SITE C FISHERIES STUDIES
PEACE RIVER FISH INVENTORY
- 2009 -

VOLUME 1 OF 2

Prepared for

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Site C Project, Corporate Affairs
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EXECUTIVE SUMMARY

BC Hydro is considering the Peace River Site C Hydroelectric Project (Site C) in north eastern British Columbia as a potential resource option to help meet BC's future electricity needs. BC Hydro is taking a stage-by-stage approach to the evaluation of Site C. BC Hydro is currently in Stage 2, Project Definition and Consultation. Fisheries studies are presently underway to add to existing baseline information and to address data gaps that have been identified.

Currently there is baseline information that describes the fish community in the Peace River from Peace Canyon (PCN) Dam to the British Columbia/Alberta boundary. Fish investigations include historical Site C baseline studies, preliminary fish surveys completed in 2005 and 2006 and ongoing studies by the Peace River Fish Index Project under the direction of BC Hydro Water License Requirements (WLR) (2001 to present). Although comprehensive, some of the baseline information that describes the Peace River fish community is general in nature and dated, hence this project.

The purpose of the 2009 study was to collect baseline information to describe the fish community in the Peace River from PCN Dam to the British Columbia/Alberta boundary. In order to achieve this goal the study used several fish capture methods in a variety of fish habitats during three seasons. It also coordinated efforts with the 2009 WLR Peace River Fish Index Project in order to maximize sampling efficiencies and to enhance the data set. The study examined environmental conditions, fish community structure, catch rate, population characteristics, and fish health. Fish also were marked with permanent tags to monitor future growth and movement patterns.

The program was successful in achieving its goal. The Peace River supports a diverse fish community that includes cold water and cool water sportfish, suckers, minnows, and sculpins. Fish community structure is not constant within the 151 km study area. There is a gradual shift from a cold water sportfish community dominated by mountain whitefish in the upstream area, to a more diverse fish community in the downstream area that is represented by multiple fish groups and species. This shift in fish community structure represents a transition from a cold, clear water fish community to a cool water fish community that contains species that are more tolerant of adverse environmental conditions (e.g., elevated fine sediment levels and higher water temperatures).

The majority of sportfish species are most numerous and reside in main channel habitats of the Peace River. A limited number of species (spottail shiner, northern pike, and yellow perch) appear to rely heavily on side channel habitats. Sucker species and many minnow species are numerous at tributary confluences, suggesting that tributaries are focal points for these populations.

Preliminary evidence suggests that most species in the study area are represented by viable, self sustaining fish populations. The majority likely spawn and rear in tributaries before recruiting to Peace River populations. Data from only one species, mountain whitefish, indicated the potential for widespread spawning in the mainstem Peace River. Large fish species such as northern pike and yellow perch appear rely heavily on protected side channel habitats for spawning and early rearing. A limited number of fish populations may be maintained by recruitment via entrainment through the PCN Dam. These include kokanee, lake trout, and lake whitefish. Only one species, goldeye, appears to be represented exclusively by adult fish, suggesting recruitment from downstream sources.

Most cold water species were recorded upstream and downstream of the proposed Site C dam (mountain whitefish, bull trout, kokanee, and rainbow trout), as were most suckers (longnose sucker, largescale sucker, and white sucker), and sculpins (prickly sculpin and slimy sculpin), and some of the minnows (lake chub, longnose dace, redside shiner, and spottail shiner). An exception to this spatial pattern was the cool water sportfish group. Burbot, goldeye, northern pike, walleye, and yellow perch, were largely restricted to the downstream section of the study area (i.e., downstream of the proposed Site C dam).

This one year of study provides a good description of the Peace River fish community. Additional work can be used to confirm these findings and to increase the certainty around future interpretation of the baseline data.

ACKNOWLEDGEMENTS

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The following persons Diversified Environmental Services assisted during the field program:

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TABLE OF CONTENTS

Page #

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LIST OF TABLES

Page #

LIST OF FIGURES

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1.0 INTRODUCTION

1.1 BACKGROUND

BC Hydro is considering the Peace River Site C Hydroelectric Project (Site C) in north eastern British Columbia as a potential resource option to help meet BC's future electricity needs. BC Hydro is taking a stage-by-stage approach to the evaluation of Site C. BC Hydro is currently in Stage 2, Project Definition and Consultation. Fisheries studies are presently underway to add to existing baseline information and to address data gaps that have been identified.

Currently there is baseline information that describes the fish community in the Peace River from Peace Canyon (PCN) Dam to the British Columbia/Alberta boundary. Fisheries investigations include historical Site C baseline studies from 1989 to 1990 (ARL 1991a, b; Pattenden *et al.* 1990, 1991), a small fish and habitat study in 1999 to 2000 (RL&L 2001), preliminary fish surveys completed in 2005 and 2006 (AMEC and LGL 2006, 2007; Mainstream 2009a), and ongoing studies (2001 to present) by the Peace River Fish Index Project under the direction of BC Hydro Water License Requirements (WLR) (P&E 2002; Mainstream and Gazey 2009).

Although comprehensive, some baseline information that describes the Peace River fish community is general in nature and dated, hence this project. In 2009, Mainstream Aquatics Ltd. was contracted by BC Hydro to conduct a seasonal fish inventory on the Peace River. The goal of the program was to address data gaps in our knowledge of the Peace River fish community.

1.2 PURPOSE AND OBJECTIVES

The purpose of the study was to collect baseline information to describe the fish community in the Peace River from PCN Dam to the British Columbia/Alberta boundary. The objectives of the study were:

1. Conduct a fish sampling program in spring, summer, and fall using multiple methods in a variety of fish habitats to collect a representative sample of the Peace River fish community.
2. Describe the fish community structure.
3. Describe the seasonal distribution and catch rates of fish populations.
4. Describe the biological characteristics and structure of fish populations.
5. Use data collected by the 2009 WLR Peace River Fish Index Project to enhance the study data.
6. Summarize the information in a concise report.

1.3 STUDY AREA

The study area included the Peace River from the PCN Dam (Km 151) to the British Columbia/Alberta boundary (Km 0). The fish inventory occurred in eight sections distributed throughout the study area (Table 1.1, Figure 1.1, Appendix A). For analytical purposes, sections were grouped into one of two zones relative to the position of the proposed Site C dam located at Km 64.8 – Zone 1 (Upstream) and Zone 2 (Downstream).

Table 1.1 Study area zones and sections, 2009 Peace River Fish Inventory.

Zone[a]	Section	Section Location	Section Location[b] (km)
1 (Upstream)	1A	Peace River Canyon area	Km 150 to 145.2
	1	Maurice Creek area	Km 137.0 to 145.2
	2	Farrell Creek area	Km 119.7 to 125.2
	3	Halfway River area	Km 89.8 to 99.2
2 (Downstream)	5	Moberly River area[c]	Km 53.4 to 64.8
	6	Pine River area	Km 46.8 to 35.7
	7	Beatton River area	Km 26.7 to 13.6

[a] Position relative to proposed Site C dam.
[b] Based on distance from BC/AB boundary.
[c] A small portion of Section 5 is located upstream of proposed Site C dam location (see Appendix A, Figures A5A and A5B).

Four criteria were used to select study sections. They included good spatial coverage of the study area, representation of major reaches, representation of major tributary confluences, and inclusion of previously sampled sites.

1.4 SAMPLE PERIOD

Three surveys were completed during the open water period, each of which was completed over a two week period that represented a season. The spring session occurred from 15 to 27 May, the summer session occurred from 14 to 25 July, and the fall session occurred from 20 September to 4 October 2009. Data from the 2009 WLR Peace River Fish Index Project that was used by the present study was collected from 18 August to 19 September 2009.

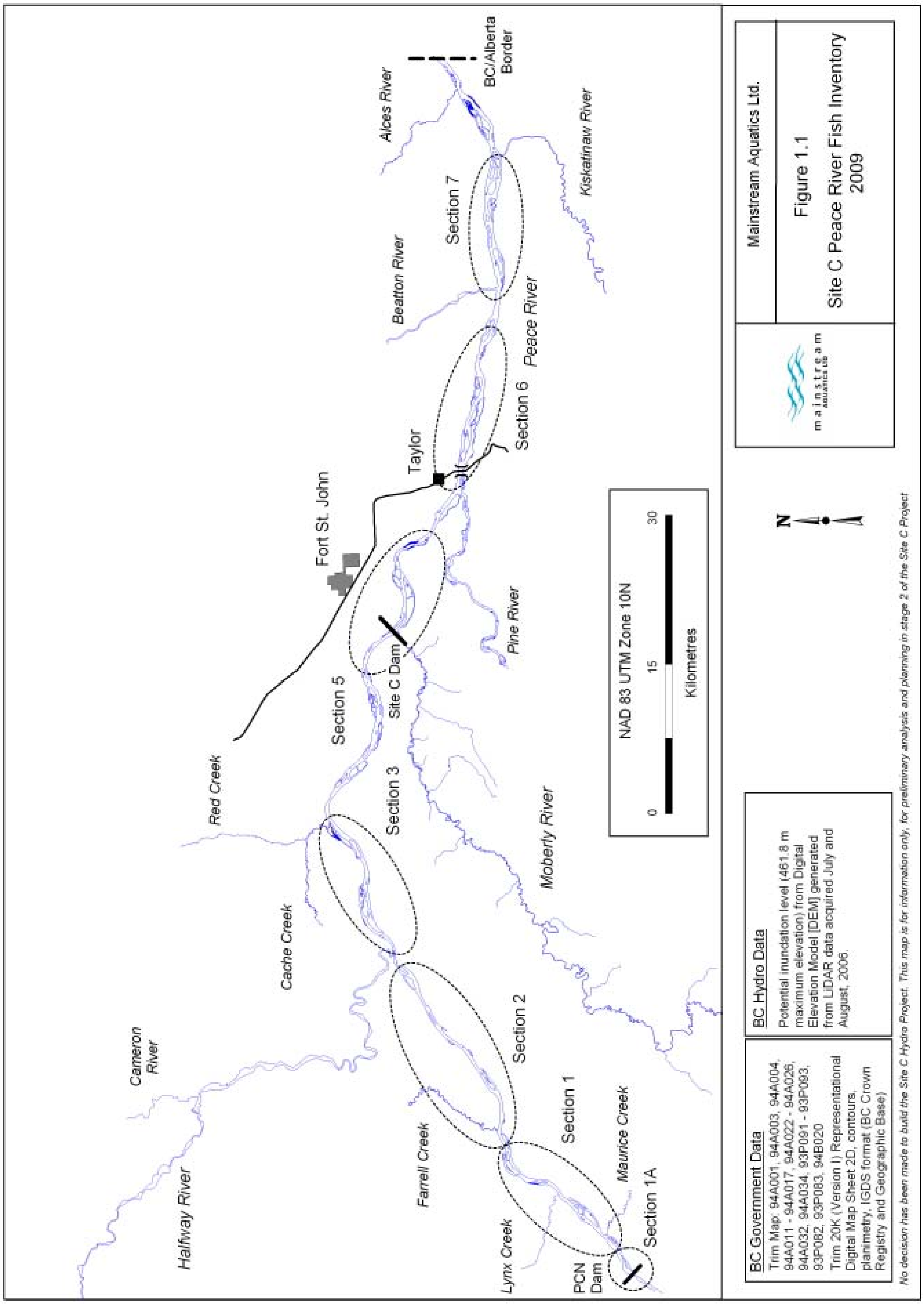
Halfway River
Cameron River
Lynx Creek
PCN Dam
Farrell Creek
Maurice Creek
Section 1A
Section 1
Section 2
Cache Creek
Red Creek
Section 3
Moberly River
Section 5
Site C Dam
Pine River
Fort St. John
Taylor
Section 6
Peace River
Beatton River
Section 7
Kiskatinaw River
Alces River
BC/Alberta Border
NAD 83 UTM Zone 10N
0
15
30
Kilometres
BC Government Data
Trim Map: 94A001, 94A003, 94A004, 94A011 - 94A017, 94A022 - 94A026, 94A032, 94A034, 93P091 - 93P093, 93P082, 93P083, 94B020
Trim 20K (Version I) Representational Digital Map Sheet 2D, contours, planimetry, IGDS format (BC Crown Registry and Geographic Base)
BC Hydro Data
Potential inundation level (461.8 m maximum elevation) from Digital Elevation Model (DEM) generated from LiDAR data acquired July and August, 2006.
N
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Figure 1.1
Site C Peace River Fish Inventory 2009
No decision has been made to build the Site C Hydro Project. This map is for information only, for preliminary analysis and planning in stage 2 of the Site C Project

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2.0 METHODS

2.1 FIELD PROGRAM

2.1.1 Approach and Design

In order to describe the Peace River fish community in the study area a variety of fish habitats were sampled using multiple fish capture methods during three seasons. The present study was coordinated with the WLR 2009 Peace River Fish Index Project in order to maximize sampling efficiencies and to enhance the data set collected by the present study. The large fish sampling component of the present study followed established protocols used by the WLR Program (Mainstream and Gazey 2009).

Site selection was based on two criteria. Firstly, sites were established in areas that represented all major habitats within a section. Secondly, attempts were made to use sites that had been inventoried during previous studies (Mainstream 2009a; P&E 2002; Mainstream and Gazey 2009). Once a site was established, attempts were made to sample the same site during subsequent seasonal programs.

Sampling occurred within three major Peace River habitats previously described by R&L (2001) and P&E (2002) as follows:

> **Main channel -** Portion of active channel that is permanently wetted and that is characterized by moving water under the typical flow regime, and the dominance of rock bed materials. This includes the thalweg channel and smaller channels that exhibit similar characteristics.
>
> **Side channel -** Portion of the active channel that is permanently wetted and that is characterized by slow moving or still water under the typical flow regime, and the presence of silt and sand bed materials. Includes channels protected from the main river flow that exhibit unique features such as standing water and emergent/submergent vegetation.
>
> **Tributary confluence -** Portion of the tributary confluence that is within the immediate influence of the Peace River flow regime. The habitat can be divided into the tributary channel proper and the confluence zone within the active Peace River channel. The confluence zone includes an upstream area that exhibits higher water velocities and is dominated by rock bed materials (i.e., riffle section) and a downstream area that exhibits low water velocities and bed materials dominated by silts and sands (i.e., backwater section).

Specific sample sites within each major habitat type were further stratified into discrete mesohabitat types based on physical characteristics. Definitions of mesohabitat types are presented in Appendix B1. The Plates section provides illustrations of the major habitat types and selected mesohabitat types within each category.

The site selection process and the number of sites sampled within each section were designed to inventory the full range of habitats present proportional to abundance of those habitats within each section.

The study was designed to capture fish species and life stages (i.e., small and large fish) present in a variety of fish habitats. This necessitated use of multiple fish capture methods, each of which was effective for the collection of fish within a particular size range and under specific sampling conditions.

For the purposes of this study small fish were defined as ≤ 200 mm fork length and included younger life stages of large fish species and all small fish species. Large fish were defined as > 200 mm fork length, which included older life stages of all large fish species.

Fish sampling conditions are controlled primarily by water depth, water velocity, and bed material type. RL&L (2001) and P&E (2002) demonstrated that standard small fish capture techniques (e.g., backpack electrofisher and beach seine) were not effective in main channel habitats in the Peace River due to high water velocities and fluctuating water levels. Subsequent work on the Peace River (Mainstream and Gazey 2006; Mainstream 2009a) established use of a small fish boat electrofisher as an effective alternative to standard fish capture methods in main channel habitats.

In total, six fish capture methods were used during the field program (Table 2.1). The methods employed were based on the size of fish targeted and the habitat sampled.

Table 2.1 Habitat and fish group targeted by fish capture method, Site C Peace River Fish Inventory 2009.

Fish Group	**Method**	**Main Channel**	**Side Channel**	**Tributary Confluence**
Small Fish	Beach Seine	x	x	x
(≤ 200 mm length)	Small-fish Boat Electrofisher	x		
	Backpack Electrofisher		x	x
	Minnow Trap	x	x	
Large Fish	Large-fish Boat Electrofisher	x	x	x
(> 200 mm length)	Gill Net		x	

2.1.2 Fish Capture Methods

Standard fish capture methods were used during the field program (Bonar *et al.* 2009). In addition, the large fish boat electrofisher program followed established methods and protocols developed by the ongoing WLR Peace River Fish Index Project (Mainstream and Gazey 2009) and the small fish boat electrofisher program followed methods and protocols previously used on the Peace River (Mainstream and Gazey 2006, Mainstream 2009a).

Large Fish Boat Electrofisher

A boat electrofisher was used to capture larger-sized fish (i.e., > 200 mm length) in nearshore habitats along the channel margin. Distances sampled from the channel margin varied from a few to tens of metres depending on channel bottom slope and water depth. Water depths ranged from 0.5 to 2.0 m. Sampling was restricted to areas ≤ 2.0 m deep, because boat electrofishing effectiveness on the Peace River is severely reduced beyond this depth.

A 5 m boat electrofisher propelled by a 175 Hp sport-jet inboard motor was used to sample large fish. The craft was equipped with a fixed-boom anode system and Smith-Root Type VIA electrofisher system. Electrofisher settings were generally maintained at an amperage output of 3.0 to 4.5 A, pulsed DC current, and a frequency of 60 Hz. These settings were sufficient to immobilize all species and minimize injury rates of susceptible species such as mountain whitefish.

The sampling procedure involved drifting downstream at motor idle along the channel margin, while outputting a continuous current of electricity. In general, boat position was maintained at a water depth of 1.0 m to 1.5 m by monitoring the depth with a sounder. The only instance when this sampling protocol changed occurred when backwater areas greater than two boat lengths were encountered. In these situations, the boat was turned into the backwater at its downstream end and the channel margin in the backwater area was sampled in an upstream direction.

Two netters positioned on a platform at the bow of the boat captured immobilized fish while the boat operator maintained the position of the craft along the channel margin. To provide a representative sample of the fish community netters were instructed not to bias their catch towards a particular species or fish size. Netters were equipped with nets having a diameter of 45 cm, a depth of 40 cm, and a mesh size of 5 cm. To facilitate capture of smaller fish, the bottom surface (40 cm^2) of each net had a mesh size of 1.5 cm. This mesh size allowed capture of fish to a minimum size of 200 mm.

Netters were instructed to retrieve immobilized fish of any species and size (> 200 mm) that were accessible from their netting position on the platform. To minimize the potential for electrofisher induced injury, no more than one fish was netted at a time and immobilized fish were removed from the water as quickly as possible.

The only exception to the above sampling protocol occurred when a rare species or life stage was encountered. In this situation, the boat was turned towards the fish and netters made every effort to capture the individual.

All fish captured were held in a 230 L holding tank equipped with a water circulating system, which provided a water exchange rate of 19 L/min. Upon completion of an electrofisher session, captured fish were processed and released. To avoid recapture of previously collected fish, processed fish were released several hundred metres upstream from the processing location. Sampled length of each site consisted of a single pass of approximately 1000 m. Site length was measured from geodetic locations (UTM coordinates) plotted onto geo-referenced base maps (scale 1:50,000 NTS topographic maps).

Small Fish Boat Electrofisher

A boat electrofisher was used to capture smaller-sized fish (i.e., ≤ 200 mm length) in shallow-water nearshore habitats along the channel margin. Sampled water depths ranged from 0.1 to 0.3 m.

The small fish boat electrofisher consisted of a double-bowed, inflatable drift boat equipped with a Smith-Root Type VIA electrofisher system, two fixed boom anodes on the bow and a cathode wire array on the stern. Electrofisher settings were maintained at an amperage output of 4.5 to 6.0 A, pulsed DC current at a frequency of 60 Hz.

The sampling procedure involved the operator positioning the boat perpendicular to the channel margin while drifting downstream and outputting a continuous current of electricity. A single netter, equipped with a net having a mesh size of 0.5 cm, was positioned at the bow of the boat to capture the temporarily immobilized fish and place them in a 30 L live well. Netters were instructed not to bias their catch towards a particular species in order to provide a representative sample of the fish community. Sampled length of each site consisted of a single pass of approximately 500 m. Site length was measured from geodetic locations (UTM coordinates) plotted onto geo-referenced base maps (scale 1:50,000 NTS topographic maps).

Backpack Electrofisher

Sampling was completed using a Smith-Root Type XII high output backpack electrofisher with settings maintained at an output of 300-400 VDC, 6 ms and a frequency of 60 Hz. The backpack electrofisher operator waded upstream along the channel margin and sampled suspected fish holding areas. The netter, who was positioned in close proximity to the electrofisher operator, collected immobilized fish and placed them in a holding bucket. A single pass was used at each site; sampled length was approximately 100 m.

Beach Seine

A beach seine was used in low velocity, deep water areas not effectively sampled by backpack electrofisher. The beach seine was 4.2 m wide and 1.5 m high with a stretched mesh size of 5.0 mm (the depth of the capture bag was 1.4 m). A two-person crew sampled perpendicular to the channel margin for a predetermined distance (25 m) before turning into shore. Captured fish were placed in a holding bucket for processing. In general, three hauls were completed adjacent to each other at each site. If sample effectiveness was low (e.g. snagged net), the haul was re-sampled.

Minnow Trap

Gee minnow traps were used to sample for species and age-classes not normally caught in gill nets (i.e., smaller fish). Gee traps were used to sample shallow (< 1.5 m) areas of selected unique habitats. Trap dimensions were 0.4 m length x 0.2 m diameter with an aperture of 0.02 m and a 0.1 m mesh. Traps were baited with cat food.

Gill Net

Small mesh nylon gill nets were used to sample deep water areas in side channels (1.0 to 3.0 m deep) that could not be effectively sampled by other methods. Gill net panels were 15.2 m x 2.4 m with stretched mesh sizes of 1.9, 3.8, 6.4, or 8.9 cm. Single gill net panels were set perpendicular to the channel margin at each site. To minimize capture mortality, gill net set times were kept to a minimum (< 2 hr).

2.1.3 Processing Fish

Biological characteristics were recorded for captured fish. Data recorded included species, fork length (± 1 mm) (total length for burbot and sculpin species), weight (± 2 g), sexual maturity from external examination, and presence of a tag, tag scar, or fin clip. Individuals that could not be identified to species in the field were assigned a unique identifier and a subsample preserved for future identification. An exception to this protocol occurred when small (i.e., < 20 mm) sculpins, suckers, or minnows were encountered. These fish were identified as “Sculpin”, “Sucker”, or “Minnow” and then released. When the catch of small fish at a site was large the first ten individuals per species were measured. The remaining fish were identified to species, enumerated, and released.

Large numbers of fish (i.e., >500) were captured at some beach seine sites (n = 11), which precluded physically counting all fish in the sample. The following protocols were used at these sites. Captured fish were placed in a bucket and thoroughly mixed. An aquarium net was used to scoop a subsample from the bucket. All fish in the "scoop" were identified and enumerated. The process was repeated for a second scoop. The remaining fish were then removed from the bucket using the aquarium net (ensuring similar sized scoops), while counting the number of scoops required to empty the bucket of fish. In the office the number of fish of each species in the two "scoop" samples was tallied. The resulting fish numbers and species composition were then applied to the sample of scoops containing unidentified, uncounted fish. This was used to calculate the total number of fish of each species collected at the site.

Each fish identified to species was assigned a species label. The common name, scientific name and label of fish species are presented in Table 2.2.

An appropriate nonlethal ageing structure (Mackay *et al.* 1990) was collected from individuals of most large fish species. The first two rays of the right pectoral fin were collected from bull trout, walleye, yellow perch, northern pike and suckers (largescale, longnose, and white). Several scales situated immediately below the back third of the dorsal fin and above the lateral line were collected from Arctic grayling, goldeye, and mountain whitefish. Structures were placed in labeled envelopes and air-dried before storage. No age structures were collected from burbot due to the requirement for lethal sampling.

In order to monitor movement patterns and measure growth during future studies, fish of all species ≥ 250 mm fork length and in good condition were marked using Passive Integrated Transponder (PIT) Tag. Tags were of the ISO type (134.2 kHz), which have a 15 digit numeric code. Tags, tag applicators, and tag readers were supplied by AVID Canada. Tags and tag applicators were sterilized in Zephiran chloride. After tag insertion, a Power Tracker VIII tag reader was used to record the numeric code.

Table 2.2 Nomenclature and abbreviations used for recorded fish species, Site C Peace River Fish Inventory 2009.

