Canada Alberta Northwest Territories

Northern River Basins Study

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Northern River Basins Study
under Project 3117-B7

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NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 23

LAKE WHITEFISH SPAWNING STUDY,

BELOW VERMILION CHUTES ON THE PEACE RIVER OCTOBER, 1992

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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.

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Whereas the above publication is the result of word conducted under the Northern River Basins Study and the terms of reference for the work 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 | 30 Nov 93
(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. Larkin | Dec 16/93
(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.

Bev Burns | Dec. 16, 1993
(Bev Burns, Co-chair) | (Date)

Lucille Partington | Dec. 16, 1993
(Lucille Partington, Co-Chair) | (Date)

NRBS.005

LAKE WHITEFISH SPAWNING STUDY, BELOW VERMILION CHUTES ON THE PEACE RIVER, OCTOBER, 1992

STUDY PERSPECTIVE

The occurrence, distribution, abundance and habitat utilization of fish species of the Peace, Athabasca and Slave rivers and their major tributaries are subjects of major interest to the Study. People living within the basins have identified fish as significant elements of the river's ecosystems. This project was undertaken to verify and document the utilization of the Peace River immediately below Vermilion Chutes by spawning Lake Whitefish. Previous preliminary fisheries inventory studies had suggested that this area may have special significance for Lake Whitefish spawning/rearing. Combined with the local utilization of Lake Whitefish for domestic and commercial purposes the value of the site to maintaining the population and its relationship with the Peace-Athabasca Delta species indicated a need for further study. A supplemental task was to describe the fish habitat and obtain fish tissue samples for contaminant analyses. Some additional information was gathered to indicate the health of the lake whitefish population.

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?

6) What is the distribution and movement of fish species in the watersheds of the Peace, Athabasca and Slave river? Where and when are they most likely to be exposed to changes in water quality and where are their important habitats?

10) How does and how could river flow regulation impact the aquatic environment?

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

Field work was initiated in the fall of 1992 and concluded prematurely because of insufficient fish population size and verification of their habitat utilization was ineffective with the techniques employed.

Additional investigations are recommended to confirm that the level of use was not simply an anomaly and that these include investigations at other sites e.g. Boyer Rapids. Information from this report will be used to design the 1994/95 Food Chain Component workplan. Fish tissues sampled for contaminant analyses have been archived pending Contaminant Component review of the existing analyses.

ACKNOWLEDGEMENTS

R.L.& L. Environmental Services Ltd. would like to acknowledge Mr. K. Crutchfield of the Northern River Basins Study and Mr. D. Walty of the Alberta Fish and Wildlife Division for providing valuable interaction and suggestions throughout all stages of this project. Mr. T. van Meer of Syncrude Canada Ltd. provided important unpublished information regarding lake whitefish spawning in the Athabasca River, and Mr. E. Gerard of Fort Chipewyan shared his first-hand knowledge of the fisheries in the Peace-Athabasca Delta; their assistance is gratefully appreciated. R.L.& L. Environmental Services would also like to thank Messrs. D. Loonskin, A. Peecheemow and J. Laboucan of Fox Lake for their able assistance in the field sampling activities.

The following employees of R.L.& L. Environmental Services Ltd. contributed to the project planning, collection of field data, data analysis, or preparation of this report:

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REPORT SUMMARY

A lake whitefish spawning study below Vermilion Chutes on the Peace River was conducted during 9-13 and 21-24 October 1992. In total, 465 fish of 11 species were captured or observed during the study. Longnose sucker and goldeye were the most abundant species (26% of total catch each), followed by northern pike (17%), walleye (11%), and burbot (7%). Lake whitefish contributed 6% to the total catch. Other species infrequently caught included flathead chub, white sucker, mountain whitefish, lake chub and trout-perch.

The frequency of each species occurrence in the catch was largely dependent on the sampling method used, and on sampling location. Longnose sucker and northern pike predominated in electrofishing catches (34% and 24% of total catch, respectively); species most frequently captured in gill nets were goldeye and walleye (40% and 21%, respectively). Comparison of catch-per-unit-effort (CPUE) between the upper and lower sites within the study area indicated that longnose sucker, walleye, and burbot were more abundant within the upper sites (i.e., immediately below the Vermilion Chutes), while all other species were more abundant in the lower sites (i.e., near the Mikkwa River confluence).

A suspected lake whitefish spawning area was identified along the south bank of the mainstem Peace River, approximately 400 to 800 m upstream of the Mikkwa River confluence. Although spawning was not confirmed by egg collections, 85% of the total lake whitefish catch was obtained from this small area. Based on the small numbers of lake whitefish captured or observed (n=26), and the scarcity of suitable spawning habitat within the area, it was concluded that only limited lake whitefish spawning occurred in the study area during 1992.

The mean size of lake whitefish captured in the study area was significantly larger than that of the spawning populations in the Athabasca River (i.e., mean fork lengths of 520 mm and 398 mm, respectively). This indicated that lake whitefish spawning populations in the lower Peace River were distinct from those that migrate out of Lake Athabasca to spawn in the Athabasca River.

In addition to documenting lake whitefish utilization of the Vermilion Chutes area, the present report includes life history data (e.g., age-length relationships, age-at- maturity) for the main fish species. Patterns of seasonal abundance are discussed on the basis of comparison with previous studies conducted during the spring and fall seasons.

To better understand lake whitefish populations in the lower Peace River, several additional studies are recommended. These include a fall spawning survey below Boyer Rapids, a follow-up survey in the Vermilion Chutes area, and use of radio telemetry to monitor lake whitefish movements and dispersal.

TABLE OF CONTENTS

Page #

LIST OF TABLES

Page #

LIST OF FIGURES

LIST OF PLATES

SECTION 1
INTRODUCTION

Based on the capture of ripe lake whitefish during the October 1988 survey below Vermilion Chutes on the Peace River (Hildebrand 1990), it was hypothesized that this area may constitute an important spawning habitat for lake whitefish population from Lake Athabasca (Figure 1.1). In order to investigate this hypothesis, and to provide quantification of the importance of this area for lake whitefish and other fish species, the Northern River Basins Study contracted R.L.& L. Environmental Services to conduct an intensive survey of this section of the river in October 1992. The survey formed part of the general fish inventory program on the Peace River. Once completed, the inventory data will be used to monitor the sensitivities of resident and migratory fish populations to present development in the basin, and to allow predictive modelling of potential impacts of planned developments in the future.

The present study was designed to estimate the number of lake whitefish and other species utilizing the study area during the late fall period, to identify lake whitefish spawning areas and the time of spawn, and to evaluate the overall egg production and its significance in terms of recruitment to the lake whitefish populations in the Peace River and Lake Athabasca. Life history data, (e.g., age, growth, length-weight relationships, and sexual maturity) were collected for the main fish species to allow comparisons with future monitoring programs. Special effort was undertaken to develop standard sampling procedures and to estimate the level of statistical significance associated with each method. In addition, the overall health of lake whitefish and other fish species was evaluated through gross pathological examinations and collections of fish for contaminant analysis.

Previous fisheries investigations of the Vermilion Chutes area were conducted as parts of overall Peace River inventory studies. Bishop (1975) collected fish during the spring seasons of 1968-1971 through gill netting and seining at selected locations along the Peace River, including the Vermilion Chutes area. Hildebrand (1990) conducted two brief sampling surveys in the area on 17-20 October 1988, and 15-17 June 1989, utilizing boat electrofishing, gill net sets, seines and set lines. More recently, Boag (1993) conducted a fisheries inventory below the Vermilion Chutes on 21-25 May 1992, using boat electrofishing and set lines. These studies provided preliminary data on seasonal patterns of fish utilization of the study area; however, little information regarding fish life history had been reported to date.

Although only a limited amount of data for the target species (i.e., lake whitefish) was obtained during the present study, information on other fish species in the Vermilion Chutes area constitutes an important addition to the present data base on fish populations of the Peace River. Because of this, the present report will focus not only on lake whitefish (as specified in the Terms of Reference), but will also discuss other main fish species encountered in the study area. Patterns of seasonal abundance will be discussed on the basis of comparisons with previous studies conducted during the spring and fall seasons. In addition, the present report will include life history data for sportfish species (e.g., age-length relationships, age-at-maturity) , which have not been reported in any of the previous investigations of the study area.

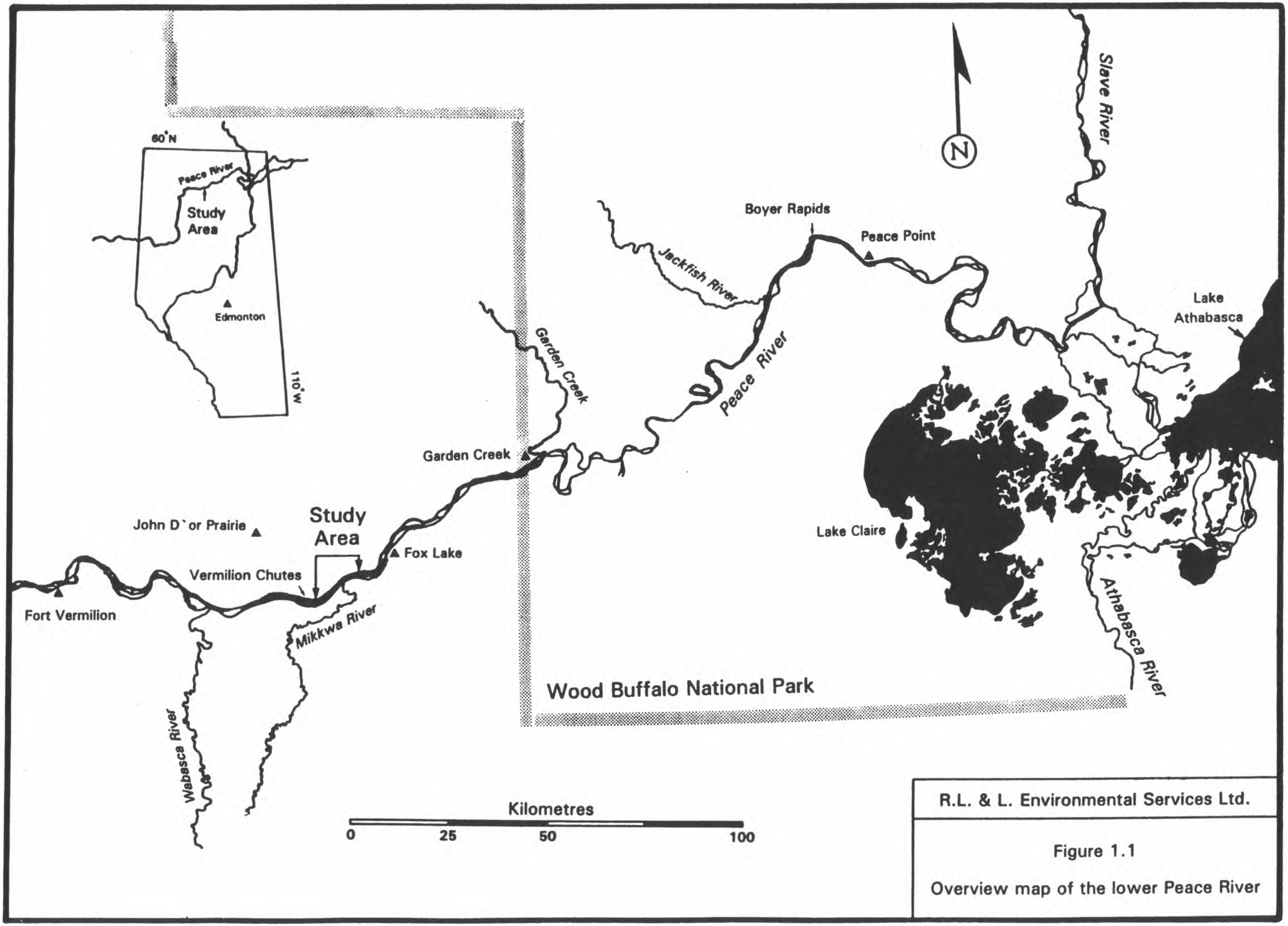

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Figure 1.1

Overview map of the lower Peace River

SECTION 2
OBJECTIVES

The objectives of this study, as specified in the Terms of Reference for Sub-Project 3117-B7 (see Appendix A), were as follows:

1. To determine the relative number of lake whitefish utilizing the Vermilion Chutes as a spawning site and the time of spawn;
2. To determine the number of eggs that are spawned and the overall significance of the recruitment to the lake whitefish populations of the Peace River system and Lake Athabasca;
3. To determine the lake whitefish movements within the Peace River;
4. To map the actual lake whitefish spawning sites and describe the habitat utilized;
5. To determine the relative abundance of all fish species in this site;
6. To determine the lake whitefish population structure within this site.

SECTION 3
METHODS

3.1 STUDY LOGISTICS AND SCHEDULING

In order to maximize the tasks to be accomplished in the short time interval of the lake whitefish spawning activities, the study utilized two three-person crews working simultaneously. Three crew members (Daniel Loonskin, Albert Peecheemow, and John Laboucan) were hired from the nearby Fox Lake Indian Reserve; their knowledge of the river environment and the traditional fishing locations proved to be a valuable asset to the study.

The abandoned Little Red River Settlement at the confluence of the Mikkwa River (Plate 1) was used as a base camp because of its close proximity to the study area. The existence of an airstrip at the settlement facilitated the transport of equipment and supplies (Plate 2). In addition, a rough road (passable only during dry weather or under frozen conditions) connects the settlement to Fox Lake, approximately 15 km away; this road was used on several occasions to transport fish samples for contaminant analysis to be frozen and stored in a walk-in freezer at Jean Baptiste School at Fox Lake.

The Vermilion Chutes are not navigable, therefore river access to the study area had to be made from downstream points of the Peace River. Although there are roads into Garden Creek and Peace Point, suitable boat launches are not available at these locations. The closest launching sites for upstream boat travel were Fort Fitzgerald / Hay Camp on the Slave River, or Fort McMurray on the Athabasca River; however, the distance, travel time, and logistics (e.g., fuel supply) required for this travel made this approach impractical and too costly. Furthermore, due to low Peace River flows during September 1992, boat travel through Boyer Rapids (Figure 1.1) was very difficult, even with a use of a jet drive (E. Gerard, pers. comm.).

The difficulties of accessing the study area by land or river necessitated the transport of all equipment and supplies by plane, chartered from Little Red Air Service in Fort Vermilion. Similarly, the electrofishing boat was airlifted from John D'or Prairie (the closest road access point) into the study area by a helicopter.

Field activities commenced on 9 October 1992. The low numbers of lake whitefish captured during the first four days of the survey suggested that the main spawning run had not yet occurred. As a consequence, field activities were suspended between 14 and 20 October. When substantial numbers of lake whitefish were not encountered during the second survey attempt (21-24 October), the Northern River Basins Study decided to terminate field activities.

3.2 BATHYMETRY

Depth profiles were taken along 14 cross-river transects, using a Lowrance Model X-15 Sonar unit equipped with chart output. The location and direction of each transect are indicated in Figure 3.1. The echosounding traces were used to locate areas of fish concentrations and to generate a bathymetric map of the study area. Because most sections of the river were shallow, the depth profiles generally were mapped using 1 m contour intervals. Contour intervals of 2 m were used only in the deeper areas immediately below the Vermilion Chutes.

3.3 FISH CAPTURE

The main methods used to capture fish were gill netting and boat electrofishing. Seining and set lines also were utilized but to a limited extent. The locations of all sampling sites are shown in Figure 3.2. The following is a brief description of each of the capture methods employed.

Gill Netting

A systematic gill netting program was conducted in deep pools and in habitats with slow current characteristics. In total, 63 monofilament gill net panels (15.2 m long and 1.8 m deep) were set on 19 occasions at 10 distinct locations within the study area (Figure 3.2). Most frequently set were gill nets of 140 mm mesh size (i.e., total of 39 panels set); however, mesh sizes of 114, 89, 64 and 38 mm also were utilized (i.e., 8, 6, 5, and 5 panels set, respectively). Standard gangs (i.e., gill nets consisting of five different mesh size panels) were set on five occasions. Nets were always set overnight, ranging from 16.5 to 23.5 hours in set duration. Data collected at each gill netting location included depth, water velocity, water temperature, substrate type, set duration, and Secchi disc visibility. Set efficiency was recorded as a degree of net fouling rated from 1 to 4, where 1 = high efficiency (net clean) and 4 = low efficiency (net heavily fouled by debris).

Boat Electrofishing

Boat electrofishing was conducted along the shorelines of the river, mostly in areas less than 2 m in depth. A 4.6 m Grumman boat equipped with Type VI electrofisher and two boom-mounted anodes was utilized. Electroshocker settings ranged from 504 to 672 VDC, outputting 5 to 7 A at a pulse width of 4 to 5 ms. In total, 16.7 km of shoreline were sampled during nine electrofishing events conducted at five established sites;

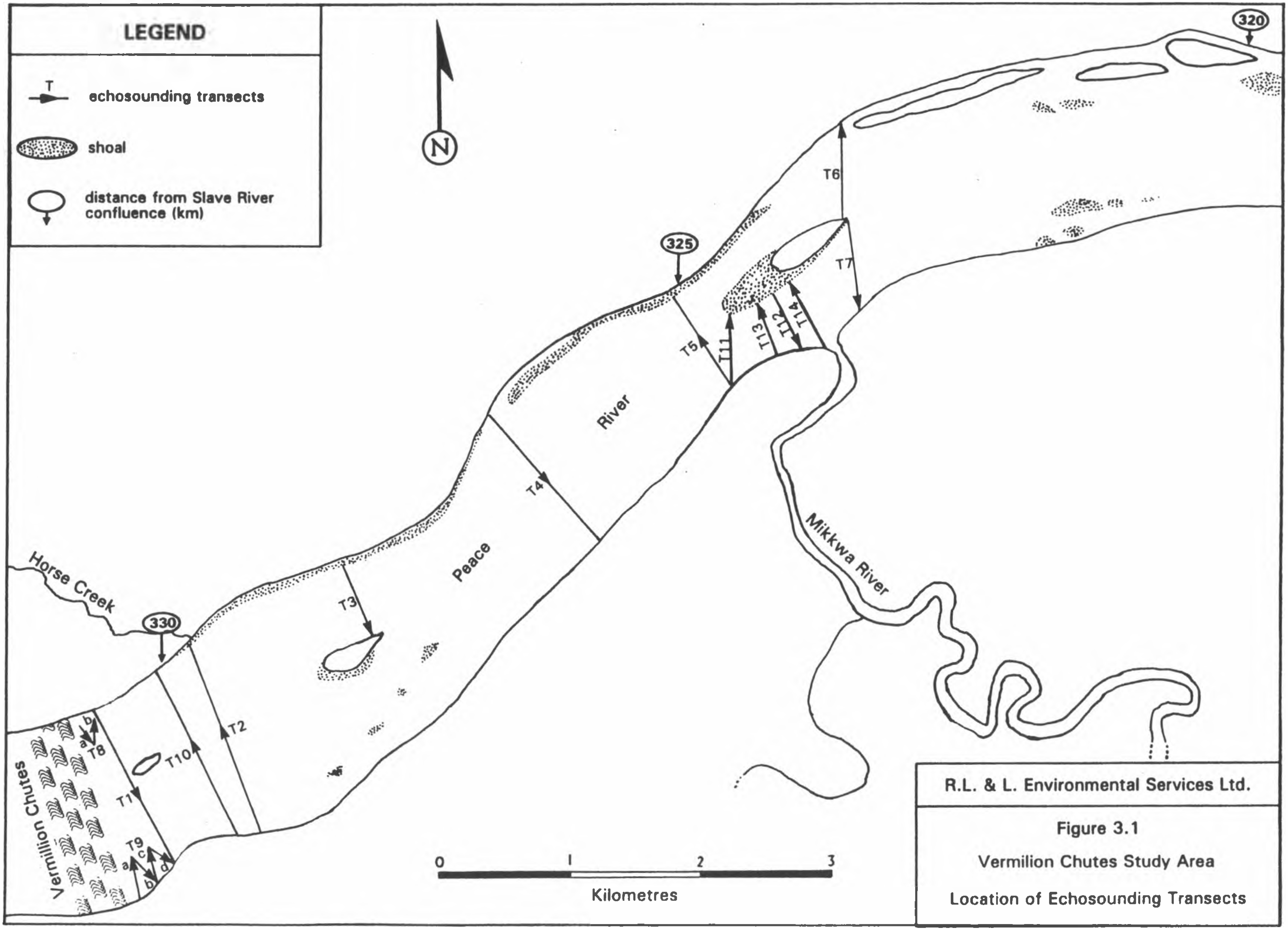

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Figure 3.1

Vermilion Chutes Study Area

Location of Echosounding Transects

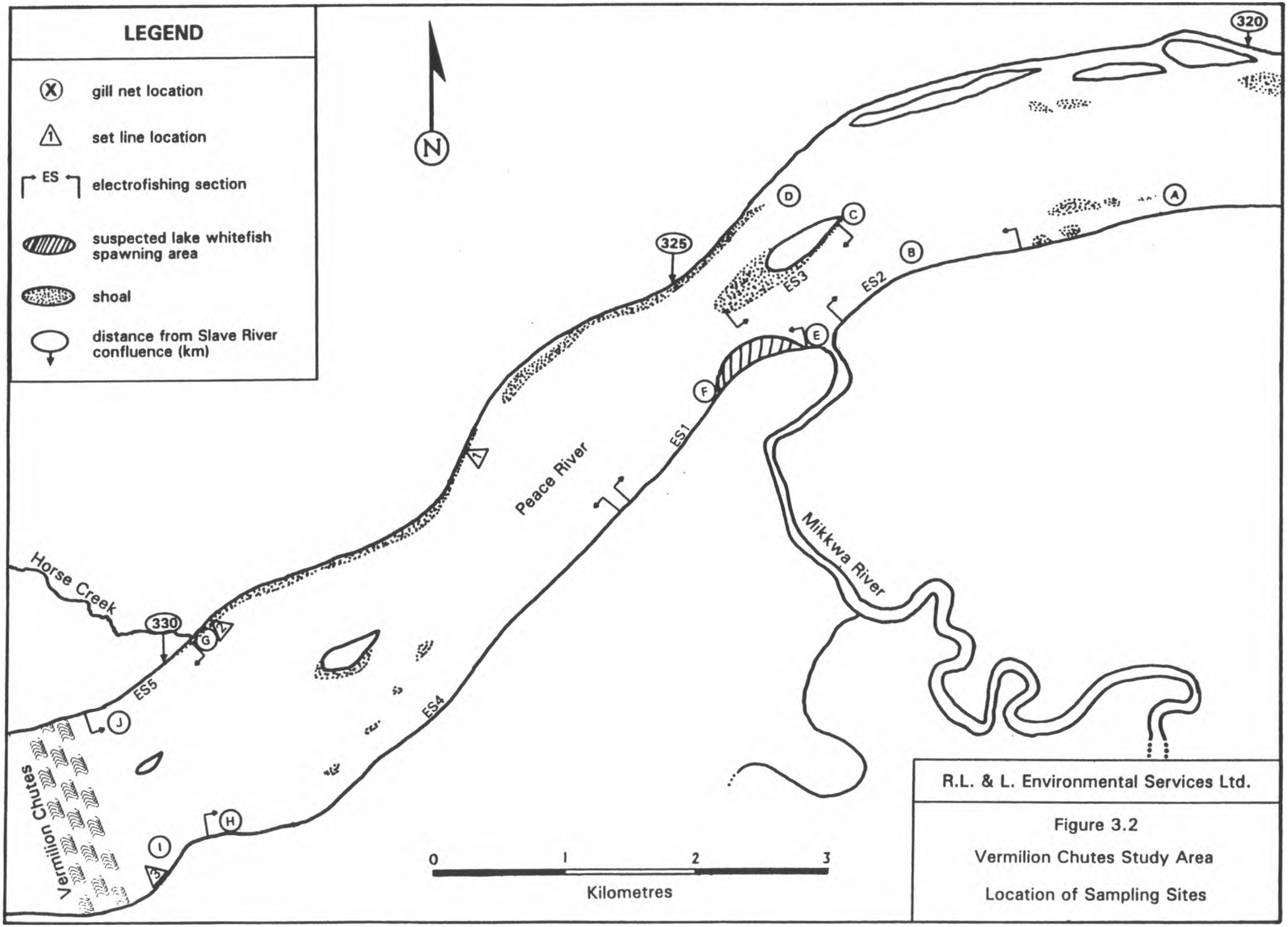

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Figure 3.2
Vermilion Chutes Study Area
Location of Sampling Sites

these sites varied between 1.1 and 4.4 km in length, and included sites sampled during the October 1988 study (Hildebrand 1990).

The procedure involved drifting downstream through a sampling site while continuously outputting pulsed DC current. Two netters were used to capture fish, which were then transferred to an on-board aerated live tank. Once sufficient numbers of fish were collected (i.e., approximately 20), the electrofishing operation was temporarily paused so that the fish could be processed (see section 3.4). Pertinent data recorded at each electrofishing station included number and species of fish captured/observed, section length, sampling time, habitat conditions (e.g., depth, water velocity estimate, substrate type, etc.), water temperature, and electrofisher settings.

Seining

A large seine net (30 m long x 3 m deep with 102 mm mesh size) was utilized on three occasions in an attempt to capture lake whitefish at the site where they were caught by the electrofishing method (approximately 0.4 to 0.8 km upstream from the Mikkwa River confluence). After the total seined area of approximately 4000 m^2 failed to produce any fish captures, this method was abandoned.

Set Lines

Three set lines, consisting of five baited hooks each, were set overnight in an attempt to capture specimens (i.e., mainly burbot and northern pike) for contaminant analysis. The set lines were set approximately 15 to 20 m offshore, and ranged from 19 to 22 hours in set duration.

3.4 FISH DATA COLLECTION

All captured fish were enumerated, measured (fork length to the nearest mm), identified to species, and examined for external gross pathology. Capture date, technique, and location were recorded. In addition, most of the fish were individually weighed (to the nearest gram on Accumet 5000 digital scale). Determinations of sex and maturity, and collections of appropriate ageing structures were obtained from subsamples of sportfish species. Generally, lethal ageing structures (i.e., opercula from goldeye, cleithra from northern pike, otoliths from lake whitefish and walleye) were collected only from fish thta succumbed during capture. In addition, non-lethal ageing structures (scales and fin rays) were collected to increase the sample size of aged fish. The methods used for determining ages of individual specimens are reported in Appendix D, Table D1. Most of the sportfish exceeding 250 mm in fork length and not required for other components of the study, were tagged with yellow Floy tags (supplied by the Northern River Basins Study) and subsequently released.

Fish samples collected for contaminant analysis (i.e., 10 lake whitefish, 12 walleye, 8 northern pike, and 14 burbot) were processed according to the procedure outlined in the Schedule A1 of the Terms of Reference (Appendix A). Fish were individually placed in contaminant-free plastic bags and frozen in dry ice within four hours after collection. Ageing structures were not collected from these fish.

Lake whitefish not used for contaminant analyses were examined for stomach contents and their gonads were individually weighed. All fish that were observed during boat electrofishing but not captured were enumerated.

3.5 EGG COLLECTION

In an attempt to determine lake whitefish spawning locations and to confirm their actual spawning, egg sampling was conducted at the site were mature adult specimens were captured by electrofishing. The egg sampling method involved use of a fine mesh dip net held on the river bottom immediately downstream of a small area (approximately 1.0 m^2) where the substrate was disturbed with a paddle. In addition, a stationary drift net (mouth opening of 60 x 30 cm) was anchored overnight below a suspected spawning site. The contents of each sample were placed in a white enamel pan and examined in the field.

3.6 DATA ANALYSES

All fish data were analyzed on a 386-33 MHz microcomputer utilizing PC-File, FISHPAK, and Lotus 123 software programs. Ageing of the fish was conducted by two independent observers, and in accordance to the methods outlined in MacKay et al. (1990). In cases where difference in ages were noted, the samples were re-aged until a consensus was reached.

