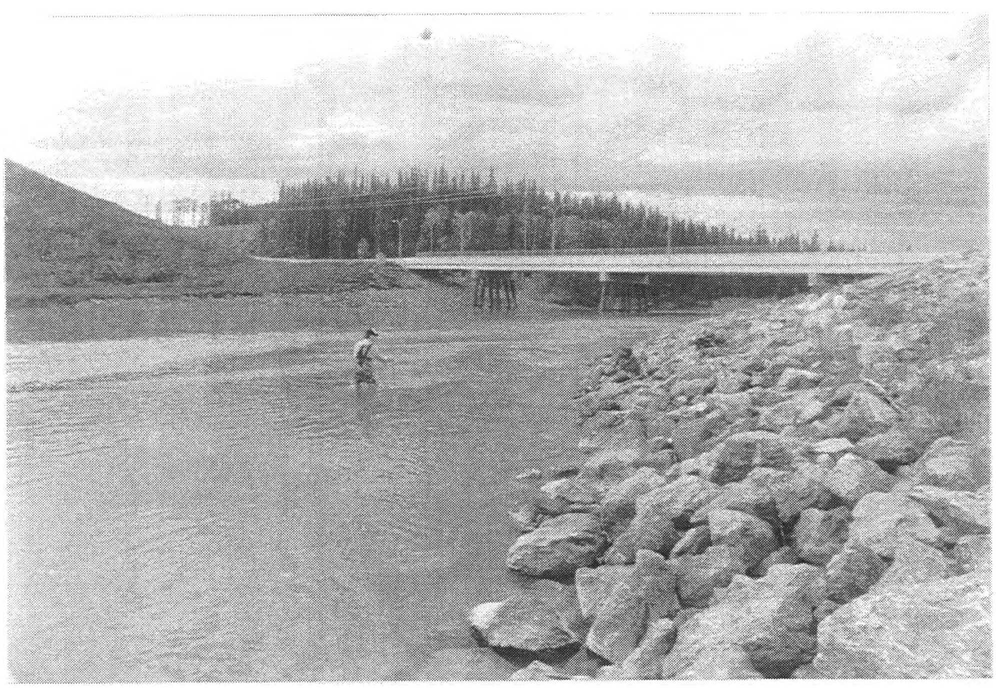
The light trap - assembled.

Light traps at Obed Mountain Coal Bridge, 2 September 1993.



A light trap in operation at Obed Mountain Coal Bridge, 2 September 1993.

Results of one night's catch (4 traps), 3 September 1993. The small group at the top are caddisflies, the remainder were terrestrial and aquatic taxa that were not specified for collection.



Collecting immature aquatic insects, 3 September 1993.