Group	Common Name	Scientific Name	Species Label
Sportfish (cold water)	Arctic grayling	*Thymallus arcticus*	GR
	Bull trout	*Salvelinus confluentus*	BT
	Kokanee	*Oncorhynchus nerka*	KO
	Lake trout	*Salvelinus namaycush*	LT
	Lake whitefish	*Coregonus clupeaformis*	LW
	Mountain whitefish	*Prosopium williamsoni*	MW
	Rainbow trout	*Oncorhynchus mykiss*	RB
Sportfish (cool water)	Burbot	*Lota lota*	BB
	Goldeye	*Hiodon alosoides*	GE
	Northern pike	*Esox lucius*	NP
	Walleye	*Sander vitreus*	WP
	Yellow perch	*Perca flavescens*	YP
Suckers	Largescale sucker	*Catostomus macrocheilus*	CSU
	Longnose sucker	*Catostomus catostomus*	LSU
	White sucker	*Catostomus commersoni*	WSC
	Sucker (young-of-the-year)	*Catostomus spp.*	YSU
Minnows[a]	Brook stickleback	*Culaea inconstans*	BSB
	Finescale dace	*Chrosomus neogaeus*	FDC
	Flathead chub	*Platygobio gracilis*	FHC
	Lake chub	*Couesius plumbeus*	LKC
	Longnose dace	*Rhinichthys cataractae*	LNC
	Northern pikeminnow	*Ptychocheilus oregonensis*	NSC
	Northern redbelly dace	*Phoxinus eos*	RDC
	Peamouth chub	*Mylocheilus caurinus*	PCC
	Pearl dace	*Semotilus margarita*	PDC
	Redside shiner	*Richardsonius balteatus*	RSC
	Spottail shiner	*Notropis hudsonius*	STC
	Trout-perch	*Percopsis omiscomaycus*	TP
Sculpins	Prickly sculpin	*Cottus asper*	CAS
	Slimy sculpin	*Cottus cognatus*	CCG
	Spoonhead sculpin	*Cottus ricei*	CRI

[a] Includes true minnows (Family Cyprinidae), trout-perch (Family Percopsidae), and sticklebacks (Family (Gasterosteidae).

The DELT Index (Ohio EPA 1996) was used to measure the physical health of fish collected by large fish boat electrofisher by external examination. The number of deformities (D), erosion (E), lesions (L), and tumours (T) on each fish was identified and the severity categorized as follows:

Deformities

Defined as twisted, missing, forked, or bulging body parts including deformed fins, barbels, abdomen, or skeleton (e.g., head, vertebrae). Deformities are classified as:

- Light (DL) when they are limited to 1 deformed fin or 1 deformed barbel.
- Heavy (DH) when there are > 2 deformed fins or barbels, or any deformity of the skeleton of other body part exclusive of fins or barbels occurs.

Erosion

Defined as loss of tissue on the fins, gill covers, and/or barbels. Erosion is classified as:

- Light (EL) when 1 fin is not eroded past a ray fork, or < 2 barbels are eroded less than half the barbel length, or the gill cover is eroded, but there is no exposed gill tissue.
- Heavy (EH) when > 2 eroded fins, or 1 fin eroded past a single ray fork, or gill cover eroded with exposed gill tissue, or > 3 eroded barbels, or a barbel eroded more than half its total length.

Lesions

Defined as open sores, exposed tissue, and/or prominent bloody areas. Lesions are classified as:

- Light (LL) when there are < 2 lesions smaller than or equal to the size of the largest scale.
- Heavy (LH) when there are > 2 small lesions, when there is a lesion larger than the size of the largest scales, or when there is raw tissue.

Tumours

Are defined as tumour like masses that cannot be easily broken when squeezed. Tumours are defined as:

- Light (TL) when < 2 tumours < the diameter of the eye. Lymphocystis patches are counted as one tumour.
- Heavy (TH) when there are > 3 tumours or there is 1 tumour larger than the diameter of the eye.

Multiple DELTS

Occur when fish have two or more DELT anomalies (M).

2.1.4 Sample and Site Characteristics

See Appendix B for definitions and Appendix D for characteristics. Parameters measured at all sites were as follows:

- Date and time
- Geodetic location
- Sample method settings
- Sample effort (seconds/meters/area)
- Water conductivity (μ*S*/cm)
- Water temperature (^{o}C)
- Water clarity (cm)
- Habitat type

Physical characteristics measured at sites located in discrete mesohabitats (i.e., beach seine, backpack electrofisher, minnow trap, and gill net) as follows:

- Water depth (cm)
- Water velocity (m/s)
- Substrate type (%)
- Available fish cover (%)
- D90 (cm)
- Substrate embeddedness (low, moderate, high)
- Substrate compaction (low, moderate, high)

2.1.5 Number and Distribution of Sites

The number and distribution of large and small fish boat electrofisher sites, which represented sampled sections, are summarized in Table 2.3. The number and distribution of beach seine, backpack electrofisher, minnow trap, and gill net sites, which represented point samples in discrete habitats, are summarized in Table 2.4. Site location data are presented in Appendix A.

Table 2.3 Number of sites sampled by zone and section and season by large fish capture methods, Site C Peace River Fish Inventory 2009.

Zone[a]	Section	Number of Sites					
		Large Fish Electrofisher			Small Fish Electrofisher		
		Spring	Summer	Fall	Spring	Summer	Fall
1 (Upstream)	1A	6	6	6	4	4	4
	1	16	16	16	14	16	16
	2	16	16	15	12	12	12
	3	16	16	17	13	14	14
2 (Downstream)	5	17	18	18	14	13	14
	6	18	18	18	14	15	14
	7	17	17	17	14	14	14
	Total	**106**	**107**	**107**	**85**	**88**	**88**

a Position relative to proposed Site C dam.

Table 2.4 Number of sites sampled by zone and section and season by small fish capture methods, Site C Peace River Fish Inventory 2009.

Zone[a]	Section	Number of Sites[b]											
		Beach Seine			Backpack Electrofisher			Gill Net			Minnow Trap		
		Spr.	Sum.	Fall	Spr.	Sum.	Fall	Spr.	Sum.	Fall	Spr.	Sum.	Fall
1 (Upstream)	1A	-	-	-	1	1	1	-	-	-	-	-	-
	1	9	9	8	4	4	5	-	-	-	9	3	6
	2	9	8	8	7	5	7	1	1	1	6	6	6
	3	6	8	7	3	3	3	2	2	2	3	3	3
2 (Downstream)	5	8	8	8	5	5	4	1	1	1	3	3	3
	6	12	10	9	2	2	1	1	1	1	4	3	3
	7	7	8	7	2	2	2	-	-	-	2	3	3
	Total	**51**	**51**	**47**	**24**	**22**	**23**	**5**	**5**	**5**	**27**	**21**	**24**

a Position relative to proposed Site C dam.
b The number of sites was dependent on seasonal availability associated with water levels encountered at the time of sampling.

2.2 OFFICE PROGRAM

2.2.1 Quality Assurance and Quality Control

All data collected in the field were recorded on standardized forms. Forms were checked daily for errors or omissions. Data were entered into standardized data entry spreadsheets using Microsoft Excel™ or Microsoft Access™. These data were visually compared to the field forms for errors and subjected to several summary analyses including graphical examination to identify errors and outliers. The checked data were then imported into a Microsoft Access™ data file for data management and storage. All subsequent analyses used data extracted from the Microsoft Access™ data file.

2.2.2 Mapping

Geodetic location information (UTM coordinates) were tabulated and plotted onto geo-referenced base maps (scale 1:50,000 NTS topographic maps) using MapInfo Professional™. River kilometre locations were then plotted on base maps. Km 0 was assigned as the British Columbia/Alberta boundary. Study area maps were generated using Trim 1:20,000 (Version 1) representational digital 2D maps (IGDS format).

2.2.3 Discharge and Water Temperature

Preliminary Peace River discharge data (no quality assurance) from Water Survey of Canada were obtained from the following stations:

Hudson's Hope -	Station 07EF001
Above Pine River -	Station 07FA004
Above Alces River -	Station 07FD010

Analyses of water temperature and discharge entailed summarizing data and presenting the information in tabular and graphical form.

2.2.4 Fish Distribution and Catch Rate

Data Selection

An important goal of the study was to describe the seasonal distribution and catch rate (catch-per-unit effort) of fish populations. To accomplish this goal the field program occurred during three seasons and utilized four small fish capture methods and two large fish capture methods in order to sample a variety of fish species, life stages, and habitats (Table 2.5; also see Tables 2.1, 2.3, and 2.4).

Most species in the large fish group were well represented using large fish capture methods and most species in the small fish group were well represented using small fish capture methods. Small fish species in the minnow and sculpin groups were scarce in the large fish catch. These groups as well as younger age cohorts of several large fish species were encountered using small fish capture methods. The results indicated that a variety of species and life stages were recorded using fish capture methods employed during the study.

Table 2.5 Number of fish recorded by species and capture method, Site C Peace River Fish Inventory 2009.

Group	Species	Small Fish Methods[a]						Large Fish Methods[a]			
		EF	**BS**	**MT**	**SF**	**Total**	**%**	**GN**	**LF**	**Total**	**%**
Sportfish (cold water)	Arctic grayling	2	11		155	*168*	*1.7*		169	*169*	*1.2*
	Bull trout	1			16	*17*	*0.2*	2	283	*285*	*2.1*
	Kokanee	4	15		113	*132*	*1.3*		41	*41*	*0.3*
	Lake trout				1	*1*	*<0.1*		5	*5*	*0.0*
	Lake whitefish		5			*5*	*0.1*	3	8	*11*	*0.1*
	Mountain whitefish	78	522		2,347	*2,947*	*29.8*	9	10,211	*10,220*	*75.3*
	Rainbow trout	8	2		247	*257*	*2.6*		245	*245*	*1.8*
	Subtotal	*93*	*555*	*0*	*2,879*	*3,527*	*35.6*	*14*	*10,962*	*10976*	*80.9*
Sportfish (cool water)	Burbot				2	*2*	*<0.1*		43	*43*	*0.3*
	Goldeye						*0.0*	6	31	*37*	*0.3*
	Northern pike	0	75		27	*102*	*1.0*	5	83	*88*	*0.6*
	Walleye		6		9	*15*	*0.2*	3	89	*92*	*0.7*
	Yellow perch	1	104		12	*117*	*1.2*		41	*41*	*0.3*
	Subtotal	*1*	*185*	*0*	*50*	*236*	*2.4*	*14*	*287*	*301.0*	*2.2*
Suckers	Largescale sucker	17	254	0	173	*444*	*4.5*	4	422	*426*	*3.1*
	Longnose sucker	129	494	7	413	*1,043*	*10.5*	2	1,646	*1,648*	*12.1*
	White sucker	51	86		45	*182*	*1.8*	14	103	*117*	*0.9*
	Subtotal	*197*	*834*	*7*	*631*	*1,669*	*16.9*	*20*	*2,171*	*2,191*	*16.2*
Sculpins	Prickly sculpin	45	76	2	252	*375*	*3.8*		2	*2*	*<0.1*
	Slimy sculpin	21	29	4	870	*924*	*9.3*		5	*5*	*<0.1*
	Spoonhead sculpin	1	1		3	*5*	*0.1*				*0.0*
	Subtotal	*67*	*106*	*6*	*1,125*	*1,304*	*13.2*		*7*	*7*	*0.1*
Minnows[b]	Brook stickleback		1			*1*	*<0.1*				*0.0*
	Finescale dace		21			*21*	*0.2*				*0.0*
	Flathead chub	2	70		61	*133*	*1.3*		8	*8*	*0.1*
	Lake chub	71	277	1	141	*490*	*4.9*		1	*1*	*<0.1*
	Longnose dace	42	172		131	*345*	*3.5*				*0.0*
	Northern pikeminnow	24	147		51	*222*	*2.2*		63	*63*	*0.5*
	Northern redbelly dace		3		2	*5*	*0.1*				*0.0*
	Peamouth						*0.0*		2	*2*	*<0.1*
	Pearl dace	1	1			*2*	*<0.1*			*0*	*0.0*
	Redside shiner	99	624	2	596	*1,321*	*13.3*		10	*10*	*0.1*
	Spottail shiner	15	219		48	*282*	*2.8*		5	*5*	*<0.1*
	Trout-perch	6	132		205	*343*	*3.5*		1	*1*	*<0.1*
	Subtotal	*260*	*1,667*	*3*	*1,235*	*3,165*	*32.0*		*90*	*90*	*0.7*
Total		**618**	**3,347**	**16**	**5,920**	**9,901**	**100.0**	**48**	**13,517**	**13,565**	**100.0**

[a] Methods: EF – backpack electrofisher; BS – beach seine; MT – minnow trap; SF – small fish boat electrofisher; GN – gill net; LF – large fish boat electrofisher.

[b] Includes true minnows (Family Cyprinidae), trout-perch (Family Percopsidae) and sticklebacks (Family Gasterosteidae).

Based on the total number of fish captured, beach seine and small fish boat electrofisher were the most effective capture method for the small fish group, while large fish boat electrofisher was the most effective capture method for the large fish group. Some fish capture methods did not collect large numbers of fish due to low sample effectiveness and/or low sample effort. Few fish were collected using minnow traps and gill nets. Total numbers of fish captured using these methods were 16 and 48, respectively. The number of fish recorded using the backpack electrofisher method also was considered low (*n* = 618 fish) when compared to the beach seine and small fish boat electrofisher catches (*n* = 3,347 and 5,920 fish, respectively). Species encountered using minnow trap, gill net, and backpack electrofisher methods were well represented by other fish capture methods. As such, catch rate was examined using data collected by beach seine, small fish boat electrofisher, and large fish boat electrofisher. Species distribution was examined using data from all capture methods.

Catch Rate Metrics

Catch rate or catch-per-unit-effort (CPUE) of fish was calculated for each site by dividing the number of fish captured by sampling effort. Catch rate was expressed as follows:

Boat electrofisher -	Number of fish/km
Backpack electrofisher -	Number of fish/m
Beach seine -	Number fish/100 m^2
Gill net -	Number fish/100 m^2/24 h
Minnow trap -	Number of fish/trap/24 h

Summary values represented mean catch rate ± standard error (SE). All analyses were completed using SPSS® 13.0 for Windows. Figures were generated using Sigmaplot® 8.0.

2.2.5 Biological Characteristics

Biological characteristics examined included length distribution, age distribution (based on age data from a random subsample or total sample depending on fish number), length-weight relationships, length-at-age, and growth rate. All analyses were completed using SPSS® 13.0 for Windows. Figures were generated using Sigmaplot® 8.0.

Raw data used was dependent on the biological characteristic analyzed. The raw sample for each species was first stratified by zone and month in order to reduce spatial and temporal variation and by method in order to reduce sample method bias. These data were then examined to ascertain which data set provided a sufficient sample size for analyses (Table 2.6). When sample sizes permitted data from Zone 1 and Zone 2 were analyzed separately to allow spatial comparisons. When small sample sizes precluded meaningful spatial comparisons, the data were combined for analyses.

Age

Ageing procedures followed those described in Mackay *et al.* (1990). Scales were immersed in water and cleaned if dirty, and then placed on a microscope slide for viewing using a dissecting microscope.

Mounting procedures for fin rays followed Koch and Quist (2007). Depending on their size, fin rays were fixed in either epoxy or resin, sectioned with a jeweler's saw, and mounted permanently on a slide for viewing under a dissecting microscope. Two experienced individuals independently aged each structure. If a discrepancy occurred between the two readers a third person examined the structure and a consensus reached as to the age of the structure. Fish age data were reported as "Standard Age", which assumes a hatch date of January 1 (Mackay *et al.* 1990).

Table 2.6 Summary of data sets used for analyses of biological characteristics for selected fish species, Site C Peace River Fish Inventory 2009.

Species[a]	Zone	Length Distribution		Length Weight		Age Distribution		Length-at-Age Growth	
		Months	Methods[b]	Months	Methods	Months	Methods	Months	Methods
GR	1, 2	9, 10	BS, LF, SF	8, 9	BS, LF, SF	7, 8, 9	LF	8, 9	BS, LF, SF
BT	1, 2	9	BS, LF, SF	8, 9	BS, LF, SF	7, 8, 9	LF	8, 9	BS, LF, SF
BB	Combined	5, 7, 8, 9	BS, LF, SF	5, 7, 8, 9	BS, LF, SF				
GE	Combined	5, 7, 9	BS, LF	5, 7, 9	BS, LF	7	LF	7	BS, LF
KO	Combined	7, 8, 9, 10	BS, LF, SF	8, 9	BS, LF, SF				
LSU	1, 2	9, 10	BS, LF, SF	7	BS, LF, SF	7	LF	7	BS, LF, SF
CSU	Combined	9, 10	BS, LF, SF	7	BS, LF, SF	7	LF	7	BS, LF, SF
MW	1, 2	9, 10	BS, LF, SF	8, 9	BS, LF, SF	8, 9	LF	8, 9	BS, LF, SF
NSC	Combined	7, 8, 9, 10	BS, LF, SF	7, 8, 9	BS, LF, SF				
NP	Combined	7, 8, 9, 10	BS, LF, SF	7, 8, 9	BS, LF, SF	7, 9	LF	7, 9	BS, LF, SF
RB	1, 2	9, 10	BS, LF, SF	8, 9	BS, LF, SF	8, 9	LF	8, 9	BS, LF, SF
WP	Combined	7, 8, 9, 10	BS, LF, SF	5, 7, 8, 9	BS, LF, SF	7, 9	LF	7, 9, 10	BS, LF, SF
WSC	Combined	7, 8, 9, 10	BS, LF, SF	7, 8, 9	BS, LF, SF				
YP	Combined	7, 9, 10	BS, LF, SF	5, 7, 9	BS, LF, SF				

[a] Species labels defined in Table 2.2
[b] Methods: BS – beach seine; LF – large fish boat electrofisher; SF – small fish boat electrofisher.

Growth

Length-at-age of fish in each zone was compared using either the actual length at age (visual assessment) or mean length at age ± SE (statistical).

Where sufficient samples were available growth rate was described using the von Bertalanffy growth equation (Busacker *et al.* 1990) as follows:

$$L_t = L_\infty \left[1 - e^{\{-k(t-t_0)\}}\right]$$

Where t represents the age of the fish in years from the starting time t_0, maximum length equals L_∞, k represents the growth coefficient, and e is the base of the natural logarithm.

When convergence was not possible using the von Bertalanffy growth equation a best-fit regression model was applied. A linear regression best described the age-length relationship as follows:

$$Y = a + bX$$

Where Y = fork length (mm), a = fork length intercept, b = slope, and X = age (years).

All growth curves were generated using Sigmaplot® 8.0.

<u>Length-Weight</u>

The length-weight relationship was characterized based on the power function as follows:

$$W = aL^b$$

Where W = weight (g), a = constant, b = exponent, and L = length (mm).

<u>Body Condition</u>

Fulton's Condition Index (*K)* was used as the metric for body condition as follows:

$$K = (W/L^3) \times 100{,}000$$

Where W = weight (g), L = length (mm), and 100,000 is a scaling constant.

To minimize potential problems associated with correlations between fish length and body condition (Cone 1989), samples were stratified by age. Body condition was compared using mean *K* at age ± SE.

2.2.6 Distribution of Young Fish

The distribution of young fish of large-fish species was examined to ascertain potential timing and source of recruitment. Age 0 fish, or Age 1 fish in the absence of young-of-the-year, were identified based on length-at-age and/or size distributions of collected fish (Table 2.7). The presence of young fish in each of the three major habitats was plotted by season using MapInfo Professional™.

2.2.7 Fish Community Health

Average DELT index values for large fish species were categorized by relative levels of impairment to health based criteria presented in Bauman *et al*. (2000). Categories of health impairment were as follows:

Background -	DELT index ≤ 0.5% of sample
Moderately Impaired -	DELT index > 0.5% to 3.0%
Strongly Impaired -	DELT index > 3.0% to 6.0%
Highly Impaired -	DELT index > 6.0%.

Table 2.7 Length of Age 0 and Age 1 fish of selected large fish species, Site C Peace River Fish Inventory 2009.

Species	Age	Spring			Summer			Fall		
		No.	Median	Range	No.	Median	Range	No.	Median	Range
Arctic grayling	0	0			46	51.0	22 – 64	57	114.0	81 –130
Bull trout	0	0			0			2	49.0	48 – 50
	1	0			7	174.0	105 – 205	5	171.0	156 – 184
Kokanee	0	0			0			4	74.5	52 – 89
	1	28	72.0	59 – 106	47	92.0	70 – 110	10	113.0	106 – 120
Longnose sucker	0	0			0			192	41.0	19 – 65
Largescale sucker	0	0			0			39	37.0	24 – 60
Mountain whitefish	0	285	22.0	15 – 34	627	52.0	27 – 78	727	87.0	34 – 113
Northern pike	0	0			40	83.5	49 – 117	3	104.0	96 – 114
Rainbow trout	0	0			1	35.0		13	58.0	39 – 73
	1	14	83.0	56 – 111	52	107.0	83 – 120	11	123.0	116 – 129
Walleye	0	0			6	64.0	56	0		
	1	5	148.0	116 – 150	0			0		
White sucker	0	0			0			91	38.0	21 – 50
Yellow perch	0	0			64	37.0	21 – 78	29	90.0	53 – 107
Sucker spp.	0	5	17.0	16 – 22	290	20.0	12 – 36	0		

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3.0 RESULTS

3.1 ENVIRONMENTAL CONDITIONS

3.1.1 Discharge

In 2009, Peace River mean daily discharge varied between 341 m^3/s and 3337 m^3/s (Figure 3.1). Mean daily discharge ranged from 912 m^3/s to 1634 m^3/s during the spring session, 1050 m^3/s to 1782 m^3/s during the summer session, and 1057 m^3/s to 1201 m^3/s during the fall session. Inputs from the major tributaries (Halfway, Moberly, Pine, Beatton, and Kiskatinaw Rivers) influenced Peace River flows, particularly between May and August. Peace River discharge was higher at downstream Water Survey of Canada sites compared to upstream sites during each of the field programs. Sampling did not occur during periods of extreme high or low flows – daily discharge during sampling was within the 25 to 75 percentile range of 2009 flows.

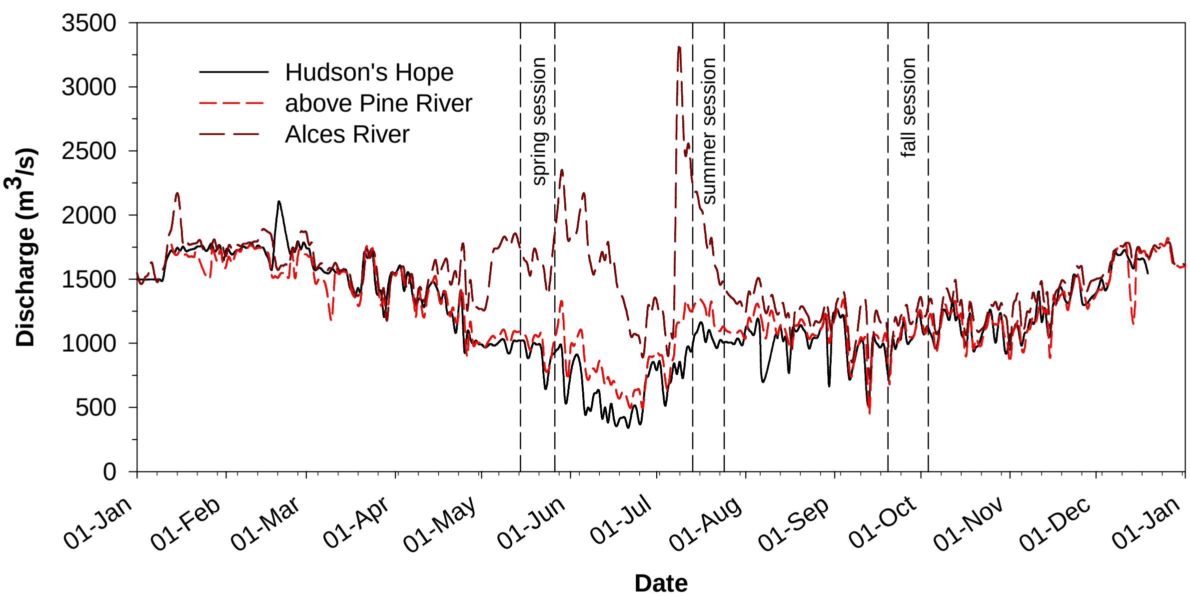

Figure 3.1 Peace River mean daily discharge at Water Survey of Canada Stations from January to December, Site C Peace River Fish Inventory 2009.

Peace River discharge was influenced by releases from the W.A.C. Bennett Dam and the PCN Dam. Hourly discharge typically fluctuated over a 24 h period, as illustrated by the flow regime recorded during May 2009 (Figure 3.2). The fluctuation in flow was most apparent immediately downstream of the PCN Dam; however, downstream effects were dampened by tributary inputs and flow attenuation. Fluctuations of hourly discharge occurred within the entire study area, which is an approximate distance of 151 km.

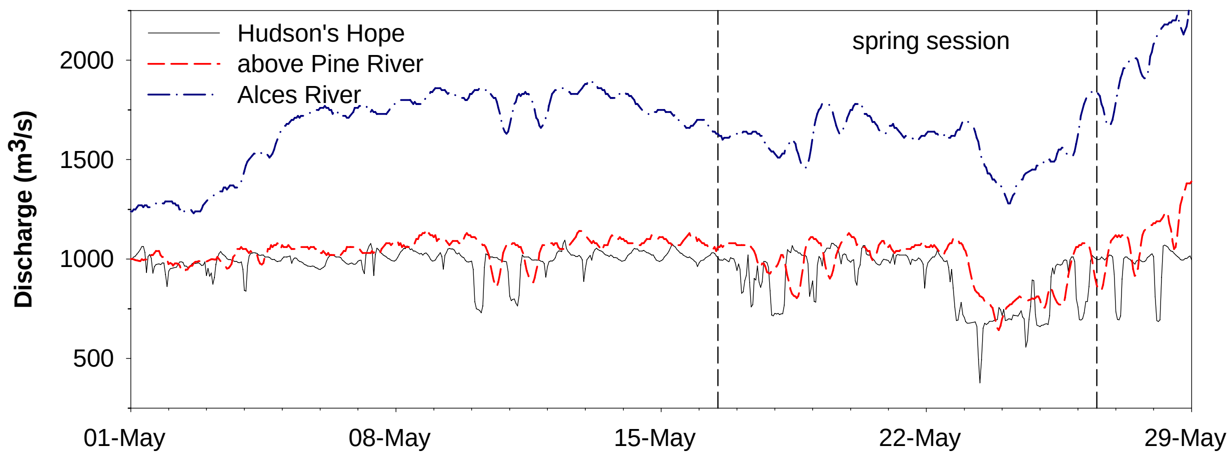

Figure 3.2 Peace River hourly discharge at Water Survey of Canada Stations during May, Site C Peace River Fish Inventory 2009.