Relative abundance of fish was calculated in terms of catch-per-unit-effort (CPUE) for each of the capture techniques employed. CPUE values for boat electrofishing were based on the number of captured and observed fish per distance sampled (in km). CPUE values for gill nets were calculated separately for each mesh size, and expressed as the total catch per net-unit, which was equivalent to 100 m^2 of net set for a period of 12 hours. Set line CPUE was expressed as fish/100 hook-hours of effort.

Mean CPUE values for each species and each capture method were calculated as recommended by Carlander et al. (1958) as follows:

$$\overline{CPUE} = \frac{(\Sigma C_i/n)}{(\Sigma E_i/n)} = \frac{(\Sigma C_i)}{(\Sigma E_i)}$$

where: $\overline{CPUE}$ = mean catch-per-unit-effort
C_i = number of fish caught in the i[th] sampling event,
E_i = effort expended in the i[th] sampling event, and
n = number of sampling events.

The variance of the estimates of mean CPUE values for each sampling method was then calculated in terms of standard error (SE) of the mean, using the propagation of errors technique for the division of two statistics (Gasaway 1967; Schmidt 1975) as follows:

$$S^2_{\overline{CPUE}} = \overline{CPUE}^{\,2} \left(\frac{S^2_{\overline{C}}}{\overline{C}^2} + \frac{S^2_{\overline{E}}}{\overline{E}^2} - \frac{2\ COV\ (\overline{C} \times \overline{E})}{(\overline{C})\ (\overline{E})} \right)$$

where:

$S^2_{\overline{CPUE}}$ = standard error squared of mean CPUE

$$S^2_{\overline{C}} = \frac{1}{n(n-1)} \left(\Sigma C_i^2 - \frac{(\Sigma C_i)^2}{n} \right)$$ = standard error squared of mean number of fish caught per sampling event

$$S^2_{\overline{E}} = \frac{1}{n(n-1)} \left(\Sigma E_i^2 - \frac{(\Sigma E_i)^2}{n} \right)$$ = standard error squared of mean effort expended per sampling event

$$COV(\overline{C} x \overline{E}) = \frac{1}{n(n-1)} \left(\Sigma C_i E_i - \frac{(\Sigma C_i)\ (\Sigma E_i)}{n} \right)$$ = covariance of catch and effort

$\overline{C}$ = mean number of fish caught per sampling event
$\overline{E}$ = mean effort expended per sampling event

In addition to the CPUE calculations for the overall study area, both electrofishing and gill net sampling events were grouped into two sets of data which corresponded to the upper (i.e., immediately below the Vermilion Chutes) and lower (near the Mikkwa River confluence) sites within the study area. CPUE values were then calculated separately for each of the two areas in order to compare fish utilization of these areas on a more localized basis.

Gill net sets which failed to capture any fish due to being fouled and tangled by the current (i.e., set no. GN11) were eliminated from CPUE calculations.

SECTION 4
PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The study area included the Peace River mainstem downstream from the lower edge of the Vermilion Chutes (Km 331 from the Slave River - Peace River confluence), and extended to approximately 3 km below the Mikkwa River confluence (Km 320). The river channel in the upper portion of the study area was predominantly singular and unobstructed with only two permanent islands present. In the lower portion (near the Mikkwa River confluence and downstream) the channel was braided (i.e., two or more channels around permanent islands). The wetted channel widths, measured by Hildebrand (1990) under flow conditions similar to those of the present study, averaged 1210 m and ranged from 680 to 1690 m. Channel and shoreline characteristics of the areas adjacent to the chutes are illustrated in Plates 3 to 6.

4.1 BATHYMETRY

Based on echosounding data (Appendix B), collected under flow regimes of approximately 1700 m^3/s (Water Survey of Canada preliminary data for Station 07KC001), most of the study area was less than 1 m deep, and consisted of extensive side, mid-channel, and point bars (Figure 4.1). The predominant substrates within these depositional bars were fine sand and silt. The deepest areas, generally between 6 and 10 m in depth, were located immediately downstream of the Vermilion Chutes; the channel bed in these areas consisted of extremely jagged and irregular limestone bedrock. The maximum recorded depth was 15.5 m at a site located approximately 40 m below the chute ledge and 60 m away from the north bank.

Water depth became increasingly shallower with downstream distance from the chutes. The maximum depth encountered at transect T2 (approximately 1 km below the chutes) was 3.4 m; at transect T4 (approximately 4 km below the chutes) it was only 1.6 m. Farther downstream, the separation of the river channel by a large permanent island opposite the Mikkwa River confluence resulted in increased channel depth near both banks of the mainstem (maximum depths recorded at transect T5 were 4.3 m near the south bank and 3.2 m near the north bank; Appendix B).

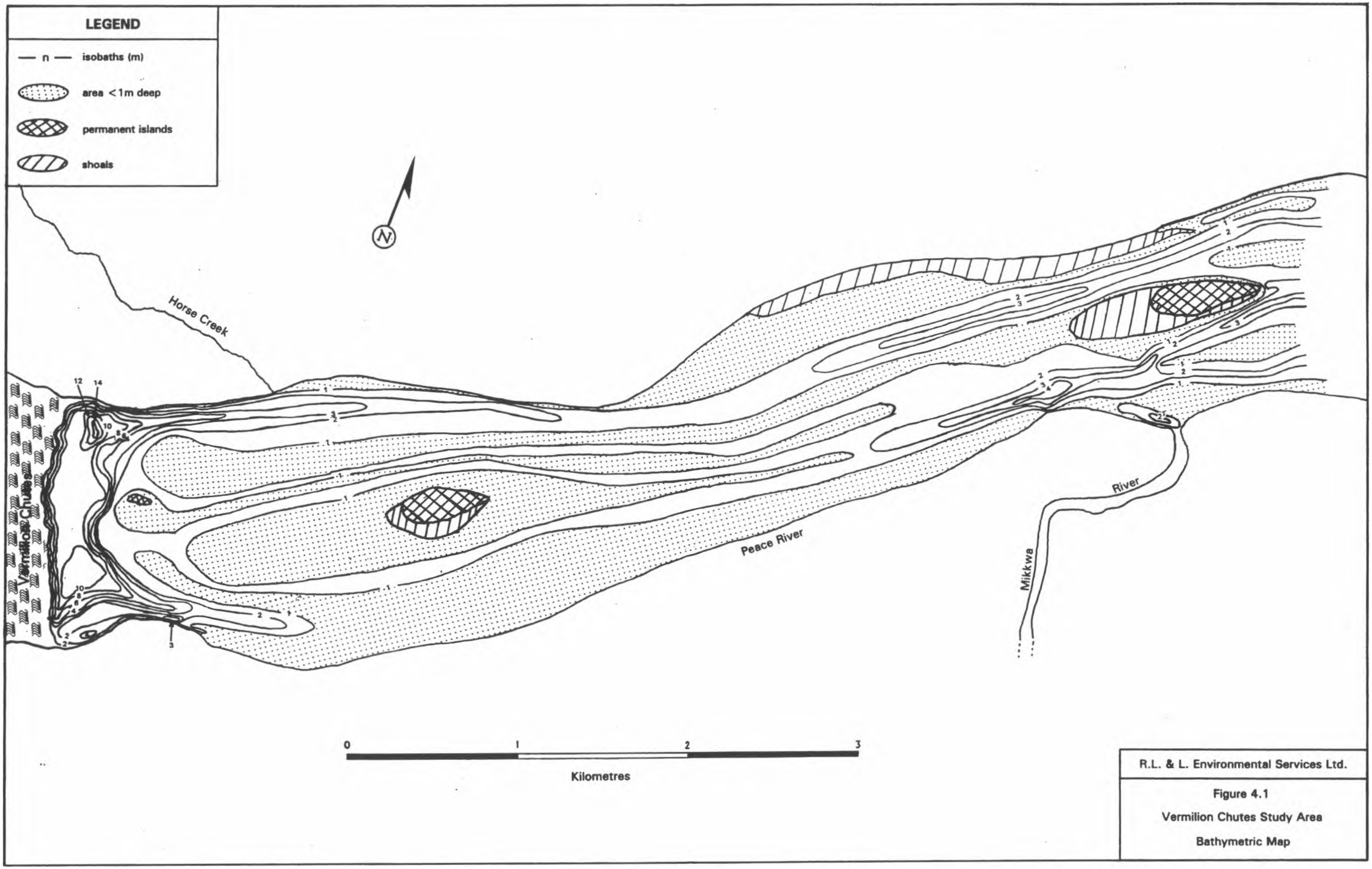

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Figure 4.1
Vermilion Chutes Study Area
Bathymetric Map

4.2 FLOW CHARACTERISTICS

The mean monthly discharges of the Peace River at Peace Point (the closest Water Survey of Canada flow monitoring station, located approximately 200 km downstream of the study area) during the 1968-1992 post-regulation period were 1671, 1777, and 1553 m^3/s in the months of September, October and November, respectively (WSC 1992). During the early fall of 1992, the flow regime of the Peace River was substantially different from the long-term mean, and from the conditions which preceded the October 1988 survey (Hildebrand 1990) (Figure 4.2). The 1992 discharges were characterized by low flows during early to mid September, followed by a dramatic increase in discharge between 16 September (1100 m^3/s) and 2 October (2440 m^3/s). Subsequently, there was a rapid decrease in discharge; by mid-October (and through the survey period), flows were similar to the mean historical October flow regimes, and also to flow regimes during the 1988 survey.

The large fluctuations in river discharge during the fall of 1992 resulted in extreme variations in daily water levels. Preliminary water level data from the Water Survey of Canada station at Fort Vermilion, located approximately 80 km upstream from the study area, are presented in Figure 4.3. Both the flow data from Peace Point (Figure 4.2), and the water level data from Fort Vermilion (Figure 4.3), show the same pattern of fluctuations throughout the fall of 1992; however, the peak events were generally recorded 3 days earlier at Fort Vermilion than at Peace Point. This delay reflects the large distance (approximately 280 km) separating the two WSC stations. During early fall of 1992 (i.e., 1-13 September), water levels at Fort Vermilion were as much as 1.2 m lower than the monthly mean. During the second half of September 1992, water levels increased rapidly to levels 0.7 m higher than the monthly mean. Subsequent decrease during early October resulted in water levels during the survey period that were very similar to the long-term monthly mean.

4.3 WATER TEMPERATURE

Surface water temperature data collected during each gill net and electrofisher sampling events are included in Appendix C, Tables C1 and C2. During the first phase of the study (10-13 October), water temperature in the mainstem Peace River varied between 5°C and 8°C. The Mikkwa River generally was 2°C or 3°C colder than the mainstem Peace River; this resulted in cooler water temperatures recorded along the south bank of the Peace River for at least 3 km downstream of the confluence (at gill net sites A and B; Appendix C, Table C1).

During the second stage of the survey, the mainstem Peace River water temperatures were considerably colder than during the first stage; they ranged from 1°C to 2°C. The Mikkwa River was partially covered by ice (along the banks), and broken ice flows were frequently observed entering the mainstem Peace River.

Throughout both survey periods, the mainstem water was turbid and muddy in appearance; Secchi disc visibility measurements ranged from 45 to 70 cm (Appendix C, Table C1).

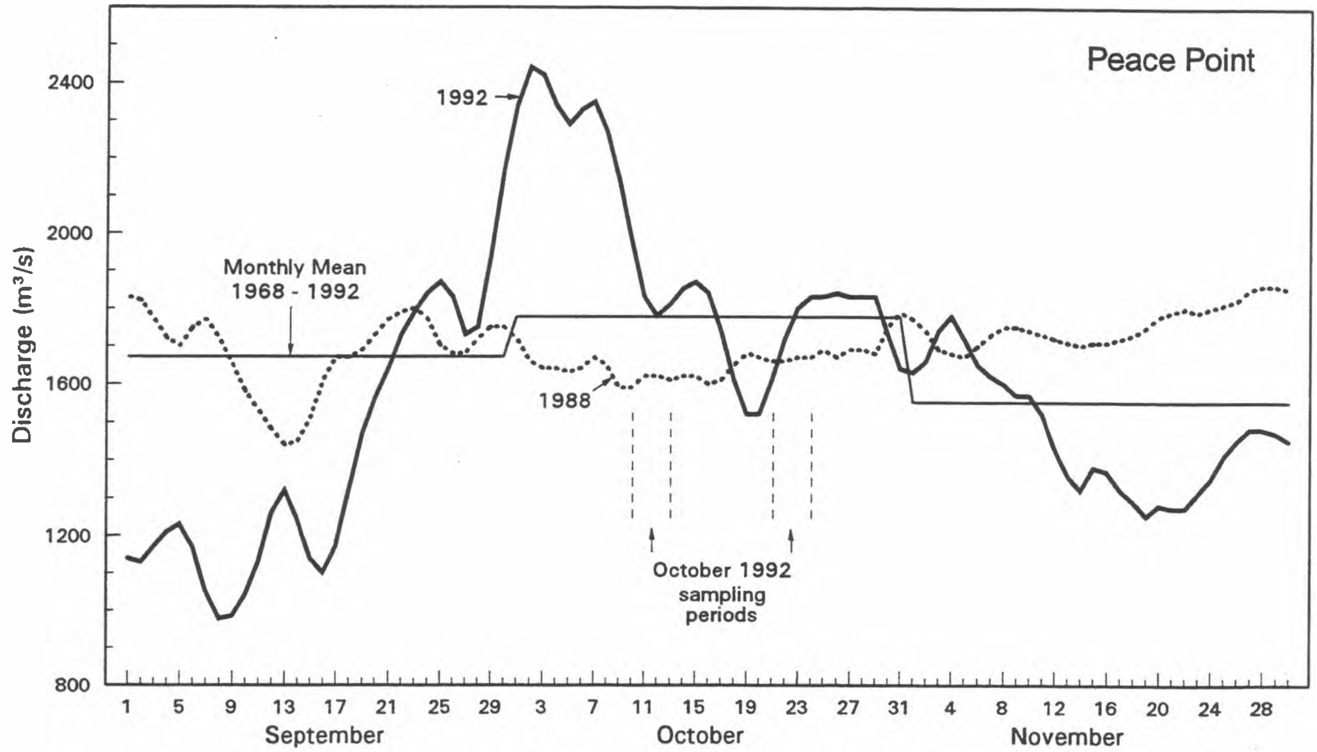

Figure 4.2 Daily discharges of the Peace River at Peace Point during the fall of 1988 and 1992, and mean monthly flows during the 1968 - 1992 post-regulation period of record (preliminary data from Water Survey of Canada Station No. 07KC001).

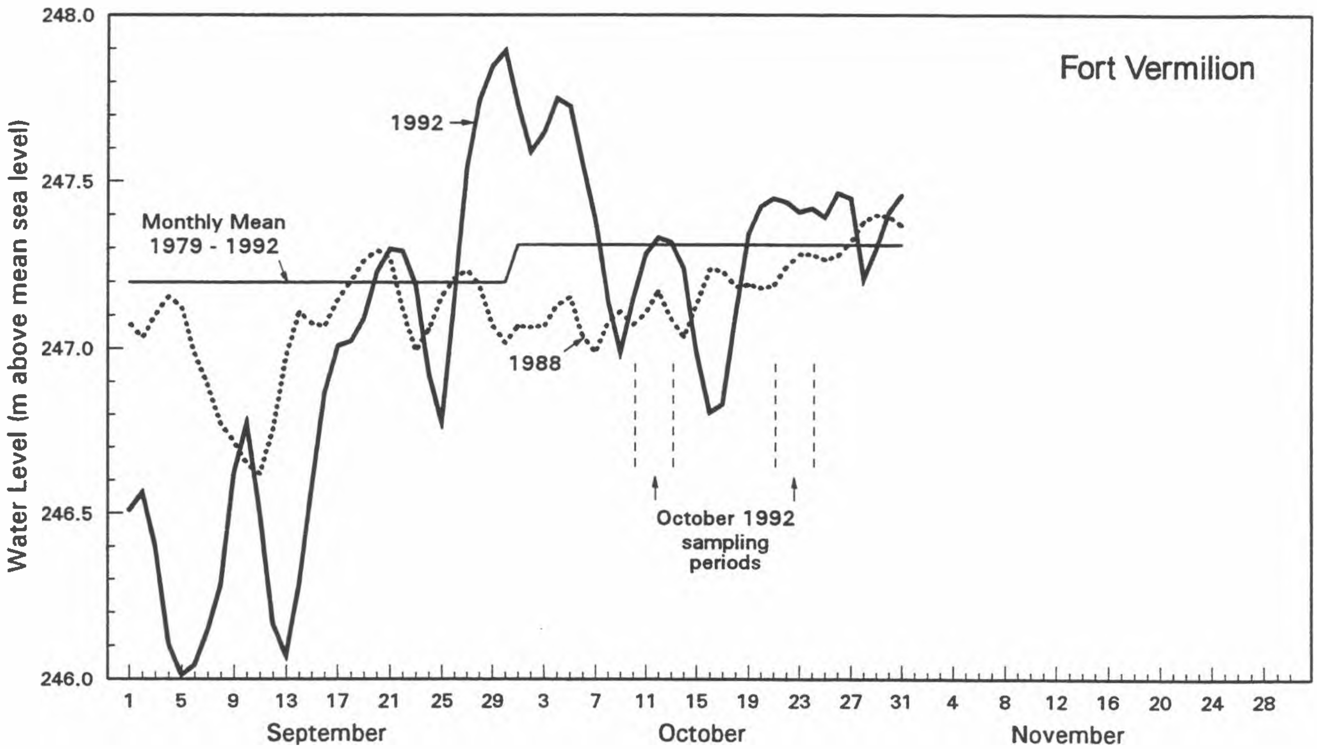

Figure 4.3 Daily water levels of the Peace River at Fort Vermilion during the fall of 1988 and 1992, and mean monthly water levels during the 1979 - 1992 period of record (preliminary data from Water Survey of Canada Station No. 07HF001).

SECTION 5
FISH SPECIES COMPOSITION AND RELATIVE ABUNDANCE

In total, 465 fish representing 11 species were captured or observed during the study (Table 5.1; Appendix C, Tables C1, C2, and C3). Longnose sucker was the dominant species (26.0% of the catch), followed by goldeye (25.8%), northern pike (17.2%), walleye (11.2%), and burbot (7.1%). Lake whitefish contributed 5.6% to the total catch. Other species infrequently caught included flathead chub (5.4%), white sucker (1.1%), mountain whitefish (0.2%), lake chub (0.2%), and trout-perch (0.2%).

Table 5.1 Fish species recorded in the Peace River below Vermilion Chutes in October 1992, and percent frequency of their occurrence.

Species	Species Code	Gill Nets		Electrofishing		Set Lines		Total	
		N[a]	%	N[a]	%	N[a]	%	N[a]	%
Lake whitefish	LKWH	1	0.5	14 (11)	9.2		0.0	26	5.6
Mountain whitefish	MNWH		0.0	1	0.4		0.0	1	0.2
Walleye	WALL	39	21.2	11 (2)	4.8		0.0	52	11.2
Northern pike	NRPK	16	8.7	33 (31)	23.5		0.0	80	17.2
Goldeye	GOLD	73	39.7	19 (28)	17.3		0.0	120	25.8
Burbot	BURB	23	12.5	1	0.4	9	100.0	33	7.1
Longnose sucker[b]	LNSC	30	16.3	30 (61)	33.5		0.0	121	26.0
White sucker[b]	WHSC	2	1.1	1 (2)	1.1		0.0	5	1.1
Flathead chub	FLCH		0.0	5 (20)	9.2		0.0	25	5.4
Lake chub	LKCH		0.0	1	0.4		0.0	1	0.2
Trout-perch	TRPR		0.0	1	0.4		0.0	1	0.2
TOTAL		184	100.0	117 (155)	100.0	9	100.0	465	100.0

[a] number captured (number observed and identified but not captured is indicated in parenthesis)
[b] 47 suckers observed during electrofishing but not identified to species, were assigned species on the basis of their relative frequency in the identified catch (i.e. 45 longnose and 2 white suckers)

The frequency of each species occurrence in the catch was largely dependant on the sample method. Most (i.e., 57%) of the electrofishing catch was comprised of longnose sucker and northern pike; these two species combined contributed only 25% to the gill net catch (Table 5.1). In contrast, goldeye and walleye were the predominant species captured in gill nets (i.e., 61% of the catch); however, their combined contribution to the electrofishing catch was only 22%. Lake whitefish were captured (or observed) almost exclusively by the electrofishing method (contributing 9.2% to the total electrofishing catch); only one specimen was captured in gill nets.

In addition to affecting the relative frequency of fish species in the catch, the three main sampling methods were characterized by different selectivity with regards to the total number of species captured. Eleven species were captured by boat electrofishing, seven species were recorded in gill net catches, and only one species (i.e., burbot) was caught in set lines (Table 5.1).

Relative abundance of each fish species, expressed as catch-per-unit-effort (CPUE) for each capture method used, is presented in Table 5.2 and Figures 5.1, 5.2 and 5.3. Considerable differences were observed in the catches within the upper (i.e., immediately below the chutes) and lower (i.e., near the Mikkwa River confluence) sections of the study area; therefore, mean CPUE values and their estimate of standard error were calculated separately for each area (Appendix C, Tables C4 and C5). In order to simplify the presentation of gill net CPUE results, and to allow comparison with data from previous studies, CPUE values for each mesh size used (Appendix C, Table C4) were averaged to obtain mean catches per one net-unit of a "standard gang" (Table 5.2). The patterns of localized abundance within the study area and comparisons with CPUE values reported in previous studies will be discussed separately for all main species in the following sub-sections.

Table 5.2 Relative abundance, expressed as catch-per-unit-effort, for fish species below Vermilion Chutes on the Peace River, October 1992.

Species	Gill Nets[a]			Boat Electrofishing[b]			Set Lines[c]
	Upper Sites	Lower Sites	Combined	Upper Sites	Lower Sites	Combined	Upper Sites
Lake whitefish	0.00	0.02	0.01	0.15	2.38	1.50	0.00
Mountain whitefish	0.00	0.00	0.00	0.00	0.10	0.06	0.00
Walleye	2.35	0.93	2.13	0.76	0.79	0.78	0.00
Northern pike	0.83	2.44	1.13	1.67	5.25	3.83	0.00
Goldeye	5.06	7.64	5.62	1.82	3.47	2.81	0.00
Burbot	1.71	0.06	1.11	0.15	0.00	0.06	2.86
Longnose sucker	2.72	0.00	2.00	11.67	1.39	5.45	0.00
White sucker	0.00	0.04	0.02	0.15	0.20	0.18	0.00
Flathead chub	0.00	0.00	0.00	2.42	0.89	1.50	0.00
Lake chub	0.00	0.00	0.00	0.00	0.10	0.06	0.00
Trout-perch	0.00	0.00	0.00	0.00	0.10	0.06	0.00
TOTAL	12.68	11.12	12.03	18.79	14.65	16.29	2.86

[a] number of fish captured in 100 m^2 of gill net (consisting of equal amounts of 38, 64, 89, 114 and 140 mm mesh size panels) set for an equivalent of 12 h (calculated using mean CPUE values for each mesh size)
[b] number of fish captured or observed/km
[c] number of fish captured/100 hook-hours

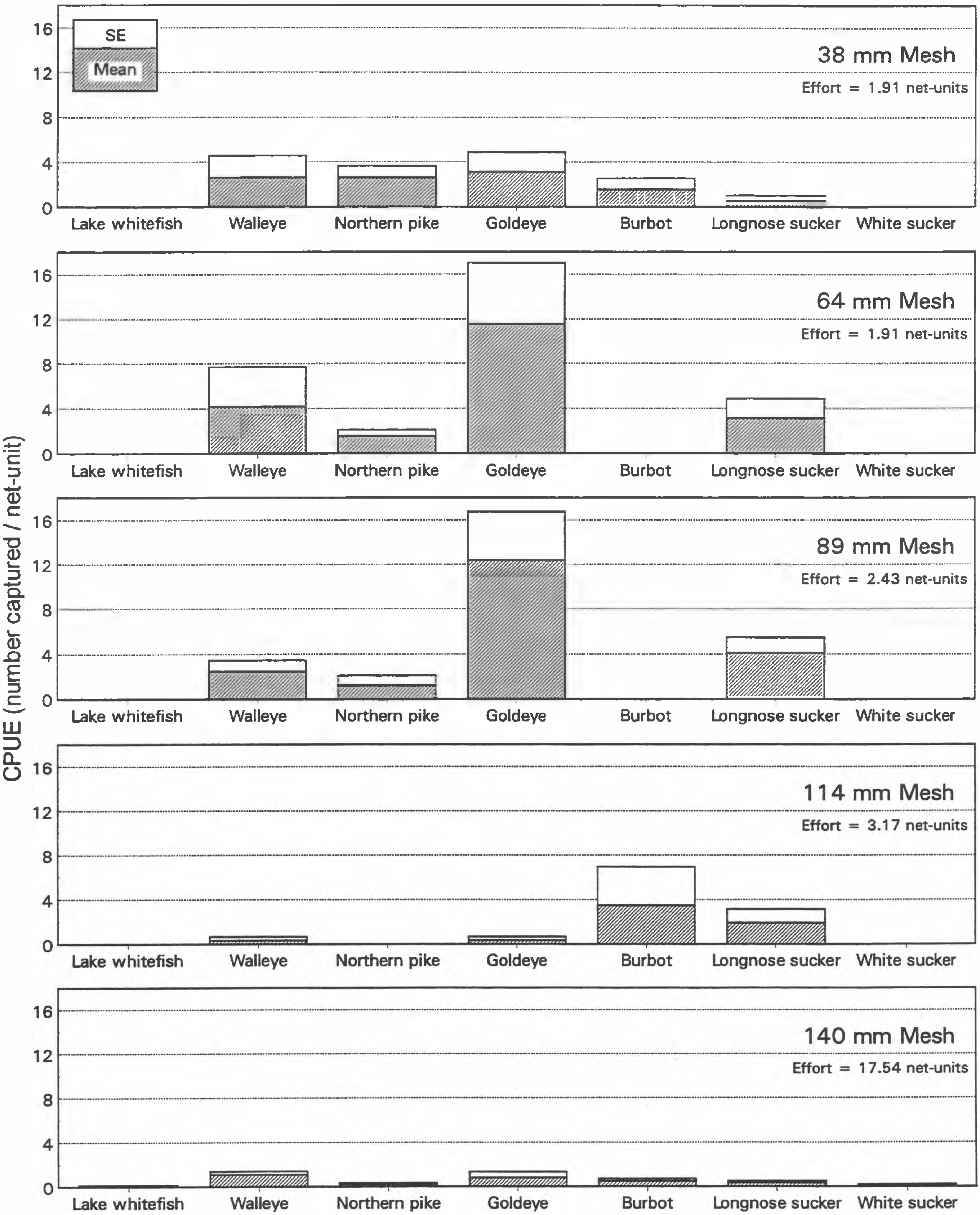

Figure 5.1 Mean catch-per-unit-effort (+1 SE) in gill nets set below Vermilion Chutes on the Peace River, October 1992. One net-unit = 100 m² of gill net set for 12 h.