3.1.2 Water Clarity

Water clarity of the Peace River recorded at sample sites varied over space and time (Figure 3.3, Appendix C). During spring and summer, water clarity was highest in the farthest upstream section of the study area (Section 1A) and lowest in the farthest downstream section of the study area (Section 7).

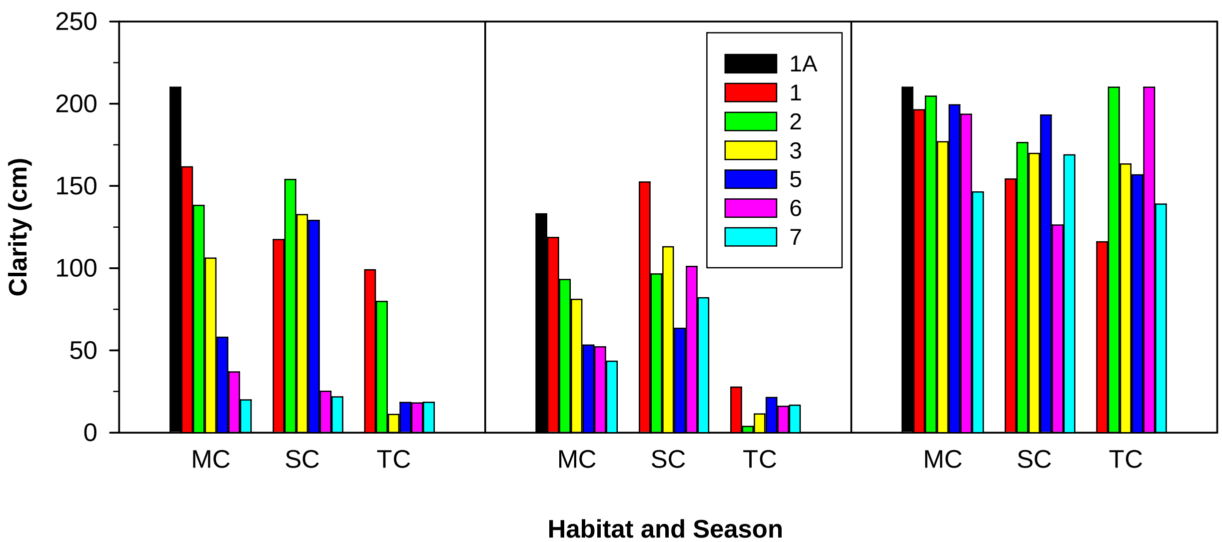

Figure 3.3 Mean water clarity measured at sample sites by section, season, and habitat, Site C Peace River Fish Inventory 2009 (MC – main channel, SC – side channel, TC – tributary confluence).

Field observations indicated that the spatial pattern reflected the interaction between the volume of clear water discharged from PCN Dam and tributary inputs (water volume and sediment load). Water clarity of the Peace River was lowest when releases from the PCN Dam were lowest and tributary flows and their sediment loads were highest. This was most apparent in Sections 6 and 7, which were downstream of the Pine River and Beatton River, respectively. During fall, water clarity was high in all sections (≥ 100 cm). During this period tributary flows and sediment loads were low.

During spring and summer, water clarity at side channel sites (SC) within each section typically was higher than at main channel sites (MC) in the same section. During these seasons, water clarity at most tributary confluence sites (TC) was low (≤ 20 cm). The differences recorded between the three habitat areas likely reflected the relative exposure of sites to tributary inputs. As well, lower water velocities in side channels would allow settling of some suspended sediments, which could result in higher water clarity.

3.1.3 Water Temperature

Water temperature of the Peace River recorded at sample sites during field programs also varied over space and time (Figure 3.4, Appendix C). Mean water temperatures ranged from 3.6^{0}C to 20.6^{0}C, with temperatures being lowest in spring, highest in summer, and intermediate in fall. During spring and summer, lowest values were recorded nearest to the PCN Dam (Section 1A), while highest temperatures were recorded at sites located at downstream locations (Sections 6 and 7). The pattern was reversed in fall.

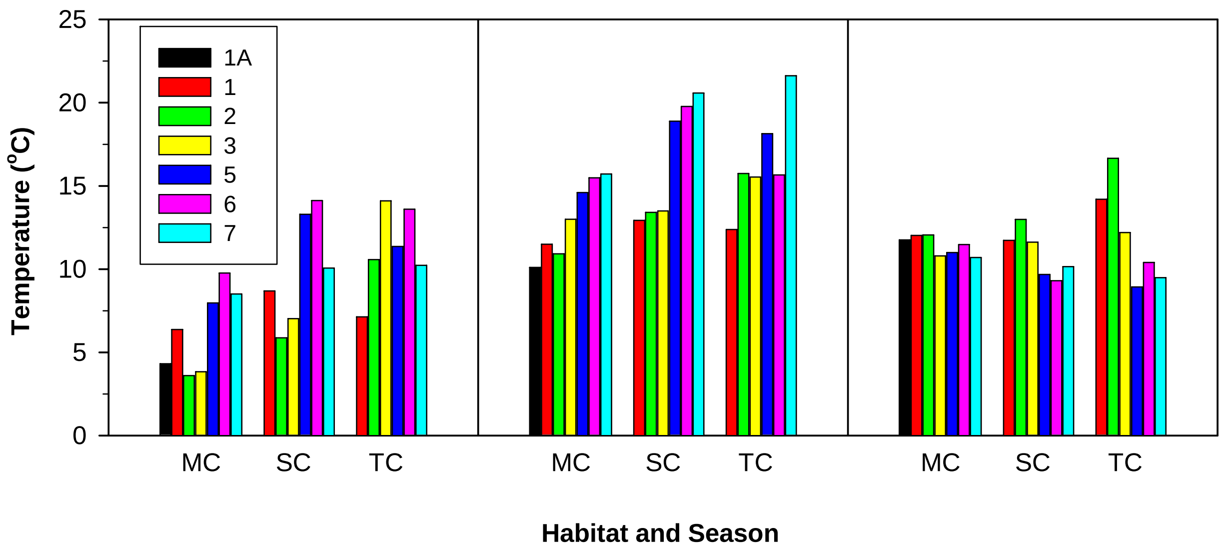

Figure 3.4 Mean water temperatures measured at sample sites by section, season, and habitat, Site C Peace River Fish Inventory 2009 (MC – main channel, SC – side channel, TC – tributary confluence).

Water temperatures differed between habitat areas. In spring and summer, average water temperatures in side channel (SC) and tributary confluence (TC) areas were higher than in main channel (MC) areas – differences ≥ 3^0C were not uncommon. Point measurements during summer also recorded very high temperatures in side channels (28.3^0C) and tributary confluences (24.5^0C).

3.1.4 Water Conductivity

Unlike water clarity and water temperature, water conductivity of the Peace River was generally stable over space and time (Figure 3.5, Appendix C). Mean conductivity ranged from 148 µS/cm to 345 µS/cm, but this range reflected differences between sampled areas rather than section or season. Mean conductivity at main channel (MC) sites during the entire field program ranged from 153 µS/cm to 213 µS/cm. Values recorded at side channel (SC) sites during the entire field program were more variable. They ranged from 155 µS/cm to 293 µS/cm. The highest values were consistently recorded in Section 6 and were caused by high point measures (> 425 µS/cm) at three sites (BS0612, BS0609, and BS0605, Appendix C4). Reasons for the high values are not known, but may be related to ground water inputs or anthropogenic causes.

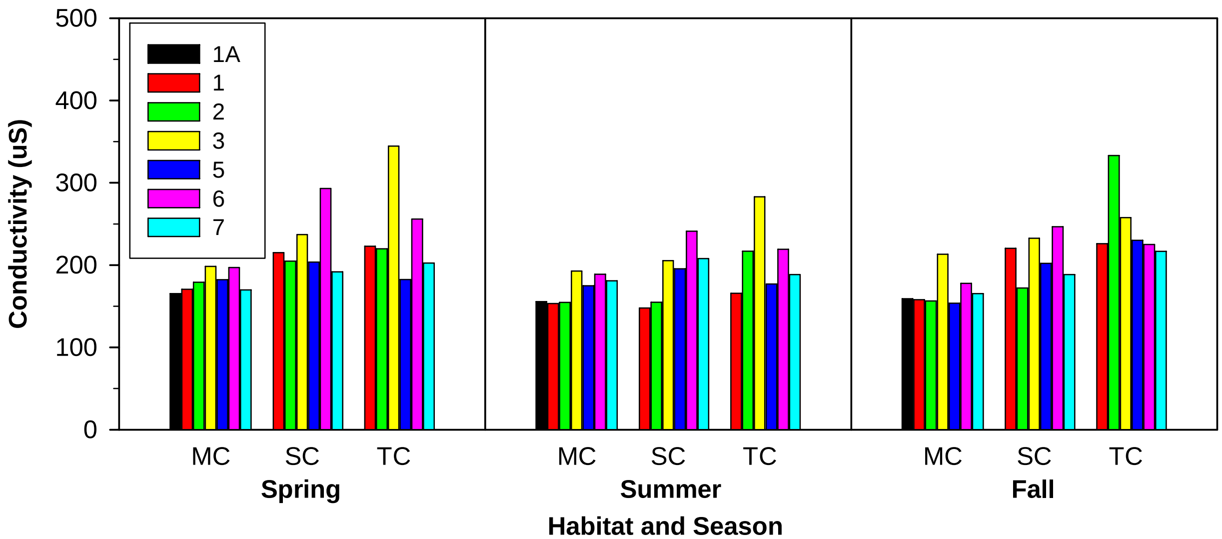

Figure 3.5 Mean water conductivity measured at sample sites by section, season, and habitat, Site C Peace River Fish Inventory 2009 (MC – main channel, SC – side channel, TC – tributary confluence).

Mean water conductivity at tributary confluence (TC) areas were more variable than at main channel or side channel areas (range of 155 µS/cm to 345 µS/cm) and tended to be the highest values recorded in each section.

3.2 FISH COMMUNITY STRUCTURE

3.2.1 Species Composition

In total, 23,466 fish representing 30 species were recorded during the Peace River Fish Inventory (Table 3.1). The recorded species included 7 cold water sportfish, 5 cool water sportfish, 3 suckers, 3 sculpins, and 12 minnows (includes true minnows, trout-perch, and sticklebacks).

Table 3.1 Composition of recorded fish species, Site C Peace River Fish Inventory 2009 (all capture methods and sample events combined).

Group[a]	Species	Total	Percent
Sportfish (cold water)	Arctic grayling	337	1.4
	Bull trout	302	1.3
	Kokanee	173	0.7
	Lake trout	6	*<0.1*
	Lake whitefish	16	0.1
	Mountain whitefish	13,167	56.1
	Rainbow trout	502	2.1
	Subtotal	*14,503*	*61.8*
Sportfish (cool water)	Burbot	45	0.2
	Goldeye	37	0.2
	Northern pike	190	0.8
	Walleye	107	0.5
	Yellow perch	158	0.7
	Subtotal	*537*	*2.3*
Suckers	Largescale sucker	870	3.7
	Longnose sucker	2,691	11.5
	White sucker	299	1.3
	Subtotal	*3,860*	*16.4*
Sculpins	Prickly sculpin	377	1.6
	Slimy sculpin	929	4.0
	Spoonhead sculpin	5	*<0.1*
	Subtotal	*1,311*	*5.6*
Minnows[b]	Brook stickleback	1	*<0.1*
	Finescale dace	21	0.1
	Flathead chub	141	0.6
	Lake chub	491	2.1
	Longnose dace	345	1.5
	Northern pikeminnow	285	1.2
	Northern redbelly dace	5	*<0.1*
	Peamouth	2	*<0.1*
	Pearl dace	2	*<0.1*
	Redside shiner	1,331	5.7
	Spottail shiner	287	1.2
	Trout-perch	344	1.5
	Subtotal	*3,255*	*13.9*
Total		**23,466**	**100.0**

[a] Does not include unidentified fish.
[b] Includes true minnows (Family Cyprinidae), trout-perch (Family Percopsidae) and sticklebacks (Family Gasterosteidae).

Based on the numerical dominance in the overall sample, cold water sportfish accounted for the highest percentage of the sample (61.8%), followed by suckers (16.4%), the minnows group (13.9%), and sculpins (5.6%). Cool water sportfish were the least abundant group (2.3%).

The numerically dominant fish species in the cold water sportfish group and the most numerous fish recorded during the study was mountain whitefish (56.1%). The next most numerically important sportfish species were rainbow trout (2.1%), Arctic grayling (1.4%), and bull trout (1.3%). The three remaining cold water sportfish contributed ≤ 1% to the sample. These included kokanee, lake trout, and lake whitefish. The latter two species were scarce (n = 6 and n = 16, respectively). Cool water sportfish were less abundant than cold water sportfish. Each of the cool water sportfish species (burbot, goldeye, northern pike, walleye, and yellow perch) contributed < 1% to the overall sample.

Longnose sucker was the numerically dominant species in the sucker group and was the second most numerous species recorded in the overall sample (11.5%). The other two species, largescale sucker and white sucker, represented 3.7% and 1.3% of the sample, respectively.

Redside shiner was the numerically dominant species in the minnow group and was the third most numerous species recorded in the overall sample (5.7%). Lake chub, longnose dace, northern pike minnow, spottail shiner, and trout-perch represented from 1.2% to 2.1% of the overall sample. Each of the remaining species in this group, which included brook stickleback, finescale dace, northern redbelly dace, peamouth, and pearl dace, were scarce (≤ 0.1%).

Slimy sculpin was the numerically dominant species in the sculpins group and was the fourth most numerous species in the overall sample (4.0%). Prickly sculpin accounted for 1.6% of the sample. Spoonhead sculpin were scarce (< 0.1% of sample).

3.2 2 Fish Assemblage

The fish assemblage recorded during the field program was not constant among sections (Figure 3.6). The cold water sportfish group accounted for the majority of the sample in each section; however, their contribution decreased from upstream to downstream. A high of 85.6% recorded in Section 1A declined to 50.0% in Section 3. Downstream of the proposed Site C Dam (Zone 2) coldwater sportfish accounted for ≤ 36.3% of the sample in each section. A similar pattern was recorded for the sculpin group. The contribution of sculpins was highest in Sections 1A (13.6%) and 1 (8.7%). The percentage of sculpins in each section was approximately 3.0% from Section 2 downstream to Section 7.

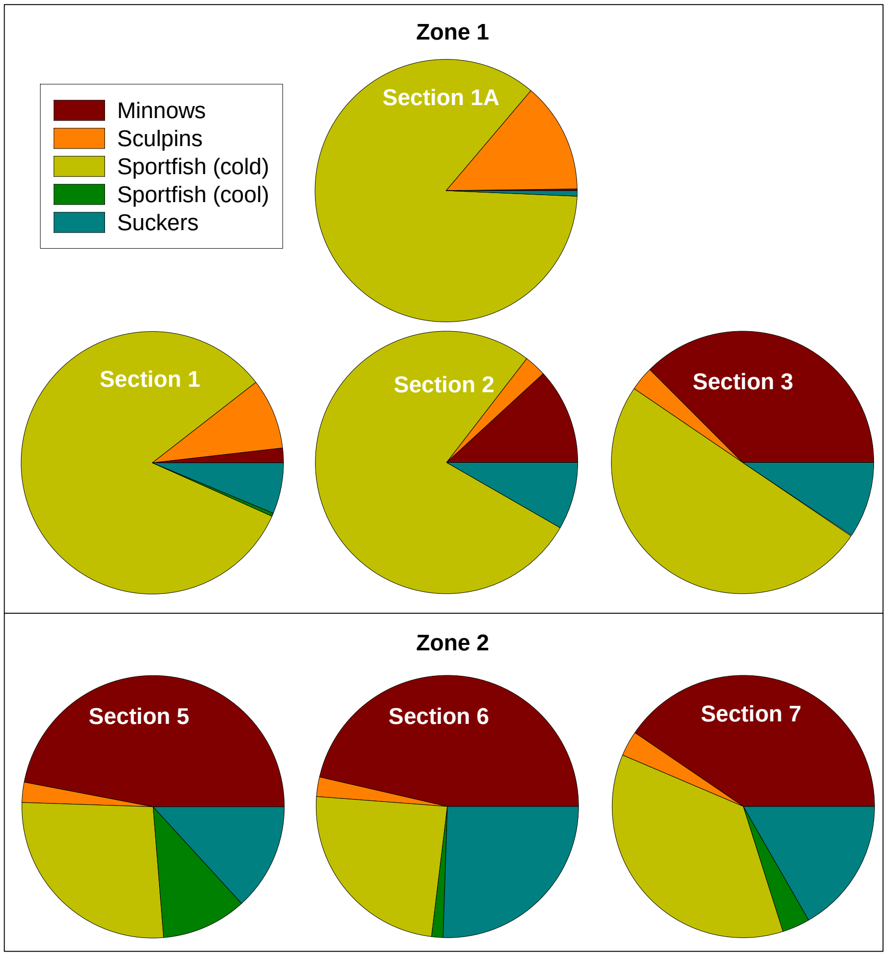

Figure 3.6 Relative contribution of fish groups by section and zone, Site C Peace River Fish Inventory 2009 (all capture methods and sample events combined).

The spatial trends recorded for the cool water sportfish, sucker, and minnow groups were the reverse of trends for the cold water sportfish and sculpin groups. There was an increase in the numerical contribution from upstream to downstream. Cool water sportfish were largely absent from all sections in Zone 1. In Zone 2 their contribution ranged from 1.4% (Section 6) to 10.5% (Section 5). For the sucker group, a low of 0.7% recorded in Section 1A increased to ≥ 13.2% in Zone 2 sections. The largest change occurred between Section 3 (9.4%) and Section 6 (25.5%). Similarly, the minnow group accounted for a small percentage of the sample in Sections 1A and 1 (≤ 1.8%). The contribution of this group increased to 11.8% in Section 2, and then jumped to ≥ 37.5% in Sections 3 to Section 7.

The fish assemblage also differed by habitat type (Figure 3.7). In Zone 1 the contribution of cold water sportfish was higher in the main channel area (84.4%) compared to side channel (49.7%) and tributary confluence areas (17.6%). A similar pattern was recorded for the sculpin group in Zone 1. In contrast, suckers were more prominent in side channels (13.2%) and tributary confluence areas (14.3%) compared to main channel areas (5.3%). The results for minnows were very similar to the sucker results. The contribution of the minnow group was higher in side channels and tributary confluences than in main channel areas. Cool water sportfish were rarely encountered in Zone 1, and they only occurred in side channel and tributary confluence areas.

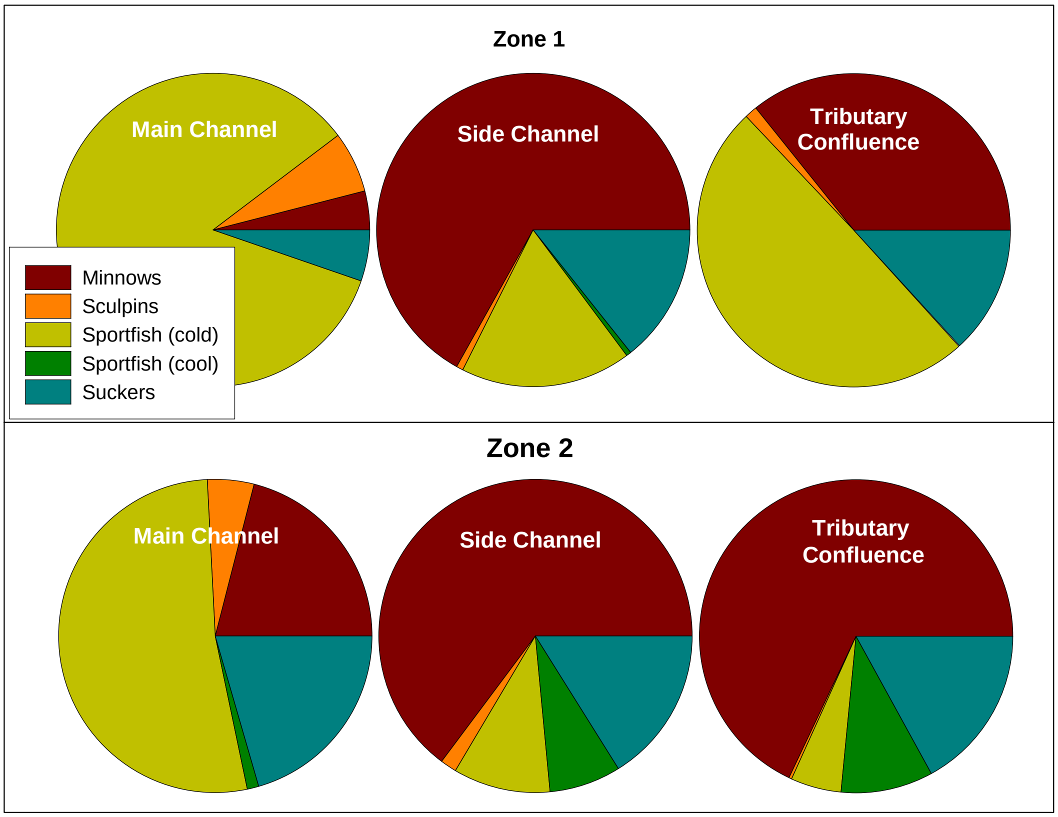

Figure 3.7 Relative contribution of fish groups by habitat type and zone, Site C Peace River Fish Inventory 2009 (all capture methods and sample events combined).

The relative contribution of each group changed in Zone 2. Within each habitat type, the contribution of cool water sportfish and sculpins was lower in Zone 1 compared to Zone 2. The reverse was true for cold water sportfish, suckers and minnows. This shift reflects the spatial differences within the study area illustrated by Figure 3.6.

Although the relative contribution of each group differed by Zone, the pattern within each habitat remained the same. The cold water sportfish group and the sculpin group were most prominent in main channel areas, while the contribution of minnows was much higher in side channel and tributary confluence areas. Cool water sportfish were also most prominent in these two areas. The only difference occurred for the sucker group. In Zone 2, this group contributed approximately 18% to the sample in each of the three habitat areas.

3.2.3 Species Diversity

In total, 30 fish species were recorded during the study, but the number of species differed between sections (Table 3.2). Species diversity, or number of species, increased from upstream to downstream. Eight species were recorded in Section 1A, which is located immediately below the PCN Dam. In Sections 1 and 2, which are located upstream of the Halfway River, 18 and 17 species were recorded, respectively. Species diversity increased to 23 and 24 species in Sections 3 and 5, respectively. The highest diversity (26 species) was recorded downstream of the Pine River confluence in Sections 6 and 7.

Table 3.2 Distribution of fish species by section and zone recorded on the Peace River, Site C Peace River Fish Inventory 2009 (all capture methods and sample events combined).

Group	**Species**	**Zone 1**				**Zone 2**		
		1A	**1**	**2**	**3**	**5**	**6**	**7**
Sportfish (cold water)	Arctic grayling		+	+	+	+	+	+
	Bull trout	+	+	+	+	+	+	+
	Kokanee	+	+	+	+	+	+	+
	Lake trout		+	+	+	+		
	Lake whitefish		+	+	+	+	+	
	Mountain whitefish	+	+	+	+	+	+	+
	Rainbow trout	+	+	+	+	+	+	+
Sportfish (cool water)	Burbot				+	+	+	+
	Goldeye					+	+	+
	Northern pike		+[b]		+	+	+	+
	Walleye				+	+	+	+
	Yellow perch					+	+	+
Suckers	Longnose sucker	+	+	+	+	+	+	+
	Largescale sucker		+	+	+	+	+	+
	White sucker		+	+	+	+	+	+
Minnows[a]	Brook stickleback							+
	Finescale dace						+	+
	Flathead chub				+		+	+
	Lake chub		+	+	+	+	+	+
	Longnose dace		+	+	+	+	+	+
	Northern pikeminnow		+	+	+	+	+	+
	Northern redbelly dace					+	+	+
	Peamouth		+		+			
	Pearl dace					+		
	Redside shiner	+	+	+	+	+	+	+
	Spottail shiner			+	+	+	+	+
	Trout-perch						+	+
Sculpins	Prickly sculpin	+	+	+	+	+	+	+
	Slimy sculpin	+	+	+	+	+	+	+
	Spoonhead sculpin				+		+	+
Total Number of Species		**8**	**18**	**17**	**23**	**24**	**26**	**26**

[a] Includes true minnows (Family Cyprinidae), trout-perch (Family Percopsidae) and sticklebacks (Family Gasterosteidae).