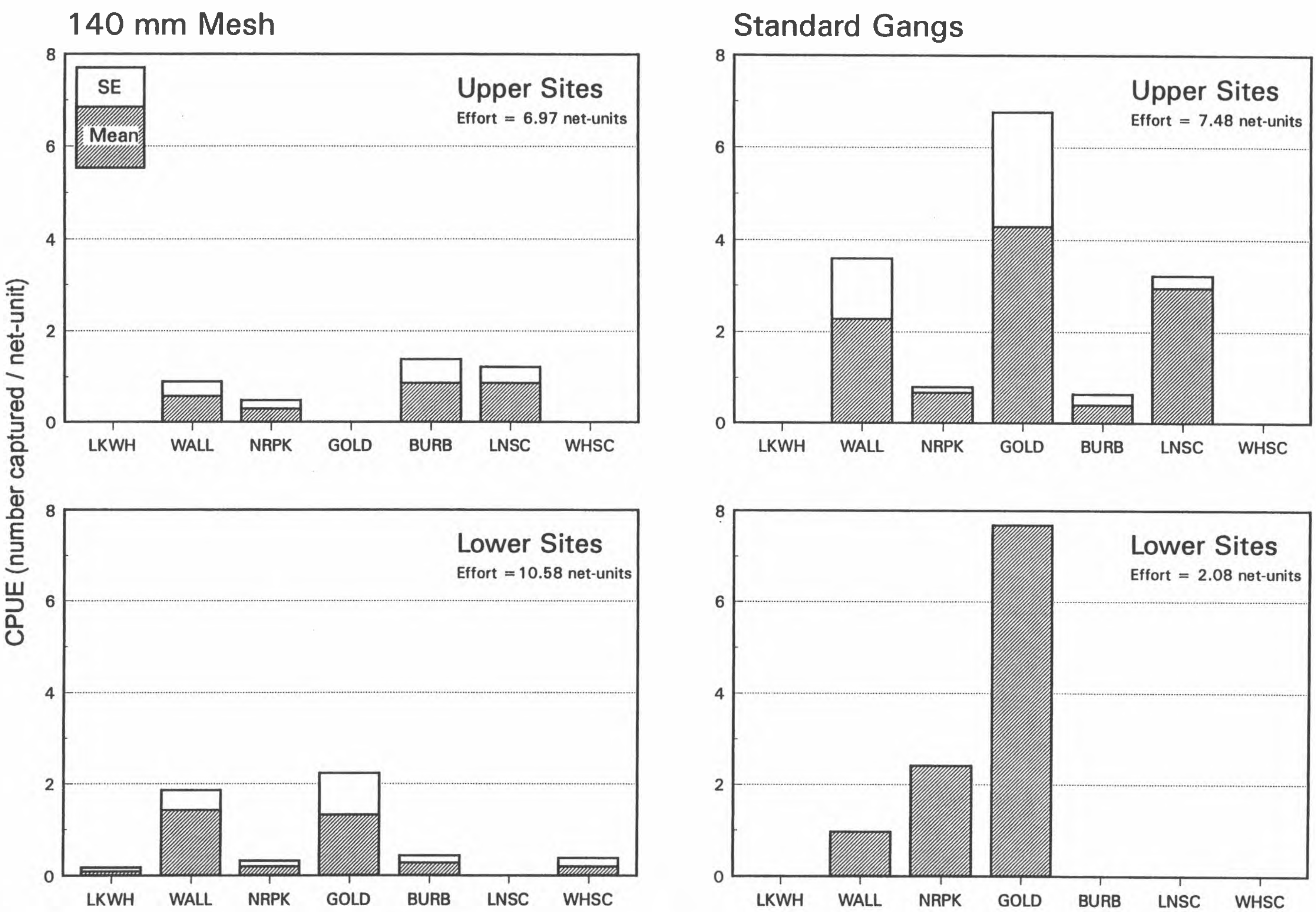

Figure 5.2 Mean catch-per-unit-effort (+1 SE) in gill nets of 140 mm mesh size and in standard gangs (38, 64, 89, 114, and 140 mm mesh size) set in the upper and lower study sites below Vermilion Chutes on the Peace River, October 1992 (1 net-unit = 100m² of net set for 12 hours).

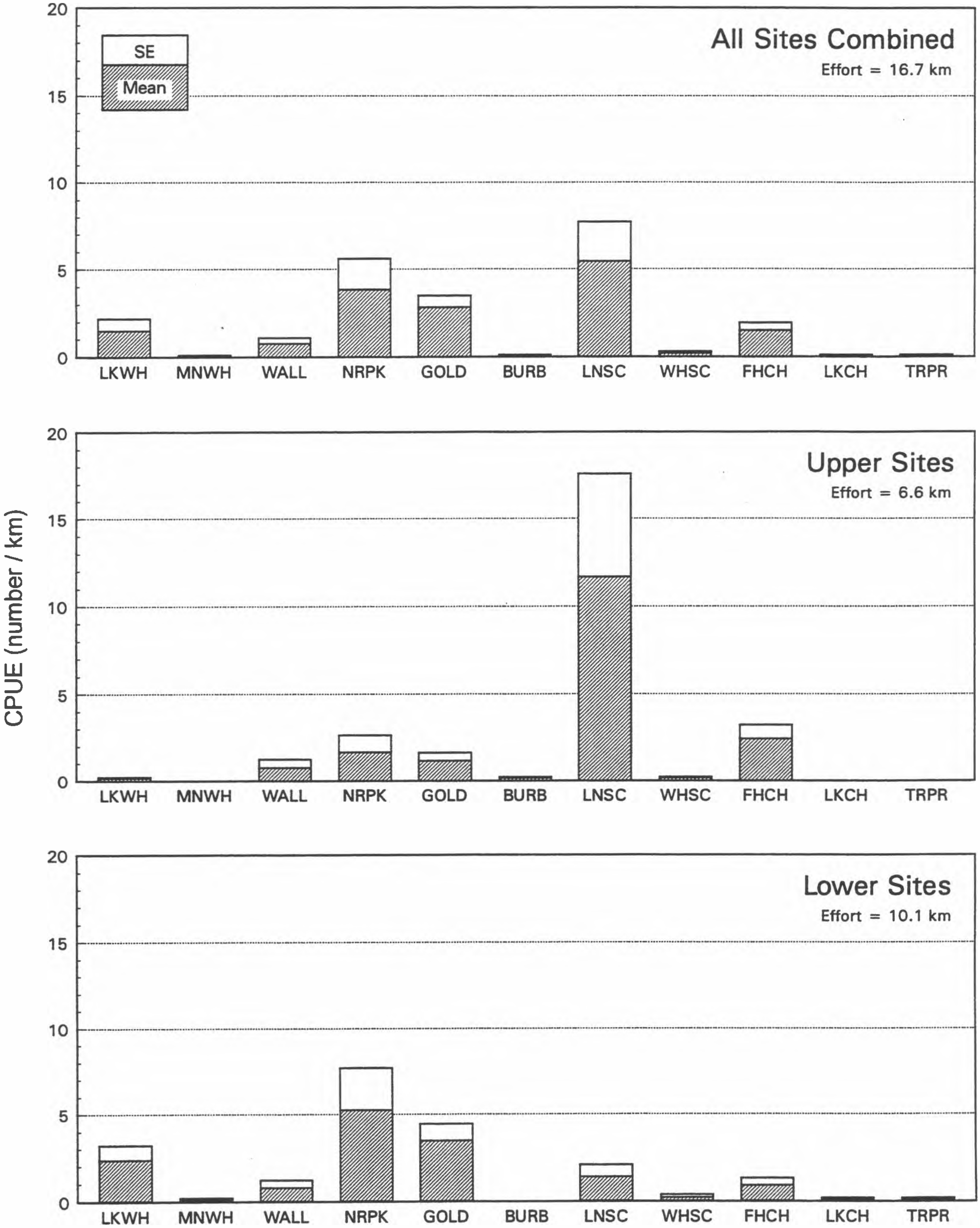

Figure 5.3 Comparison of mean catch-per-unit-effort (+1 SE) for all fish species captured or observed during boat electrofishing in the Vermilion Chutes area of the Peace River, October 1992.

5.1 LAKE WHITEFISH

The overall boat electrofishing CPUE for lake whitefish was 1.5 fish/km (Table 5.2; Figure 5.1). On a localized basis, lake whitefish were more frequently caught or observed in the lower sites than in the upper sites (i.e., CPUE values of 2.38 and 0.15 fish/km, respectively). The highest mean CPUE rate (3.67 fish/km; Appendix C, Table C2) was recorded at station ES1 (immediately upstream of the Mikkwa River confluence). Only one lake whitefish was captured by gill nets; this individual was caught in 140 mm mesh size net at location C (Figure 3.2).

The lake whitefish catch rate reported by Hildebrand (1990) for electrofisher sampling during October 1988 was 2.65 fish/km (Figure 5.4). When the sampling stations in October 1988 corresponded in location to the lower stations in the 1992 study, the CPUE rates were very similar (i.e., 2.65 fish/km in 1988 and 2.38 fish/km in 1992). In addition, Hildebrand reported that 92% of the total lake whitefish catch was obtained at Station ES1; the same sampling station contributed 88% to the catch in 1992. Lake whitefish were not captured in gill nets in 1988, likely due to the low level of effort expanded in setting large-sized gill nets (i.e., only 0.46 net-units of 140 mm mesh).

Spring surveys conducted in June 1989 (Hildebrand 1990) and May 1992 (Boag 1993) failed to detect lake whitefish presence in the study area. This indicates that these fish utilize the Vermilion Chutes area only during the fall spawning season; during the rest of the year they most likely inhabit Lake Athabasca or the Peace-Athabasca Delta, as was documented for the lake whitefish populations that spawn in the Athabasca River (Jones et al. 1978; Bond 1980; Berry 1986).

5.2 WALLEYE

The overall electrofishing CPUE value for walleye was 0.78 fish/km; there was no difference between catch rates in the upper and lower sections of the study area (Figure 5.3). In contrast, standard gang gill net catch rates were more than twice as high in the upper sites than in the lower (i.e., 2.35 and 0.93 fish/net-unit, respectively; Figure 5.2). Walleye were most frequently caught in gill nets of 64 mm mesh size (CPUE of 4.19 fish/net-unit) and least frequently in 114 mm mesh (0.32 fish/net-unit; Figure 5.1). The catch rate in 140 mm mesh size gill nets was considerably greater in the lower than in the upper sites (i.e., 1.42 and 0.57 fish/net-unit, respectively), indicating that although walleye in general were more abundant near the chutes, the larger size classes tended to be found in the vicinity of the Mikkwa River confluence. Analysis of fish size data corroborated this by revealing significant (t-test; $p < 0.05$) difference between the mean fork lengths of walleye

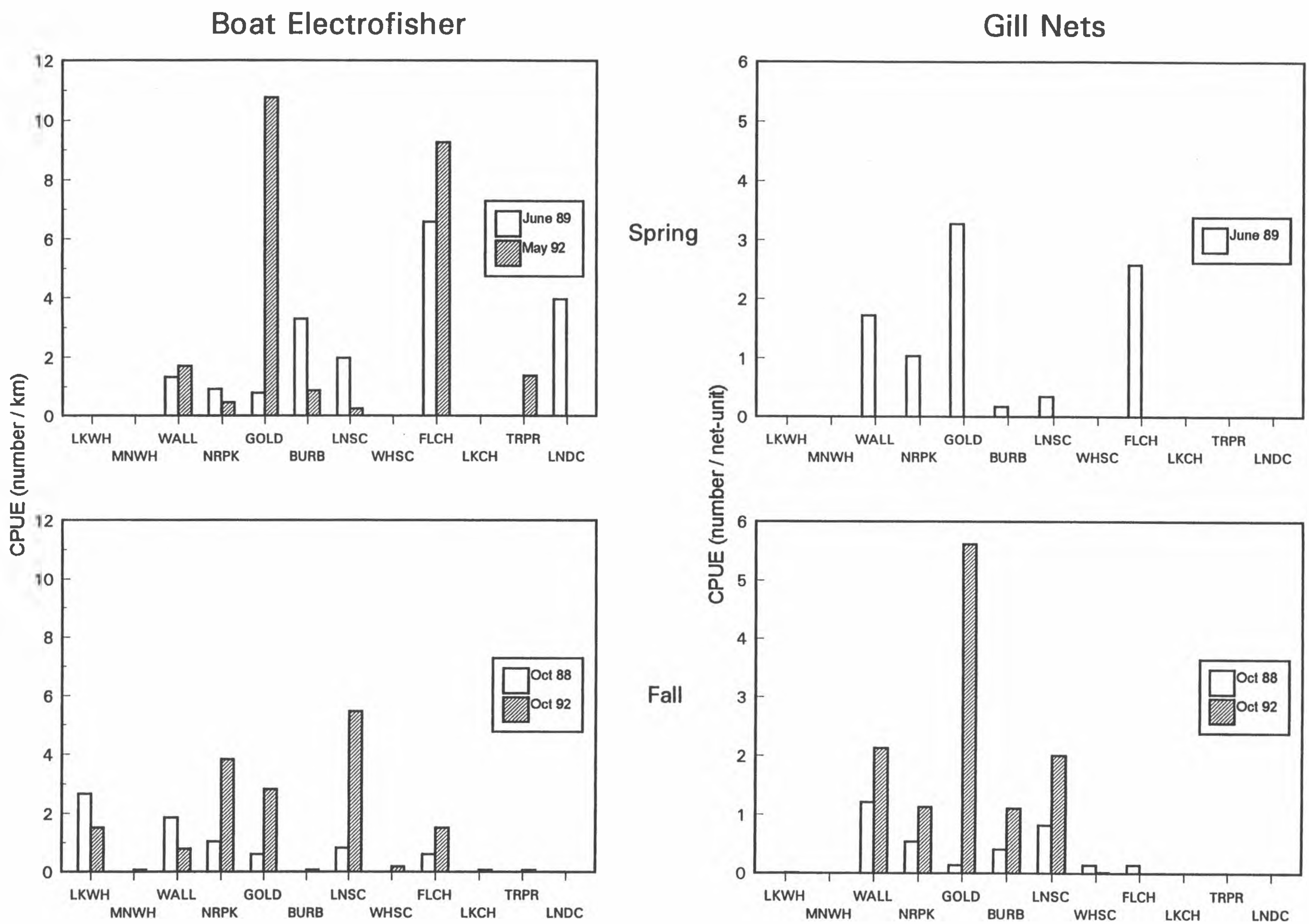

Figure 5.4 Comparison of catch-per-unit-effort (CPUE) for boat electrofishing and gill netting methods during spring (Hildebrand 1990, Boag 1993) and fall (Hildebrand 1990, present study) surveys below Vermilion Chutes on the Peace River. One net-unit = 100 m² of equal amounts of 38, 64, 89, 114 and 140 mm mesh size nets set for 12 h.

captured in the upper and lower sections of the study area (i.e., 429 and 521 mm, respectively; Appendix D, Table D1).

The comparison of walleye CPUE values reported by Hildebrand (1990) and Boag (1993) for both spring and fall surveys with values from the present study, do not indicate substantial changes in catch rates between either the seasons or survey years (Figure 5.4). This indicates that walleye inhabiting the Peace River below the Vermilion Chutes are probably year-round residents, utilizing the area (including the Mikkwa River and Horse Creek tributaries) for all life history functions (i.e., spawning, rearing, feeding and overwintering). Support for this hypothesis was provided by walleye that were tagged in the study area shortly after spawning in May 1992 and recaptured in the same area at the end of July and in mid-October (see Section 9).

5.3 NORTHERN PIKE

Northern pike was the most common species captured or observed during electrofishing in the lower sections of the study area (CPUE of 5.25 fish/km; Table 5.2 and Figure 5.3). This species was approximately three times less abundant in the upper sections (CPUE of 1.67 fish/km). Standard gang gill net catch rates indicated a similar three-fold difference in relative abundance between the upper and lower sections of the study area (CPUE of 0.83 and 2.44 fish/net-unit, respectively). Northern pike were most frequently caught in nets with the smallest mesh size (i.e., 38 mm); catch rates tended to decrease with increasing mesh sizes (Figure 5.1).

In comparison to the October 1988 survey (Hildebrand 1990), northern pike catch rates were approximately two or three times higher in October 1992, during both gill net and electrofishing sampling events (Figure 5.4). The reason for this increase is unknown; however, it may be partially due to a greater representation of smaller-sized fish in the 1992 catch (i.e., 59% of the catch were less than 340 mm in fork length; in 1988 the corresponding proportion was 25%; Appendix D, Table D2).

Northern pike were consistently captured in the area during spring and fall sampling surveys (Hildebrand 1990; Boag 1993); this suggested a year-round presence in the study area. This hypothesis was supported by the tagged fish recapture data (see Section 9). The sedentary nature of northern pike was documented during the 1976-1980 fish movement studies conducted in the Peace-Athabasca Delta and the Athabasca River, where 77% of recaptured fish (n=712) were taken within 10 km of their original release site (Bond 1980; Berry 1986).

5.4 GOLDEYE

Goldeye was the main fish species captured in gill nets (40% of the total catch); the mean overall catch rate in a standardized gang was 5.62 fish/net-unit (Table 5.2). Highest catch rates were recorded in the 89 and 64 mm mesh sizes (i.e., 12.35 and 11.51 fish/net-unit, respectively); catches in larger mesh sizes averaged less than one fish/net-unit (Figure 5.1, Appendix C, Table C4). The mean CPUE by boat electrofishing was 2.81 fish/km.

Goldeye were frequently captured throughout the study area, but tended to be more abundant in the lower sampling sites than in the upper. This trend was evident in catch rates from both gill nets (i.e., 7.64 and 5.06 fish/net-unit for lower and upper sites, respectively) and electrofishing (i.e., 3.47 and 1.82 fish/km, respectively).

Hildebrand (1990) captured or observed only five goldeye during the October 1988 survey and suggested that this species overwinters in downstream areas. Large concentrations of goldeye encountered during the present study suggested that, at least in some years, goldeye may overwinter in the Vermilion Chutes area. Extensive investigations of goldeye populations in the Peace-Athabasca Delta (Donald and Kooyman 1974, 1977; Kristensen and Summers 1978; Kristensen 1981) indicated that most fish overwinter in the lower Peace River, move into the Delta in May and June to spawn, and remain there until late summer before returning to the lower Peace River. The capture of large numbers of mature goldeye below Vermilion Chutes in May 1992 (Boag 1993) indicated that goldeye population in the study area may exhibit different migratory patterns than populations in the Peace-Athabasca Delta. The hypothesis that goldeye spawn in the vicinity of the study area was also indirectly supported by the numerous catches of goldeye (including yearlings) in June 1989 (Hildebrand 1990), and by the findings of young-of-the-year fish during the present study (see Section 7.4).

5.5 BURBOT

Catch rate of burbot in standard gang gill nets averaged 1.11 fish/net-unit; highest CPUE values were recorded from the 114 mm mesh size (i.e., 3.47 fish/net-unit; Appendix C, Table C4). Most (i.e., 87%) burbot were captured in the upper sections of the study area, mainly in the vicinity of the Horse Creek confluence. The gill net CPUE values averaged 1.71 and 0.06 fish/net-unit in the upper and lower sites, respectively. Only one burbot was captured or observed during boat electrofishing; this individual was taken near the chutes. Sampling by set lines was conducted only in the upper sites; the mean CPUE was 2.86 fish/100 hook-hours.

Burbot were present, although not abundant, in all of the previous spring and fall surveys (Figure 5.4). The capture of juveniles in May 1992 (Boag 1993) indicates a use of the study area for rearing purposes. Mean

CPUE values for gill net sampling were higher in October 1992 than in October 1988 (i.e., 1.11 and 0.41 fish/net-unit, respectively; Figure 5.4) suggesting an increase in abundance between the two periods.

5.6 LONGNOSE SUCKER

Longnose sucker were the most frequently captured or observed fish in the study area; mean CPUE by boat electrofishing was 5.45 fish/km. This species showed a strong preference for upper sections of the study area (immediately below the chutes) where the mean electrofishing CPUE value was 11.67 fish/km. In contrast, only 1.39 fish/km were captured or observed in the lower sites near the Mikkwa River confluence. Similar distribution patterns were observed in the gill netting results; in the upper sites catch rates averaged 2.72 fish/net-unit, while no longnose sucker were recorded in the lower sites.

The reported CPUE values for longnose sucker from the October 1988 survey (Hildebrand 1990) were considerably lower than the corresponding catch rates from the present study (Figure 5.4). This was likely due to the greater amount of sampling effort expanded in the upper sites (i.e., areas of longnose sucker concentrations) in 1992 than in 1988.

Longnose sucker were present in the study area during all spring and fall surveys. Their greater abundance during the fall season suggested that they overwinter in the Peace River mainstem. Spent adults and young juveniles were recorded within the lowermost reaches of Horse Creek and the Mikkwa River in May 1992 (Boag 1993); their presence indicated a spawning use of these systems.

5.7 OTHER SPECIES

One mountain whitefish was captured by electrofishing near the mouth of the Mikkwa River (Station ES 3; Figure 3.2). This adult specimen (age 8, length 364 mm, weight 701 g) constitutes the first record of this species in the lower Peace River mainstem (i.e., below the Wolverine River confluence).

White sucker were caught infrequently during the present study (i.e., gill net CPUE of 0.02 fish/net-unit; electrofishing CPUE of 0.18 fish/km). They were recorded in the area during the October 1988 survey; however, they were absent from the spring survey catches in 1989 and 1992 (Hildebrand 1990; Boag 1993).

Flathead chub were the predominant forage fish within the study area. They were captured only by the electrofishing method, and were more abundant in the upper than in the lower sampling areas (the mean catch rates were 2.42 and 0.89 fish/km, respectively; Table 5.2). Comparison with the previous studies (Hildebrand 1990; Boag 1993) indicated that flathead chub were captured more frequently during the spring surveys than in the fall (Figure 5.4).

Lake chub and trout-perch were represented by one individual each in the October 1992 study. Both were captured by electrofishing near the Mikkwa River confluence.

SECTION 6
FISH SIZE DISTRIBUTION

Length-frequency distributions of fish species captured below Vermilion Chutes are presented in Figure 6.1 and Appendix D, Table D2. The relationships between length and weight (i.e., length-weight regression and condition factor) are presented in Table 6.1. The discussion of the results and comparisons to the previous studies are presented below for each of the major fish species encountered.

Table 6.1 Length-weight relationship for the main fish species captured below Vermilion Chutes on the Peace River, October 1992.

Species	Length-Weight Regression ($W=aL^b$)				Condition Factor	
	a	b	n	r^2	Mean	SE
Lake whitefish	1.588×10^{-7}	3.732	6	0.707	1.58	0.09
Walleye	1.206×10^{-6}	3.378	35	0.984	1.24	0.03
Northern pike	1.410×10^{-6}	3.274	43	0.998	0.71	0.02
Goldeye	1.946×10^{-6}	3.306	86	0.952	1.14	0.01
Burbot	6.707×10^{-5}	2.638	22	0.776	0.65	0.02
Longnose sucker	1.087×10^{-5}	3.028	26	0.927	1.29	0.02

6.1 LAKE WHITEFISH

The mean fork length of the 15 lake whitefish captured in the study area was 520 mm (Appendix D, Table D2). Fork lengths ranged from 464 to 582 mm; 73% of the catch was larger than 500 mm (Appendix D, Table D1). The largest individual weighed 3614 g. The seven lake whitefish captured in the same area by Hildebrand (1990) in October 1988 averaged 483 mm in fork length, ranging between 420 and 540 mm. Considering the small number of measured fish, the two samples appeared similar in their size distribution. In contrast, the mean fork length of lake whitefish captured during the spawning period in the Athabasca and Clearwater rivers in October 1977 was 398 mm; only one out of 1366 captured fish was larger than 500 mm in length (Jones et al. 1978). This indicated that although both the Peace River and Athabasca River spawning migrations of lake whitefish were assumed to originate from Lake Athabasca, spawners at Vermilion Chutes were much larger than Athabasca River spawners. Similar comparison to the size distribution of lake whitefish populations studied by R.L.& L./E.M.A. (1985) during the 1983-1984 spawning run from Great Slave Lake into the lower Slave River (i.e., mean fork length of 397 mm; only 0.7% of fish > 500 mm), provided additional evidence of the uniqueness of the Vermilion Chutes lake whitefish with regards to their large size distribution.

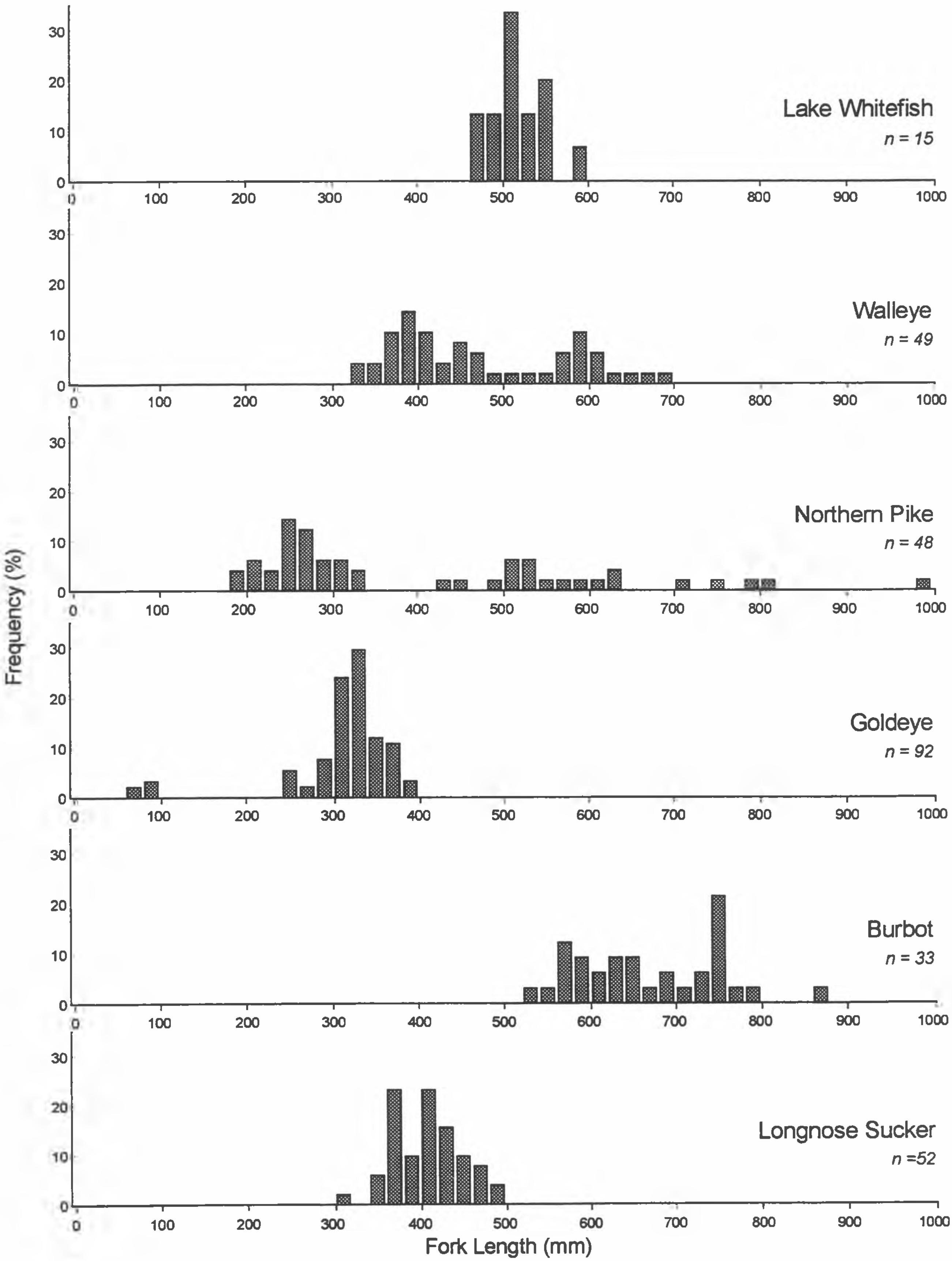

Figure 6.1 Length frequency distribution of the main fish species captured below Vermilion Chutes on the Peace River, 1992.

The length-weight relationship indicated positive allometric growth (i.e., b=3.732; Table 6.1), which was similar to that reported by Hildebrand (1990) (i.e., b=3.828). Mean condition factors of lake whitefish captured in 1992 and 1988 also were similar (i.e., 1.58 and 1.67, respectively).

6.2 WALLEYE

Walleye captured in the Vermilion Chutes area ranged between 324 and 690 mm in fork length; the mean length was 478 mm (Appendix D, Tables D1 and D2). The largest individual weighed 4679 g. The length-frequency histogram indicated a bimodal size distribution, with fish in the 360-420 mm and 560-620 mm length intervals captured most frequently (Figure 6.1). Comparison between the sizes of walleye captured in the lower and upper sections of the study area revealed that the lower areas (i.e., near the Mikkwa River confluence) were utilized by fish that were on the average considerably larger than those inhabiting the upper areas immediately below the chutes (i.e., mean fork lengths of 521 and 429 mm, respectively).

Hildebrand (1990) reported that walleye captured below the Vermilion Chutes in October 1988 ranged from 352 to 546 mm in fork length, and averaged 417 mm. Fish captured during the present study were substantially larger; this was most likely due to the more extensive use of 140 mm mesh size gill nets in 1992, which contributed to the selective capture of larger-sized fish. Length-weight relationships and condition factors for walleye captured in 1992 and 1988 were similar (i.e., b=3.378 in 1992 and 3.361 in 1988; condition factor=1.24 in 1992 and 1.21 in 1988).

6.3 NORTHERN PIKE

The sample of northern pike captured during the present study averaged 402 mm in fork length, and ranged between 189 and 993 mm (Appendix D, Table D1). Most (i.e., 59%) of the catch consisted of fish less than 400 mm in length; however, large-sized individuals (i.e., >700 mm) were not uncommon, contributing 10% to the total catch. The largest captured specimen weighed 9823 g.

The length-weight regression indicated positive allometric growth both in 1992 and in 1988 (i.e., b=3.274 and 3.103, respectively). Condition factors also were similar for the two surveys (i.e., 0.71 in 1992 and 0.76 in 1988).

6.4 GOLDEYE

The mean fork length of the juvenile and adult goldeye sample was 325 mm; they ranged in size from 243 to 394 mm. The heaviest individual weighed 743 g. Five young-of-the-year goldeye (see Section 7.4) were captured; they averaged 80 mm in fork length.

The length-frequency distribution of goldeye sampled in the study area during May 1992 (Boag 1993) indicated a high frequency (approximately 60%) of yearling and juvenile fish (i.e., <300 mm) in the catch. The corresponding frequency of subadults in the October 1992 catch was only 21%, suggesting that most of the juveniles did not overwinter in the same areas as the adults.

The comparison of length-weight regression and condition factor data for October 1992 and June 1989 (Hildebrand 1990) indicated that goldeye were in slightly better condition (i.e., heavier for a given length) in the fall than in the spring (condition factors of 1.14 and 1.06, respectively). This was probably due to the fact that the spring fish were sampled shortly after spawning, while the fall fish had a full summer feeding season behind them.

6.5 BURBOT

The mean total length of burbot captured in October 1992 was 667 mm (526 to 875 mm range; Appendix D, Table D1). The highest recorded weight was 3489 g for a 752 mm specimen; however, weight was not recorded for two fish that were even longer. A large part (i.e., 39%) of the October 1992 catch consisted of fish larger than 700 mm (Appendix D, Table D2). In comparison, fish in this large size-class contributed only 5% to the May 1992 catch from the lower Peace River survey (Boag 1993).

The length-weight regression indicated negative allometric growth both in 1992 and in 1988 (i.e., b=2.638 and 2.700, respectively). The mean condition factors were similar for the two surveys (i.e. 0.65 in 1992 and 0.58 in 1988).

6.6 LONGNOSE SUCKER

The mean fork length of longnose sucker sampled in October 1992 was 407 mm; lengths ranged from 309 to 482 mm. This size distribution was similar to the October 1988 sample that had a mean length of 395 mm and ranged from 359 to 430 mm (Hildebrand 1990). In contrast, the longnose sucker catch during the May 1992 survey (Boag 1993) included juvenile and probably yearling fish (as small as 56 mm in fork length).

The mean condition factor of longnose sucker was 1.29 in October 1992 and 1.35 in October 1988 (Hildebrand 1990). The length-weight regressions also were similar during the two surveys (b=3.028 and 2.859, respectively).

SECTION 7
FISH AGE, GROWTH AND SEXUAL MATURITY

Appropriate ageing structures were collected from a subsample of sportfish species that were not required for contaminant analysis. As such, the sample sizes of aged fish are small; nevertheless, the results presented below constitute the first record of fish age data from the study area. The age-length relationships are indicated in Figure 7.1 and Appendix D, Table D3; the following is a brief discussion of the results for the major species captured.

7.1 LAKE WHITEFISH

Ages were determined for five individuals; these ranged from 11 to 13 years old (Appendix D, Table D3). The mean fork lengths-at-age were 511, 536 and 552 mm for the 11, 12 and 13 year old cohorts, respectively. These lengths were substantially greater than those reported for the corresponding age-classes from the 1977 lake whitefish spawning study in the Athabasca and Clearwater rivers (i.e., 449, 438 and 463 mm, respectively; Jones et al. 1978). These differences suggested that lake whitefish spawners in the Athabasca and Peace rivers may have represented distinct populations (see Section 6.1). Similar differences in length-at-age data were noted in the comparison of the Vermilion Chutes lake whitefish to the Great Slave Lake populations spawning in the lower Slave River (i.e., mean fork lengths of 465, 454 and 484 mm for age 11, 12 and 13 fish, respectively; R.L.& L./E.M.A. 1985).

Out of the total of 15 lake whitefish captured during the present study, 14 were mature males, most (64%) of which were ripe (Appendix D, Table D1). The only female captured during the study was in ripe condition; it was caught on 22 October at a location approximately 1.5 km downstream from the site where most of the males were congregating.

The mean weight of testes collected from a sample of five ripe males was 68 g (ranging from 36 to 143 g; Appendix D, Table D1). On the average, testes contributed 3.1% to the overall body weight in males.

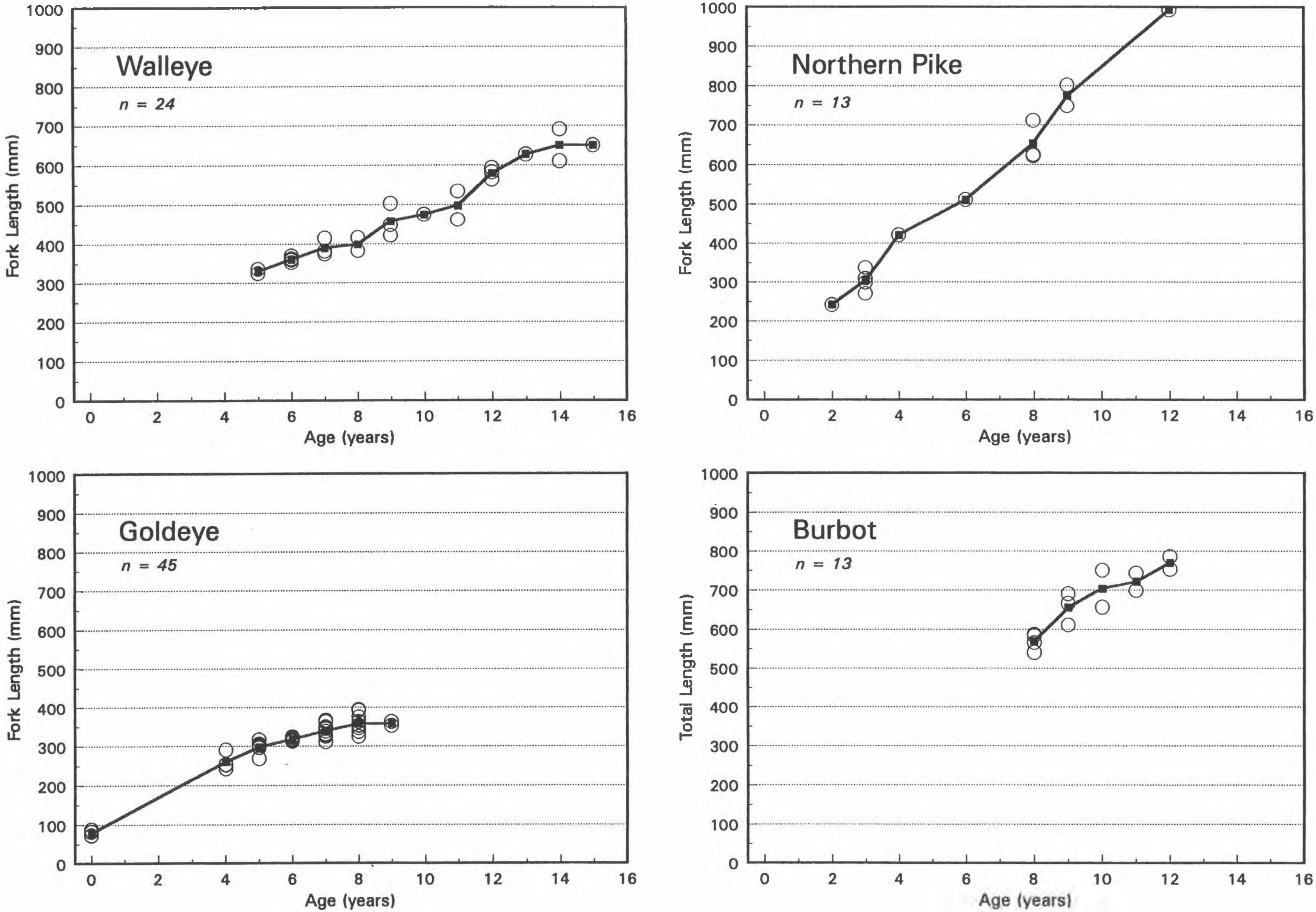

Figure 7.1 Age-length relationships of the main fish species captured below the Vermilion Chutes on the Peace River, October 1992. Age-specific mean lengths are connected by lines; circles represent data from individual fish.

7.2 WALLEYE

The age-length relationship for walleye (n=24) is indicated in Figure 7.1. Walleye in the sample varied from 5 to 15 years of age; the mean age was 9.25 years (Appendix D, Table D3). Throughout this age-class interval, growth seemed to be linear, with increments of approximately 30 mm per year.

The sex ratio of the sample was 10 males to 14 females. All of the males that were six years old or older were mature (or developing for the next spawning season); only one immature (age-5) individual was recorded. In contrast, the youngest mature female was 11 years old; three females that were 9 and 10 years old (ranging from 421 to 503 mm in fork length) were noted to be immature, with no signs of gonad development for the previous or the upcoming spawning seasons (i.e., ovaries were small and transparent, residual eggs were absent). Similar finding of one immature female of age-12 (564 mm fork length) suggested that attainment of sexual maturity in the Peace River female walleye may be inhibited by unknown factors.

7.3 NORTHERN PIKE

The aged sample of northern pike (n=13) included a wide range of ages (i.e., age-2 to age-12); the mean age was 6 years. Length-at-age data suggested that this species grows approximately 68 mm in length per year (Figure 7.1).

Sex and maturity were determined for 12 fish; the ratio was 4 males to 8 females. The youngest sexually mature male was age-3; the corresponding age in females was age-6 (Appendix D, Table D1). All northern pike older than age-6 were sexually mature.

7.4 GOLDEYE

The mean age of the goldeye sample from the study area (n=45) was 6 years; ages ranged from 0 to 9 years. Young-of-the-year fish were aged on the basis of fork lengths, which were similar to those reported by Kristensen (1981) for age-0 fish from the Peace-Athabasca Delta. Older fish were aged by either opercula or scales (Appendix D, Table D1); therefore, caution is required when comparisons to other studies are attempted. Nevertheless, the age-length relationship reported for the Vermilion Chutes area (Figure 7.1) closely approximated that of goldeye populations in the Peace-Athabasca Delta (Kristensen 1981, Donald and Kooyman 1977). Furthermore, the age-length relationship showed that fish from the study area were substantially larger at a given age than those from the upper Peace River (Donald and Kooyman 1977). These findings corroborate

Donald and Kooyman's (1977) hypothesis that the Vermilion Chutes separate the Peace River goldeye into two distinct populations.

Sex determinations indicated that goldeye were almost equally represented by both sexes (i.e., 21 males and 19 females; Appendix D, Table D1). Consistent with Donald and Kooyman's (1977) findings, all fish aged 5 years or less were sexually immature. The youngest mature males were six years old; females matured later (youngest was age 7). A relatively large proportion (i.e., 33%) of fish aged 8 and 9 years were sexually immature. Their gonads showed no signs of prevous spawning activity, and a complete lack of development for the upcoming spawning season.

7.5 BURBOT

The age-length relationship for the burbot is indicated in Figure 7.1. The mean age of the sample (n=13) was 9.6 years; ages ranged from 8 to 12 years. Within this age-class interval, burbot increased in length at a rate of approximately 40 mm per year.

Sexes were represented almost equally in the sample (i.e., six males and seven females). Although all age-8 individuals of both sexes were sexually mature, two age-10 females (656 and 750 mm in length) were found to be immature, with no indication of gonad development from the previous or for the upcoming spawning seasons.

SECTION 8
GROSS PATHOLOGY EXAMINATIONS

External examinations of lake whitefish (n=15) identified two specimens that displayed abnormalities (Appendix D, Table D1). One individual (sample #19) had an open abrasion in the rear abdominal area, probably caused by a predatory bird attack. The other fish (sample #56) displayed red circular lesions, of unknown origin, on the anterior part of the abdomen (see Plates 7 and 8); this specimen was preserved for contaminant analysis. No internal pathological abnormalities were recorded during the examination of the sample of six lake whitefish.

Only one other external abnormality was recorded from all captured fish examined. This was a northern pike juvenile (sample #12; Appendix D, Table D1) whose entire skin was covered by small black spots. This condition was most likely caused by a strigeid fluke *Uvulifer ambloplitis*; the externally encysted stage of this trematode is often present in extreme numbers on individual northern pike (Scott and Crossman 1973). Incidence of "black spot disease" was also recorded in northern pike during the October 1988 survey in the study area (Hildebrand 1990).

SECTION 9
FISH TAGGING SUMMARY

In total, 390 fish were tagged within the study area during May 1992 (Boag 1993); seven recaptures have been reported to date (Table 9.1). Four of these (three goldeye and one walleye) were captured by anglers at the end of July in the Mikkwa River approximately 100 m from the confluence; two of the goldeye were tagged within the lower 1.5 km of the Mikkwa River, while the remaining goldeye and walleye were tagged in the Peace River mainstem within 5 km of the Mikkwa River confluence. The three fish that were recaptured in October (one walleye, one northern pike and one longnose sucker) were tagged on 21 May at the mouth of Horse Creek. The recapture sites were within 500 m of the original release locations.

Table 9.1 Number of fish tagged and recaptured below Vermilion Chutes on the Peace River during May 1992 (Boag 1993) and October 1992 (present study).

Species	Tagged in May 1992[a]	Recaptured July 1992[b]	Recaptured Oct 1992[c]	Tagged in Oct 1992
Walleye	53	1	1	13
Northern pike	26		1	11
Goldeye	265	3		9
Burbot	19			4
Longnose sucker	26		1	
White sucker	1			
Mountain whitefish				1
TOTAL	390	4	3	38

[a] includes fish tagged in the lower parts of Horse Creek and Mikkwa River
[b] captured and killed by Daniel Loonskin of Fox Lake
[c] captured and released during the present study

During the present study a total of 38 fish were tagged and released (Table 9.1). Two of these (one walleye and one northern pike) were recaptured at the same locations (within 500 m) one or two days after release (Appendix D, Table D1).

SECTION 10
LAKE WHITEFISH SPAWNING AREAS AND EGG COLLECTIONS

The area where most lake whitefish were captured by boat electrofishing was located approximately 400 to 800 m upstream from the confluence of the Mikkwa River, and immediately downstream and offshore from a bedrock outcrop on the south bank (Plates 9 and 10). It consisted of a shallow (i.e., 0.6 - 1.0 m) shelf, extending approximately 30 m offshore and covered with gravel, pebble and cobble substrates. Surface water velocities ranged from 0.3 to 0.7 m/s. Echosounding data revealed a deeper channel approximately 100 to 200 m offshore; however, higher water velocities (i.e., 0.8 - 1.0 m/s) and greater water depth (i.e., maximum of 4.6 m) prevented effective sampling of the deeper channel areas by the electrofisher and gill net methods. Traces of fish concentrations in the channel were not displayed on the echosounding tapes. Sampling of the nearshore areas adjacent to the channel (approximately 4000 m^2 in total) with a large mesh seine on 12 October failed to capture fish.

Collection of eggs was attempted by means of a small-mesh drift net set on 12 October at a site approximately 500 m upstream of the Mikkwa River confluence, 15 m offshore, and in 0.45 m depth of water. Water velocity at 0.6 depth was 0.28 m/s, and the substrate consisted of large gravel and pebble (approximately 0.5 to 3.0 cm in diameter). The drift net catch was examined after a 27.5 h sampling period; fish eggs were not present.

Additional egg sampling was conducted on 24 October by holding a fine mesh dip net on the river bottom immediately downstream of a small area where substrate was disturbed with a paddle. This type of sampling was repeated 12 times throughout selected spots within the suspected spawning area, at water depths ranging from 0.6 to 1.1 m. Careful examination of the contents of each sample did not reveal the presence of fish eggs.

Although eggs were not collected as a confirmation that lake whitefish spawned in the area, it was assumed that the spawning grounds were located in the area described above. This assumption was based on the following observations:

1. Substrate type, water depth and velocities were very similar to those described for lake whitefish spawning grounds in the Athabasca River by Jones et al. (1978) and McCart et al. (1977);

2. Other areas of suitable spawning habitat were not found within the study area (i.e., sand and silt were the predominating substrates along most echosounding transects, except for bedrock substrates immediately below the chutes); and

3. Of the 26 lake whitefish captured or observed during the study, 22 were found within the area in question, 3 were approximately 1.0 to 1.5 km downstream, and only one fish was found upstream (approx. 4 km away from the suspected spawning grounds).

SECTION 11
DISCUSSION

Based on the existence of extensive lake whitefish spawning migrations between Lake Athabasca and the Athabasca River (Jones et al. 1978a; Bond 1980; Bond and McCart 1980; McCart et al. 1982), it was hypothesized that the Peace River, being the other major component of the Peace-Athabasca Delta complex, might also be used by lake whitefish for spawning purposes. This hypothesis was supported by the October 1988 capture of ripe lake whitefish near the Mikkwa River confluence, and by concentrations of unidentified fish (suspected to be lake whitefish) recorded on echosounding charts from immediately below the Vermilion Chutes (Hildebrand 1990).

The present study confirmed that lake whitefish were present in the Peace River below Vermilion Chutes during the spawning period; however, the study results indicated that the spawning population was much smaller than that reported for the Athabasca River (i.e., approximately 300 000; McCart et al. 1982). Whereas in the Athabasca River 68.2% of the total fish catch during October 1977 (n=2213) was comprised of lake whitefish (Jones et al. 1978a), this species contributed only 5.6% to the total catch (n=465) in the Peace River during the present study. This large difference in the frequency of lake whitefish in the catches may have been partially due to the differences in the amount of effort and type of capture gear utilized by the two studies; however, several additional considerations (discussed below) provided indirect evidence that the importance of the Vermilion Chutes area for lake whitefish spawning was substantially lower in comparison to areas utilized in the Athabasca River.

Lake whitefish that spawn in rivers usually do so in shallow running water or rapids over a gravel and rubble bottom (Machniak 1975). Substrates where eggs were found in the Athabasca River ranged from rock and boulder to mixed gravel and sand; eggs were not found on pure sand or mud substrates (Jones et al. 1978a). Whereas coarse substrates suitable for lake whitefish spawning were widely distributed below the Mountain and Cascade rapids areas on the Athabasca River (Jones et al, 1978b), the areas below the Vermilion Chutes on the Peace River were characterized by a predominance of fine sand and silt substrates. Suitable substrate types (i.e., rock, cobble and gravel) were encountered only on a very localized basis (i.e., immediately below the chutes and near the confluence of the Mikkwa River), indicating that a large spawning run of lake whitefish to the Vermilion Chutes area would likely be limited by the scarcity of suitable spawning habitat. Furthermore, extreme fluctuations in water level, as evidenced during September 1992 (Figure 4.3), have the potential of reducing the amount of suitable habitat to an even greater extent. If the timing of these fluctuations coincides with the lake whitefish spawning and egg incubation period, eggs deposited in shallow water (i.e., < 1 m) may become desiccated or frozen.

One of the most apparent differences between the lake whitefish spawning runs in the Athabasca and the Peace rivers relates to the size distribution of fish in the spawning populations. Jones et al. (1978a) reported that the mean fork length of lake whitefish spawning near Fort McMurray on the Athabasca River in October 1977 was 398 mm; only one out of 1366 captured fish exceeded 500 mm in length. In contrast, the mean fork length of lake whitefish captured during the present study was 520 mm, with 73% of the catch larger than 500 mm. Despite the small sample size (n=15) of the Peace River fish, the difference in mean lengths was highly significant (t-test; $P<0.001$), indicating that the Athabasca River and the Peace River spawning runs were composed of fish that originated from distinct subpopulations. This finding was also supported by the differences in growth rates (i.e., Peace River fish were larger at a given age than the Athabasca River fish; see section 7.1).

The data from the Athabasca River 1977 spawning run were collected at a time when commercial exploitation of lake whitefish in Lake Athabasca was considerably higher than at present (Mitchell and Prepas 1990); therefore, the absence of large-sized fish (i.e., >500 mm) in the 1977 catch may have resulted from selective harvesting of large fish by the commercial and domestic fisheries. Nevertheless, more recent data on the lake whitefish spawning run in the Athabasca River, collected by Syncrude Canada Ltd. in 1989-1990 (T. van Meer, pers. comm.), indicated that size distribution among the spawning fish has not substantially changed since the late 1970's (i.e., mean length = 405 mm; of 343 fish none exceeded 500 mm in length). Historically, the small body size of Lake Athabasca lake whitefish also was observed by Rawson (1947), who reported that the mean length of commercially caught fish (i.e., 413 mm) was considerably smaller that the mean length of the commercial lake whitefish catch in Great Slave Lake (i.e., 470 mm).

Based on these differences in body size, it seems unlikely that the lake whitefish captured below Vermilion Chutes during the present study originated from Lake Athabasca. An alternate explanation is that this population resides in the lower Peace River (and possibly in the north-western section of the Peace-Athabasca Delta) throughout most of the year, without venturing into Lake Athabasca proper. There are no data to prove this hypothesis; however, considering the large number of oxbow lakes in the lower reaches of the Peace River and the productive nature of the Peace-Athabasca Delta, it seems more likely that higher growth rates could be attained there than in the oligotrophic eastern basin of Lake Athabasca.

The interruption of field activities between 14 and 20 of October contributed to the low catches of lake whitefish during the present study. Although the total number of lake whitefish captured or observed during the early survey period (i.e., 9-13 October; 12 fish) was very similar to that of the later period (i.e., 21-24 October; 14 fish), more intensive spawning may have occurred during the week when sampling was not conducted. The sudden decrease in water temperature (i.e., from 6°C on 13 October to 2°C on 21 October) may have resulted in the acceleration of the spawning activities; however, it is unlikely that a large spawning population would have arrived, spawned, and left the area within such a short period of time. Catch rate data from the Athabasca River spawning runs indicated that increased lake whitefish catches took place over a period of approximately five weeks, while the peak of the spawning activities persisted for almost two weeks (Bond 1980; Jones et al. 1978).

The comparison of lake whitefish catches during the present study to those from the October 1988 survey (Hildebrand 1990), indicates close similarities both in the electrofishing catch rates (i.e., 2.38 and 2.65 fish/km, respectively) and in the location of the catches (i.e., 88% of the 1992 catch, and 92% of the 1988 catch were obtained at station ES1). The recordings of fish on echosounding charts from transects immediately below the chutes during the present study revealed occasional presence of individual fish; however, the presence of large fish concentrations, as reported by Hildebrand (1990), was not observed in 1992. Based on the predominance of longnose sucker in the catches from immediately below the chutes, it is suspected that the individual fish traces obtained on 1992 echosounding charts were likely caused by longnose sucker.

Although the results of the present study indicate that lake whitefish spawning within the Vermilion Chutes area in October 1992 was not very extensive nor involved large numbers of fish, they do not preclude the possibility of substantial spawning migrations of lake whitefish in other years. The very sudden and large increase in the Peace River flow regime during the weeks preceding the 1992 spawning period, may have affected the success of the spawning migrations, by making passage of the Boyer Rapids near Peace Point much more difficult than during years of more "average" flows. The utilization of the areas below Boyer Rapids by lake whitefish spawning populations have not previously been studied; however, local residents from Fort Chipewyan and Peace Point reported fall concentrations of fish within this potentially suitable spawning habitat (E. Gerard; D. Loonskin, pers. comm.). Attempts to verify the extent of the 1992 spawning run at Boyer Rapids through communication with the Peace Point residents proved unsuccessful since none of the local residents fished there during the fall season (A. Peecheemow, pers. comm.).

In addition to collecting data on lake whitefish, the present study identified several previously unreported characteristics regarding the utilization of the Vermilion Chutes area by other fish species. These included:

1. Capture of young-of-the-year goldeye in October 1992 indicated that spawning may have occurred in the vicinity of the study area. Although it was possible that these fish could have drifted from areas upstream of Vermilion Chutes, captures of mature adults below the chutes in May 1992 (Boag 1993) supported the possibility of spawning taking place below the chutes. If true, this finding was contrary to the previous belief that most goldeye from the lower Peace River (i.e., downstream of Vermilion Chutes) migrate to the Peace-Athabasca Delta to spawn (Donald and Kooyman 1977).

2. Examinations of sexual maturity revealed that considerable proportions of older age-classes of walleye, goldeye and burbot were immature, with no indication of gonad development for the previous or upcoming spawning seasons. The reason for this delay or inhibition of sexual development is unknown.

3. The pattern of fish species utilization of the study area was related to the proximity of the Vermilion Chutes. Longnose sucker and burbot were captured almost exclusively in the upper sites of the study area (i.e., close to the chutes); most of the other species were more abundant in the lower sites (i.e., near the Mikkwa River confluence).

4. The capture of one mountain whitefish specimen was the first record of this species occurrence in the lower Peace River (i.e., below Wolverine River).

SECTION 12
CONCLUSION

Due to the limited number of lake whitefish captured, some of the study objectives and requirements, as stated in the Terms of Reference (Appendix A), were difficult to achieve. These included estimates of lake whitefish spawning population size, and determinations of fecundity, overall egg production and recruitment. In addition, the study requirements to tag 2000 lake whitefish and to determine age, length and weight distributions from a sample of 300 lake whitefish were not fulfilled.

Despite the above shortcomings, the present study demonstrated that the underlying hypothesis of the study (i.e., "the Vermilion Chutes constitute a key spawning habitat for lake whitefish from Lake Athabasca" and "the magnitude or significance of this spawning site for lake whitefish is extremely high") was false, at least in the fall of 1992. Lake whitefish catch rates reported by Hildebrand (1990) in October 1988 were very similar to those recorded during the present study; this implied that spawning lake whitefish utilized the Vermilion Chutes area to approximately the same extent in 1988 as in 1992. The scarcity of suitable spawning habitat within the study area provided further indication that lake whitefish spawning was restricted to relatively small numbers of fish, and confined to only a small area near the confluence of the Mikkwa River.

Based on the difference in body size between the lake whitefish captured below Vermilion Chutes and those that migrate out of Lake Athabasca to spawn in the Athabasca River, it is likely that these two populations are distinct from each other. Although it is possible that both spawning runs originate from Lake Athabasca, it seems more probable that the Vermilion Chutes spawners originate from the lower Peace River, or the north-western section of the Peace-Athabasca Delta.

SECTION 13
RECOMMENDATIONS FOR FURTHER STUDIES

Although the present study confirmed the use of the Vermilion Chutes area by spawning lake whitefish populations, the magnitude of the spawning run, its place of origin, and the existence of other spawning sites within the lower Peace River remain unknown.

Before undertaking intensive field studies in the lower Peace River, it is recommended that a thorough interview survey be conducted among native fishermen from the surrounding communities (i.e., Fort Chipewyan, Peace Point, Garden Creek, and Fox Lake) in order to collect information regarding the past and present locations of lake whitefish concentrations. This local knowledge will aid in selecting areas where effort should be concentrated during future studies. In addition, it may also be possible to involve the participation of local residents in the collection of preliminary data (e.g. employing them to set gill nets and to record catches).