[b] Recorded only at the confluence of Maurice Creek.

The majority of fish species recorded during the study were widely distributed (Table 3.2). In total, 17 species were recorded in 5 or more sections. These included Arctic grayling, bull trout, kokanee, lake whitefish, mountain whitefish, northern pike, rainbow trout, longnose sucker, largescale sucker, white sucker, lake chub, longnose dace, northern pikeminnow, redside shiner, spottail shiner, prickly sculpin, and slimy sculpin.

Of the 13 species that exhibited a more restricted distribution (present in ≤ 4 sections), most (11 species) were located only in Zone 2 and/or in the lower portion of Zone 1 (Section 3). These included burbot, goldeye, walleye, yellow perch, brook stickleback, finescale dace, flathead chub, northern redbelly dace, pearl dace, trout-perch, and spoonhead sculpin.

3.2.4 Species Occurrence

The occurrence of fish at sample sites within each section varied depending on species and section (Figure 3.8). As expected from numbers presented in Table 3.1, species that were numerically scarce also occurred sporadically in the study area. In the sportfish group, lake trout and lake whitefish were infrequently encountered in any one section. For each of these species, percent occurrence did not exceed 2.7% in Zone 1 or Zone 2. In the minnow group, brook stickleback, finescale dace, northern redbelly dace, peamouth, and pearl dace also occurred at very few sites in each section within Zone 1 or Zone 2 (≤ 1.6%). Spoonhead sculpin in the sculpin group was rarely recorded (≤ 1.6% of sampled sites).

For several species, percent occurrence differed between Zones 1 and 2. In the sportfish and sculpin groups, bull trout, kokanee, rainbow trout, and prickly sculpin were more frequently encountered in Zone 1 compared to Zone 2. Slimy sculpin occurred equally in both zones. The opposite was true for burbot, goldeye, northern pike, walleye, and yellow perch. Similarly, in the sucker and minnow groups the occurrence of longnose suckers, largescale suckers, white suckers, flathead chub, lake chub, longnose dace, spottail shiners, redside shiners, and trout-perch were generally higher at sites in Zone 2 compared to sites in Zone 1. For other species such as Arctic grayling and mountain whitefish there were no large differences between zones.

Although the occurrence of the majority of species differed between zones, species occurrence in the three habitat types was generally consistent (Figure 3.9). The sportfish species Arctic grayling, bull trout, kokanee, lake trout, mountain whitefish, and rainbow trout were most often encountered in main channel areas, and usually were much less likely to occur at sites within side channel and tributary confluence areas. Burbot, goldeye, northern pike, and walleye were most likely to occur at tributary confluences.

Yellow perch were encountered almost exclusively in side channels and northern pike were also frequently encountered in this habitat.

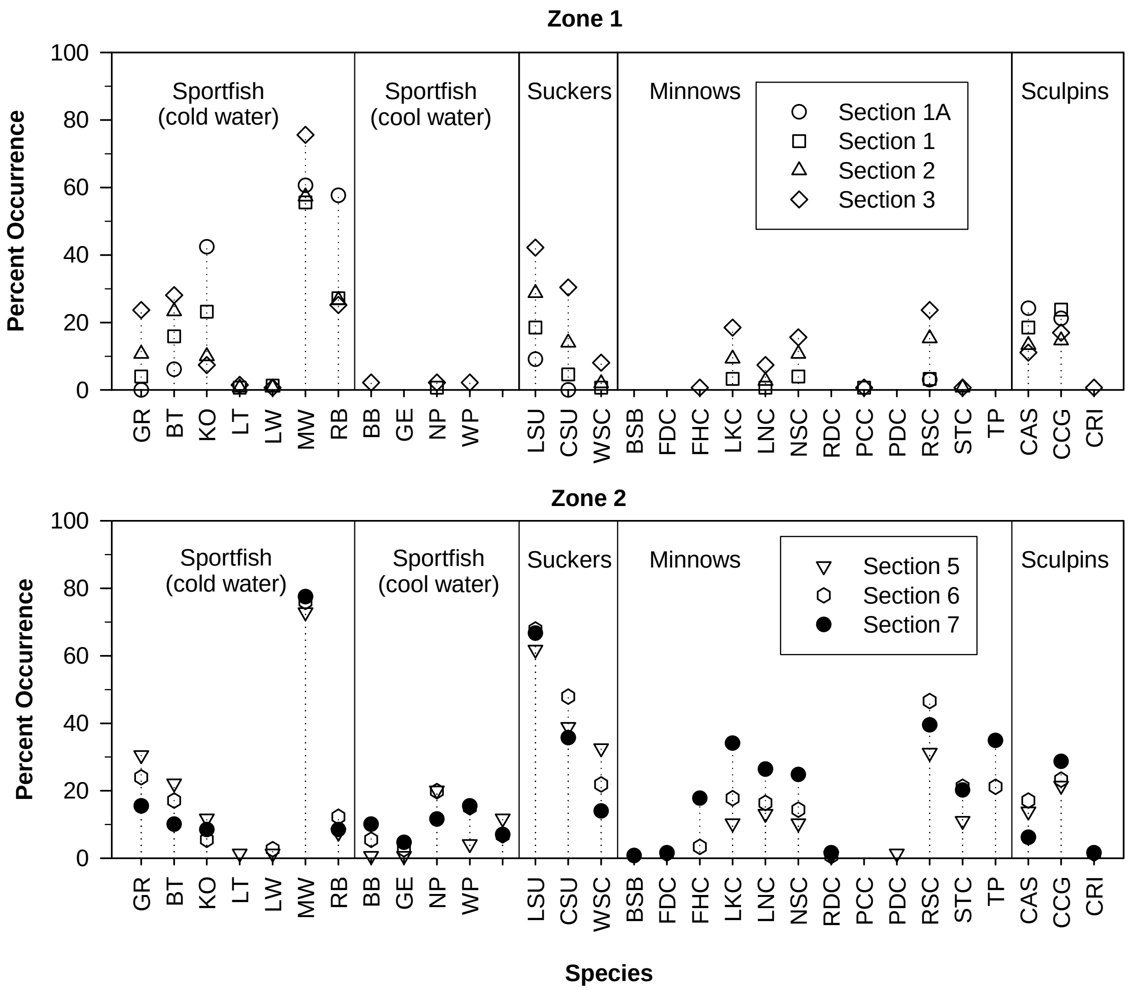

Figure 3.8 Percent occurrence of fish species at sampled sites within each section by zone, Site C Peace River Fish Inventory 2009 (all capture methods and sample events combined).

The 12 species in the minnow group were most frequently recorded at sites located in tributary areas. There were three exceptions to this pattern. Lake chub in Zone 2 were just as likely to occur at sites located in tributary confluence and side channel areas. Spottail shiner primarily occurred in side channel areas, and trout-perch occurrence was equal across all habitats. In the sculpin group, prickly sculpin was also likely to occur at sites in all three habitats, whereas slimy sculpin were most likely to be found in main channel areas.

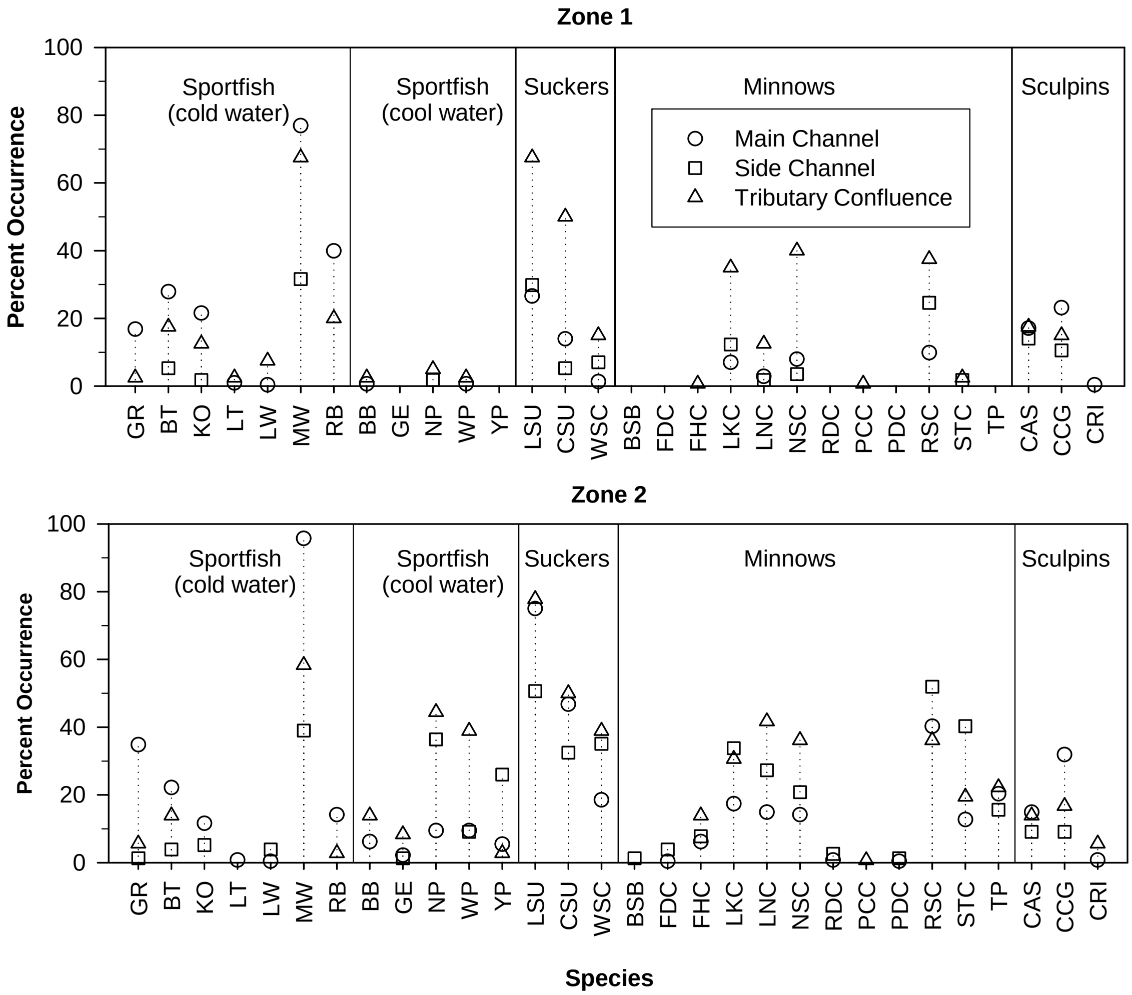

Figure 3.9 Percent occurrence of fish species at sampled sites within habitat types by zone, Site C Peace River Fish Inventory 2009 (all capture methods and sample events combined).

3.3 COLD WATER SPORTFISH POPULATIONS

Information presented in this section includes summaries of catch rates, biological characteristics, and recruitment of selected cold water sportfish populations. Raw data and summaries for all cold water sportfish populations are presented in Appendix E (catch rates), Appendix F (biological characteristics), and Appendix G (young fish distribution). It should be noted that biological characteristics data collected during the present study were augmented with data collected from the 2009 WLR Peace River Fish Index Project (Mainstream and Gazey 2010). Appendix F identifies those data.

3.3.1 Arctic grayling

3.3.1.1 Catch Rate

In total, 337 Arctic grayling were recorded in the study area. Arctic grayling catch rates were highest in main channel areas, but Arctic grayling were rarely encountered in side channel and tributary confluence areas (Figure 3.10). Catch rates of small Arctic grayling were higher than for large Arctic grayling. Average large fish catch rates did not exceed 1.8 fish/km whereas small fish catch rates did not exceed 3.0 fish/km.

Catch rates of large Arctic grayling were highest in Section 2 to Section 6, while catch rates of small Arctic grayling were highest in Section 3 to Section 7. These spatial patterns may reflect the distribution of recruitment sources of small Arctic grayling (Sections 3 to 7 are located in immediate vicinities of major tributaries to the Peace River [Figure 1.1]), as well as the distribution of habitats preferred by Arctic grayling.

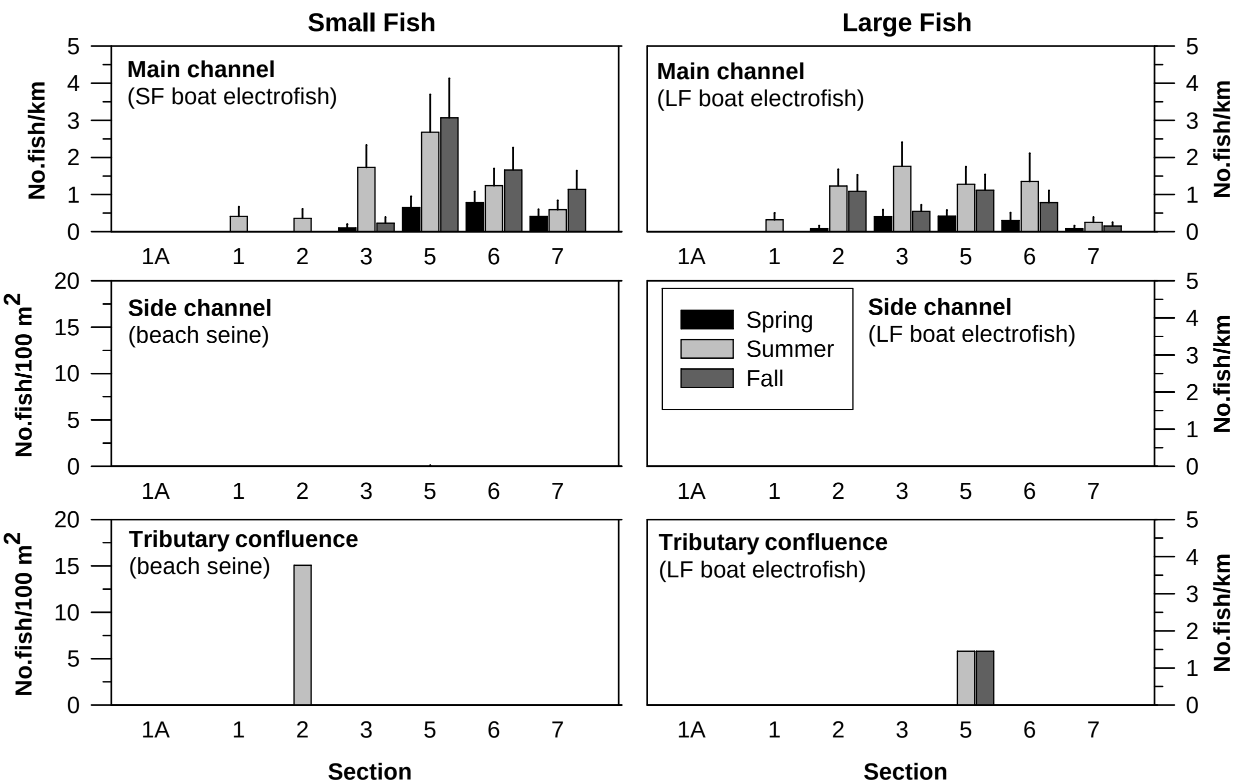

Figure 3.10 Average catch rates (± SE) of Arctic grayling in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

There were differences in the seasonal catch rates of Arctic grayling. Catch rates of small and large Arctic grayling were highest in summer and fall. The elevated small fish catch rates in summer and fall may suggest an influx of fish due to out migration from recruitment tributaries. The low catch rates of large Arctic grayling in spring suggest the absence of fish due to movement of adults out of the Peace River study area into spawning tributaries.

3.3.1.2 Biological Characteristics

In total, 184 Arctic grayling were sampled for biological characteristics – 63 from Zone 1 and 121 from Zone 2. Sampled fish ranged in length from 81 mm to 385 mm, ranged in weight from 6 g to 762 g, and ranged from Age 0 to Age 5.

The size and age distributions of Arctic grayling differed between Zone 1 and Zone 2 (Figure 3.11). Based on the combined sample from all capture methods, Zone 1 contained a higher number of fish ≥ 250 mm length (≥ Age 2) and Zone 2 contained a higher number of fish ≤ 150 mm length (≤ Age 1).

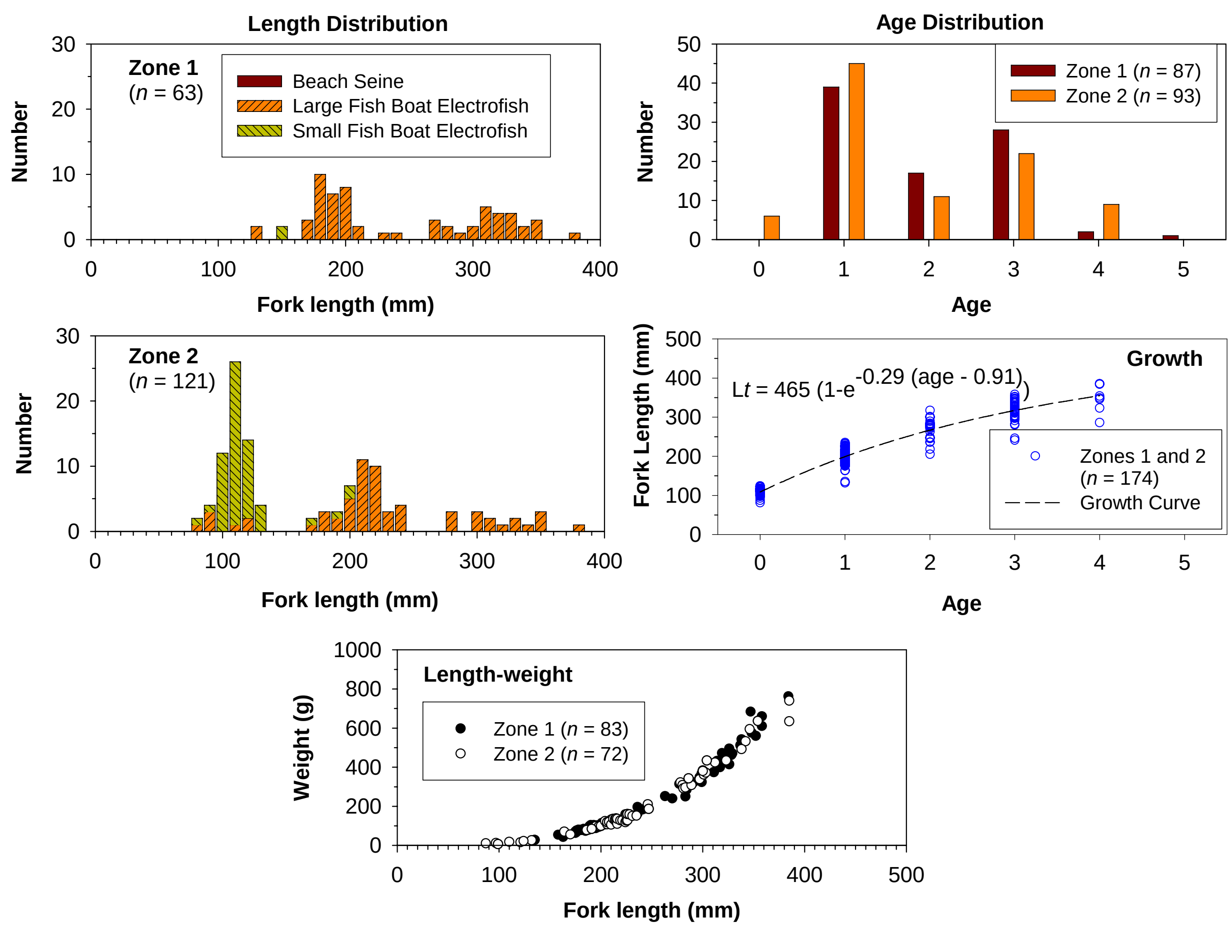

Figure 3.11 Biological characteristics of sampled Arctic grayling, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

A visual assessment of the weight-length relationship (Figure 3.11) and a comparison of length-at-age and condition-at-age summaries (Table 3.3) indicated no large differences between zones in Arctic grayling condition or growth. The growth curve using the combined data indicated a von Bertalanffy growth form.

Table 3.3 Mean length-at-age and condition-at-age of Arctic grayling in Zone 1 and Zone 2, Site C Peace River Fish Inventory 2009.

Age	Fork Length				Condition (*K*)			
	Zone 1		Zone 2		Zone 1		Zone 2	
	n	Mean (± 95%CI)	*n*	Mean (± 95%CI)	*n*	Mean (± 95%CI)	*n*	Mean (± 95%CI)
0	0		33	109.2 ± 3.7				
1	39	188.3 ± 4.3	35	209.1 ± 7.1	35	1.30 ± 0.04	31	1.28 ± 0.05
2	16	266.3 ± 16.3	7	275.3 ± 18.2	14	1.31 ± 0.06	6	1.33 ± 0.09
3	21	323.1 ± 11.9	15	309.7 ± 15.2	19	1.36 ± 0.04	9	1.38 ± 0.06
4	1	384.0	7	346.9 ± 31.0	1	1.35	6	1.34 ± 0.13

3.3.1.3 Distribution of Young Fish

There were spatial, seasonal, and habitat differences in the distribution of Age 0 Arctic grayling in the Peace River (Figure 3.12). Age 0 Arctic grayling were recorded in summer and fall primarily downstream of the proposed Site C dam (Zone 2) in Sections 5, 6, and 7. Age 0 Arctic grayling were recorded at only one site in Zone 1.

Eleven fish were captured at the confluence of Farrell Creek in Section 2 at a backpack electrofisher site. Main channels were the primary habitat.

3.3.2 Bull trout

3.3.2.1 Catch Rates

In total, 302 bull trout were recorded in the study area. Bull trout were encountered in main channel areas, side channel areas, and tributary confluence areas, but the catch was almost entirely composed of larger fish (> 200 mm fork length) (Figure 3.13). Average large bull trout catch rates in main channel areas did not exceed 2.4 fish/km, and in general, values were > 1.0 fish/km in side channel and tributary confluence areas. Exceptions to this occurred at specific sites. Higher catch rates during spring, summer, and fall in Section 1 were recorded at the Lynx Creek confluence. The high catch rates recorded in Section 2 in spring occurred at the Farrell Creek confluence and a side channel area.

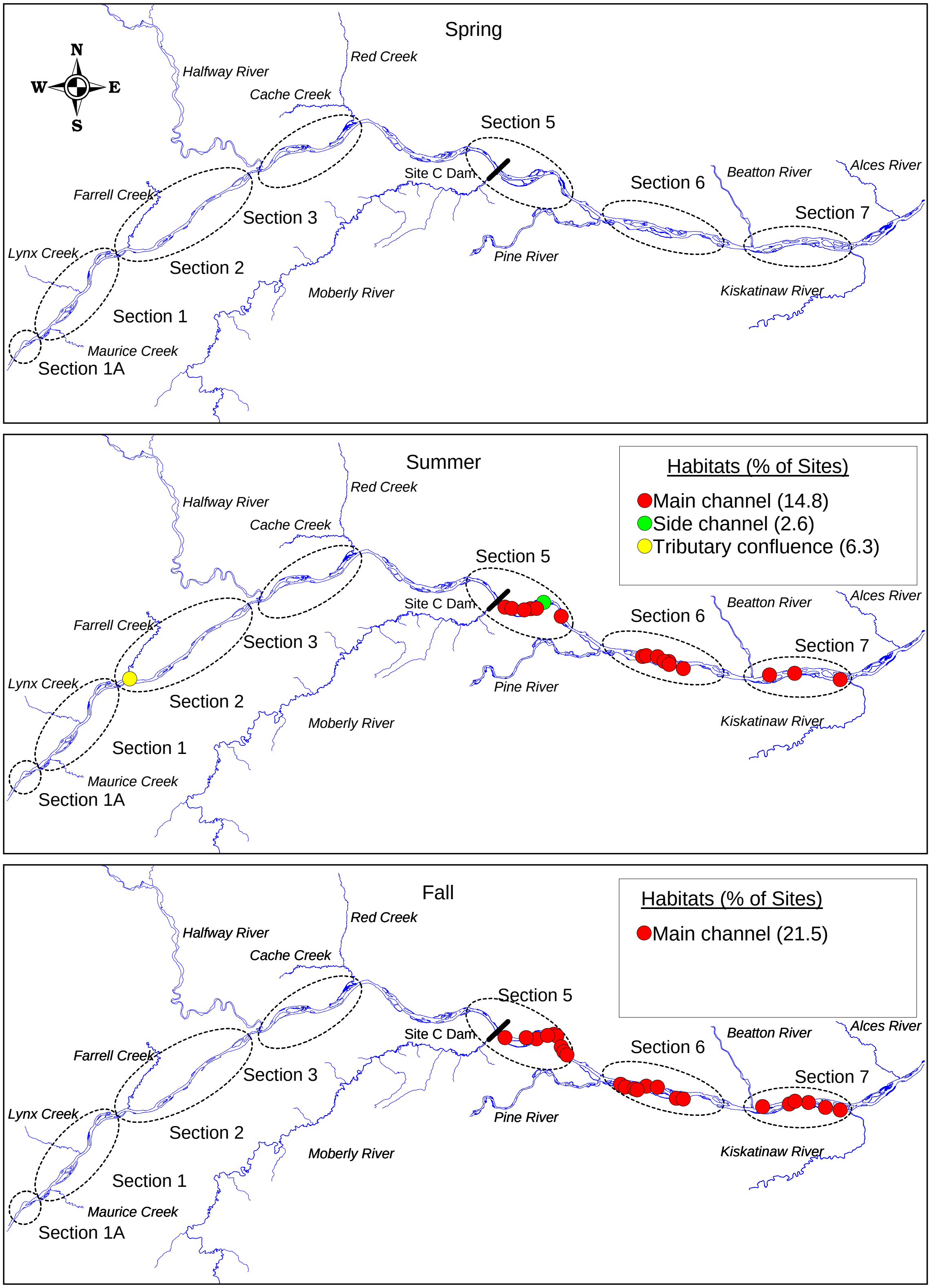

Figure 3.12 Distribution of Age 0 Arctic grayling, Site C Peace River Fish Inventory 2009.