Depending on the outcome of these preliminary investigations, it is recommended that the future studies include one or more of the alternatives outlined below:

1. Fall fisheries survey below Boyer Rapids.

Assuming that the lake whitefish spawning migration originates in the Peace-Athabasca Delta or in the lower reaches of the Peace River, fish sampling below the Boyer Rapids would intercept the upstream migration at the lowermost location where potential suitable spawning habitat is available. The existence of an all-weather road to Peace Point, as well as the possibility of hiring a jet drive boat from Fort Chipewyan, could greatly facilitate the logistical requirements for this survey, in comparison to other sites where air transportation is required.

2. Follow-up survey below Vermilion Chutes.

Having determined the exact site where lake whitefish can be captured during the fall spawning period (i.e., 500 m upstream of the Mikkwa River confluence), fishing effort should be concentrated at this site in order to tag as many fish as possible. Assuming that concentrations of fish will be similar to those found in 1992, it is estimated that 200 or 300 fish can be tagged by repeated electrofishing within the site. Considerations should be made for planning subsequent sampling in the lower Peace River and in the Peace-Athabasca Delta, so that the extent of lake whitefish migrations can be determined from tag recaptures.

3. Radiotelemetry studies

Because of the large body size of lake whitefish captured near the Mikkwa River confluence during the present study, it is believed that they would make suitable candidates for radio transmitter implantations. By implanting the tags at the uppermost limit of their spawning migration, the subsequent tracking of the marked fish through aerial surveillance would allow determination of other critical habitats (i.e., overwintering, summer feeding), documentation of movement patterns and home range, and dispersal of the population.

SECTION 14
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PLATES

Plate 1. The abandoned Little Red River settlement at the confluence of the Mikkwa and Peace rivers.

Plate 2. Airstrip at the Little Red River settlement.

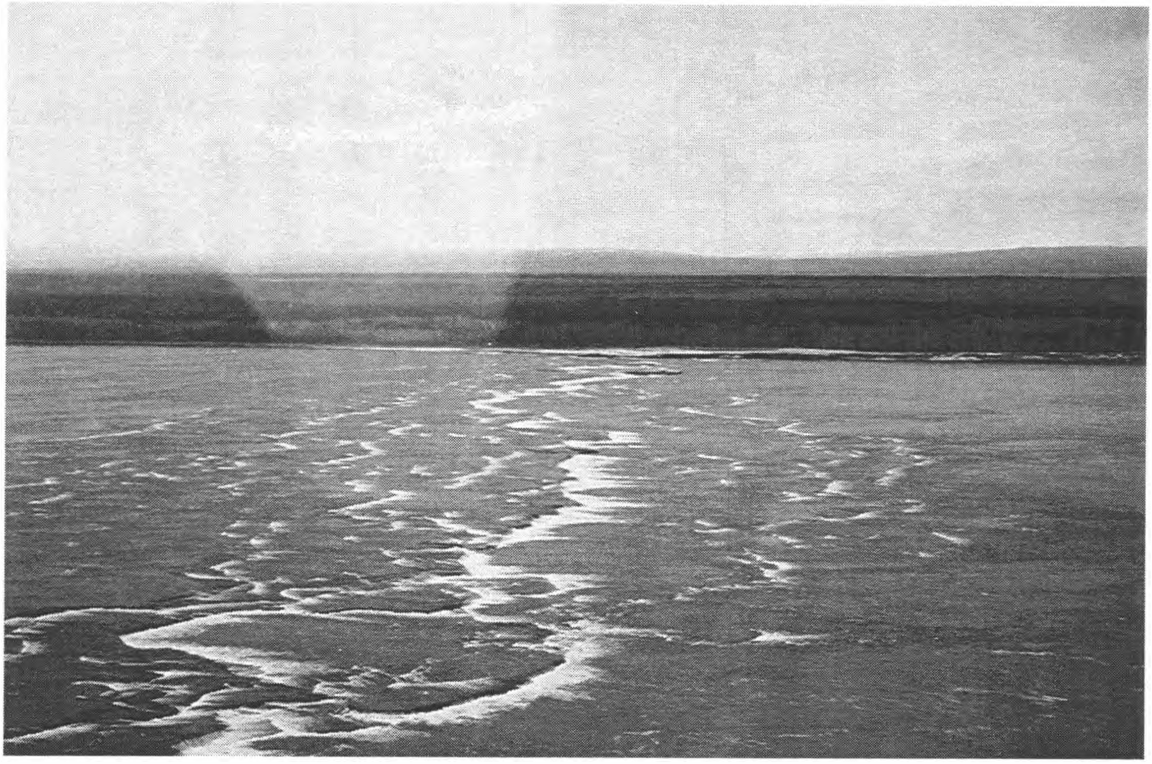


Plate 3. Aerial view of the Vermilion Chutes (looking north).

Plate 4. Vertical limestone banks along the north shoreline below the chutes.

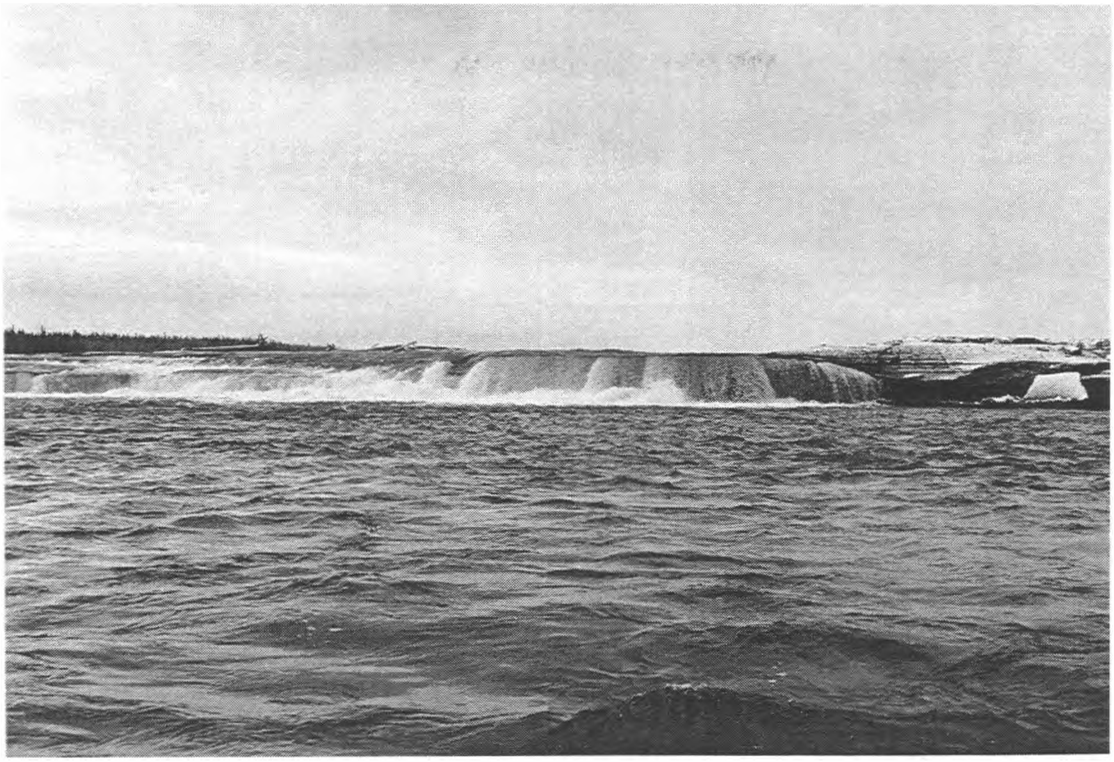


Plate 5. Vermilion Chutes near the north bank.

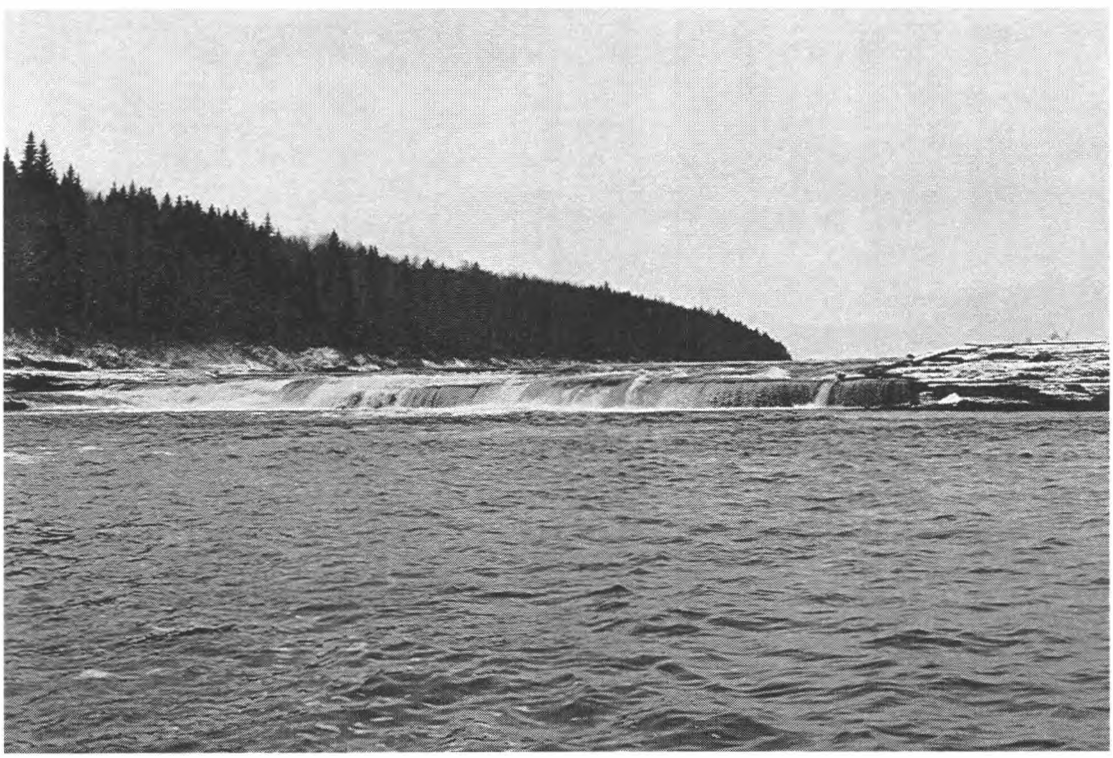


Plate 6. Shoreline along the south bank of the chutes.

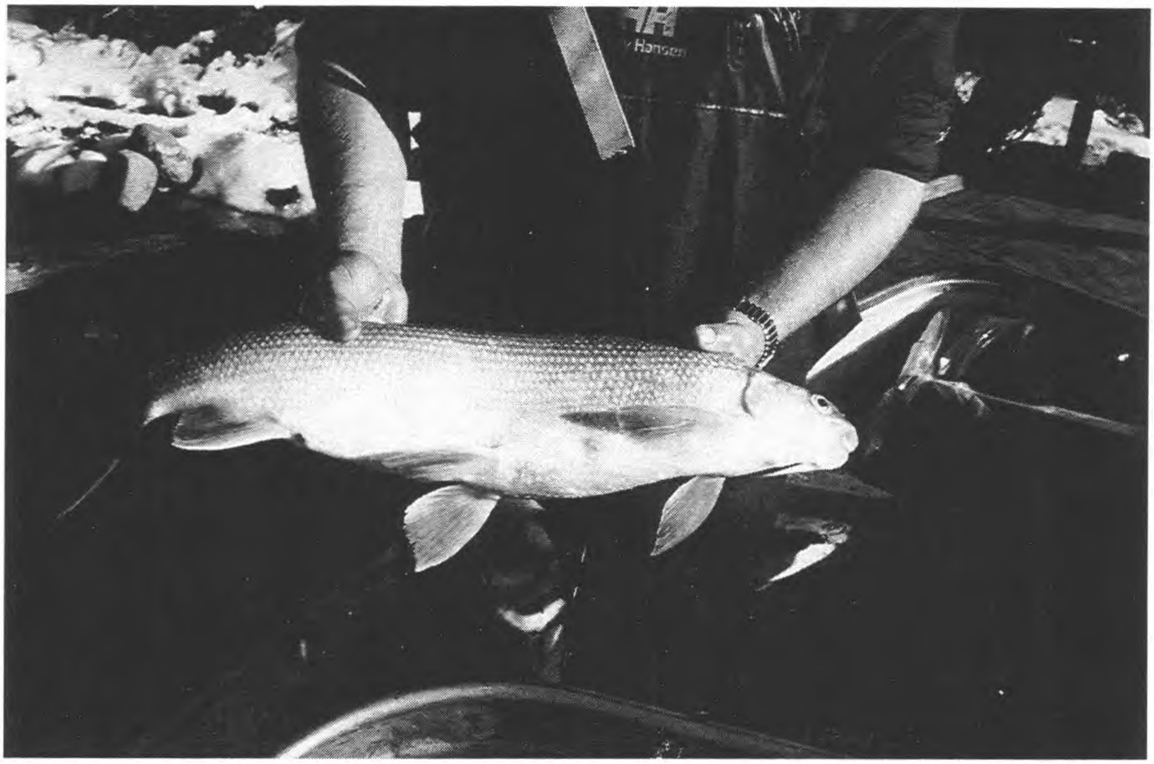


Plate 7. Lake whitefish (sample #56) captured by electrofishing immediately upstream of the Mikkwa River confluence.

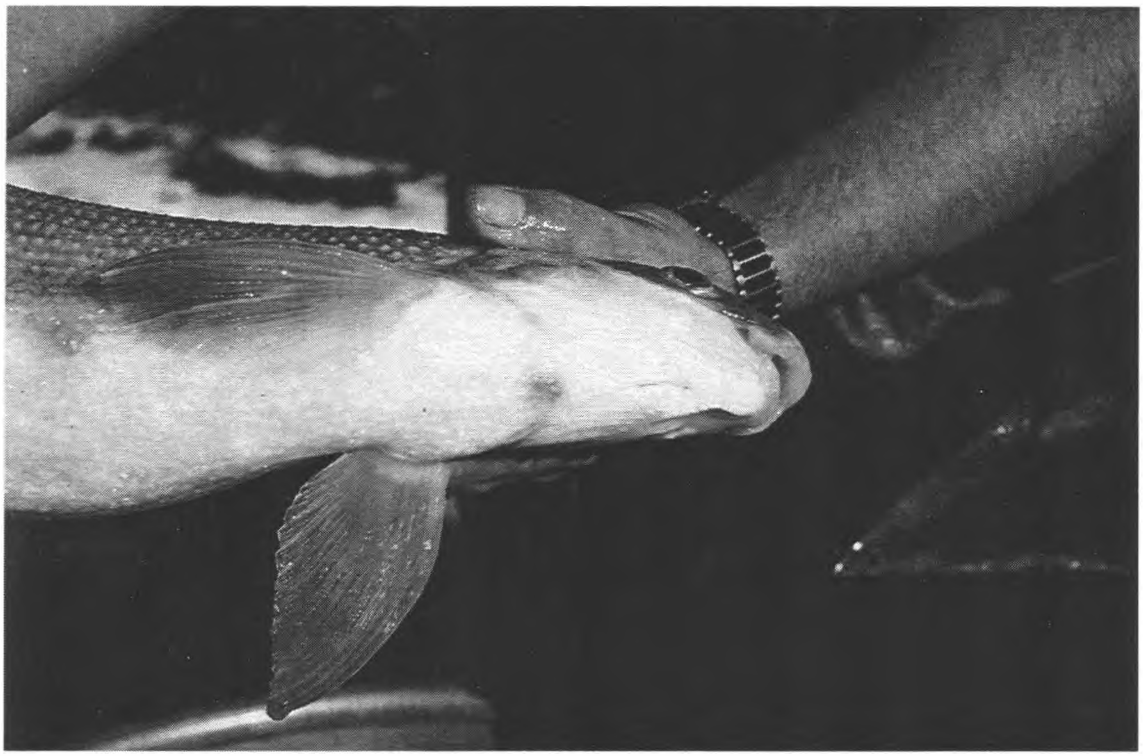


Plate 8. Close-up view of lake whitefish (sample #56), showing lesions in the abdominal area.

Plate 9. Suspected lake whitefish spawning area located along the south bank approximately 700 m upstream from the Mikkwa River confluence.

Plate 10. Gravel and cobble substrates along the shoreline of the suspected lake whitefish spawning area.

APPENDIX A

TERMS OF REFERENCE

NORTHERN RIVER BASINS STUDY
SCHEDULE A - TERMS OF REFERENCE

PROJECT 3117 GENERAL FISH INVENTORIES - PEACE RIVER
SUB-PROJECT 3117-B7 LAKE WHITEFISH SPAWNING (VERMILION CHUTES - PEACE RIVER)

Description

A consultant will be retained to examine the hypothesis that the Vermilion Chutes on the Peace River constitute a key spawning habitat for lake whitefish from Lake Athabasca. Further, the magnitude or significance of this spawning site for lake whitefish is extremely high and a quantification would be desirable.

Some of the information to be gathered may be designed in such a manner as to indicate the health of this lake whitefish population in light of various contaminants that may enter the Peace River.

Previous preliminary fisheries inventory studies have suggested that this area may have special significance.

Objectives

1. To determine the relative number of lake whitefish utilizing the Vermilion Chutes as a spawning site and the time of the spawn.

2. To determine the number of eggs that are spawned and the overall significance of the recruitment to the lake whitefish populations of the Peace River system and Lake Athabasca.

3. To determine the lake whitefish movements within the Peace River.

4. To map the actual lake whitefish spawning sites and describe the habitat utilized.

5. To determine the relative abundance of all fish species in this site.

6. To determine the lake whitefish population structure within this site.

Study Location

The study area is defined as part of Reach 7 and 8 in the 1992 D. A. Westworth report entitled "A General Fish and Riverine Habitat of the Peace and Slave Rivers in Alberta" and by Reach 7 in the R.L. & L report of 1990 entitled "Investigations of Fish and Habitat Resources of the Peace River in Alberta".

The study area will involve the Vermilion Chutes and downstream areas as they may relate to the objectives.

Study Requirements

The contractor will:

1. Collect the necessary information to determine the estimated number of lake whitefish that are utilizing the Vermilion Chutes area for spawning.

2. From a sample of 300 lake whitefish determine the age-weight distribution, age-length distribution, age-frequency distribution and length-frequency distribution of the lake whitefish population utilizing the Vermilion Chutes.

3. Determine the fecundity of the lake whitefish and estimate the overall egg production and recruitment to the lake whitefish population.

4. Characterize the lake whitefish spawning habitat and map the areas utilized in the vicinity of the Vermilion Chutes.

5. Determine the relative abundance of all fish species in this reach. This will be achieved through fishing techniques that will provide the smallest variance in catch by species and by number. C.U.E. results will be reported. Standardized methodology must be employed. A variety of techniques such as electroshocking, beach seining and gill nets could be deployed with a minimum of 30 individual samples of each fishing method contributing to a determination of the method that provides the lowest variance for C.U.E. by species and number. The proposal should specify the details associated with providing meaningful estimates.

6. Mark approximately 2000 lake whitefish within this site using conventional tagging techniques that will support the long term assessments on fish migration. Information to be recorded includes species, unique tag number, date of capture, length, sex (ripe fish), age (appropriate aging structures from McKay et al), location (UTM coordinates), gross morphology (as per Schedule A). All tags to be supplied by the Northern River Basins Study.

7. Collect 20 lake whitefish (of older age classes) and 20 burbot (of older age classes) for contaminant analyses. (Schedule A1 describes the fish sampling protocol).

8. Develop a set of standards on which future monitoring may evaluate lake whitefish reproductive status that may be influenced by chemical contaminants. The consultant is requested to examine the above in detail and recommend the feasibility and predictive capability of such a program in light of various contaminants entering the river system. The consultant should consider such parameters as age of maturation, present abundance of mature non-spawners, gonad weight to body weight relationships (sexes separate) and fecundity.

9. Endeavour to utilize local contractors and services for the field studies and maintain a list of supplies and services utilized along with dollars spent.

10. Make every effort to minimize fish mortality. All sacrificed fish are to be disposed of in a manner acceptable to the Alberta Fish & Wildlife Division. Appropriate non-lethal capture methods will be used in a manner that will enable comparisons of abundance, size and occurrence during the sampling period.

11. Progress reports, final manuscripts, electronic data files, samples and photographic materials are to be delivered to the Study Office as per Schedule B. The format for the final report will follow the editorial style of the Canadian Journal of Fisheries and Aquatic Sciences.

12. Utilize standard sampling methods that achieve the highest level of statistical significance keeping in mind the nature of the information required and the possible limited sample sizes.

PROJECT 3117 GENERAL FISH INVENTORIES
SUB-PROJECT 3117-B7 LAKE WHITEFISH SPAWNING (VERMILION CHUTES - PEACE RIVER)

SCHEDULE A1

A. FISH SAMPLING PROTOCOL - CONTAMINANT ANALYSIS

1. Fish may be collected using a variety of techniques including:

   - Electro-shocking
   - Gill nets
   - Seines
   - Drift nets
   - Set lines
   - Angling

2. All samples must be submitted as intact whole fish.

3. All fish samples are to be frozen as soon as possible after collection.

4. Details of species, length, date, location and the collector's name must be recorded with the sample number for each sample and this information must be supplied directly with the fish and on the outside packaging.

5. All fish must either be:

   (a) immediately processed (length) and directly placed into contaminant free plastic bags supplied by the Northern River Basins Study and the bags specifically labelled, or

   (b) placed into stainless steel buckets or basins (rinsed for each site with a solvent series as described in the "Instrument and Equipment Cleaning Procedure" provided below) and kept cool until processed, and then placed into approved contaminant free plastic bags and the bags specifically labelled.

   Instrument and Equipment Cleaning Procedures:

   i) washed with tap water and laboratory detergent,

   ii) rinsed with tap water and deionized water (18 meg-ohm),

   iii) rinsed with pesticide grade acetone, hexane, dichloromethane and hexane, respectively, and

   iv) air dried and heated to 325°C for six hours. All cleaned instruments and equipment to be wrapped in heat treated (325°C) aluminum foil until required.

   N.B. Placing fish in ordinary plastic bags will contaminate the samples.

6. The use of dry ice for initial freezing and shipping is the approved method. Alternatives are ice packs and then ice, and may be used only as a secondary means on occasion where there may exist a shortfall in available dry ice. Fish processed by this latter means are to be frozen within 12 hours.

7. The use of sturdy styrofoam coolers is most practical and is recommended. Styrofoam coolers of weak construction may not assure constant freezing and may break down during shipping. Coleman type coolers may be used but not necessarily be returned immediately for repetitive use. The Contractor is responsible for picking up coolers when notified by Alberta Environment.

8. Place dry ice both on top and bottom of coolers to assure that no freeze-thaw cycles will occur during transport.

   N.B.: Any freeze-thaw, however moderate it may be, will cause contaminant migration within a sample and this may affect contaminant concentration levels in tissues.

9. Ship samples as soon as possible or, if not possible, samples must be kept frozen in a freezer at -20° until shipping. Samples of liver tissue for MFO analysis must be stored at -60°C or colder.

   Any contractor/consultant or government personnel that is transporting fish to Edmonton must contact one of the following people before leaving place of origin:

Earle Baddaloo	Work:	(403) 427-6102
	Home:	(403) 434-8967
Sub Ramamoorthy	Work:	(403) 427-6102
	Home:	(403) 435-8137

   <u>**If the above personnel are not in**</u>, a message indicating fish is on its way and approximate time of arrival in Edmonton **<u>must</u>** be left with the secretary (in office) between 8:15 a.m. and 4:30 p.m., or on an answering machine (home) after 4:30 p.m., before leaving place of origin.

   Upon arrival in Edmonton with specimens from Northern River Basins Study projects, contractor(s) or consultant(s) should contact one of the above personnel again.

   If the above personnel cannot be contacted on a weekday (Monday to Friday), contractor(s)/consultant(s) should proceed directly to **VERSACOLD only between 8:00 a.m. and 4:00 p.m. Drop cargo (fish) off at VERSACOLD under the name of Earle Baddaloo, Alberta Environment. <u>DO NOT LEAVE FISH OUTSIDE OF VERSACOLD!!</u>**

VERSACOLD IS OPEN BETWEEN 0800 AND 1600 HOURS. MONDAY THROUGH FRIDAY.

ADDRESS: 9002 - 20 Street
Edmonton, Alberta
TELEPHONE: (403) 464-1770
CONTACT: Mr. Merve Permann

If fish tissue arrive after 4:00, contractor(s)/consultant(s) must make every effort to contact Mr. Baddaloo or Dr. Ramamoorthy so that alternate storage for the night or weekend may be found.

It is, therefore, imperative to call contacts before leaving place of origin so that they (contacts) will be aware of the transport activity and can make arrangements for the arrival of the specimens.

WEEKEND TRANSPORT

If fish has to be transported to Edmonton on the weekend (Saturday, Sunday or public holiday), the contractor(s)/consultant(s) or government personnel should contact Mr. Baddaloo or Dr. Ramamoorthy on the last working day before the weekend or public holiday. (If contacts are not available, messages must be left with the secretary.) Again, before leaving place of origin, please call contacts at home and leave a message if they are not there; and upon arrival in Edmonton, please call contact again.

10. Any deviation from the above established protocol/procedure should be justified and accounted for in writing and a detailed description of what was done is to be submitted with the fish sample; this is to assure credibility and validity of results.

11. Develop a photographic record of equipment and techniques to capture and process fish samples. As appropriate, take close-up photographs of fish exhibiting internal and/or external abnormalities. Use 35 mm 200 ASA Fuji slide film in a camera having a 50-55 mm lens. Maintain records to associate photographs with sample material.

PROJECT 3117 GENERAL FISH INVENTORIES
SUB-PROJECT 3117-B7 LAKE WHITEFISH SPAWNING (VERMILION CHUTES - PEACE RIVER)

SCHEDULE B - DUE DATES FOR DELIVERABLES

1.	Draft Report (supply 10 copies)	February 2, 1993
2.	Final Project Report (supply 30 copies)	March 1, 1993
3.	Supply 30 copies and the camera-ready original of the final draft and reports as well as electronic disks (Word Perfect)	March 1, 1993

Payment

1. Subject to prior approval from the Department, payments will be made based on monthly invoices submitted up to 90 percent of the maximum contract amount of $53,674.

   (a) The following maximum rates will be paid for services rendered:

Project Manager	$73.75/hour or	$590/day
Senior Biologist/Biologist III	62.50/hour or	500/day
Biologist II	46.88/hour or	375/day
Biological Technician III	36.88/hour or	295/day
Biological Technician I	23.75/hour or	190/day
Word Processing or Drafting	35.00/hour	
Local Assistants/Guides		150/day

   (b) Subject to prior approval from the Department travel expenses incurred in performing the services will be paid as follows:

   (i) accommodation - at cost on submission of receipts;
   (ii) transportation - at cost on submission of receipts;
   (iii) meals - at cost on submission of receipts or as specified below without receipts

   - Breakfast - $5.80
   - Lunch - $7.40
   - Dinner - $13.50

   (c) Incidental expenses incurred in performing the services may be reimbursed at cost on submission of receipts.

   (d) Travel by private vehicle will be reimbursed at the rate of $0.25 per kilometre and this shall include fuel and maintenance.

   (e) For in-house services including, but not limited to, photocopies and fax charges, at cost, provided quantities and rates are specified.

2. The final payment, not greater than 10 percent of the contract amount, will be made upon acceptance of the final report.

Reporting

1. The final reports for the Northern River Basins Study must be provided with hard copies (30) and an electronic disks (Word Perfect).

2. Specific data within the reports must be placed on D-Base for incorporation into other government data storage facilities.

3. For any photographs to be taken, 35 mm, 200 ASA Fuji slide film in a camera having a 50-55 mm lens is required.

Canada Alberta Northwest Territories

Northern River Basins Study

September 17, 1992

Mr. Curtiss McLeod
R L & L Environmental Services Ltd.
17312 - 106 Avenue
Edmonton, Alberta

Dear Mr. McLeod

Re: Project 3117-B7 Lake Whitefish Spawning Near the Vermilion Chutes - Peace River

From our telephone conversation of September 16, 1992, I would like to confirm our discussion with regard to the selection of your proposal to complete the above named project on behalf of the Northern River Basins Study.

The points we have agreed to are as follows:

1. Depending upon the extent of the lake whitefish spawning area, you may have to adjust the 500 metre transect spacings to better describe a more confined area. Should the spawning area be very confined, we would expect transects at closer intervals.

2. All lake whitefish that are to be tagged will also require the removal of the adipose fin.

3. Fish to be used for age-frequency distributions should be taken from a method that is most indicative of a "random" sampling technique.

4. Fish to be collected for chemical analyses should follow the outlined procedure within the Terms of Reference. The fish should be appropriately measured as per those instructions.

5. The assessment of sampling techniques should insure that a valid assessment of the most effective techniques be determined. The repeating of the methods 30 times may still be required to make such a determination but <u>if a valid determination</u> could be substantiated with less sampling, okay (page 3 of the proposal).

Otherwise congratulations on your project proposal.

NORTHERN RIVER BASINS STUDY

R. Makowecki

Ray Makowecki

cc: D. Marko
N. Jankovic

/mcr; 7415-3117-B7/064

#690, Standard Life Centre, 10405 - Jasper Avenue, Edmonton, Alberta, T5J 3N4
(403) 427-1742 Fax (403) 422-3055

R.L. & L. ENVIRONMENTAL SERVICES LTD.

17312 - 106 Avenue
EDMONTON, Alberta T5S 1H9
Phone: (403) 483-3499 Fax: (403) 483-1574

MEMO

TO: Curt McLeod **DATE:** 29 April 1993

FROM: Jacek Patalas

RE: Draft Report "Lake whitefish spawning study below Vermilion Chutes on the Peace River, 1992"

Although many of the objectives relating to lake whitefish spawning were not completed due to their near absence from the study area, the draft report will present additional information which was collected and analyzed, but not specifically requested in the Terms of Reference. These include:

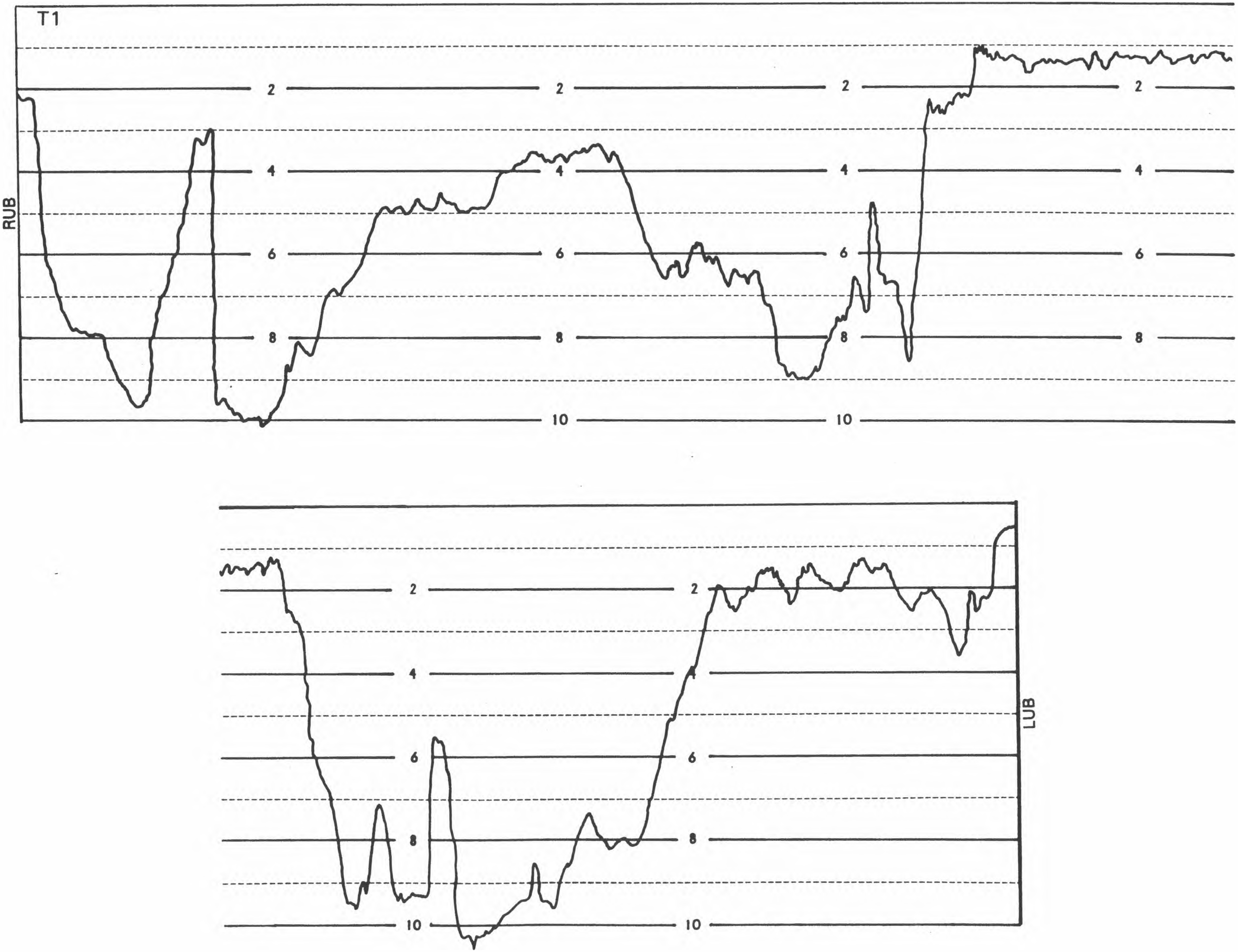
- bathymetric map of the study area
- life history data (i.e., growth, maturity, age frequencies) for goldeye, walleye, northern pike and burbot
- seasonal movements of main species based on CPUE comparison with previous studies.

The decision to collect ageing structures from species other than lake whitefish was verbally approved by both Ken Crutchfield and Dave Walty during telephone conversations around 16 October 1992. The processing of the ageing structures was discussed with Gary Ash sometime in January, and a verbal go-ahead was given.

It should also be pointed out that fish collection for contaminant analysis was expanded (on NRBS request) to include walleye, northern pike, in addition to lake whitefish and burbot only (as specified in the Terms of Reference).

APPENDIX B

ECHOSOUNDING TRANSECTS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4
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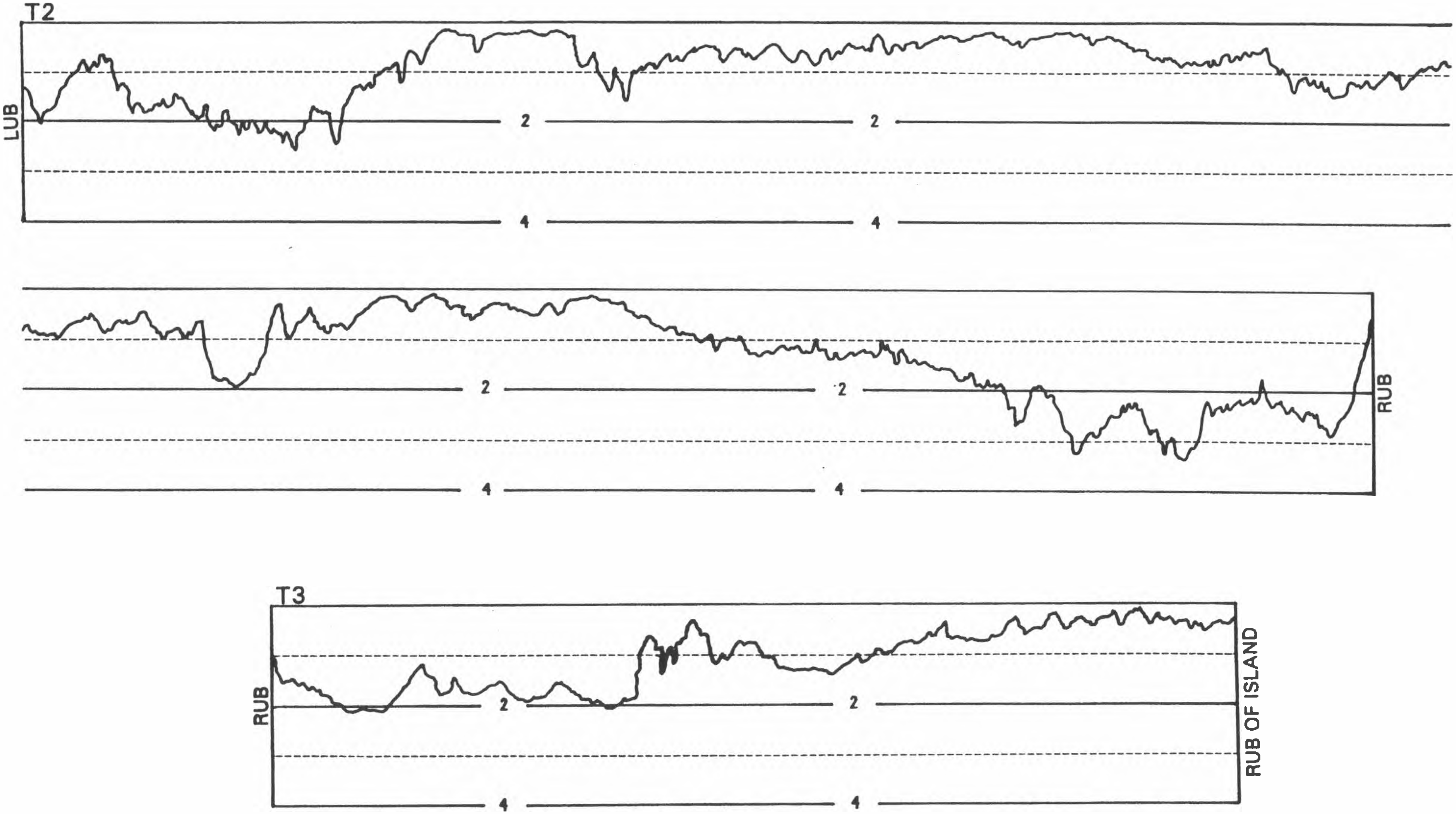
10
LUB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RUB
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T3
RUB
2
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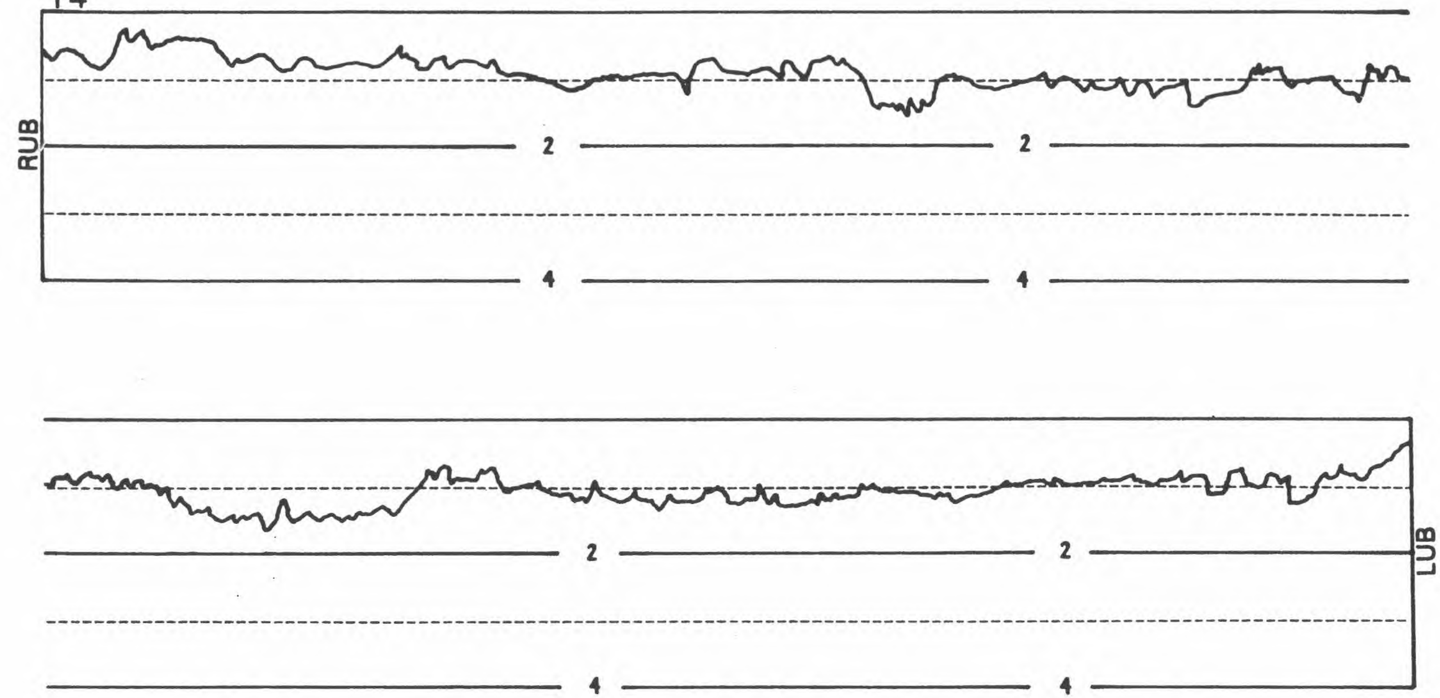
4
4
RUB OF ISLAND

T4



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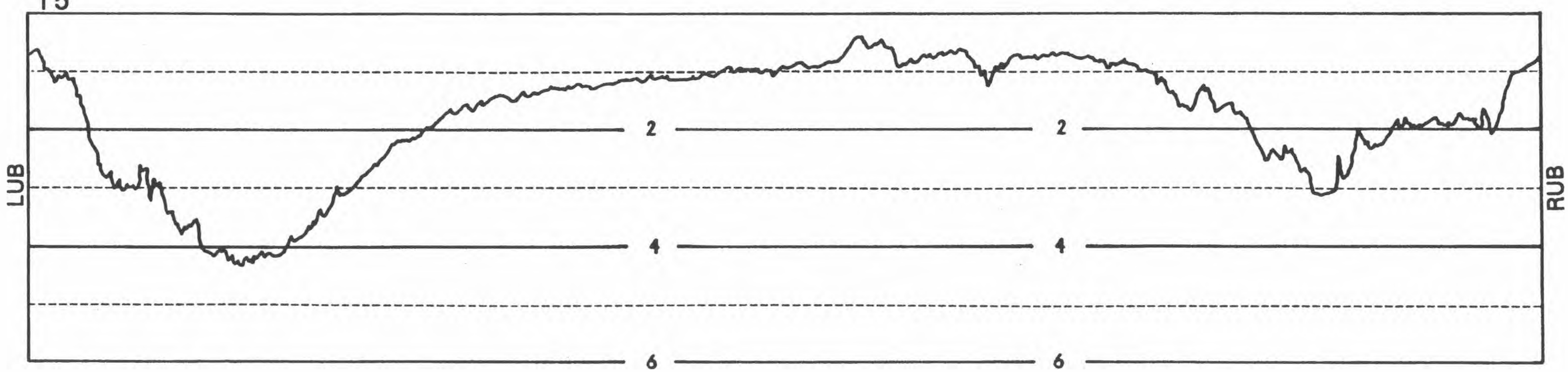

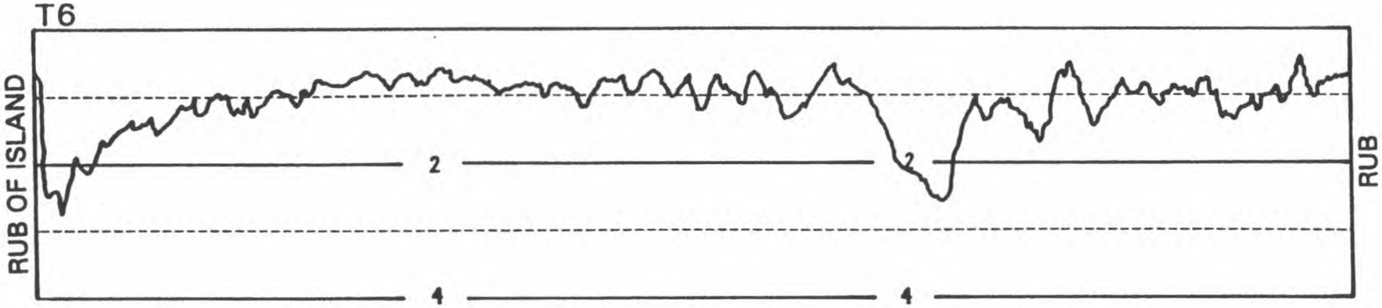

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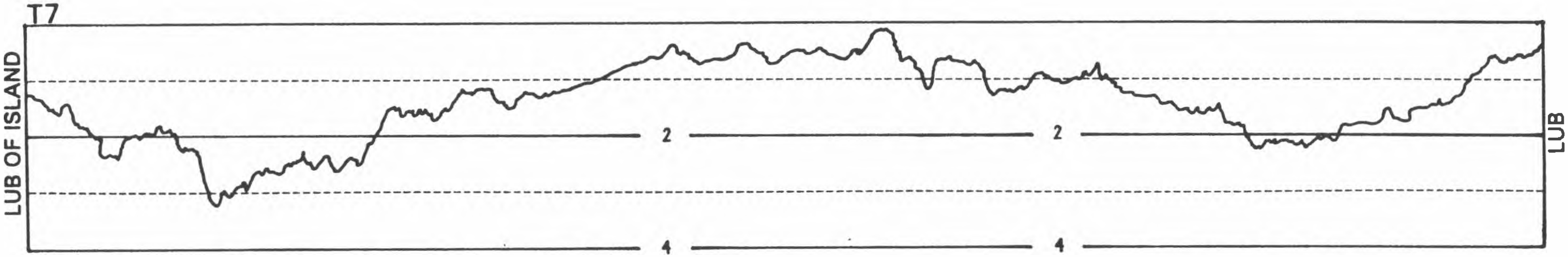
2
4
4
RUB



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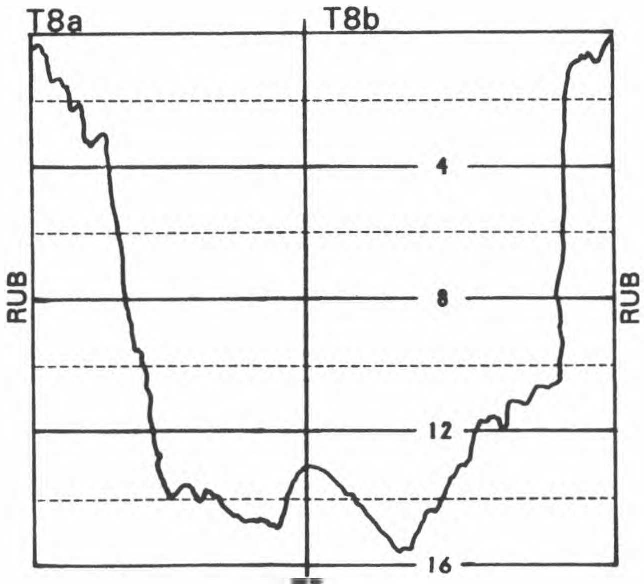
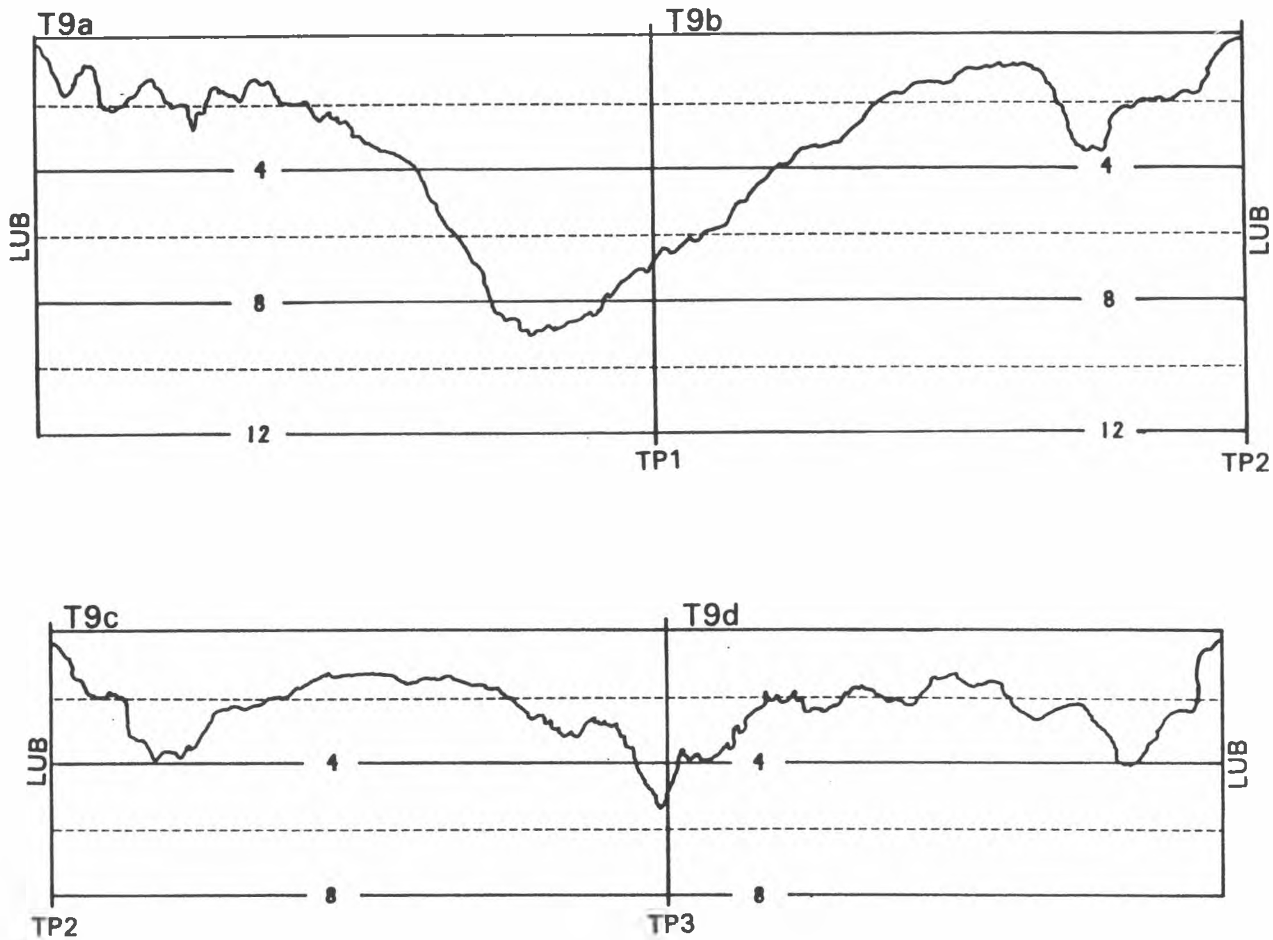
2
4
4
LUB

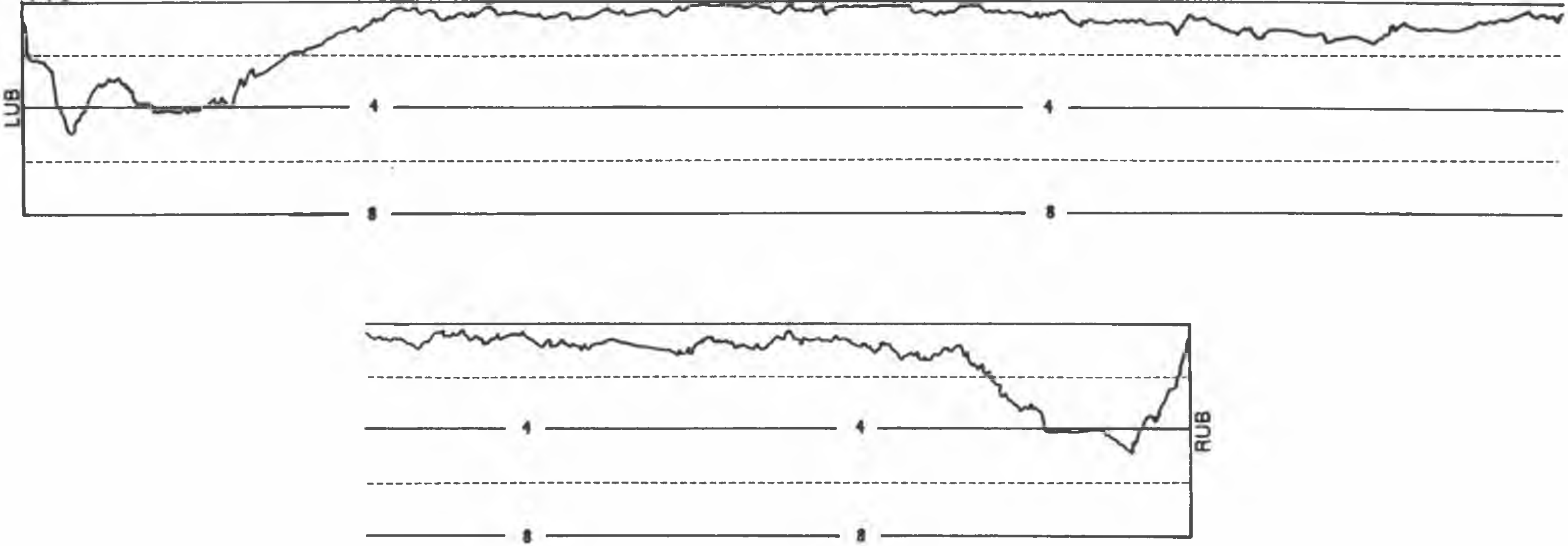


T8a
T8b
RUB
4
8
12
16
RUB



T9a
T9b
LUB
4
8
12
TP1
TP2
T9c
T9d
TP3

T10



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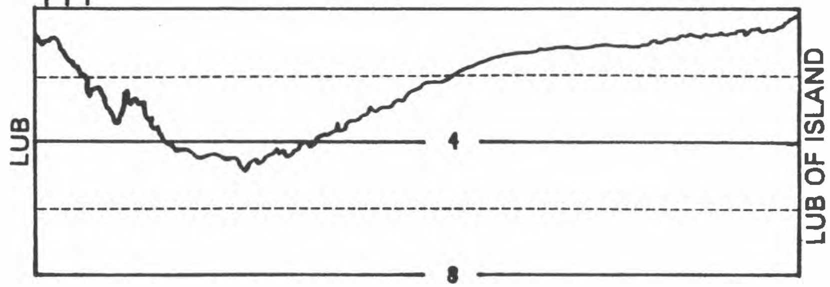

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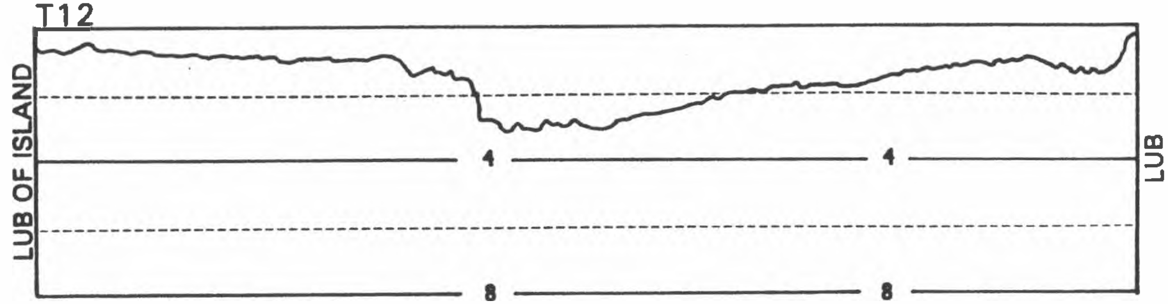
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LUB
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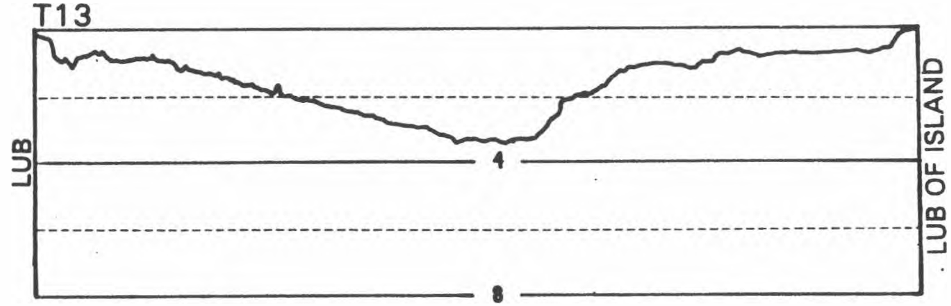
T13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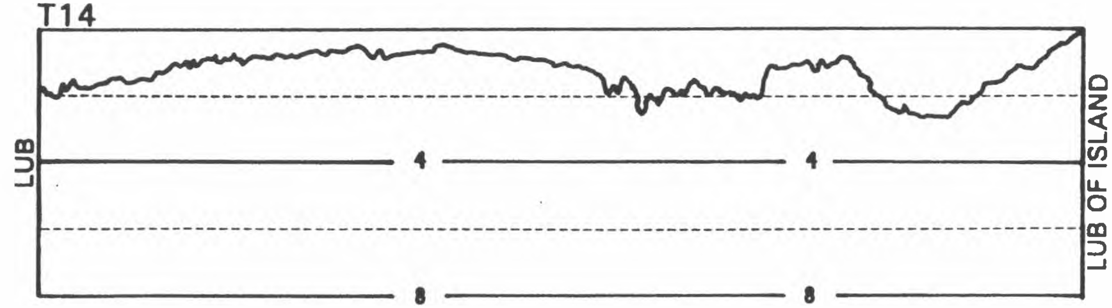
T14


LUB
LUB OF ISLAND
4
4
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8

APPENDIX C

FISH CATCH SUMMARIES

Table C1. Summary of gill net catches below Vermilion Chutes on the Peace River, October 1992.