In all cases the high catch rates were caused by the capture of 2 to 3 fish at each location. The high catch rate recorded in Section 3 in spring occurred in the Halfway River confluence area, where 16 adult bull trout were recorded. A concentration of adult bull trout also were recorded in the same location in spring 2008 (Mainstream 2009b).

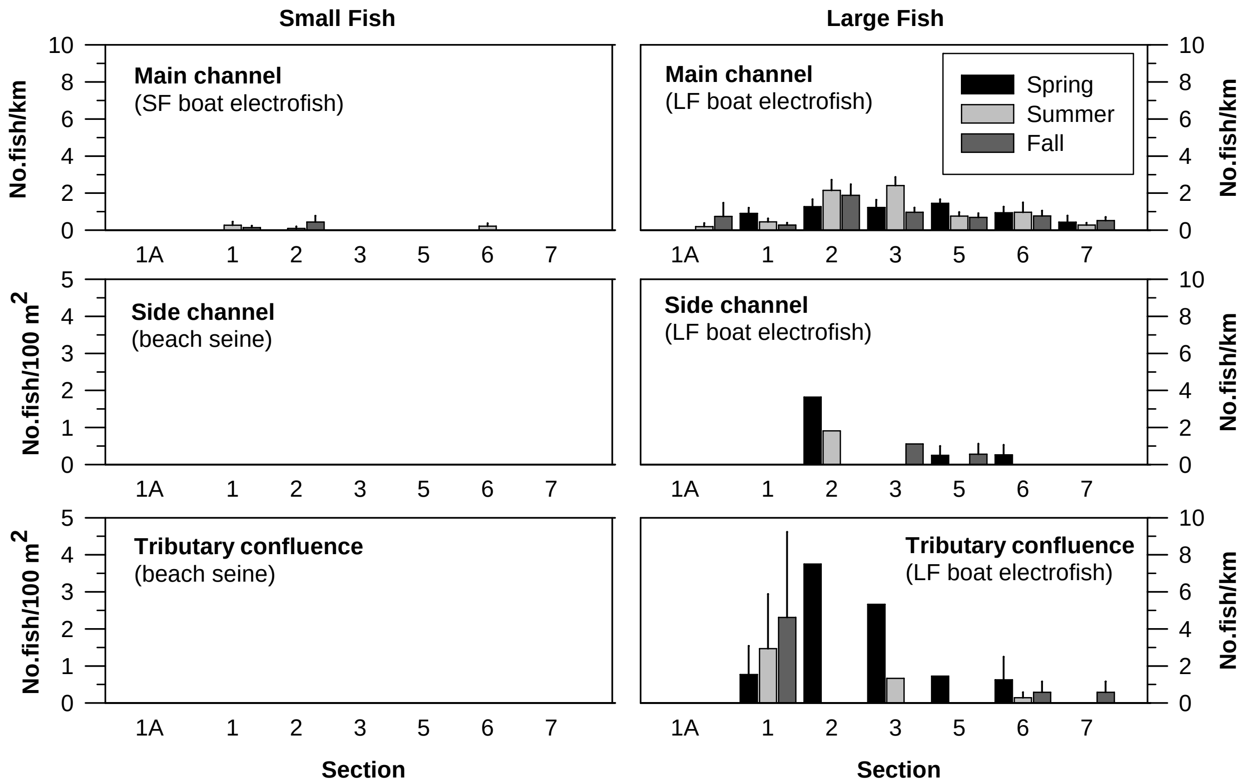

Figure 3.13 Average catch rates (± SE) of bull trout in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

The catch rate of large bull trout was highest in Section 2 to Section 6; however, fish were recorded in all sections during the study. Small bull trout, although encountered in very low numbers, were recorded in Sections 1, 2, and 6. These spatial patterns likely reflect the distribution of the bull trout population in the Peace River study area. Subadult and adult fish were located primarily in Sections 2 to 6. Small bull trout are largely absent from the Peace River because this population rears in upper Halfway River tributaries.

There were no strong seasonal differences in bull trout catch rates even though adult bull trout migrate into major tributaries such as the Halfway River in late summer to spawn. The lack of a seasonal change in catch rates may reflect the low catchability of this species and/or the preponderance of subadult bull trout in the Peace River population (see Section 3.3.2.2).

3.3.2.2 Biological Characteristics

In total, 179 bull trout were sampled for biological characteristics – 123 from Zone 1 and 56 from Zone 2. Sampled fish ranged in length from 48 mm to 878 mm, ranged in weight from 28 g to 9,140 g, and ranged from Age 0 to Age 11.

The size and age distributions of bull trout did not differ between Zone 1 and Zone 2 (Figure 3.14), based on visual assessment. Both samples were dominated by juveniles and subadults (200 mm length to 600 mm length; Age 2 to Age 6; Mainstream and Gazey 2009). A small number of young fish were encountered only in Zone 1 (≤ 200 mm length; ≤ Age 1) and adult fish (> Age 6) were scarce in both zones.

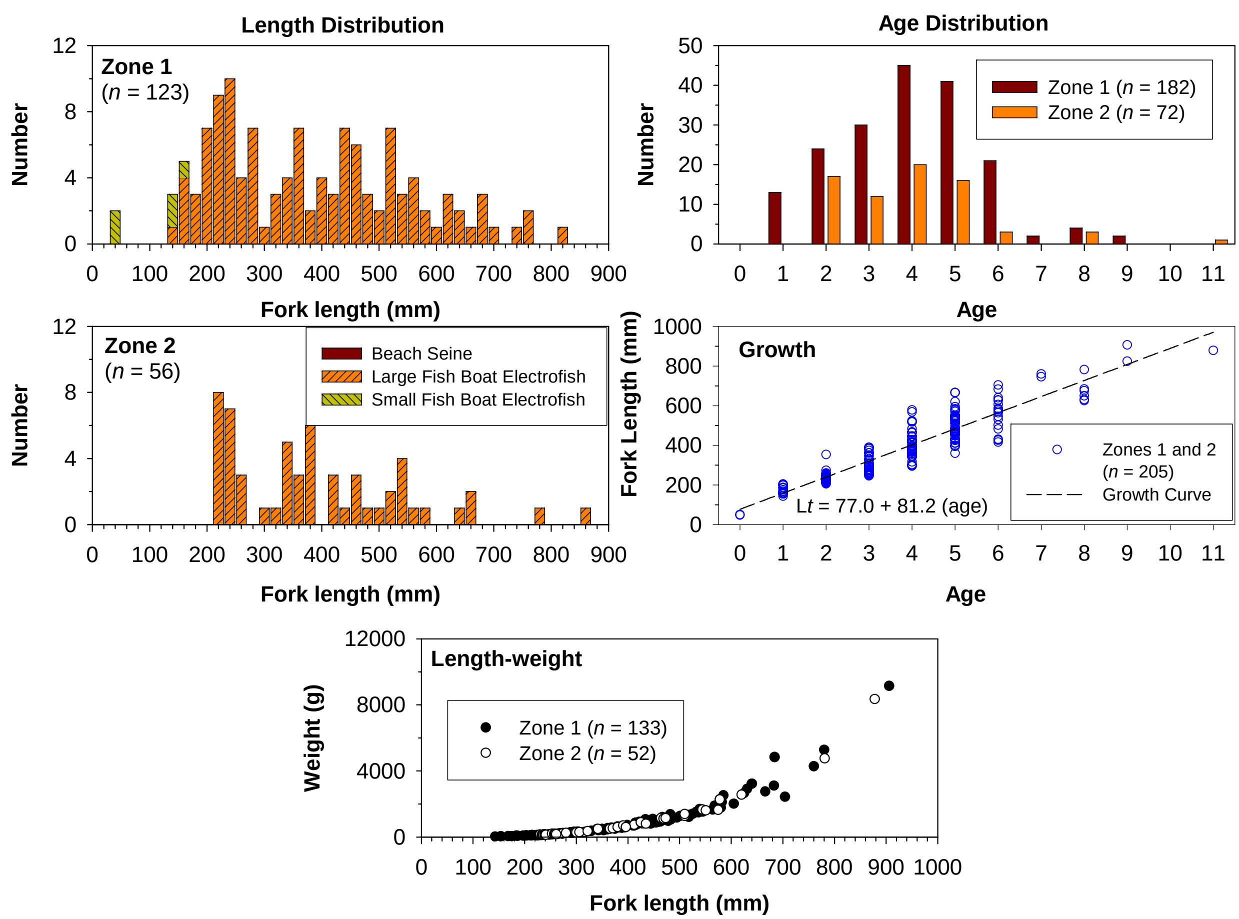

Figure 3.14 Biological characteristics of sampled bull trout, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

A visual assessment of the weight-length relationship (Figure 3.14) and a comparison of length-at-age and condition-at-age summaries (Table 3.4) indicated no differences between zones in bull trout condition or growth. The growth curve using the combined data indicated a linear growth form. The lack of a von Bertalanffy growth form is an artifact of the very small sample of adult fish; therefore, it is not representative of the growth rate of the entire population structure. It does indicate that bull trout in the Peace River exhibit a high growth rate.

Table 3.4 Mean length-at-age and condition-at-age of bull trout in Zone 1 and Zone 2, Site C Peace River Fish Inventory 2009.

Age	Fork Length				Condition (*K*)			
	Zone 1		Zone 2		Zone 1		Zone 2	
	n	Mean (± 95%CI)	*n*	Mean (± 95%CI)	*n*	Mean (± 95%CI)	*n*	Mean (± 95%CI)
0	2	49.0 ± 4.3						
1	13	176.1 ± 12.7			11	1.08 ± 0.09		
2	22	231.0 ± 7.2	14	249.8 ± 18.3	14	1.03 ± 0.04	11	1.06 ± 0.06
3	24	303.5 ± 20.3	10	296.0 ± 24.2	20	1.05 ± 0.03	8	1.03 ± 0.06
4	31	409.9 ± 24.4	16	393.8 ± 35.7	23	1.06 ± 0.05	13	1.10 ± 0.05
5	32	484.4 ± 23.6	12	523.5 ± 51.0	26	1.03 ± 0.04	8	1.01 ± 0.04
6	17	562.9 ± 44.4	1	530.0	13	1.03 ± 0.10		
7	2	752.5 ± 32.3			1	0.97		
8	3	646.7 ± 59.7	3	701.7 ± 128.5	3	1.25 ± 0.42	1	1.00
9	2	865.0 ± 176.4			1	1.23		
10								
11			1	878.0			1	1.23

3.3.2.3 Distribution of Young Fish

There were spatial and seasonal differences in the recruitment of young (Age 0 and Age 1) bull trout in the Peace River (Figure 3.15). Young bull trout were recorded primarily in the upper portion of the study area (Sections 1, 2, and 3). This included two Age 0 fish in fall (both recorded in Section 1) and twenty two Age 1 fish recorded in summer and fall (Appendix F). The presence of young bull trout well upstream of the Halfway River, which is thought to be the primary spawning and rearing system for the Peace River population provides evidence of alternate sources of recruitment for this population (i.e., entrainment through PCN Dam), under the assumption that young bull trout do not migrate well upstream in the Peace River from the confluence of the Halfway River. Only two Age 1 bull trout were recorded downstream of the proposed Site C dam, both in Section 6. The fish in Section 6 may have originated from the Pine River system. All young bull trout were recorded in main channel habitats.

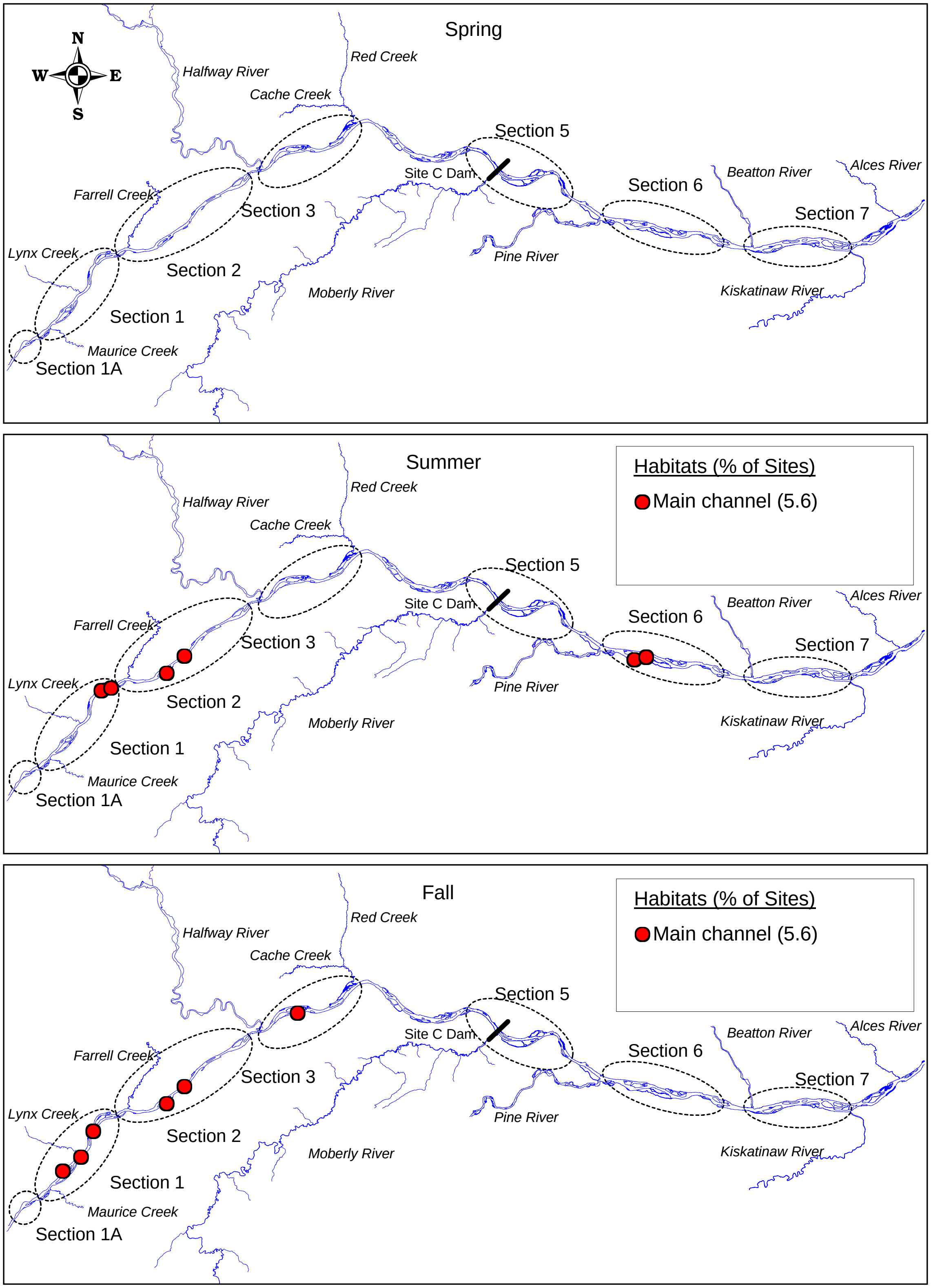

Figure 3.15 Distribution of young (Age 0 and Age 1) bull trout, Site C Peace River Fish Inventory 2009.

3.3.3 Kokanee

3.3.3.1 Catch Rate

In total, 173 kokanee were recorded in the study area. Kokanee catch rates were highest in main channel areas and fish were rarely encountered in side channel and tributary confluence areas (Figure 3.16). Small kokanee catch rates were higher than for large kokanee. Average large fish catch rates did not exceed 2.0 fish/km, while small fish catch rates did not exceed 3.5 fish/km. Large kokanee were largely restricted to and exhibited highest catch rates in Sections 1A; however, large fish were encountered as far downstream as Section 7. Small kokanee catch rates were highest in Section 1A; however, catch rates of small fish > 1.0 fish/km were recorded as far downstream as Section 5 and this size group extended down to Section 7. The spatial pattern of kokanee catch rate likely reflects recruitment from upstream of the PCN Dam and the restricted distribution of preferred kokanee habitats.

There were no large differences in the seasonal catch rates of kokanee. The increase in small kokanee catch rates recorded in fall in Section 1A may reflect downstream movement of fish from upstream reservoir populations.

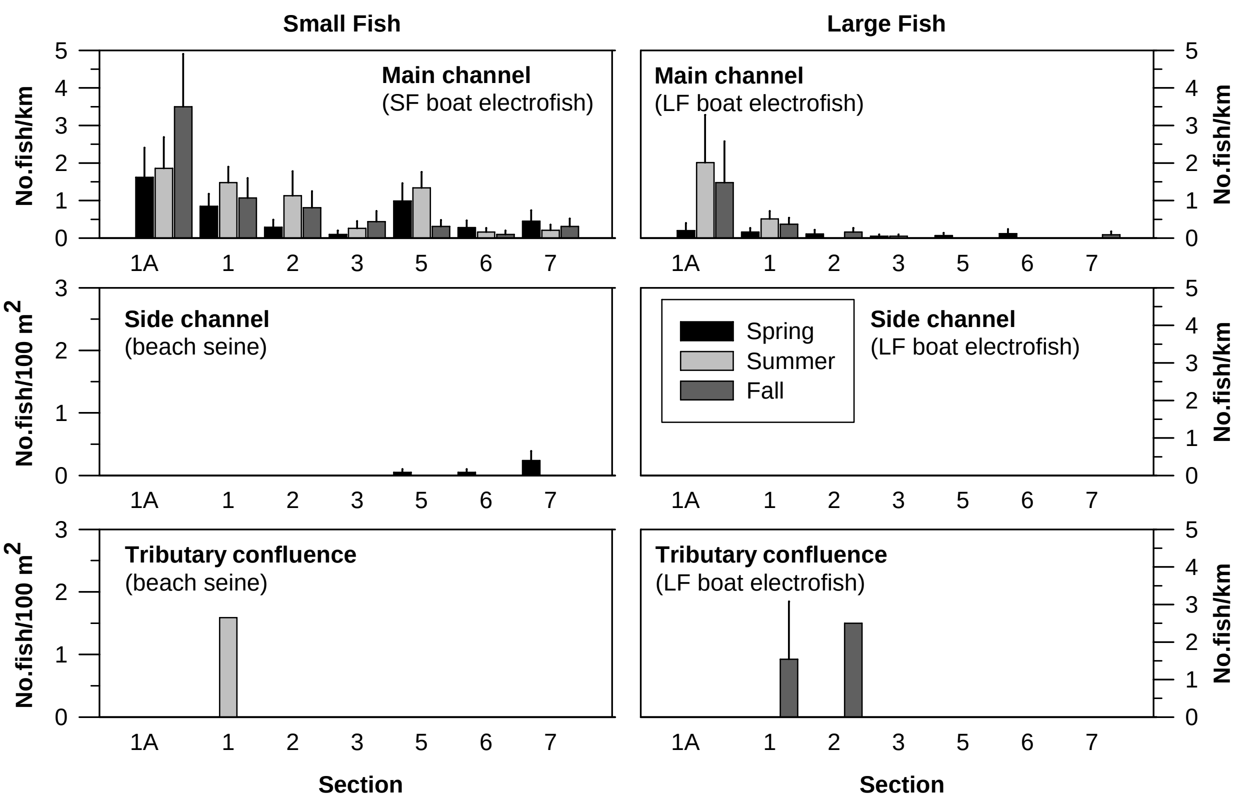

Figure 3.16 Average catch rates (± SE) of kokanee in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

3.3.3.2 Biological Characteristics

In total, 147 kokanee were sampled for biological characteristics (Figure 3.17). Sampled fish ranged in length from 52 mm to 252 mm and ranged in weight from 14 g to 220 g. Data from both zones were combined for analyses and the kokanee sample was not aged. The size distribution of kokanee suggested numerical dominance of two age classes – Age 1 (80 mm to 110 mm length) and Age 3 (170 mm to 200 mm length).

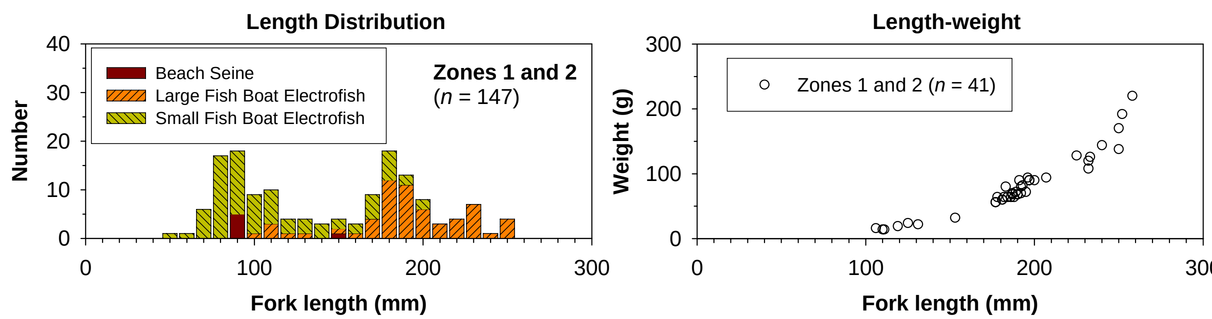

Figure 3.17 Biological characteristics of sampled kokanee, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

A small number of fish (*n* = 2) may have represented Age 0 fish (≤ 67 mm length). The weight-length relationship (Figure 3.17) indicated allometric growth and condition (*K*) estimate of the sample (1.08 ± 0.02) indicated good body condition.

3.3.3.3 Distribution of Young Fish

Age 0 kokanee represented a small portion of young kokanee recorded in the study area (4.3% of sample, Appendix F). Young (Age 0 and Age 1) kokanee were widely distributed (Figure 3.18). Fish were located in all sections in spring and summer, and in all sections except Section 6 in fall. Kokanee were most often encountered in Sections 1A, 1, and 2 during each season, which supports the hypothesis that entrainment from upstream populations is the source of recruitment for the Peace River population. This also was supported by higher catch rates in upstream sections (Figure 3.16).Young kokanee were most frequently encountered in main channel habitats.

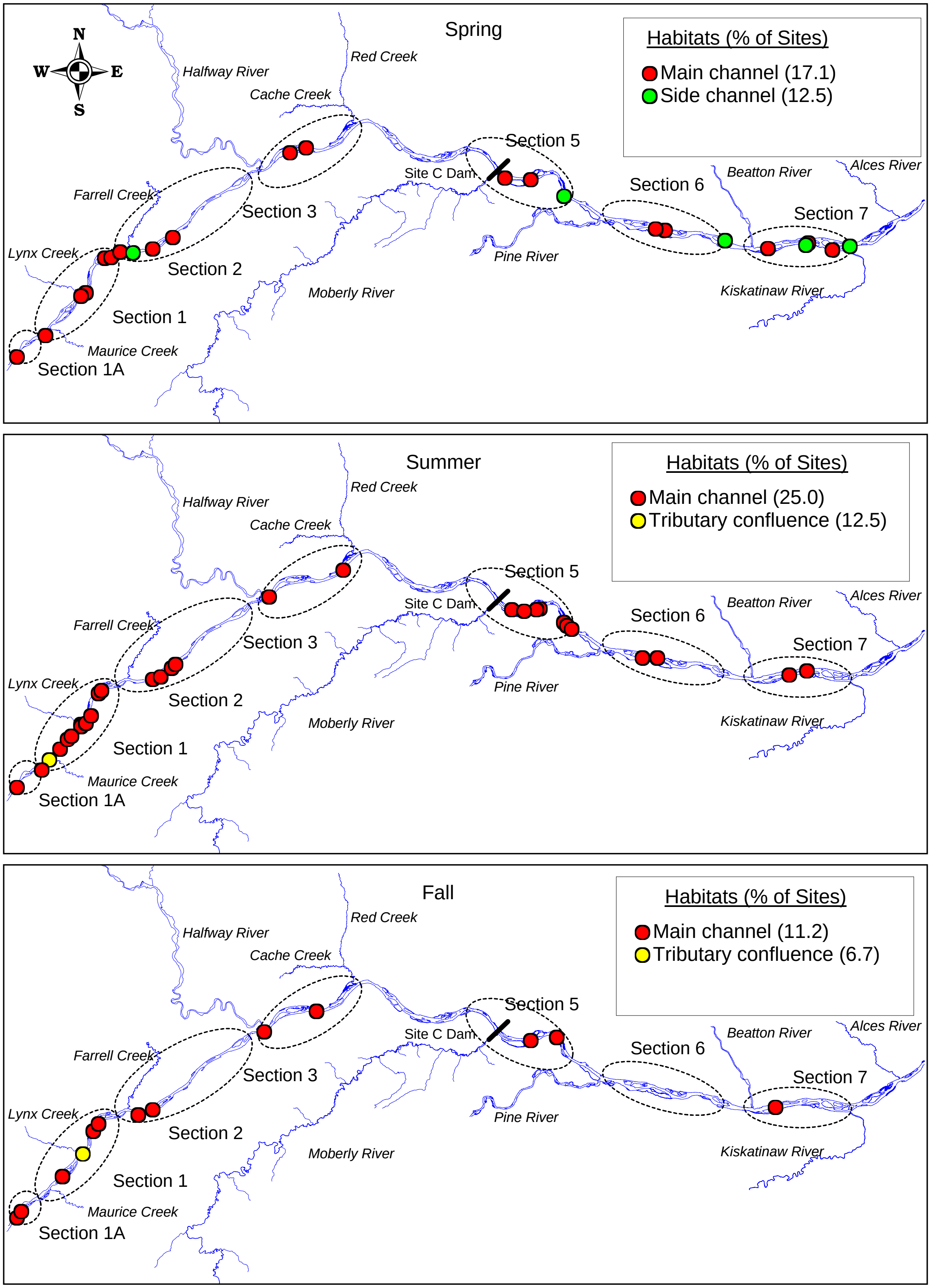

Figure 3.18 Distribution of young (Age 0 and Age 1) kokanee, Site C Peace River Fish Inventory 2009.

3.3.4 Lake trout

Lake trout were scarce in the Peace River. Six fish were recorded during the study (Appendix E FigureE1). This included one fish at the confluence of Maurice Creek in Section 1, one fish in each of Section 2 and Section 3, and two fish in Section 5.

Five of these fish were subadults or adults (fork length ≥ 359 mm). One fish located in Section 2 was 98 mm in fork length and was Age 1. The occurrence of a young fish provides an indication of recruitment from spawning activity within the study area, or entrainment of young fish from populations located upstream of PCN Dam.

3.3.5 Lake whitefish

Lake whitefish were scarce; sixteen fish were recorded during the study (Appendix E Figure E2). These fish were recorded in Sections 1 to 6. The majority of fish (*n* = 12) were recorded in side channel areas and tributary confluence areas. Eleven fish were ≥ 332 mm fork length and ranged from Age 5 to Age 9. The five remaining lake whitefish were YOY fish. Four individuals were collected from a side channel in Section 5, while one Age 0 fish was collected from a side channel in Section 6. The presence of YOY fish at these sites provides evidence of lake whitefish spawning activity.

3.3.6 Mountain whitefish

3.3.6.1 Catch Rate

Mountain whitefish catch rates were very high in the Peace River study area (Figure 3.19). Small and large mountain whitefish were recorded in all sections and all habitat areas, but catches were higher in main channel habitats. Catch rates of large and small mountain whitefish exhibited distinct spatial patterns. Average catch rates of large mountain whitefish in main channel areas increased from approximately 40.0 fish/km in Section 1A, to peak levels in Section 2 (approximately 60 fish/km), and then gradually declined to approximately 10 fish/km in Section 7. This spatial pattern was consistent among seasons, although there was a trend of increasing rates from spring to fall in Sections 1A and 1.

Small mountain whitefish exhibited the opposite spatial trend. Catch rates in main channel areas increased from upstream to downstream. Average values were lowest in the uppermost Sections 1A and 1 (≤ 4.6 fish/km), then progressively increased from Section 2 to Section 5 (≥ 30.0 fish/km). Catch rates of small mountain whitefish then remained stable or declined slightly downstream to Section 7. Average catch rates in Sections 6 and 7 were approximately 25 fish/km.

Seasonal catch rates of small mountain whitefish in main channel areas varied. In spring the highest average catch rate was recorded in Section 6 (44.1 fish/km). In summer, the highest catch rate was recorded in Section 5 (54.1 fish/km), whereas in fall the highest average catch rate occurred in Section 3 (27.6 fish/km). This pattern may suggest a progressive upstream movement of small mountain whitefish during the open water period.

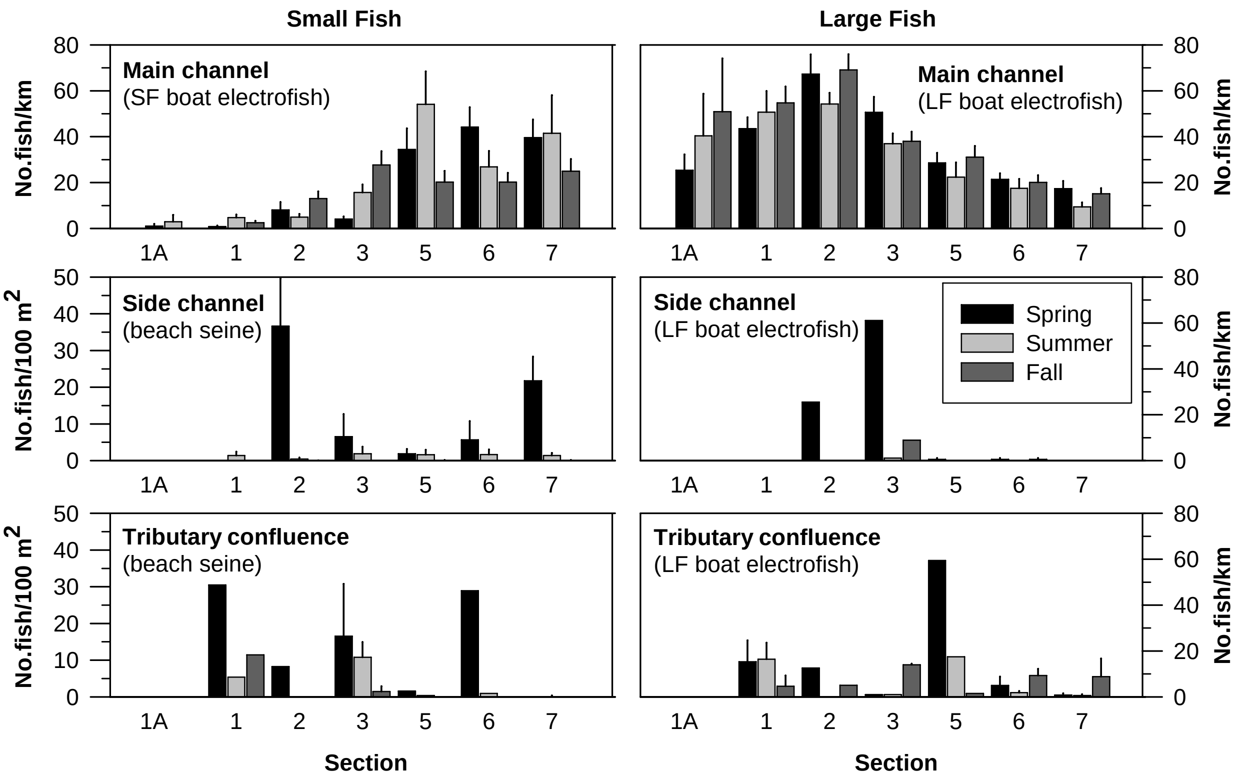

Figure 3.19 Average catch rates (± SE) of mountain whitefish in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

The patterns of large and small mountain whitefish catch rates suggest spatial segregation of younger and older cohorts of the Peace River population. Younger fish occur primarily from Section 5 downstream, while older fish are most abundant from Section 2 upstream. The absence of small mountain whitefish in the extreme upstream Sections 1A and 1 suggests a paucity of suitable rearing habitats and/or the absence of recruitment sources.

3.3.6.2 Biological Characteristics

In total, 9,834 mountain whitefish were sampled for biological characteristics – 6,516 from Zone 1 and 3,318 from Zone 2. A subsample of fish was used for age related metrics – 469 from Zone 1 and 469 from Zone 2. Sampled fish ranged in length from 34 mm to 495 mm, ranged in weight from 2 g to 1,734 g, and ranged from Age 0 to Age 13.

The size and age distributions of mountain whitefish differed between Zone 1 and Zone 2 (Figure 3.20). Based on the combined sample from all capture methods, mountain whitefish in Zone 1 exhibited a distinct unimodal size distribution (200 mm length to 400 mm length) and age distribution (Age 3 to Age 6). Two weak modal peaks were recorded from 70 mm length to 100 mm length (Age 0) and 150 mm length to 190 mm length (Age 1). In contrast, mountain whitefish in Zone 2 exhibited a wide, multimodal size distribution with strong representation by smaller, younger fish (Age 0 and Age 1) and representation by larger (≥ 450 mm), older (≥ Age 7) fish.

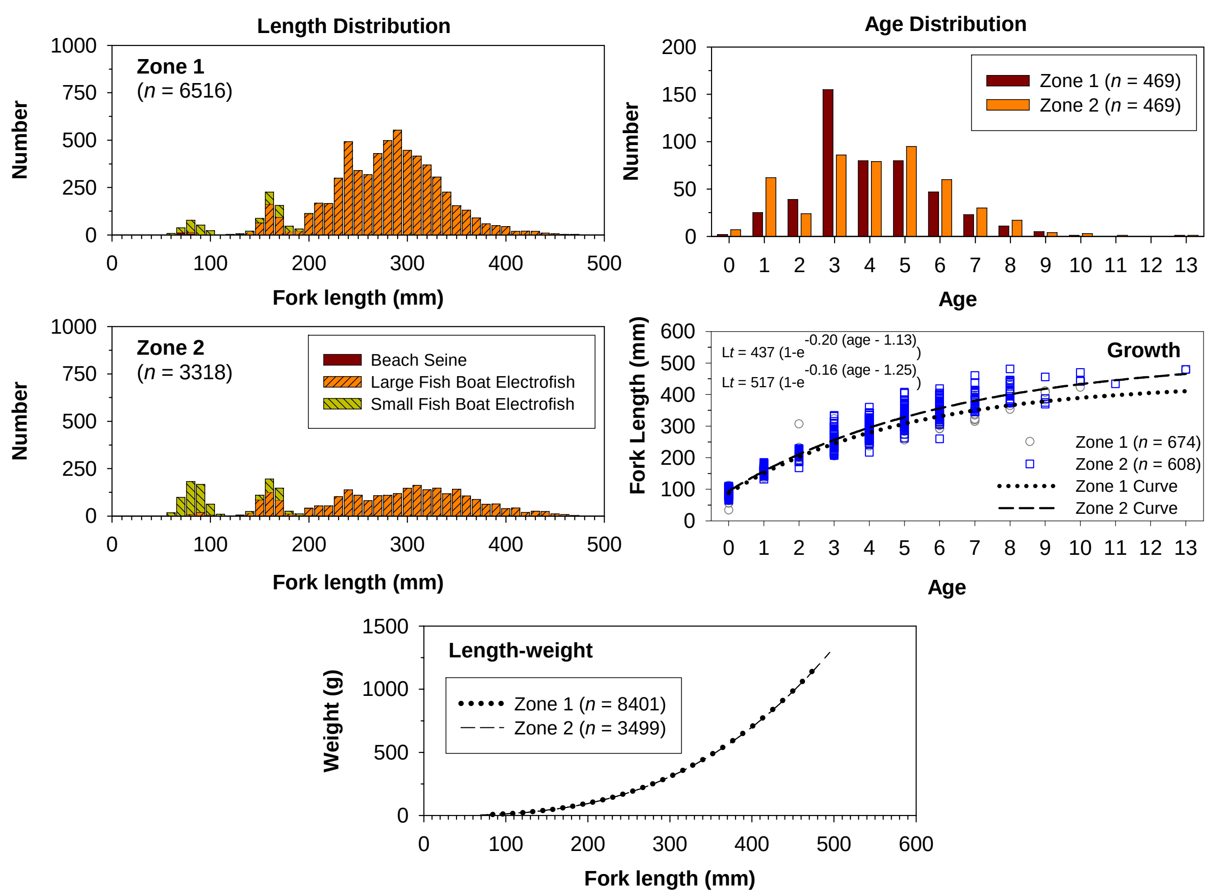

Figure 3.20 Biological characteristics of sampled mountain whitefish, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses; length-weight relationship represented by power curve in place of raw data).

A visual assessment of the weight-length relationship (Figure 3.20) and condition-at-age summaries (Table 3.5) indicated no large differences between zones in mountain whitefish condition. However, the length-at-age summary and the growth curve indicated spatial difference in growth. After Age 3 mountain whitefish in Zone 1 grow at a slower rate and reached a smaller length-at-age compared to fish in Zone 2.

Table 3.5 Mean length-at-age and condition-at-age of mountain whitefish in Zone 1 and Zone 2, Site C Peace River Fish Inventory 2009.

Age	Fork Length				Condition (*K*)			
	Zone 1		Zone 2		Zone 1		Zone 2	
	n	Mean (± 95%CI)	*n*	Mean (± 95%CI)	*n*	Mean (± 95%CI)	*n*	Mean (± 95%CI)
0	207	85.9 ± 1.5	146	92.5 ± 1.5				
1	25	163.0 ± 3.8	62	163.7 ± 2.7	25	1.10 ± 0.03	62	1.08 ± 0.03
2	39	210.9 ± 6.1	24	209.5 ± 6.3	39	1.13 ± 0.04	24	1.10 ± 0.03
3	155	245.2 ± 2.7	86	255.3 ± 5.5	153	1.15 ± 0.02	86	1.10 ± 0.02
4	80	278.9 ± 3.7	79	294.6 ± 6.0	80	1.16 ± 0.02	79	1.14 ± 0.03
5	80	302.5 ± 4.3	95	327.7 ± 5.5	80	1.16 ± 0.03	94	1.11 ± 0.02
6	47	320.1 ±4.8	60	355.2 ± 7.2	47	1.13 ± 0.03	60	1.10 ± 0.02
7	23	350.9 ± 10.4	30	376.7 ± 10.8	23	1.18 ± 0.06	30	1.11 ± 0.03
8	11	381.0 ± 16.5	17	411.0 ± 16.0	11	1.08 ± 0.11	17	1.08 ± 0.06
9	5	400.0 ± 13.7	4	397.0 ± 55.5	5	1.05 ± 0.10	4	1.19 ± 0.30
10	1	423.0	3	451.7 ± 29.2	1	1.24	3	1.10 ± 0.08
11			1	434.0			1	1.09
12								
13	1	478.0	1	480.0	1	1.12	1	1.20

3.3.6.3 Distribution of Young Fish

Age 0 mountain whitefish were widely distributed in the study area (Figure 3.21). Fish were recorded in most sections (all except Section 1A) during all seasons. The presence of Age 0 mountain whitefish in the Peace River in spring, which represented recently emerged fish, indicated that mountain whitefish spawning occurs as far upstream as Section 1. The complete absence of Age 0 mountain whitefish in Section 1A provides evidence that there is no recruitment from upstream sources.

Habitat use by Age 0 mountain whitefish varied by season. In spring, fish were recorded most often in side channel habitats. In summer and fall Age 0 mountain whitefish were more likely to occur in main channel sites.

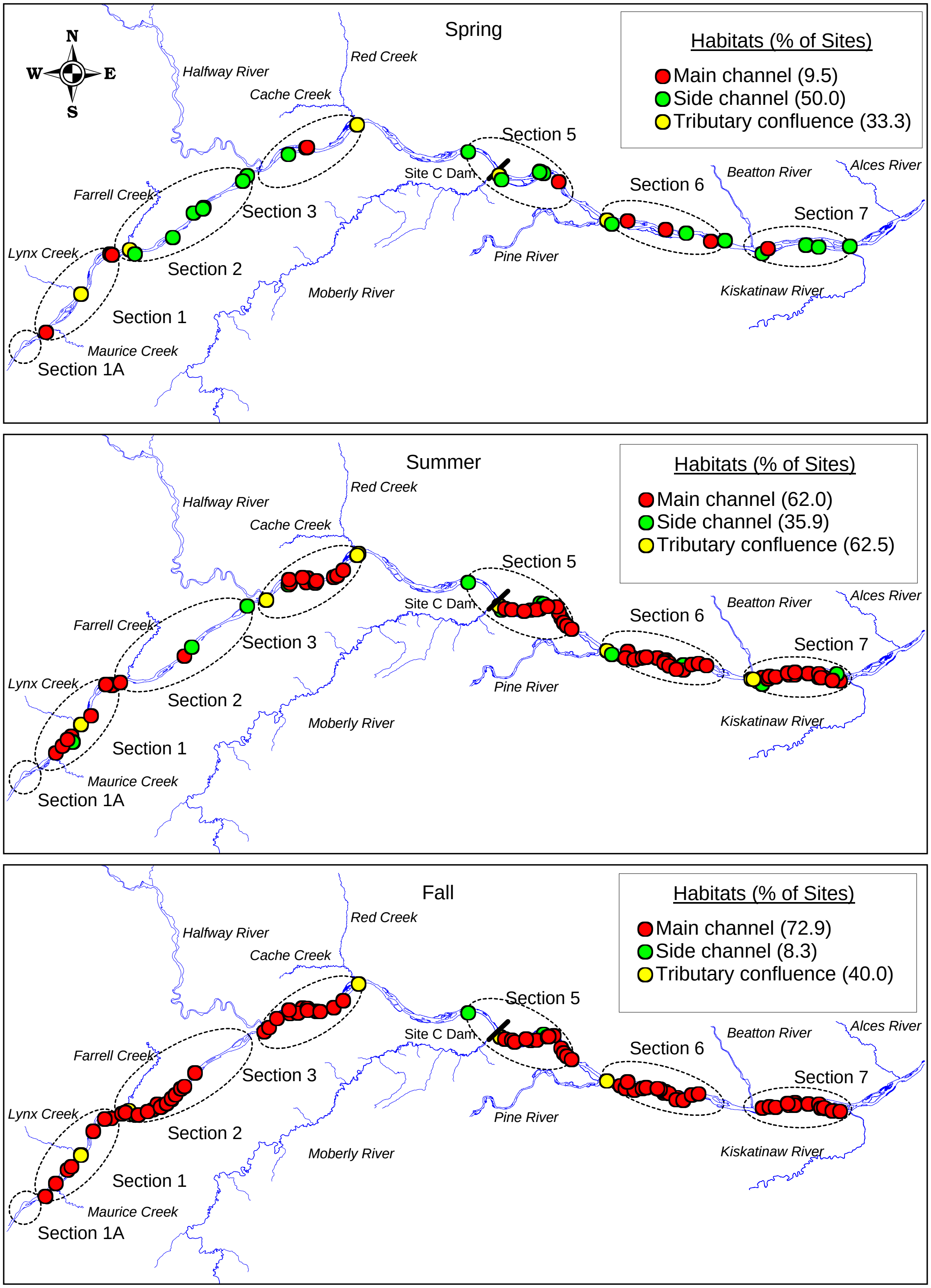

Figure 3.21 Distribution of Age 0 mountain whitefish, Site C Peace River Fish Inventory 2009.

3.3.7 Rainbow trout

3.3.7.1 Catch Rate

In total, 502 rainbow trout were recorded in the study area. Rainbow trout catch rates were highest in main channel areas, and rainbow trout were rarely encountered in side channel and tributary confluence areas (Figure 3.22). Average catch rates of small and large rainbow trout were generally similar and did not exceed 7.6 fish/km. Catch rates of both size groups of rainbow trout were highest in in Sections 1A to Section 3; however both large and small fish were recorded in all study sections. Catch rates of rainbow trout tended to decline from upstream to downstream.

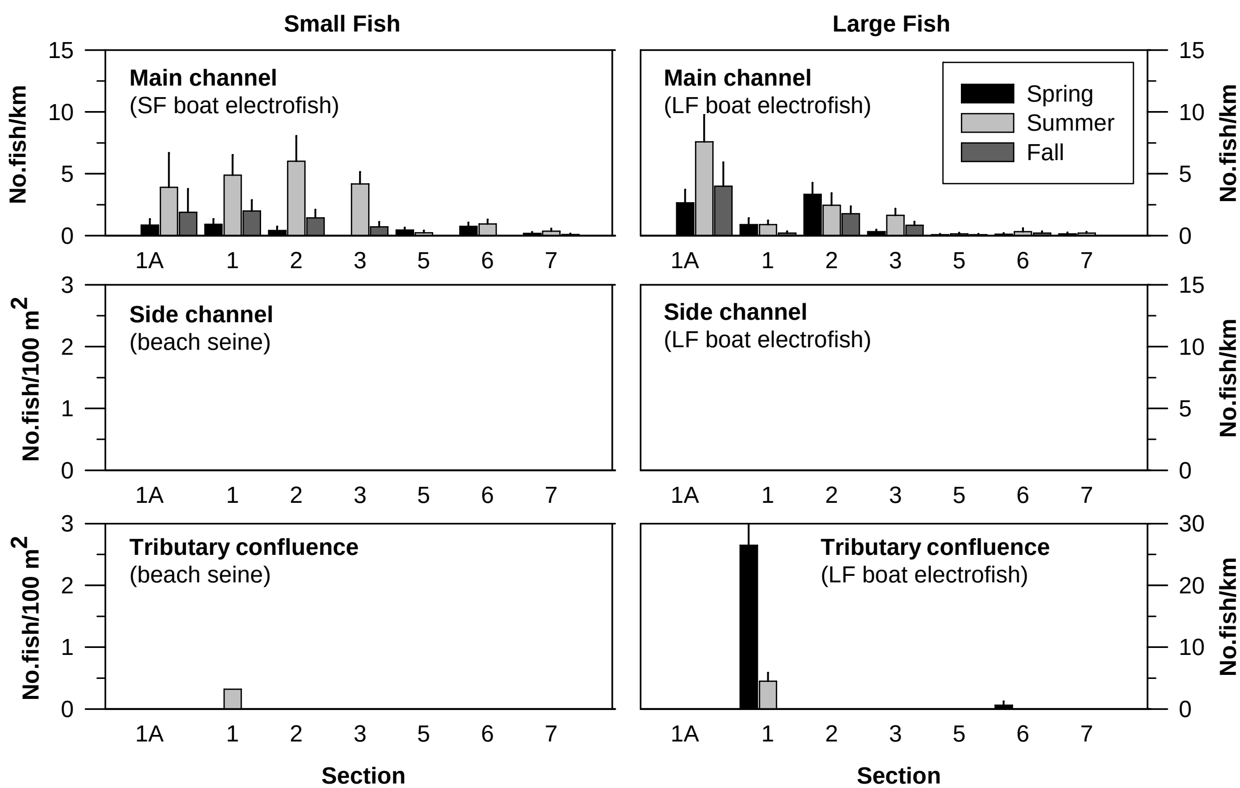

Figure 3.22 Average catch rates (± SE) of rainbow trout in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

There were seasonal differences in rainbow trout catch rates. Within each section, catch rates of both size groups were lowest in spring, highest in summer, and intermediate in fall. The only exception to this pattern was for large rainbow trout in Section 2; which exhibited a slightly higher catch rate in spring compared to summer.

3.3.7.2 Biological Characteristics

In total, 203 rainbow trout were sampled for biological characteristics (Figure 3.23). Sampled fish ranged in length from 47 mm to 472 mm and ranged in weight from 18 g to 1,388 g, and ranged from Age 0 to Age 5. Data from both zones were combined for analyses. The size distribution of rainbow trout was broad and contained several modal peaks indicating good representation from several age classes. The first two modal peaks at 70 mm length and 150 mm, represented Age 0 and Age 1 fish, respectively.

The age distribution generated from the large fish boat electrofisher catch was numerically dominated by Age 2 fish followed by a rapid decline of older age classes.

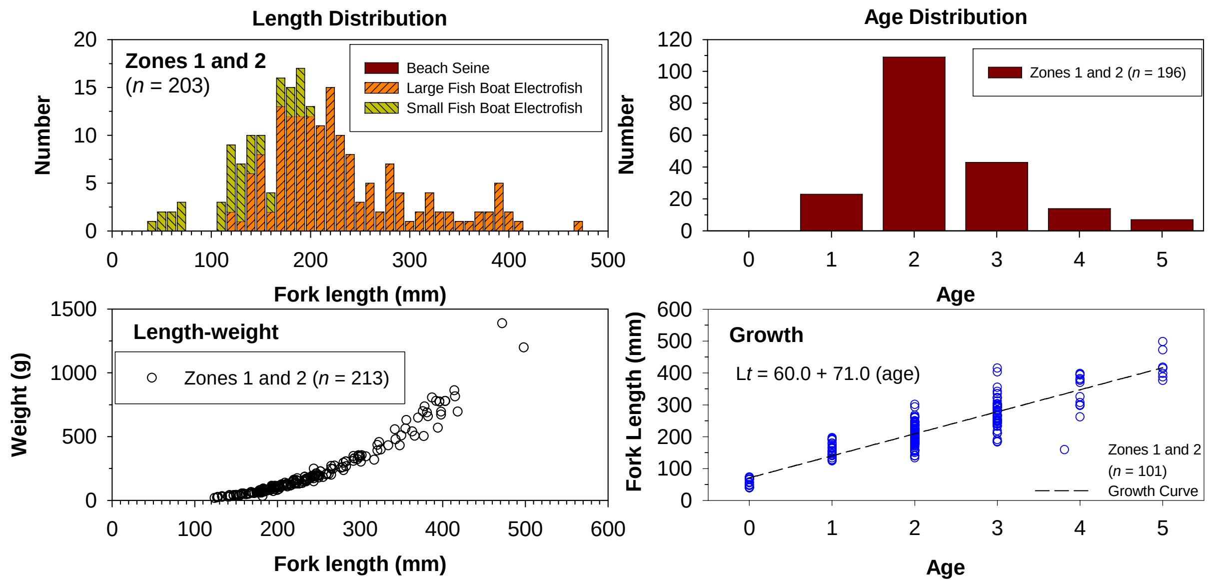

Figure 3.23 Biological characteristics of sampled rainbow trout, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

The weight-length relationship illustrated in Figure 3.23 indicated allometric growth and condition (*K*) at-age estimates presented in Table 3.6 indicated good body condition ($K \geq 1.00$). A visual assessment of the growth curve and length-at-age summary (Table 3.6) indicated rapid growth. The lack of a von Bertalanffy growth form may indicate constant rapid growth until mortality.