Set No.	Site [a]	Set Date (Oct)	Set Time	Set Duration (h)	Net Units [b]	Water Depth (m)	Water Velocity (cm/s)	Air Temp. Set (°C)	Air Temp. Lift (°C)	Water Temp. Set (°C)	Water Temp. Lift (°C)	Secchi Visib. (cm)	Bottom Type	Net Effic. [c]	Mesh Size (mm)	Number of Fish Captured [d] LKWH	WALL	NRPK	GOLD	BURB	LNSC	WHSC	TOTAL
GN1A	D	10	12:25	22.3	0.51	1.5	25	12	3	7	6	60	gravel	1	140		2	1					3
GN1B	D	10	12:25	22.3	0.51	2.0	25	12	3	7	6	60	gravel	1	140		3	1					4
GN2A	A	10	13:00	22.0	0.50	3.0	30	12	3	5	4	60	sand	3	140		1		9				10
GN2B	A	10	13:00	22.0	0.50	3.0	30	12	3	5	4	60	sand	3	140							2	2
GN2C	A	10	13:00	22.0	0.50	2.5	30	12	3	5	4	60	silt	3	140				4				4
GN3A	I	10	16:30	22.8	0.52	3.5	40	10	9	8	7	50	silt	2	140						1		1
GN3B	I	10	16:30	22.8	0.52	3.0	40	10	9	8	7	50	rock	2	140		1				2		3
GN3C	I	10	16:30	22.8	0.52	2.0	40	10	9	8	7	50	rock	2	89		3	1	11		1		16
GN4	J	10	16:50	22.9	0.52	2.0	20	10	9	8	7	55	silt	2	38		1	2	3	1			7
GN4	J	10	16:50	22.9	0.52	3.0	20	10	9	8	7	55	rock	2	64				13		1		14
GN4	J	10	16:50	22.9	0.52	5.0	30	10	9	8	7	55	rock	2	89				6		4		10
GN4	J	10	16:50	22.9	0.52	7.0	40	10	9	8	7	55	rock	2	114						4		4
GN4	J	10	16:50	22.9	0.52	7.0	50	10	9	8	7	55	rock	2	140		2						2
GN5A	E	11	14:30	20.7	0.47	1.5	40	10	-1	7	6	50	rock	1	140								0
GN5B	E	11	14:30	20.7	0.47	1.7	40	10	-1	7	6	50	rock	1	140								0
GN5C	E	11	14:30	20.7	0.47	2.0	40	10	-1	7	6	50	silt	1	140								0
GN6A	H	11	15:00	23.5	0.54	2.5	50	10	0	7	6	50	rock	1	140		1				1		2
GN6B	H	11	15:00	23.5	0.54	3.5	20	10	0	7	6	50	rock	1	140								0
GN7A	J	11	16:40	22.2	0.51	2.5	20	7	0	7	6	50	rock	3	140								0
GN7B	J	11	16:40	22.2	0.51	12.5	100	7	0	7	6	50	rock	3	140								0
GN8	G	11	18:30	21.0	0.48	2.5	20	5	3	6	5	65	silt	3	38		4	1	3	2	1		11
GN8	G	11	18:30	21.0	0.48	2.2	20	5	3	6	5	65	silt	3	64		7	1	4		1		13
GN8	G	11	18:30	21.0	0.48	2.0	20	5	3	6	5	65	silt	3	89		1		3		2		6
GN8	G	11	18:30	21.0	0.48	1.5	20	5	3	6	5	65	silt	3	114						2		2
GN8	G	11	18:30	21.0	0.48	1.3	20	5	3	6	5	65	silt	3	140								0
GN9A	C	12	18:30	16.5	0.38	1.7	60	3	0	6	6	60	rock	3	140								0
GN9B	C	12	18:30	16.5	0.38	2.0	60	3	0	6	6	60	silt	3	140								0
GN10A	C	12	18:45	16.5	0.38	2.4	10	3	0	6	6	60	sand	2	140								0
GN10B	C	12	18:45	16.5	0.38	2.7	20	3	0	6	6	60	rock	2	140								0
GN10C	C	12	18:45	16.5	0.38	2.0	0	3	0	6	6	60	sand	2	140		3		1				4
GN11*	B	12	19:00	16.7	0.38	2.0	60	3	0	4	3	65	gravel	4	38								0
GN11*	B	12	19:00	16.7	0.38	2.1	60	3	0	4	3	65	gravel	4	64								0
GN11*	B	12	19:00	16.7	0.38	2.3	60	3	0	4	3	65	sand	4	89								0
GN11*	B	12	19:00	16.7	0.38	2.4	60	3	0	4	3	65	sand	4	114								0
GN11*	B	12	19:00	16.7	0.38	2.5	60	3	0	4	3	65	sand	4	140								0
GN12A	C	21	17:00	19.0	0.43	2.0	40	11	6	2	1	45	rock	3	140								0
GN12B	C	21	17:00	19.0	0.43	2.2	40	11	6	2	1	45	rock	3	114		1						1
GN12C	C	21	17:00	19.0	0.43	2.3	40	11	6	2	1	45	sand	3	140	1							1
GN13	D	21	17:15	18.3	0.42	1.5	20	11	6	2	1	45	gravel	2	38			2					2
GN13	D	21	17:15	18.3	0.42	1.5	20	11	6	2	1	45	gravel	2	64			1	5				6
GN13	D	21	17:15	18.3	0.42	1.5	20	11	6	2	1	45	gravel	2	89		1	2	10				13
GN13	D	21	17:15	18.3	0.42	1.5	20	11	6	2	1	45	gravel	2	114				1				1
GN13	D	21	17:15	18.3	0.42	1.5	20	11	6	2	1	45	gravel	2	140		1						1
GN14A	E	21	17:30	21.5	0.49	2.3	40	10	11	1	1	45	sand	2	140		2			1			3
GN14B	E	21	17:30	21.5	0.49	2.2	40	10	11	1	1	45	sand	2	140		1			1			2
GN14C	E	21	17:30	21.5	0.49	2.1	40	10	11	1	1	45	sand	2	140								0
GN15A	G	22	16:30	19.0	0.43	1.9	30	8	7	1	2	60	sand	2	140					1	1		2
GN15B	G	22	16:30	19.0	0.43	2.0	30	8	7	1	2	60	sand	2	114					11			11
GN15C	G	22	16:30	19.0	0.43	2.5	40	8	7	1	2	60	sand	2	140					3			3
GN16	J	22	17:30	21.7	0.49	1.3	30	8	7	1	2	55	rock	3	38								0
GN16	J	22	17:30	21.7	0.49	2.5	30	8	7	1	2	55	rock	3	64		1	1			4		6
GN16	J	22	17:30	21.7	0.49	3.0	30	8	7	1	2	55	rock	3	89		1				3		4
GN16	J	22	17:30	21.7	0.49	3.0	30	8	7	1	2	55	rock	3	114								0
GN16	J	22	17:30	21.7	0.49	3.0	30	8	7	1	2	55	rock	3	140								0
GN17A	I	22	18:00	21.8	0.50	2.2	40	5	7	1	2	55	rock	1	140			1					1
GN17B	I	22	18:00	21.8	0.50	2.0	40	5	7	1	2	55	rock	1	140			1			1		2
GN17C	I	22	18:00	21.8	0.50	1.9	40	5	7	1	2	55	rock	1	140					2			2
GN18A	E	23	16:20	17.9	0.41	1.9	30	6	5	1	2	60	silt	1	140		1						1
GN18B	E	23	16:20	17.9	0.41	2.3	30	6	5	1	2	60	gravel	1	140		1			1			2
GN18C	E	23	16:20	17.9	0.41	2.7	30	6	5	1	2	60	gravel	1	140								0
GN19A	F	23	16:50	17.2	0.39	1.0	40	6	5	2	2	70	gravel	1	140								0
GN19B	F	23	16:50	17.2	0.39	1.1	40	6	5	2	2	70	gravel	1	114			1			1		2
GN19C	F	23	16:50	17.2	0.39	1.2	40	6	5	2	2	70	gravel	1	140								0
TOTAL																1	39	16	73	23	30	2	184

[a] see Figure 3.2 for gill net set locations
[b] 1 net unit = 100 m² of gill net set for an equivalent of 12 hours
[c] net efficiency, as affected due to fouling by debris, was rated on a scale of 1 to 4 (1 = no fouling, 4 = heavy net fouling)
[d] for species code explanation see Table 5.1
* net was dragged by current and tangled; not included in CPUE calculations

Table C2. Fish species captured or observed during boat electroshocking below Vermilion Chutes on the Peace River, October 1992.

Station No.	Date (Oct)	Start Time	Water Temp. (°C)	Sampling Effort (km)	Sampling Effort (s)	Number of Fish Captured / (Observed) [a] LKWH	MNW	WALL	NRPK	GOLD	BURB	LNSC	WHSC	FLCH	LKCH	TRPR	Total Captured	Total Observed	TOTAL
ES1	11	13:00	6.5	2.0	1206	3 (6)			15 (13)	3 (4)							21	(23)	44
ES1	22	11:45	1.0	2.0	1374	5 (4)		1	4 (1)	1		4 (1)		2	1	1	19	(6)	25
ES1	23	11:15	1.0	2.0	1271	4		5	1 (1)	1 (4)		1 (6)	1 (1)	(4)			13	(16)	29
ES2	10	14:00	4.5	1.7	969			1	1 (1)	3 (5)							5	(6)	11
ES3	11	11:30	6.5	1.2	677	1 (1)		1	7 (6)	2 (2)				1 (2)			12	(11)	23
ES3	22	16:00	1.5	1.2	584		1		1 (2)	3 (7)		1 (1)					6	(10)	16
ES4	11	16:00	6.5	4.4	1928	1		1 (1)	1 (3)	4 (6)	1	(26)	(1)	(8)			8	(45)	53
ES5	11	15:00	6.5	1.1	747			2 (1)	3 (3)	1		8 (12)		(6)			14	(22)	36
ES5	22	17:15	1.5	1.1	657				(1)	1		16 (15)		2			19	(16)	35
TOTAL				16.7	9413	14 (11)	1 (0)	11 (2)	33 (31)	19 (28)	1 (0)	30 (61)	1 (2)	5 (20)	1 (0)	1 (0)	117	(155)	272

[a] see Table 5.1 for species code explanation

Table C3. Fish species captured by set lines below Vermilion Chutes on the Peace River, October 1992.

Set Line No.	Set Date (Oct)	Set Time	Sampling Effort Period (h)	No. Hooks	Hook-Hours	Number Captured Burbot	TOTAL
SL1	22	17:00	22.0	5	110	4	4
SL2	22	17:00	19.0	5	95	4	4
SL3	22	18:00	22.0	5	110	1	1
TOTAL			63.0	15	315	9	9

Table C4. Catch summary and CPUE (number caught / net-unit) for fish species captured in gill net sets below Vermilion Chutes on the Peace River, October 1992.

Location	Mesh Size (mm)	Number of Sets	Net Units [a]	Parameter	Lake whitefish	Walleye	Northern pike	Goldeye	Burbot	Longnose sucker	White sucker	TOTAL
Upper Sites (Loc. G-J)	38	3	1.50	Number Caught	0	5	3	6	3	1	0	18
				Mean CPUE (±SE)	0.00	3.34 (±2.46)	2.01 (±1.13)	4.01 (±1.99)	2.01 (±1.18)	0.67 (±0.68)	0.00	12.04 (±6.52)
	64	3	1.50	Number Caught	0	8	2	17	0	6	0	33
				Mean CPUE (±SE)	0.00	5.35 (±4.50)	1.34 (±0.70)	11.37 (±7.48)	0.00	4.01 (±2.03)	0.00	22.07 (±4.92)
	89	4	2.01	Number Caught	0	5	1	20	0	10	0	36
				Mean CPUE (±SE)	0.00	2.48 (±1.00)	0.50 (±0.86)	9.93 (±4.38)	0.00	4.97 (±1.35)	0.00	17.87 (±4.63)
	114	4	1.93	Number Caught	0	0	0	0	11	6	0	17
				Mean CPUE (±SE)	0.00	0.00	0.00	0.00	5.70 (±5.90)	3.11 (±1.90)	0.00	8.81 (±3.77)
	140	14	6.97	Number Caught	0	4	2	0	6	6	0	18
				Mean CPUE (±SE)	0.00	0.57 (±0.32)	0.29 (±0.19)	0.00	0.86 (±0.51)	0.86 (±0.34)	0.00	2.58 (±0.62)
	Standard Gang [b]	3	7.48	Number Caught	0	17	5	32	3	22	0	79
				Mean CPUE (±SE)	0.00	2.27 (±1.32)	0.67 (±0.13)	4.28 (±2.48)	0.40 (±0.23)	2.94 (±0.28)	0.00	10.57 (±3.24)
Lower Sites (Loc. A-F)	38	1	0.42	Number Caught	0	0	2	0	0	0	0	2
				Mean CPUE (±SE)	0.00	0.00	4.81	0.00	0.00	0.00	0.00	4.81
	64	1	0.42	Number Caught	0	0	1	5	0	0	0	6
				Mean CPUE (±SE)	0.00	0.00	2.40	12.02	0.00	0.00	0.00	14.42
	89	1	0.42	Number Caught	0	1	2	10	0	0	0	13
				Mean CPUE (±SE)	0.00	2.40	4.81	24.04	0.00	0.00	0.00	31.25
	114	3	1.24	Number Caught	0	1	0	1	0	0	0	2
				Mean CPUE (±SE)	0.00	0.81 (±0.79)	0.00	0.81 (±0.80)	0.00	0.00	0.00	1.61 (±0.76)
	140	24	10.58	Number Caught	1	15	2	14	3	0	2	37
				Mean CPUE (±SE)	0.09 (±0.09)	1.42 (±0.44)	0.19 (±0.13)	1.32 (±0.91)	0.28 (±0.16)	0.00	0.19 (±0.19)	3.50 (±1.04)
	Standard Gang [b]	1	2.08	Number Caught	0	2	5	16	0	0	0	23
				Mean CPUE (±SE)	0.00	0.96	2.40	7.69	0.00	0.00	0.00	11.06
All Sites Combined	38	4	1.91	Number Caught	0	5	5	6	3	1	0	20
				Mean CPUE (±SE)	0.00	2.62 (±1.96)	2.62 (±1.04)	3.14 (±1.73)	1.57 (±0.98)	0.52 (±0.52)	0.00	10.46 (±5.07)
	64	4	1.91	Number Caught	0	8	3	22	0	6	0	39
				Mean CPUE (±SE)	0.00	4.19 (±3.52)	1.57 (±0.58)	11.51 (±5.52)	0.00	3.14 (±1.75)	0.00	20.40 (±4.03)
	89	5	2.43	Number Caught	0	6	3	30	0	10	0	49
				Mean CPUE (±SE)	0.00	2.47 (±1.00)	1.23 (±0.86)	12.35 (±4.38)	0.00	4.12 (±1.35)	0.00	20.16 (±4.63)
	114	7	3.17	Number Caught	0	1	0	1	11	6	0	19
				Mean CPUE (±SE)	0.00	0.32 (±0.32)	0.00	0.32 (±0.32)	3.47 (±3.50)	1.89 (±1.26)	0.00	6.00 (±3.25)
	140	38	17.54	Number Caught	1	19	4	14	9	6	2	55
				Mean CPUE (±SE)	0.06 (±0.06)	1.08 (±0.30)	0.23 (±0.11)	0.80 (±0.56)	0.51 (±0.22)	0.34 (±0.15)	0.11 (±0.11)	3.13 (±0.67)
	Standard Gang [b]	4	9.56	Number Caught	0	19	10	48	3	22	0	102
				Mean CPUE (±SE)	0.00	1.99 (±1.01)	1.05 (±0.41)	5.02 (±1.98)	0.31 (±0.20)	2.30 (±0.70)	0.00	10.67 (±2.40)

[a] 1 net unit = 100 m^2 of gill net set for an equivalent of 12 hours
[b] 1 standard gang consists of equal amounts of 38, 64, 89, 114, and 140 mm mesh

Table C5. Catch-per-unit-effort (CPUE) for fish species captured or observed during boat electroshocking below Vermilion Chutes on the Peace River, October 1992.

Station	Effort	CPUE (number/km) [a]											
No.	(km)	LKWH	MNWH	WALL	NRPK	GOLD	BURB	LNSC	WHSC	FLCH	LKCH	TRPR	TOTAL
ES1	2.0	4.50	0.00	0.00	14.00	3.50	0.00	0.00	0.00	0.00	0.00	0.00	22.00
ES1	2.0	4.50	0.00	0.50	2.50	0.50	0.00	2.50	0.00	1.00	0.50	0.50	12.50
ES1	2.0	2.00	0.00	2.50	1.00	2.50	0.00	3.50	1.00	2.00	0.00	0.00	14.50
ES2	1.7	0.00	0.00	0.59	1.18	4.71	0.00	0.00	0.00	0.00	0.00	0.00	6.47
ES3	1.2	1.67	0.00	0.83	10.83	3.33	0.00	0.00	0.00	2.50	0.00	0.00	19.17
ES3	1.2	0.00	0.83	0.00	2.50	8.33	0.00	1.67	0.00	0.00	0.00	0.00	13.33
ES4	4.4	0.23	0.00	0.45	0.91	2.27	0.23	5.91	0.23	1.82	0.00	0.00	12.05
ES5	1.1	0.00	0.00	2.73	5.45	0.91	0.00	18.18	0.00	5.45	0.00	0.00	32.73
ES5	1.1	0.00	0.00	0.00	0.91	0.91	0.00	28.18	0.00	1.82	0.00	0.00	31.82
Upper Stations (ES4 & ES5)													
n		*1*	*0*	*5*	*11*	*12*	*1*	*77*	*1*	*16*	*0*	*0*	*124*
Mean CPUE		**0.15**	**0.00**	**0.76**	**1.67**	**1.82**	**0.15**	**11.67**	**0.15**	**2.42**	**0.00**	**0.00**	**18.79**
Standard Error		0.08		0.50	1.00	0.45	0.08	5.94	0.08	0.80			6.74
Lower Stations (ES1, ES2 & ES3)													
n		*24*	*1*	*8*	*53*	*35*	*0*	*14*	*2*	*9*	*1*	*1*	*148*
Mean CPUE		**2.38**	**0.10**	**0.79**	**5.25**	**3.47**	**0.00**	**1.39**	**0.20**	**0.89**	**0.10**	**0.10**	**14.65**
Standard Error		0.85	0.10	0.43	2.46	0.95		0.68	0.19	0.42	0.10	0.10	2.33
All Stations Combined													
n		*25*	*1*	*13*	*64*	*47*	*1*	*91*	*3*	*25*	*1*	*1*	*272*
Mean CPUE		**1.50**	**0.06**	**0.78**	**3.83**	**2.81**	**0.06**	**5.45**	**0.18**	**1.50**	**0.06**	**0.06**	**16.29**
Standard Error		0.69	0.06	0.32	1.80	0.66	0.05	2.28	0.12	0.45	0.06	0.06	2.58

[a] see Table 5.1 for species codes

APPENDIX D

FISH LIFE HISTORY DATA

Table D1. Raw data for fish captured below Vermilion Chutes on the Peace River, October 1992.

Sample Number	Species	Fork Length (mm)	Weight (g)	Sex & Mat. (a)	Gonad Weight (g)	Age (yr)	Ageing Method (b)	Capture Method (c)	Mesh Size (mm)	Yellow Tag Number	Date of Capture	Station (d)	Location (d)	Capt Code (e)	Pres. Code (f)	Comments
53	Lake whitefish	464		08				ES			22 Oct 92	ES1		1	1	
98	Lake whitefish	472		09				ES			23 Oct 92	ES1		1	1	
16	Lake whitefish	496	1991	08	46	11	SO	ES			11 Oct 92	ES3		1		stomach empty
56	Lake whitefish	499		08				ES			22 Oct 92	ES1		1	1	red spots on abdomen
54	Lake whitefish	501		08				ES			22 Oct 92	ES1		1	1	
96	Lake whitefish	507		09				ES			23 Oct 92	ES1		1	1	
55	Lake whitefish	518		08				ES			22 Oct 92	ES1		1	1	
51	Lake whitefish	518	1729	07	36	11	SO	ES			11 Oct 92	ES4		1		stomach empty
18	Lake whitefish	518	2418	08	143	11	SO	ES			11 Oct 92	ES1		1		stomach empty
99	Lake whitefish	521		09				ES			23 Oct 92	ES1		1	1	
17	Lake whitefish	536	2499	08	65	12	SO	ES			11 Oct 92	ES1		1		stomach empty
19	Lake whitefish	552	2410	08	52	13	SO	ES			11 Oct 92	ES1		1		stomach empty; bird puncture marks
52	Lake whitefish	555		08				ES			22 Oct 92	ES1		1	1	
97	Lake whitefish	557		09				ES			23 Oct 92	ES1		1	1	
767	Lake whitefish	582	3614	18				GN	140		22 Oct 92	GN12C	C	1	1	
71	Mountain whitefish	364	701			8	SC	ES		1024	22 Oct 92	ES3		0		
61	Walleye	375						ES			22 Oct 92	ES1		1	1	
43	Walleye	378	605					ES		1017	11 Oct 92	ES5		0		
103	Walleye	386						ES			23 Oct 92	ES1		1	1	
5	Walleye	398	851					ES		1002	10 Oct 92	ES2		0		
102	Walleye	402						ES			23 Oct 92	ES1		1	1	
104	Walleye	407						ES			23 Oct 92	ES1		1	1	
49	Walleye	414	683					ES		1022	11 Oct 92	ES4		0		
100	Walleye	447						ES			23 Oct 92	ES1		1	1	
42	Walleye	454	1081					ES		1016	11 Oct 92	ES5		0		
101	Walleye	479						ES			23 Oct 92	ES1		1	1	
6	Walleye	667	4274					ES		1003	11 Oct 92	ES3		0		recap 13 Oct 92 @ GN10C (sample # 741)
718	Walleye	324	400	01		5	FR	GN	64		12 Oct 92	GN8	G	1		
734	Walleye	335	358	11		5	FR	GN	38		12 Oct 92	GN8	G	1		
722	Walleye	352	463	11		6	FR	GN	64		12 Oct 92	GN8	G	1		
719	Walleye	358	469	11		6	FR	GN	64		12 Oct 92	GN8	G	1		
803	Walleye	362	482	04		6	FR	GN	64		23 Oct 92	GN16	J	1		
656	Walleye	369	520	04		6	DS	GN	89		11 Oct 92	GN3C	I	1		
721	Walleye	374	691	04		7	FR	GN	64		12 Oct 92	GN8	G	1		
720	Walleye	381	680	04		7	FR	GN	64		12 Oct 92	GN8	G	1		
717	Walleye	382	682	04		8	FR	GN	64		12 Oct 92	GN8	G	1		
737	Walleye	383						GN	38	9011	12 Oct 92	GN8	G	2		tagged 21 May 92 @ Horse Ck. (345 mm)
738	Walleye	390						GN	38	1505	12 Oct 92	GN8	G	0		
736	Walleye	390						GN	38	1504	12 Oct 92	GN8	G	0		
655	Walleye	414	839	04		7	DS	GN	89		11 Oct 92	GN3C	I	1		
797	Walleye	415	817	04		8	FR	GN	89		23 Oct 92	GN16	J	1		
716	Walleye	421	886	11		9	FR	GN	64		12 Oct 92	GN8	G	1		
768	Walleye	436						GN	114	1507	22 Oct 92	GN12B	C	0		
710	Walleye	448	1144	04		9	DS	GN	89		12 Oct 92	GN8	G	1		
769	Walleye	456	1376					GN	140		22 Oct 92	GN14B	E	1	1	
633	Walleye	461	1199	14		11	SO	GN	140		11 Oct 92	GN2A	A	1		bright gold coloration
654	Walleye	475	1275	11		10	DS	GN	89		11 Oct 92	GN3C	I	1		
772	Walleye	490	1627					GN	140		22 Oct 92	GN14A	E	1	1	
746	Walleye	503	1550	11		9	FR	GN	89		22 Oct 92	GN13	D	1		
650	Walleye	534	1650	04		11	DS	GN	140		11 Oct 92	GN3B	I	1		
771	Walleye	542	2306					GN	140		22 Oct 92	GN14A	E	1	1	
632	Walleye	564	2230	11		12	SO	GN	140		11 Oct 92	GN1B	D	1		
810	Walleye	568	2530					GN	140		24 Oct 92	GN18A	E	1	1	
669	Walleye	572						GN	140	1501	11 Oct 92	GN4	J	0		

Table D1 (continued). Raw data for fish captured below Vermilion Chutes on the Peace River, October 1992.