Table 3.6 Mean length-at-age and condition-at-age of rainbow trout (Zones 1 and 2 combined), Site C Peace River Fish Inventory 2009.

Age	Fork Length		Condition (*K*)	
	n	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**
0	13	57.2 ± 7.7		
1	23	160.3 ± 10.1	22	1.22 ± 0.07
2	109	206.6 ± 5.8	92	1.25 ± 0.03
3	43	276.3 ± 15.4	35	1.26 ± 0.05
4	14	348.5 ± 27.2	12	1.21 ± 0.08
5	7	423.3 ± 40.4	7	1.18 ± 0.16

3.3.7.3 Distribution of Young Fish

Age 0 rainbow trout accounted for a small percentage of young rainbow trout in the study area (16% of sample; Appendix F). All but one Age 0 fish were recorded in fall and all were located upstream of Section 3. The results suggested that Age 0 rainbow trout initially rear in tributaries before entering the Peace River in fall. Young (Age 0 and Age 1) rainbow trout were located primarily upstream of the proposed Site C dam location (Figure 3.24).

Most fish were recorded at sites in Sections 1A, 1, 2, and 3, with a limited number of fish occurring at sites in Sections 5, 6, and 7 (5 sites in spring and 3 sites in summer). The presence of young rainbow trout in Sections 1 and 2 correspond to tributaries that provide potential spawning and rearing areas for the Peace River rainbow trout population (Maurice Creek, Lynx Creek, and possibly Farrell Creek). The cluster of sites containing young rainbow trout in Section 3, suggests that rainbow trout may recruit from the Halfway River or disperse from upstream areas of the Peace River. The presence of young fish in Section 1A, which is upstream of any potential spawning and rearing tributaries, indicates that there may be recruitment of rainbow trout via entrainment through the PCN Dam. Young rainbow trout were recorded primarily in main channel habitats.

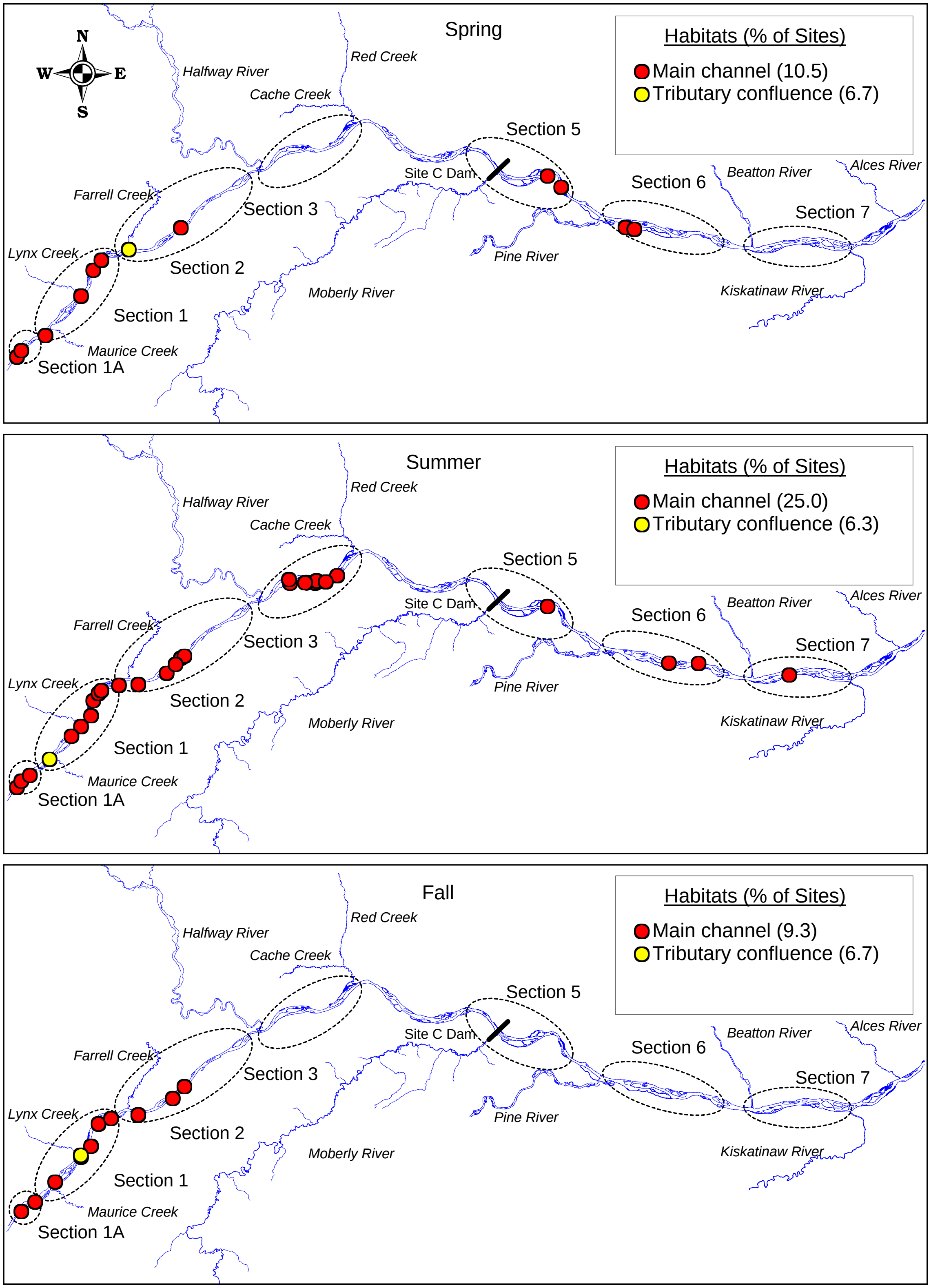

Figure 3.24 Distribution of young (Age 0 and Age 1) rainbow trout, Site C Peace River Fish Inventory 2009.

3.4 COOL WATER SPORTFISH POPULATIONS

Information presented in this section includes summaries of catch rates, biological characteristics, and recruitment of selected cool water sportfish populations. Raw data and summaries for all cool water sportfish populations are presented in Appendix E (catch rates), Appendix F (biological characteristics), and Appendix G (young fish distribution). It should be noted that biological characteristics data collected during the present study were augmented with data collected from the 2009 WLR Peace River Fish Index Project (Mainstream and Gazey 2010). Appendix F identifies those data.

3.4.1 Burbot

In total, 45 burbot were recorded during the study and catch rates were low (Appendix E Figure E3). Burbot were recorded in Sections 3, 5, 6, and 7, which are in the downstream portion of the Peace River study area. Burbot catch rates were highest in Section 6 and Section 7 during spring. Average catch rates in spring ranged from 1.6 fish/km to 3.2 fish/km. Tributary confluences where burbot were encountered included the Pine River, Beatton River, and Kiskatinaw River. Fish were encountered in main channel and tributary confluence areas and consisted entirely of large fish (total length ≥ 300 mm) (Appendix F).

3.4.2 Goldeye

In total, 27 goldeye were encountered during the study with fish recorded from Sections 5, 6, and 7 (Appendix E Figure E4). All goldeye recorded during the study were ≥ 332 mm length and were adults (Age 8 to Age 15) (Table 3.7).

Table 3.7 Mean length-at-age and condition-at-age of goldeye (Zones 1 and 2 combined), Site C Peace River Fish Inventory 2009.

Age	**Fork Length**		**Condition (*K*)**	
	n	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**
8	2	349.0 ± 73.2	2	1.07 ± 0.14
9	4	369.5 ± 28.0	4	1.08 ± 0.13
10	8	379.6 ± 15.0	8	1.14 ± 0.06
11	4	366.0 ± 10.6	4	1.06 ± 0.09
12	2	382.5 ± 2.2	2	1.27 ± 0.64
13	2	388.0	2	1.03 ± 0.24
14	1	390.0	1	1.01
15	1	407.0	1	1.13

Goldeye occurred in all three habitat areas, but catch rates in main channel and side channel areas were very low (≤ 0.5 fish/km). A very high average catch rate recorded in Section 7 in summer (30.0 fish/km) was caused by the capture of 17 fish at the confluence of the Beatton River during a single sample session. In addition, six goldeye were captured in a gill net set in a single side channel located in Section 6 during summer (Appendix E Figure E4).

Goldeye catch rates were highest during summer; however, a single fish was recorded in Section 7 in spring and in fall. The presence of this migratory species in Section 7 during the spring period suggests use of the area for spawning by goldeye.

3.4.3 Northern pike

3.4.3.1 Catch Rate

In total, 190 northern pike were recorded in the study area. Northern pike catch rates were highest and this species was consistently recorded in Sections 5, 6, and 7 (Figure 3.25). Small and large fish were recorded in all three habitats, but catch rates of both groups were higher in side channel and tributary confluence areas than in main channel areas.

Average catch rates in main channel areas were generally ≤ 0.3 fish/km. Average catch rates in side channel and tributary confluence areas were generally ≥ 1.5 fish/km (large fish) and were generally ≥ 0.5 fish/100 m^2 (small fish). There were no consistent patterns in northern pike seasonal catch rates.

Northern pike were also recorded in Section 1 and Section 7. The high catch rate of 41.2 fish/km recorded in Section 1 in fall occurred at the Maurice Creek tributary confluence when 11 fish were captured during one session. This finding likely reflects out migration of northern pike from the Maurice Creek system, rather than high use of Section 1 by northern pike.

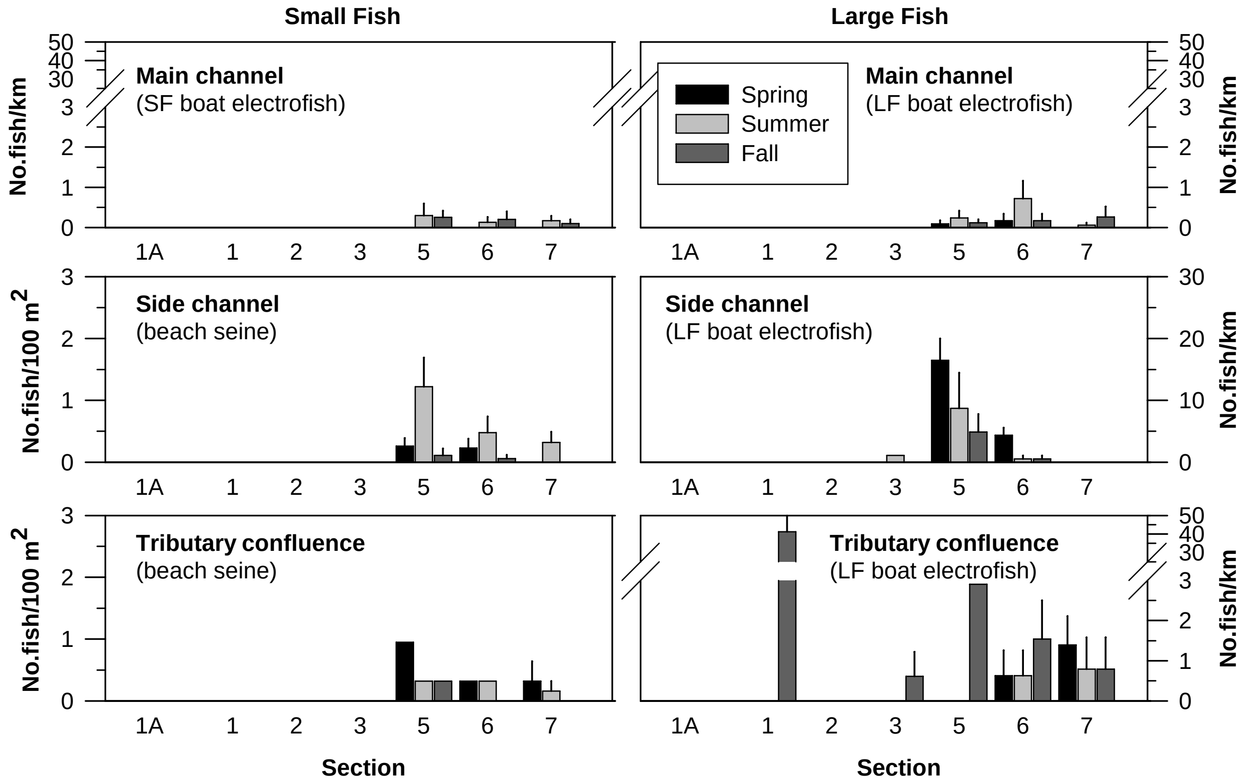

Figure 3.25 Average catch rates (± SE) of northern pike in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

3.4.3.2 Biological Characteristics

In total, 130 northern pike were sampled for biological characteristics (Figure 3.26). Sampled fish ranged in length from 49 mm to 897 mm, ranged in weight from 6 g to 5,300 g, and ranged from Age 0 to Age 7. Data from both zones were combined for analyses. The size distribution of northern pike was broad and contained several modal peaks indicating good representation by several age classes. The first two modal peaks at 100 mm length and at 210 mm length represented Age 0 and Age 1, fish respectively.

The age distribution generated from the large fish boat electrofisher catch was numerically dominated by Age 3 and Age 5 fish suggesting variable year class strength. The absence of Age 0 fish in the age distribution was an artifact of the fish capture method rather than an absence of this age class from the population – note length distribution in Figure 3.26 that is based on multiple capture methods.

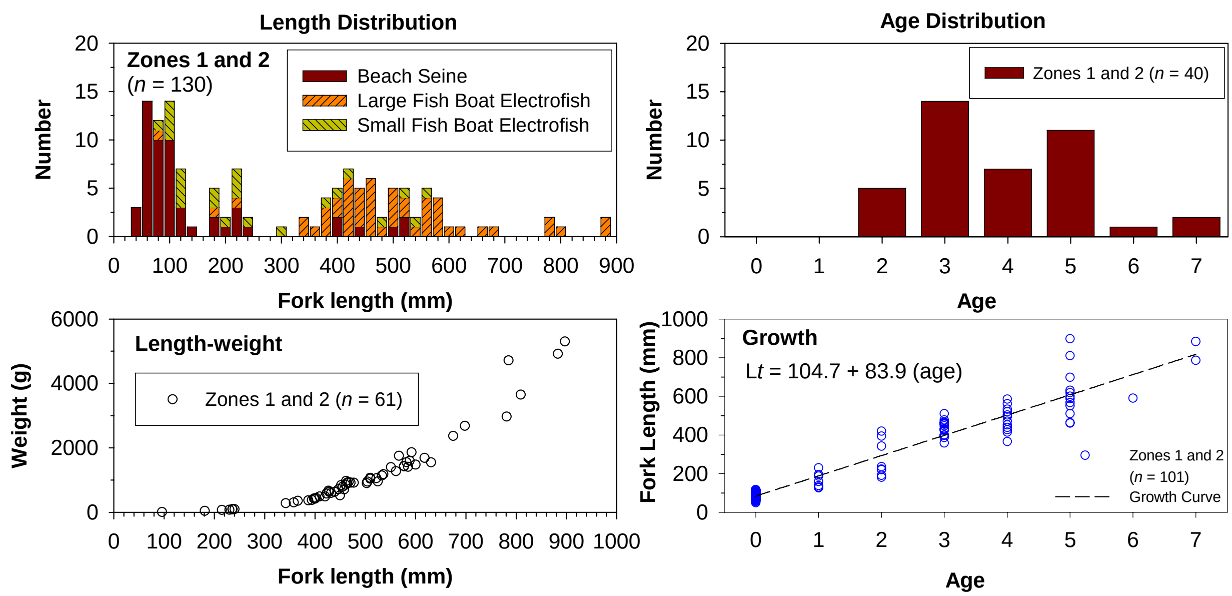

Figure 3.26 Biological characteristics of sampled northern pike, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

The weight-length relationship illustrated in Figure 3.26 indicated allometric growth and condition (*K*) at-age estimates presented in Table 3.8 indicated poor body condition (K < 1.00). A visual assessment of the growth curve and length-at-age summary (Table 3.8) indicated rapid linear growth.

Table 3.8 Mean length-at-age and condition-at-age of northern pike (Zones 1 and 2 combined), Site C Peace River Fish Inventory 2009.

Age	**Fork Length**		**Condition (*K*)**	
	n	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**
0	43	87.1 ± 5.8		
1	9	158.0 ± 28.4		
2	8	275.9 ± 77.2	5	0.68 ± 0.04
3	14	435.9 ± 23.2	14	0.78 ± 0.06
4	12	480.5 ± 40.4	8	0.77 ± 0.06
5	12	616.2 ± 82.5	12	0.78 ± 0.06
6	1	590.0		
7	2	834.0 ± 210.8	2	0.84 ± 0.56

3.4.3.3 Distribution of Young Fish

Age 0 northern pike were recorded downstream of the proposed Site C dam location in Section 5, 6, and 7 (Figure 3.27). Age 0 fish were recorded during summer and fall at sites in main channel and side channel habitats; however, highest fish numbers occurred in side channels within each section (Appendix G).

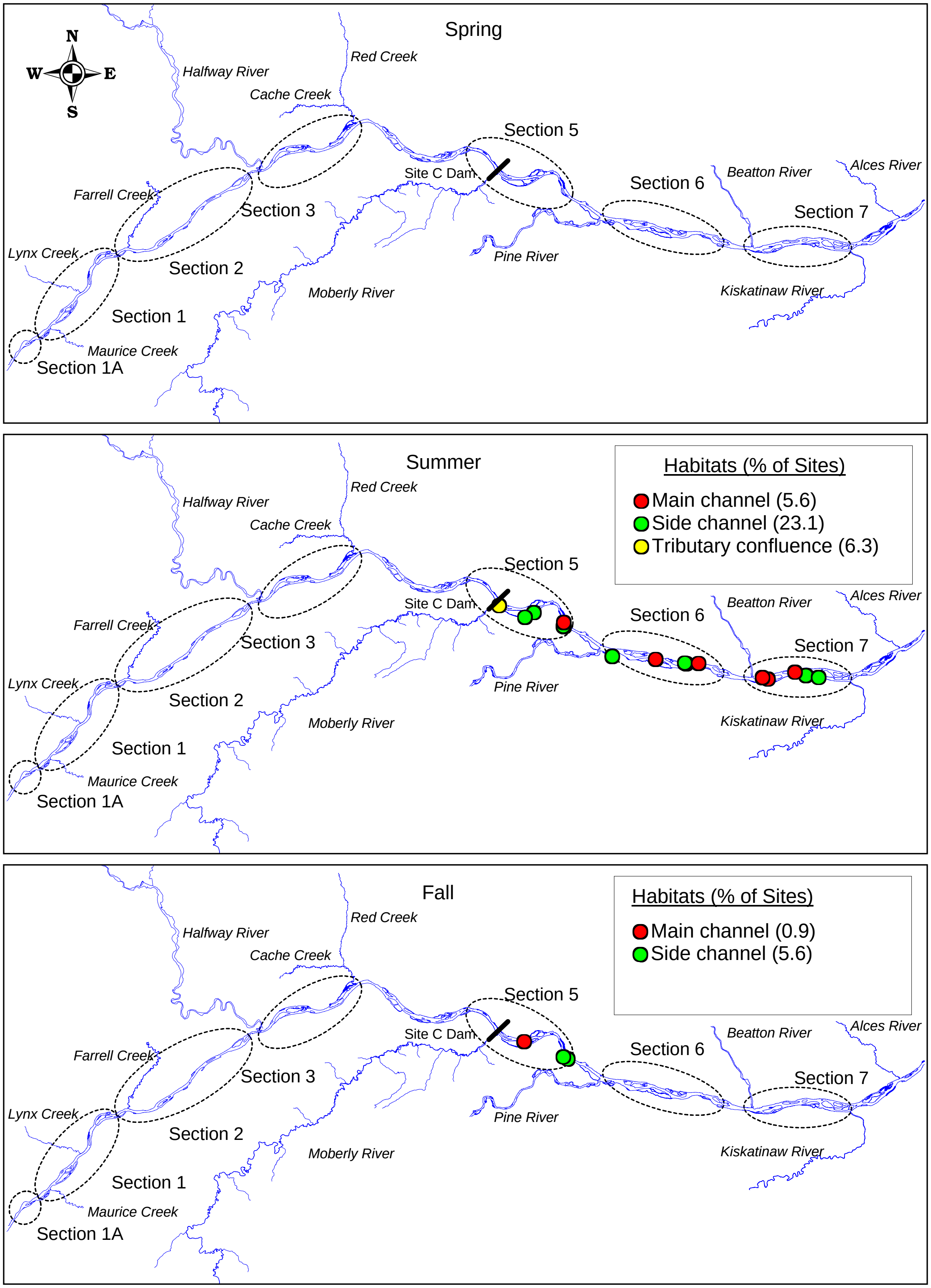

Figure 3.27 Distribution of young (Age 0 and Age 1) northern pike, Site C Peace River Fish Inventory 2009.

3.4.4 Walleye

3.4.4.1 Catch Rate

Walleye were recorded in the downstream portion of the study area in Sections 3, 5, 6, and 7 (Figure 3.28). Small fish were largely absent from the sample. Large walleye catch rates increased from upstream to downstream. Catch rates were lowest in Section 3, intermediate in Section 5, and highest in Sections 6 and 7. Large walleye occurred in all three habitat areas, but catch rates in main channel areas were very low (≤ 0.5 fish/km) compared to catch rates in side channel and tributary confluence areas (≥ 1.0 fish/km). Large walleye catch rates were highest at tributary confluence areas. Fish were recorded at the Halfway River (Section 3), the Moberly River (Section 5), Pine River (Section 6) as well as the Beatton River and Kiskatinaw River (Section 7). The very high average catch rate recorded in Section 7 in summer (51.7 fish/km) was caused by the capture of 21 fish at the confluence of the Beatton River during a single sample session. There were no strong seasonal differences in walleye catch rates.

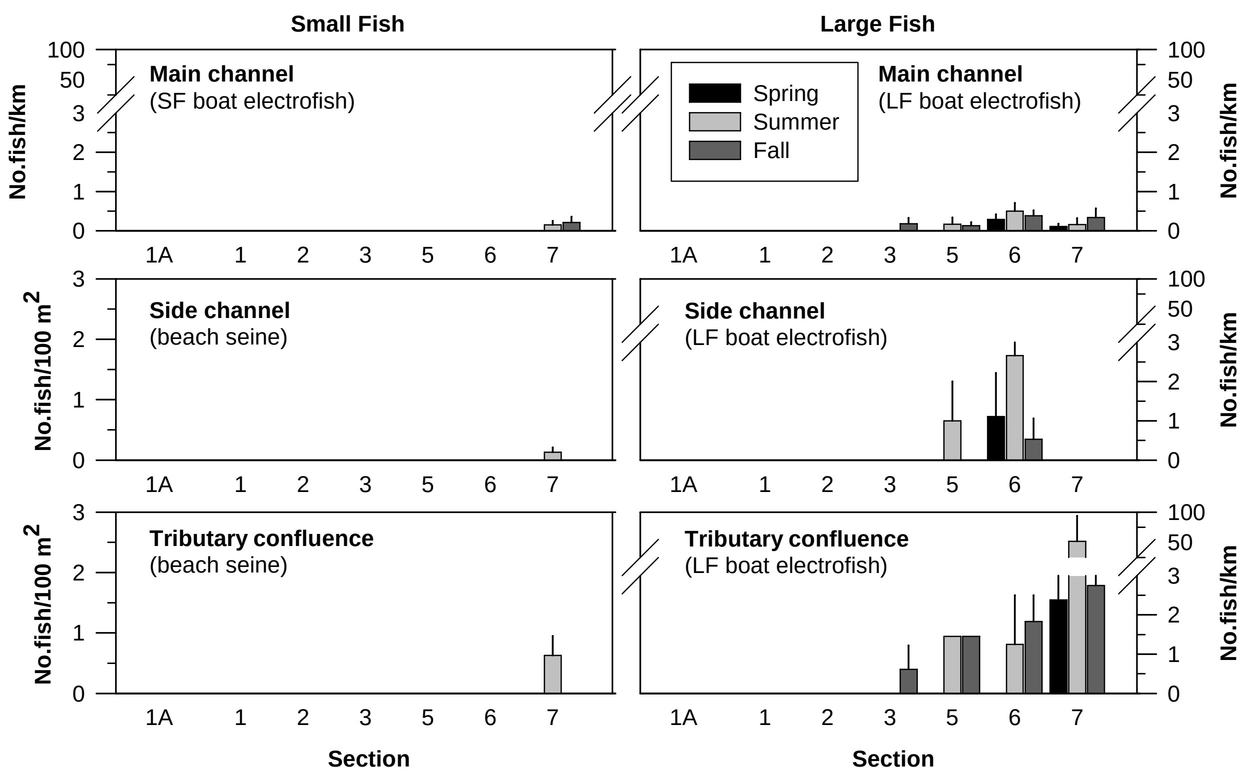

Figure 3.28 Average catch rates (± SE) of walleye in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

3.4.4.2 Biological Characteristics

In total, 89 walleye were sampled for biological characteristics (Figure 3.29). Sampled fish ranged in length from 56 mm to 602 mm and ranged in weight from 26 g to 2,650 g, and ranged from Age 0 to Age 14. Data from both zones were combined for analyses. The size distribution of walleye was broad, but was composed of discrete groupings. The first two modal peaks at 50 mm length and at 150 mm length represented Age 0 and Age 1, fish respectively. The other group (350 mm length to 500 mm length) represented adult fish (Age 6 to Age 11). It is unknown why fish Aged 2 to 5 were largely absent from the sample. This may represent a series of consecutive year class failures, or subadult walleye did not use the Peace River study area during the periods sampled. The age distribution generated from the large fish boat electrofisher catch was numerically dominated by Age 6 and 7 fish with a gradual decline in the numbers of older fish.