Sample Number	Species	Fork Length (mm)	Weight (g)	Sex & Mat. (a)	Gonad Weight (g)	Age (yr)	Ageing Method (b)	Capture Method (c)	Mesh Size (mm)	Yellow Tag Number	Date of Capture	Station (d)	Location (d)	Capt Code (e)	Pres. Code (f)	Comments
701	Walleye	580						GN	38	1503	11 Oct 92	GN4	J	0		
628	Walleye	582	2950	14		12	SO	GN	140		11 Oct 92	GN1A	D	1		
811	Walleye	584	2775					GN	140		24 Oct 92	GN18A	E	1	1	
744	Walleye	592	2765					GN	140		22 Oct 92	GN13	D	1	1	
627	Walleye	593	3200	14		12	SO	GN	140		11 Oct 92	GN1A	D	1		
670	Walleye	600						GN	140	1502	11 Oct 92	GN4	J	0		
706	Walleye	610	2980	14		14	SO	GN	140		12 Oct 92	GN6A	H	1		
740	Walleye	610						GN	140	1506	13 Oct 92	GN10C	C	0		
630	Walleye	627	2830	14		13	SO	GN	140		11 Oct 92	GN1B	D	1		
631	Walleye	650	3592	14		15	SO	GN	140		11 Oct 92	GN1B	D	1		
741	Walleye	667	4274					GN	140	1003	13 Oct 92	GN10C	C	2		tagged 11 Oct 92 @ ES 3 (sample #6)
742	Walleye	690	4679	14		14	FR	GN	140		13 Oct 92	GN10C	C	1		
33	Northern pike	189	43					ES			11 Oct 92	ES1		0		
24	Northern pike	193	36					ES			11 Oct 92	ES1		0		
25	Northern pike	204	49					ES			11 Oct 92	ES1		0		
32	Northern pike	212	66					ES			11 Oct 92	ES1		0		
30	Northern pike	218	66					ES			11 Oct 92	ES1		0		
29	Northern pike	224	71					ES			11 Oct 92	ES1		0		
23	Northern pike	247	83					ES			11 Oct 92	ES1		0		
26	Northern pike	247	94					ES			11 Oct 92	ES1		0		
13	Northern pike	248	97					ES			11 Oct 92	ES3		0		
14	Northern pike	249	105					ES			11 Oct 92	ES3		0		
40	Northern pike	250	99					ES			11 Oct 92	ES5		0		
28	Northern pike	253	108					ES			11 Oct 92	ES1		0		
11	Northern pike	261	111					ES		1007	11 Oct 92	ES3		0		
10	Northern pike	263	120					ES		1006	11 Oct 92	ES3		0		
27	Northern pike	265	116					ES			11 Oct 92	ES1		0		
31	Northern pike	270	133					ES			11 Oct 92	ES1		0		
15	Northern pike	272	133					ES		1009	11 Oct 92	ES3		0		
12	Northern pike	283	163					ES		1008	11 Oct 92	ES3		0		black spot disease
34	Northern pike	286	160					ES			11 Oct 92	ES1		0		
35	Northern pike	300	184					ES			11 Oct 92	ES1		0		
72	Northern pike	309	209			3	FR	ES		1025	22 Oct 92	ES3		0		
22	Northern pike	311	196					ES			11 Oct 92	ES1		0		
9	Northern pike	322	230					ES		1005	11 Oct 92	ES3		0		
39	Northern pike	420	547					ES		1015	11 Oct 92	ES5		0		recap 12 Oct 92 @ GN8 (sample #723)
105	Northern pike	441						ES			23 Oct 92	ES1		1	1	
58	Northern pike	489						ES			22 Oct 92	ES1		1	1	
59	Northern pike	504						ES			22 Oct 92	ES1		1	1	
4	Northern pike	507	908					ES		1001	10 Oct 92	ES2		0		
60	Northern pike	520						ES			22 Oct 92	ES1		1	1	
57	Northern pike	542						ES			22 Oct 92	ES1		1	1	
48	Northern pike	568	1436					ES		1021	11 Oct 92	ES4		0		
41	Northern pike	590	1358					ES		9005	11 Oct 92	ES5		2		tagged 21 May 92 @ Horse Ck. (564 mm)
21	Northern pike	603	1784					ES		1011	11 Oct 92	ES1		0		
736	Northern pike	227						GN	38		12 Oct 92	GN8	G	0		
766	Northern pike	242	92	01		2	CL	GN	38		22 Oct 92	GN13	D	1		
765	Northern pike	270	125	11		3	CL	GN	38		22 Oct 92	GN13	D	1		
696	Northern pike	298	182	01		3	SC	GN	38		11 Oct 92	GN4	J	1		
802	Northern pike	337	267	04		3	CL	GN	64		23 Oct 92	GN16	J	1		
723	Northern pike	420	547	11		4	SC	GN	64	1015	12 Oct 92	GN8	G	3		tagged 11 Oct 92 @ ES5 (sample # 39)
748	Northern pike	511	1094	14		6	CL	GN	89		22 Oct 92	GN13	D	1		
808	Northern pike	523	1138					GN	140		23 Oct 92	GN17A	I	1	1	
813	Northern pike	534	1415					GN	114		24 Oct 92	GN19B	F	1	1	

Table D1 (continued). Raw data for fish captured below Vermilion Chutes on the Peace River, October 1992.

Sample Number	Species	Fork Length (mm)	Weight (g)	Sex & Mat. (a)	Gonad Weight (g)	Age (yr)	Ageing Method (b)	Capture Method (c)	Mesh Size (mm)	Yellow Tag Number	Date of Capture	Station (d)	Location (d)	Capt Code (e)	Pres. Code (f)	Comments
695	Northern pike	622	2016	14		8	SC	GN	38		11 Oct 92	GN4	J	1		
657	Northern pike	625	2024	04		8	SC	GN	89		11 Oct 92	GN3C	I	1		
747	Northern pike	711	3089	14		8	CL	GN	89		22 Oct 92	GN13	D	1		
759	Northern pike	748	3361	14		9	CL	GN	64		22 Oct 92	GN13	D	1		
807	Northern pike	786	3992					GN	140		23 Oct 92	GN17B	I	1	1	
629	Northern pike	802	4930	14		9	SC	GN	140		11 Oct 92	GN1B	D	1		
626	Northern pike	993	9823	14		12	SC	GN	140		11 Oct 92	GN1A	D	1		
70	Goldeye	72				0	LF	ES			22 Oct 92	ES1		0		
75	Goldeye	74				0	LF	ES			22 Oct 92	ES3		0		
76	Goldeye	82				0	LF	ES			22 Oct 92	ES3		0		
74	Goldeye	83				0	LF	ES			22 Oct 92	ES3		0		
108	Goldeye	88				0	LF	ES			23 Oct 92	ES1		0		
7	Goldeye	244	168					ES			11 Oct 92	ES3		0		
47	Goldeye	248	153					ES			11 Oct 92	ES4		0		
38	Goldeye	276	223					ES		1014	11 Oct 92	ES5		0		
46	Goldeye	284	224					ES		1020	11 Oct 92	ES4		0		
20	Goldeye	302	303					ES		1010	11 Oct 92	ES1		0		
77	Goldeye	315	259	20		6	SC	ES		1026	22 Oct 92	ES5		0		
3	Goldeye	318	377					ES			10 Oct 92	ES2		0		
36	Goldeye	318	324					ES		1012	11 Oct 92	ES1		0		
8	Goldeye	324	351					ES		1004	11 Oct 92	ES3		0		
44	Goldeye	338	407					ES		1018	11 Oct 92	ES4		0		
37	Goldeye	343	474					ES		1013	11 Oct 92	ES1		0		
45	Goldeye	359	544					ES		1019	11 Oct 92	ES4		0		
1	Goldeye	363	511					ES			10 Oct 92	ES2		0		
2	Goldeye	382	658					ES			10 Oct 92	ES2		0		
764	Goldeye	243	148	01		4	OP	GN	64		22 Oct 92	GN13	D	1		
641	Goldeye	253	170	01		4	SC	GN	140		11 Oct 92	GN2A	A	1		
763	Goldeye	254	169	01		4	OP	GN	64		22 Oct 92	GN13	D	1		
640	Goldeye	269	222	01		5	SC	GN	140		11 Oct 92	GN2A	A	1		
676	Goldeye	285	269					GN	89		11 Oct 92	GN4	J	1		
680	Goldeye	286	318					GN	89		11 Oct 92	GN4	J	1		
639	Goldeye	290	285	01		4	SC	GN	140		11 Oct 92	GN2A	A	1		
689	Goldeye	293	288					GN	64		11 Oct 92	GN4	J	1		
667	Goldeye	296	276	01		5	SC	GN	89		11 Oct 92	GN3C	I	1		
668	Goldeye	298	277	01		5	SC	GN	89		11 Oct 92	GN3C	I	1		
660	Goldeye	302	308	01		5	SC	GN	89		11 Oct 92	GN3C	I	1		
642	Goldeye	305	312	11		5	SC	GN	140		11 Oct 92	GN2A	A	1		
691	Goldeye	305	307					GN	64		11 Oct 92	GN4	J	1		
690	Goldeye	308	333					GN	64		11 Oct 92	GN4	J	1		
754	Goldeye	311	313	01		7	OP	GN	89		22 Oct 92	GN13	D	1		
693	Goldeye	312	352					GN	64		11 Oct 92	GN4	J	1		
757	Goldeye	312	308	11		6	OP	GN	89		22 Oct 92	GN13	D	1		
686	Goldeye	312	323					GN	64		11 Oct 92	GN4	J	1		
666	Goldeye	312	310	03		6	SC	GN	89		11 Oct 92	GN3C	I	1		
682	Goldeye	315	313					GN	64		11 Oct 92	GN4	J	1		
677	Goldeye	315	357					GN	89		11 Oct 92	GN4	J	1		
762	Goldeye	316	404	04		6	OP	GN	64		22 Oct 92	GN13	D	1		
665	Goldeye	316	341	01		5	SC	GN	89		11 Oct 92	GN3C	I	1		
758	Goldeye	318	384	01		6	OP	GN	89		22 Oct 92	GN13	D	1		
692	Goldeye	318	407					GN	64		11 Oct 92	GN4	J	1		
688	Goldeye	318	360					GN	64		11 Oct 92	GN4	J	1		
728	Goldeye	319	385					GN	64		12 Oct 92	GN8	G	1		
678	Goldeye	319	391					GN	89		11 Oct 92	GN4	J	1		

Table D1 (continued). Raw data for fish captured below Vermilion Chutes on the Peace River, October 1992.

Sample Number	Species	Fork Length (mm)	Weight (g)	Sex & Mat. (a)	Gonad Weight (g)	Age (yr)	Ageing Method (b)	Capture Method (c)	Mesh Size (mm)	Yellow Tag Number	Date of Capture	Station (d)	Location (d)	Capt Code (e)	Pres. Code (f)	Comments
661	Goldeye	322	378	01		6	SC	GN	89		11 Oct 92	GN3C	I	1		
714	Goldeye	322	419					GN	89		12 Oct 92	GN8	G	1		
731	Goldeye	323	392					GN	38		12 Oct 92	GN8	G	1		
756	Goldeye	324	405	04		6	OP	GN	89		22 Oct 92	GN13	D	1		
753	Goldeye	325	354	11		7	OP	GN	89		22 Oct 92	GN13	D	1		
755	Goldeye	325	383	01		8	OP	GN	89		22 Oct 92	GN13	D	1		
727	Goldeye	327	390					GN	64		12 Oct 92	GN8	G	1		
698	Goldeye	327	393					GN	38		11 Oct 92	GN4	J	1		
749	Goldeye	327	416	14		7	OP	GN	89		22 Oct 92	GN13	D	1		
685	Goldeye	329	435					GN	64		11 Oct 92	GN4	J	1		
664	Goldeye	329	389	14		7	SC	GN	89		11 Oct 92	GN3C	I	1		
684	Goldeye	330	376					GN	64		11 Oct 92	GN4	J	1		
699	Goldeye	330	440					GN	38		11 Oct 92	GN4	J	1		
679	Goldeye	330	418					GN	89		11 Oct 92	GN4	J	1		
726	Goldeye	330	442					GN	64		12 Oct 92	GN8	G	1		
662	Goldeye	330	426	04		7	SC	GN	89		11 Oct 92	GN3C	I	1		
743	Goldeye	331	421					GN	140		13 Oct 92	GN10C	C	1		
694	Goldeye	333	397					GN	64		11 Oct 92	GN4	J	1		
725	Goldeye	333	415					GN	64		12 Oct 92	GN8	G	1		
732	Goldeye	336	459					GN	38		12 Oct 92	GN8	G	1		
760	Goldeye	337	482	01		8	OP	GN	64		22 Oct 92	GN13	D	1		
715	Goldeye	337	496					GN	89		12 Oct 92	GN8	G	1		
761	Goldeye	337	472	14		8	OP	GN	64		22 Oct 92	GN13	D	1		
658	Goldeye	338	481	01		7	SC	GN	89		11 Oct 92	GN3C	I	1		
648	Goldeye	338	413	14		7	SC	GN	140		11 Oct 92	GN2C	A	1		
683	Goldeye	342	407					GN	64		11 Oct 92	GN4	J	1		
647	Goldeye	344	511	14		7	SC	GN	140		11 Oct 92	GN2C	A	1		
635	Goldeye	345	466	14		7	SC	GN	140		11 Oct 92	GN2A	A	1		
659	Goldeye	347	491	14		8	SC	GN	89		11 Oct 92	GN3C	I	1		
675	Goldeye	349						GN	89		11 Oct 92	GN4	J	1		
636	Goldeye	349	480	04		7	SC	GN	140		11 Oct 92	GN2A	A	1		
752	Goldeye	352	482	14		8	OP	GN	89		22 Oct 92	GN13	D	1		
750	Goldeye	353	542	11		9	OP	GN	89		22 Oct 92	GN13	D	1		
634	Goldeye	354	564	14		8	SC	GN	140		11 Oct 92	GN2A	A	1		
697	Goldeye	360	612					GN	38		11 Oct 92	GN4	J	1		
663	Goldeye	362	556	11		9	SC	GN	89		11 Oct 92	GN3C	I	1		
745	Goldeye	362	579	14		8	OP	GN	114		22 Oct 92	GN13	D	1		
638	Goldeye	362	583	04		7	SC	GN	140		11 Oct 92	GN2A	A	1		
733	Goldeye	365	563					GN	38		12 Oct 92	GN8	G	1		
713	Goldeye	365	589					GN	89		12 Oct 92	GN8	G	1		
637	Goldeye	366	572	14		7	SC	GN	140		11 Oct 92	GN2A	A	1		
687	Goldeye	367	590					GN	64		11 Oct 92	GN4	J	1		
751	Goldeye	374	651	14		8	OP	GN	89		22 Oct 92	GN13	D	1		
645	Goldeye	392	743	14		8	SC	GN	140		11 Oct 92	GN2C	A	1		
646	Goldeye	394	689	14		8	SC	GN	140		11 Oct 92	GN2C	A	1		
50	Burbot	596	1092					ES		1023	11 Oct 92	ES4		0		
783	Burbot	560						GN	114		23 Oct 92	GN15B	G	1	1	
778	Burbot	571						GN	114		23 Oct 92	GN15B	G	1	1	
789	Burbot	578						GN	114		23 Oct 92	GN15B	G	1	1	
788	Burbot	583	1272	14		8	OT	GN	114		23 Oct 92	GN15B	G	1		
786	Burbot	587	1373	04		8	OT	GN	114		23 Oct 92	GN15B	G	1		
782	Burbot	602						GN	114		23 Oct 92	GN15B	G	1	1	
787	Burbot	611	1499	15		9	OT	GN	114		23 Oct 92	GN15B	G	1		
780	Burbot	623						GN	114		23 Oct 92	GN15B	G	1	1	

Table D1 (continued). Raw data for fish captured below Vermilion Chutes on the Peace River, October 1992.

Sample Number	Species	Fork Length (mm)	Weight (g)	Sex & Mat. (a)	Gonad Weight (g)	Age (yr)	Ageing Method (b)	Capture Method (c)	Mesh Size (mm)	Yellow Tag Number	Date of Capture	Station (d)	Location (d)	Capt Code (e)	Pres. Code (f)	Comments
781	Burbot	627						GN	114		23 Oct 92	GN15B	G	1	1	
770	Burbot	640	2043					GN	140		22 Oct 92	GN14B	E	1	1	
812	Burbot	656	2152					GN	140		24 Oct 92	GN13A	E	1	1	
785	Burbot	666	2080	14		9	OT	GN	114		23 Oct 92	GN15B	G	1		
776	Burbot	690	2437	14		9	OT	GN	140		23 Oct 92	GN15C	G	1		
779	Burbot	706						GN	114		23 Oct 92	GN15B	G	1	1	
804	Burbot	720	2396					GN	140		23 Oct 92	GN17C	I	1	1	
773	Burbot	724	2830					GN	140		22 Oct 92	GN14A	E	1	1	
775	Burbot	741						GN	140		23 Oct 92	GN15C	G	1	1	
730	Burbot	743	1775	04		11	OT	GN	38		12 Oct 92	GN8	G	1		
777	Burbot	748						GN	140		23 Oct 92	GN15A	G	1	1	
805	Burbot	752	3489					GN	140		23 Oct 92	GN17C	I	0		
729	Burbot	752	1937	04		12	OT	GN	38		12 Oct 92	GN8	G	1		
774	Burbot	777						GN	140		23 Oct 92	GN15C	G	1	1	
700	Burbot	875						GN	38		11 Oct 92	GN4	J	0		
110	Burbot	526	1039					SL		1028	23 Oct 92	SL1		0		
112	Burbot	540	1163	04		8	OT	SL			23 Oct 92	SL1		1		
790	Burbot	565	1121	01		8	OT	SL			23 Oct 92	SL2		1		
111	Burbot	623	1301					SL		1029	23 Oct 92	SL1		0		
793	Burbot	656	1951	11		10	OT	SL			23 Oct 92	SL2		1		
791	Burbot	698	1920	04		11	OT	SL			23 Oct 92	SL2		1		
109	Burbot	742	2782					SL		1027	23 Oct 92	SL1		0		
809	Burbot	750	2274	11		10	OT	SL			23 Oct 92	SL3		1		
792	Burbot	785	2842	14		12	OT	SL			23 Oct 92	SL2		1		
90	Longnose sucker	309	402					ES			22 Oct 92	ES5		0		
92	Longnose sucker	346	513					ES			22 Oct 92	ES5		0		
65	Longnose sucker	360	608					ES			22 Oct 92	ES1		0		
73	Longnose sucker	361	517					ES			22 Oct 92	ES3		1		
64	Longnose sucker	367	595					ES			22 Oct 92	ES1		0		
63	Longnose sucker	369	641					ES			22 Oct 92	ES1		0		
107	Longnose sucker	369	638					ES			23 Oct 92	ES1		0		
89	Longnose sucker	374	727					ES			22 Oct 92	ES5		0		
62	Longnose sucker	375	662					ES			22 Oct 92	ES1		0		
93	Longnose sucker	378	765					ES			22 Oct 92	ES5		0		
85	Longnose sucker	379	798					ES			22 Oct 92	ES5		0		
82	Longnose sucker	398	817					ES			22 Oct 92	ES5		0		
87	Longnose sucker	399	817					ES			22 Oct 92	ES5		0		
78	Longnose sucker	404	843					ES			22 Oct 92	ES5		0		
84	Longnose sucker	408	814					ES			22 Oct 92	ES5		0		
79	Longnose sucker	410	933					ES			22 Oct 92	ES5		0		
91	Longnose sucker	410	1041					ES			22 Oct 92	ES5		0		
81	Longnose sucker	413	943					ES			22 Oct 92	ES5		0		
80	Longnose sucker	418	924					ES			22 Oct 92	ES5		0		
86	Longnose sucker	421	1022					ES			22 Oct 92	ES5		0		
83	Longnose sucker	429	950					ES			22 Oct 92	ES5		0		
88	Longnose sucker	442	1110					ES			22 Oct 92	ES5		0		
704	Longnose sucker	350						GN	89		11 Oct 92	GN4	J	0		
724	Longnose sucker	351	537					GN	64		12 Oct 92	GN8	G	1		
799	Longnose sucker	361						GN	64		23 Oct 92	GN16	J	0		
712	Longnose sucker	363	585					GN	89		12 Oct 92	GN8	G	1		
801	Longnose sucker	367						GN	64		23 Oct 92	GN16	J	0		
681	Longnose sucker	383						GN	64		11 Oct 92	GN4	J	0		
711	Longnose sucker	397	780					GN	89		12 Oct 92	GN8	G	1		
798	Longnose sucker	398						GN	64		23 Oct 92	GN16	J	0		

Table D1 (continued). Raw data for fish captured below Vermilion Chutes on the Peace River, October 1992.

Sample Number	Species	Fork Length (mm)	Weight (g)	Sex & Mat. (a)	Gonad Weight (g)	Age (yr)	Ageing Method (b)	Capture Method (c)	Mesh Size (mm)	Yellow Tag Number	Date of Capture	Station (d)	Location (d)	Capt Code (e)	Pres. Code (f)	Comments
705	Longnose sucker	400						GN	89		11 Oct 92	GN4	J	0		
672	Longnose sucker	403						GN	114		11 Oct 92	GN4	J	0		
795	Longnose sucker	403						GN	89		23 Oct 92	GN16	J	0		
814	Longnose sucker	408						GN	114		24 Oct 92	GN19B	F	0		
702	Longnose sucker	412						GN	89		11 Oct 92	GN4	J	0		
653	Longnose sucker	414						GN	89		11 Oct 92	GN3C	I	0		
708	Longnose sucker	421						GN	114		12 Oct 92	GN8	G	0		
671	Longnose sucker	422						GN	114		11 Oct 92	GN4	J	0		
651	Longnose sucker	423						GN	140		11 Oct 92	GN3B	I	0		
709	Longnose sucker	424						GN	114		12 Oct 92	GN8	G	0		
784	Longnose sucker	431	955					GN	140		23 Oct 92	GN15A	G	1		
794	Longnose sucker	436						GN	89		23 Oct 92	GN16	J	0		
796	Longnose sucker	443						GN	89		23 Oct 92	GN16	J	0		
703	Longnose sucker	445						GN	89		11 Oct 92	GN4	J	0		
674	Longnose sucker	456						GN	114		11 Oct 92	GN4	J	0		
800	Longnose sucker	458						GN	64		23 Oct 92	GN16	J	0		
652	Longnose sucker	462						GN	140		11 Oct 92	GN3B	I	0		
673	Longnose sucker	472						GN	114		11 Oct 92	GN4	J	0		
806	Longnose sucker	478						GN	140		23 Oct 92	GN17B	I	0		
707	Longnose sucker	478						GN	140		12 Oct 92	GN6A	H	0		
649	Longnose sucker	482						GN	140		11 Oct 92	GN3A	I	0		
739	Longnose sucker	482						GN	38	9015	12 Oct 92	GN8	G	2		tagged 21 May 92 @ Horse Ck. (448 mm)
106	White sucker	485	1868					ES			23 Oct 92	ES1		0		
644	White sucker	445						GN	140		11 Oct 92	GN2B	A	1		
643	White sucker	520						GN	140		11 Oct 92	GN2B	A	1		
67	Flathead chub	155	40					ES			22 Oct 92	ES1		0		
95	Flathead chub	175	56					ES			22 Oct 92	ES5		0		
94	Flathead chub	197	84					ES			22 Oct 92	ES5		0		
66	Flathead chub	212	103					ES			22 Oct 92	ES1		0		
69	Lake chub	95	10					ES			22 Oct 92	ES1		0		
68	Trout-perch	76						ES			22 Oct 92	ES1		0		

(a) Sex and maturity codes:
01 to 10 = male; 11 to 20 = female; 99 = sex indeterminable due to small gonad size
01 and 11 = immature; has never spawned before and will not spawn during the next spawning season
02 and 12 = maturity questionable; cannot be determined if will spawn during the next spawning season
03 and 13 = developing; has never spawned before but will spawn during next season
04 and 14 = mature; has spawned before and will spawn during the coming spawning season
05 and 15 = mature; has spawned before but will not spawn during the coming spawning season
07 and 17 = gravid; sexual organs filling ventral cavity
08 and 18 = ripe; roe or milt extruded in response to very slight pressure on belly
09 and 19 = spent; spawning completed
10 and 20 = sex determined by external characteristics; not verified by gonad examination

(b) Ageing methods: SC = scales; OT = otoliths; FR = fin rays; CL = cleithra; DS = dorsal spines; OP = operculae; CS = cleithra & scales; SF = scales & fin rays; SO = scales & otoliths; LF = length frequency

(c) Capture methods: ES = boat electroshocker; GN = gill nets; SL = set lines

(d) see Figure 3.1 for station and site locations

(e) Capture codes: 0 = first capture, released; 1 = first capture, sacrificed; 2 = recapture, released

(f) Preservation code: 1 = whole specimen preserved for contaminant analyses

Table D2. Length frequency (%) distribution of fish captured below Vermilion Chutes on the Peace River, October 1992.

Fork Length Interval (mm)	Lake whitefish	Mountain whitefish	Walleye	Northern Pike	Goldeye	Burbot	Longnose sucker	White sucker	Flathead chub	Lake chub	Trout-perch
60 - 79					2.2						100.0
80 - 99					3.3					100.0	
100 - 119											
120 - 139											
140 - 159									25.0		
160 - 179									25.0		
180 - 199				4.2					25.0		
200 - 219				6.3					25.0		
220 - 239				4.2							
240 - 259				14.6	5.4						
260 - 279				12.5	2.2						
280 - 299				6.3	7.6						
300 - 319				6.3	23.9		1.9				
320 - 339			4.1	4.2	29.3						
340 - 359			4.1		12.0		5.8				
360 - 379		100.0	10.2		10.9		23.1				
380 - 399			14.3		3.3		9.6				
400 - 419			10.2				23.1				
420 - 439			4.1	2.1			15.4				
440 - 459			8.2	2.1			9.6	33.3			
460 - 479	13.3		6.1				7.7				
480 - 499	13.3		2.0	2.1			3.8	33.3			
500 - 519	33.3		2.0	6.3							
520 - 539	13.3		2.0	6.3		3.0		33.3			
540 - 559	20.0		2.0	2.1		3.0					
560 - 579			6.1	2.1		12.1					
580 - 599	6.7		10.2	2.1		9.1					
600 - 619			6.1	2.1		6.1					
620 - 639			2.0	4.2		9.1					
640 - 659			2.0			9.1					
660 - 679			2.0			3.0					
680 - 699			2.0			6.1					
700 - 719				2.1		3.0					
720 - 739						6.1					
740 - 759				2.1		21.2					
760 - 779						3.0					
780 - 799				2.1		3.0					
800 - 819				2.1							
820 - 839											
840 - 859											
860 - 879						3.0					
880 - 899											
900 - 919											
920 - 939											
940 - 959											
960 - 979											
980 - 999				2.1							
n	*15*	*1*	*49*	*48*	*92*	*33*	*52*	*3*	*4*	*1*	*1*
Mean Length (mm)	520	364	478	402	312	667	407	483	185	95	76

Table D3. Age-specific mean lengths and weights of fish captured below Vermilion Chutes on the Peace River, October 1992.

Species	Age (yr)	n	Fork Length (mm) Mean	Fork Length (mm) (95% C.I.)	Weight (g) Mean	Weight (g) (95% C.I.)
Lake whitefish	11	3	511	(479 - 542)	2046	(1182 - 2910)
	12	1	536		2499	
	13	1	552		2410	
Mountain whitefish	8	1	364		701	
Walleye	5	2	330	(260 - 399)	379	(112 - 646)
	6	4	360	(349 - 372)	484	(443 - 524)
	7	3	390	(337 - 443)	737	(516 - 957)
	8	2	399	(189 - 608)	750	(0 - 1607)
	9	3	457	(354 - 561)	1193	(362 - 2025)
	10	1	475		1275	
	11	2	498	(34 - 961)	1425	(0 - 4290)
	12	3	580	(543 - 616)	2793	(1542 - 4045)
	13	1	627		2830	
	14	2	650	(142 - 1158)	3830	(0 - 14623)
	15	1	650		3592	
Northern pike	2	1	242		92	
	3	4	304	(259 - 348)	196	(102 - 290)
	4	1	420		547	
	6	1	511		1094	
	8	3	653	(527 - 778)	2376	(843 - 3910)
	9	2	775	(432 - 1118)	4146	(0 - 14113)
	12	1	993		9823	
Goldeye	0	4	78	(69 - 87)	[a]	
	4	4	260	(227 - 293)	193	(94 - 292)
	5	6	298	(281 - 314)	289	(246 - 332)
	6	7	317	(313 - 321)	350	(297 - 403)
	7	12	339	(329 - 349)	450	(399 - 502)
	8	10	357	(341 - 374)	554	(473 - 634)
	9	2	358	(300 - 415)	549	(460 - 638)
Burbot	8	4	569	(535 - 603)	1232	(1052 - 1413)
	9	3	656	(555 - 756)	2005	(829 - 3182)
	10	2	703	(106 - 1300)	2113	(61 - 4165)
	11	2	721	(435 - 1006)	1848	(926 - 2769)
	12	2	769	(559 - 978)	2390	(0 - 8139)

[a] not weighed