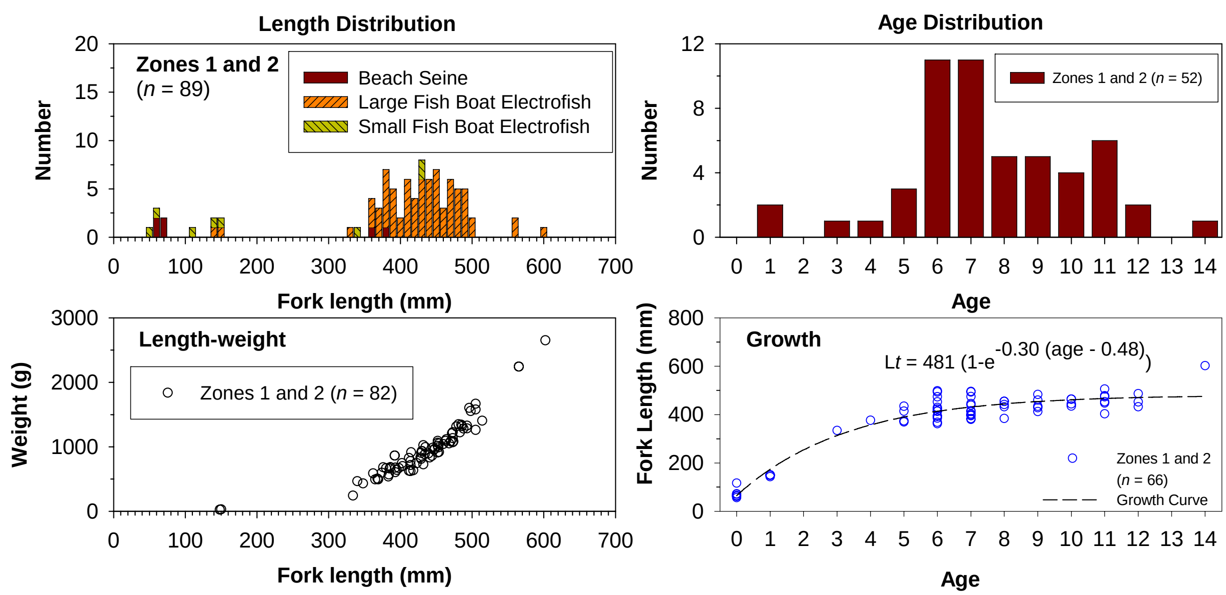

Figure 3.29 Biological characteristics of sampled walleye, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

The weight-length relationship illustrated in Figure 3.29 indicated allometric growth and condition (*K*) at-age estimates presented in Table 3.9 indicated good body condition ($K \geq 1.00$). A visual assessment of the growth curve and length-at-age summary (Table 3.9) indicated a von Bertalanffy growth form.

Table 3.9 Mean length-at-age and condition-at-age of walleye (Zones 1 and 2 combined), Site C Peace River Fish Inventory 2009.

Age	Fork Length		Condition (*K*)	
	n	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**
0	7	72.1 ± 18.0		
1	4	147.8 ± 4.6	2	0.85 ± 0.19
2				
3	1	334.0	1	0.65
4	1	376.0	1	1.28
5	4	397.8 ± 43.7	3	1.00 ± 0.24
6	13	422.8 ± 26.8	13	1.10 ± 0.05
7	12	427.7 ± 26.0	12	1.10 ± 0.08
8	5	433.0 ± 33.3	5	1.00 ± 0.09
9	5	443.4 ± 32.3	5	1.10 ± 0.06
10	4	451.5 ± 19.9	4	1.10 ± 0.13
11	6	459.8 ± 34.6	6	1.11 ± 0.09
12	3	456.7 ± 50.2	3	1.14 ± 0.26
13				
14	1	602.0	1	1.21

3.4.4.3 Distribution of Young Fish

All young walleye (Age 0 and Age 1) were recorded in Section 7 (Figure 3.30). All eight Age 0 walleye recorded during the study were captured at the mouth of the Beatton River or immediately downstream from this site (Appendix F). The four Age 1 fish were more widely distributed and were recorded at main channel and side channel sites downstream of the Beatton River.

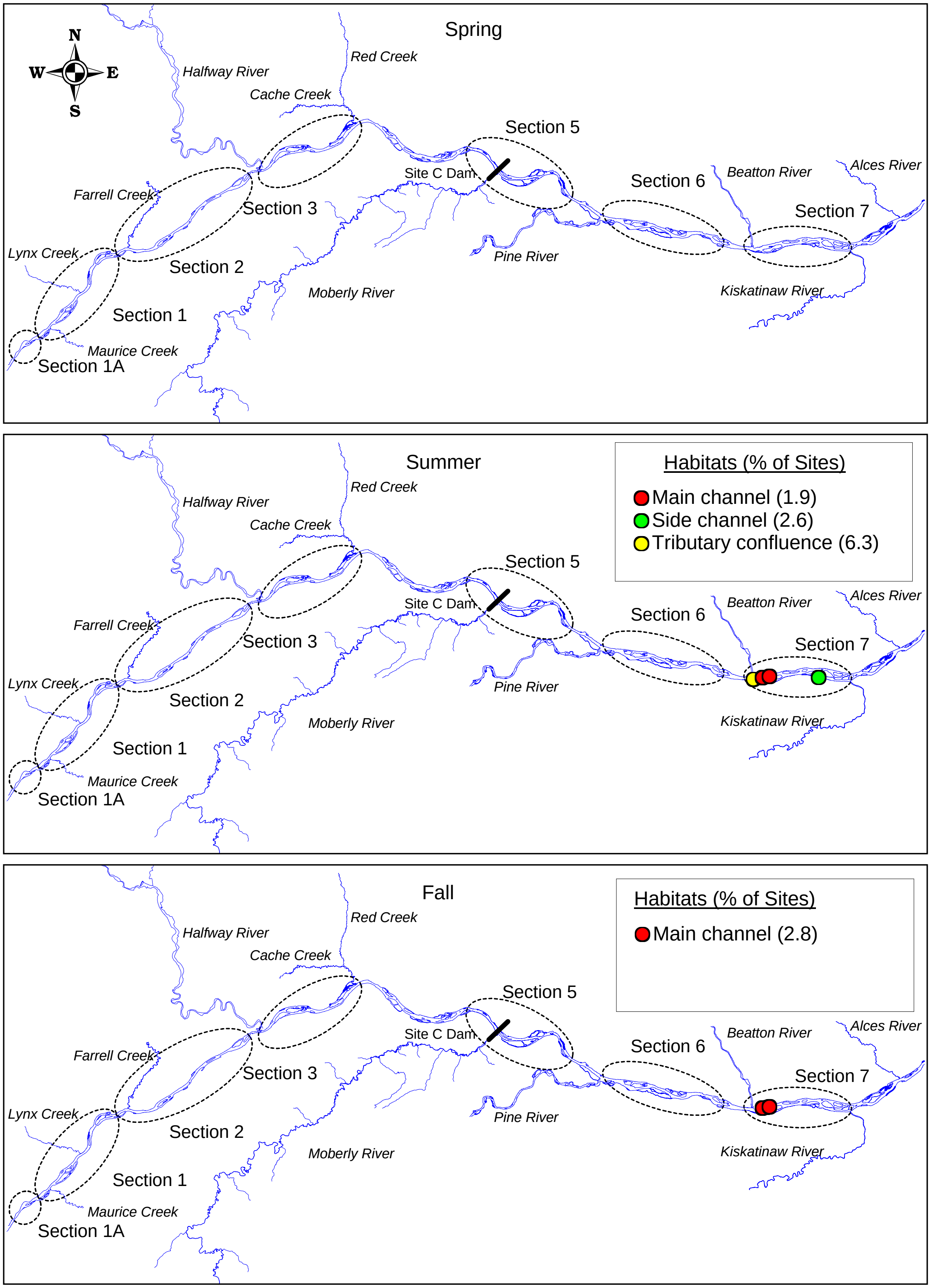

Figure 3.30 Distribution of young (Age 0 and Age 1) walleye, Site C Peace River Fish Inventory 2009.

3.4.5 Yellow perch

3.4.5.1 Catch Rate

Yellow perch exhibited a restricted distribution in the study area (Figure 3.31). Although fish were recorded in Sections 5, 6, and 7 and in main channel and side channel habitats, yellow perch catch rates were high only in side channels in Section 5. In this area, average catch rates of small yellow perch were as high as 26.6 fish/100 m^2 using a beach seine and catch rates of large yellow perch were as high as 14.1 fish/km with the boat electrofisher. Catch rates of yellow perch in Section 5 side channels increased between spring and fall. These findings likely reflected increased vulnerability to fish capture methods (i.e., young fish became large enough to collect) rather than an increase in fish abundance.

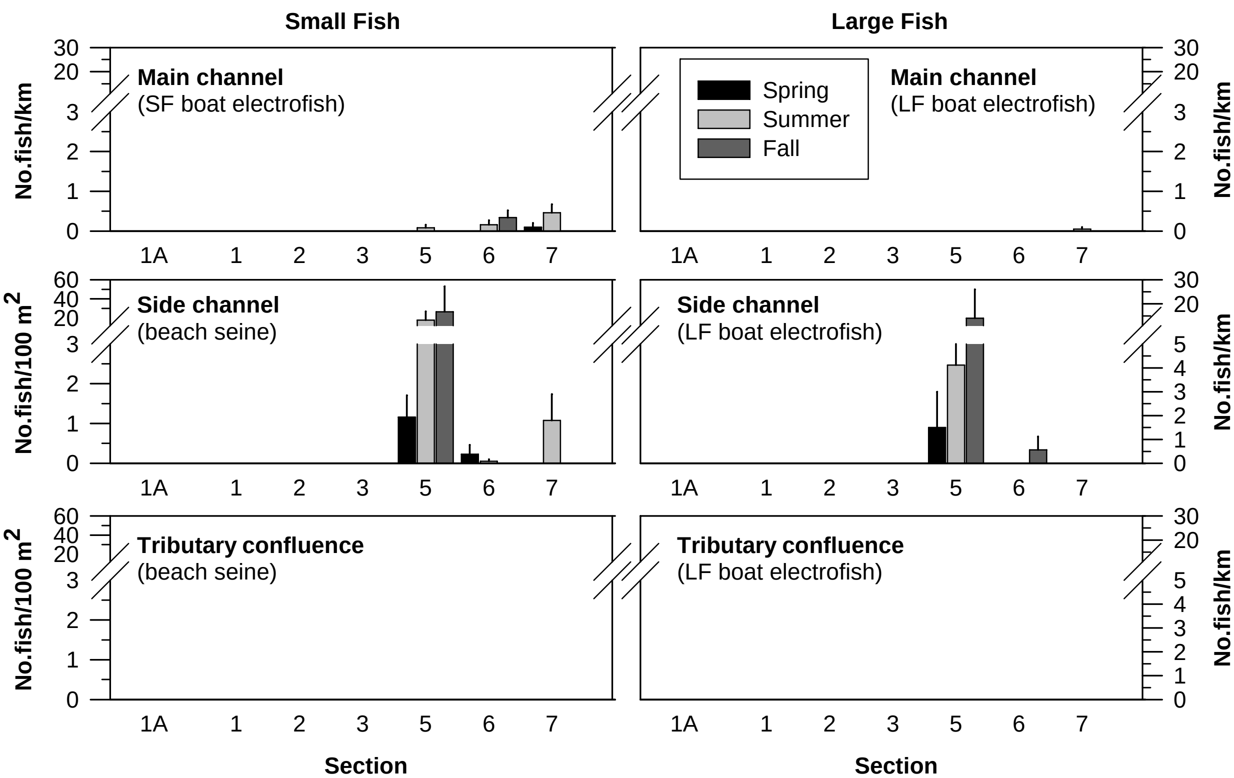

Figure 3.31 Average catch rates (± SE) of yellow perch in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

3.4.5.2 Biological Characteristics

In total, 125 yellow perch were sampled for biological characteristics (Figure 3.32). Sampled fish ranged in length from 21 mm to 274 mm and ranged in weight from 2 g to 334 g. The yellow perch sample was not aged and fish were recorded only in Zone 2. The size distribution of yellow perch contained several modal peaks indicating good representation by several age classes. The first modal peaks at 30 mm length represented Age 0 fish. The weight-length relationship indicated allometric growth and condition (*K*) estimate of the sample (1.39 ± 0.05) indicated good body condition.

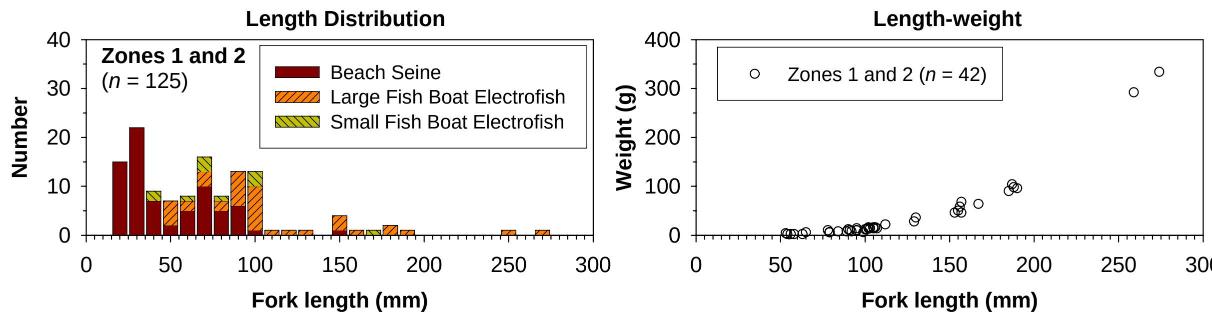

Figure 3.32 Biological characteristics of sampled yellow perch, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

3.4.5.3 Distribution of Young Fish

Age 0 yellow perch were recorded downstream of the proposed Site C dam location in Sections 5, 6, and 7 (Figure 3.33). Fish were recorded in summer and fall. Like northern pike, the absence of Age 0 yellow perch in the spring likely was caused by emergence of fry after completion of the spring session. Age 0 fish numbers were highest and were most often recorded at sites located in side channel habitats, but low numbers of fish also were recorded in main channel habitats (Appendix G).

3.5 SUCKER POPULATIONS

Information presented in this section includes summaries of catch rates, biological characteristics, and recruitment of sucker populations. Raw data are presented in Appendix E (catch rates), Appendix F (biological characteristics), and Appendix G (young fish distribution). It should be noted that biological characteristics data collected during the present study were augmented with data collected from the 2009 WLR Peace River Fish Index Project (Mainstream and Gazey 2010). Appendix F identifies those data.

3.5.1 Longnose sucker

3.5.1.1 Catch Rate

Longnose suckers catch rates were high in the study area (Figure 3.34). This species was located in all seven sections and in all three habitats. In main channel areas, longnose suckers catch rates increased from upstream to downstream. Very low catch rates of small and large fish were recorded in Sections 1A and 1(≤ 0.8 fish/km for both groups). Catch rates increased to a high of approximately 10 fish/km in Sections 6 and 7.

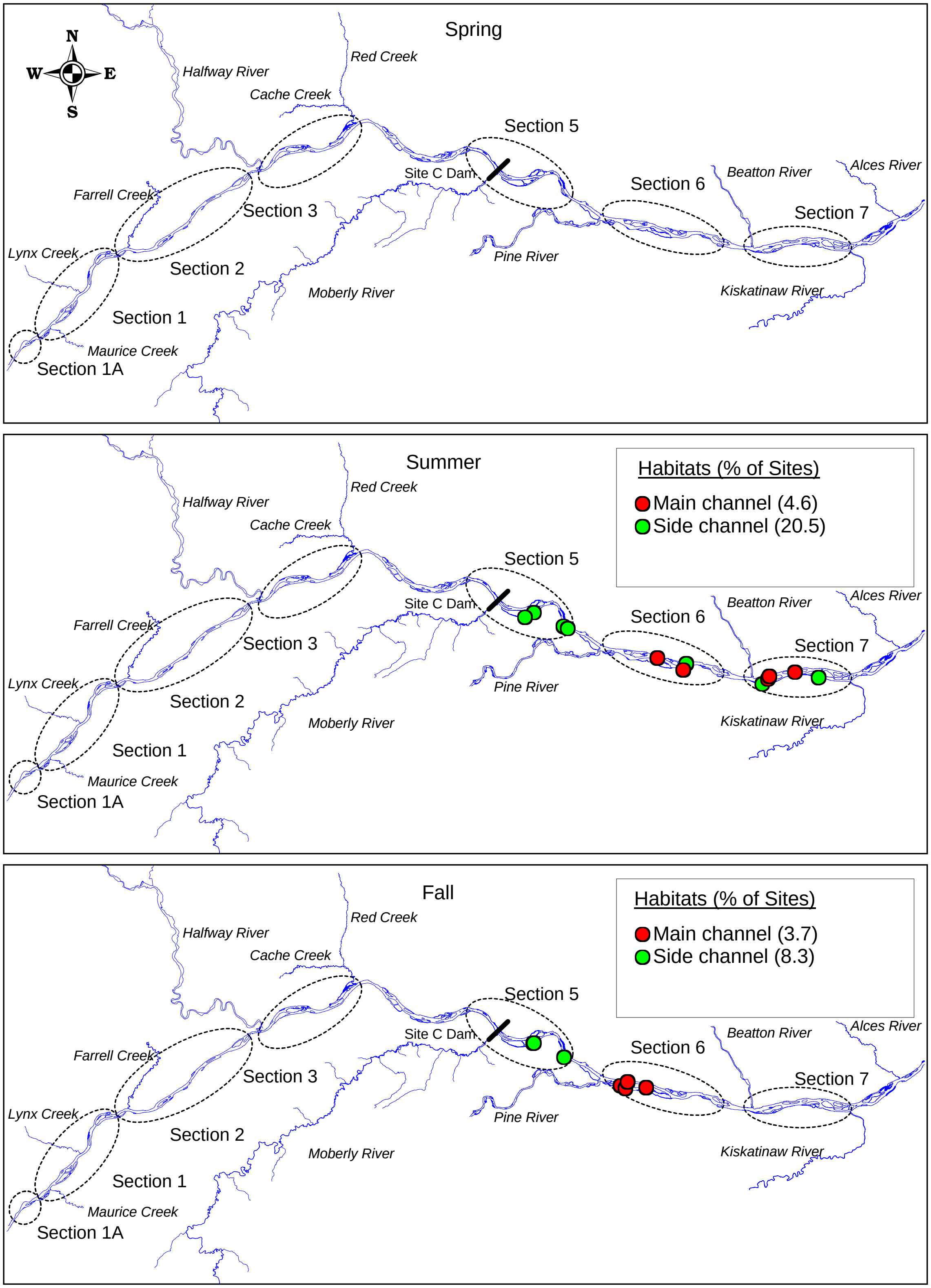

Figure 3.33 Distribution of young (Age 0) yellow perch, Site C Peace River Fish Inventory 2009.

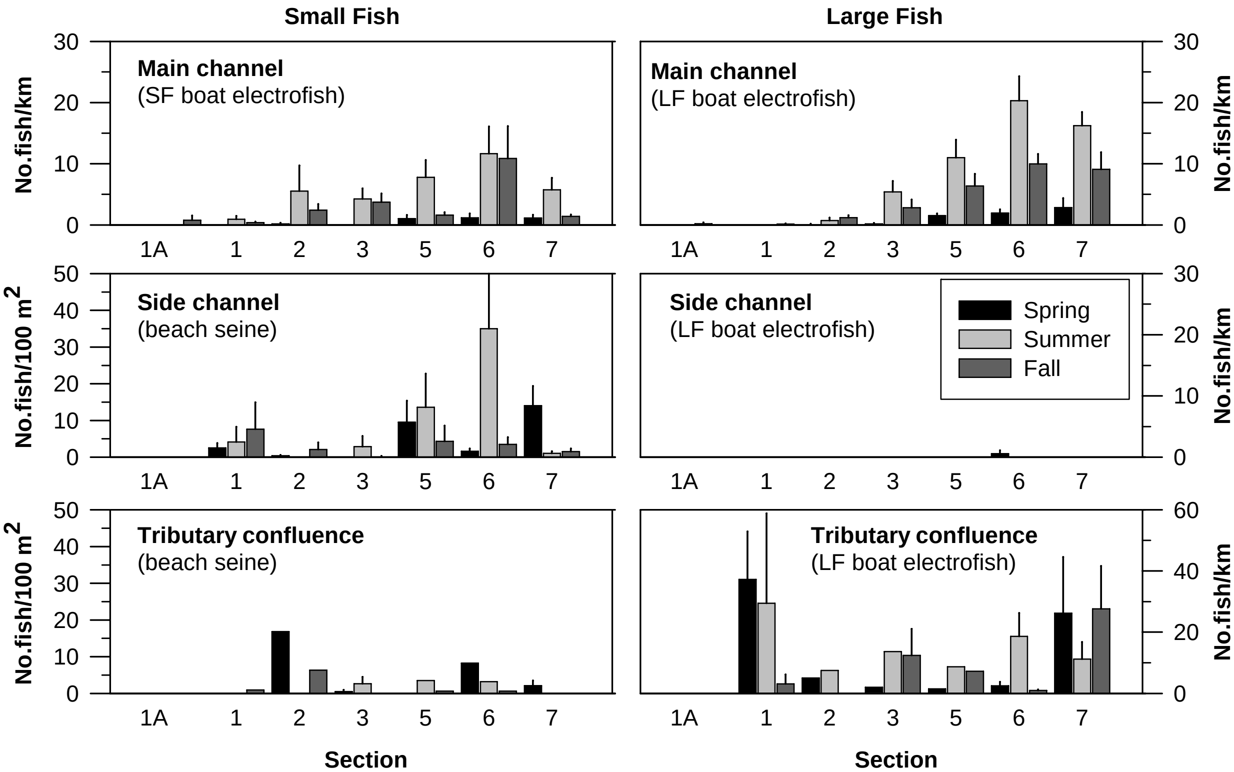

Figure 3.34 Average catch rates (± SE) of longnose suckers in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

Within each section, large fish catch rates were higher at tributary confluences compared to main channel areas. In addition, the highest large fish catch rates for this species were recorded at Section 1 tributary confluence sites (≥ 29.4 fish/km), which are in contrast to large fish catch rates in main channel areas in the same section. Beach seine results also indicated that small longnose sucker catch rates were high at tributary confluences.

Large longnose suckers were scarce in side channel habitats. In contrast, catch rates for small longnose suckers were high in side channels. Average catch rates for small fish were ≥ 10.0 fish/100 m^2. These results may reflect differences in habitat preference by small and large fish.

There were seasonal differences in longnose sucker catch rates in main channel areas. Catch rates were lowest in spring, highest in summer, and intermediate in fall. The low catch rates of adult longnose suckers in spring may reflect movement into tributaries by spawning adults. The high catch rates recorded at some tributary confluences in spring may represent concentrations of pre-spawning fish.

3.5.1.2 Biological Characteristics

In total, 1,062 longnose suckers were sampled for biological characteristics – 324 from Zone 1 and 738 from Zone 2. A subsample of fish was used for age related metrics – 94 from Zone 1 and 107 from Zone 2. Sampled fish ranged in length from 19 mm to 493 mm, ranged in weight from 14 g to 1,472 g, and ranged from Age 0 to Age 18.

The size and age distributions of longnose suckers differed between Zone 1 and Zone 2 (Figure 3.35). Based on combined samples from all capture methods, size distributions in both zones were broad and contained several modal peaks suggesting the presence of multiple age classes. Samples from both zones were dominated by larger (≥ 350 mm length), older (≥ Age 5) fish. However, in Zone 1 smaller, (≤ 300 mm length), younger (≤ Age 4) fish were not well represented. In contrast, Zone 2 contained higher numbers of young fish (20 mm to 70 mm length; Age 0) and subadult fish (150 mm to 300 mm length; Ages 1 to 4) within the 0 to 300 mm size range.

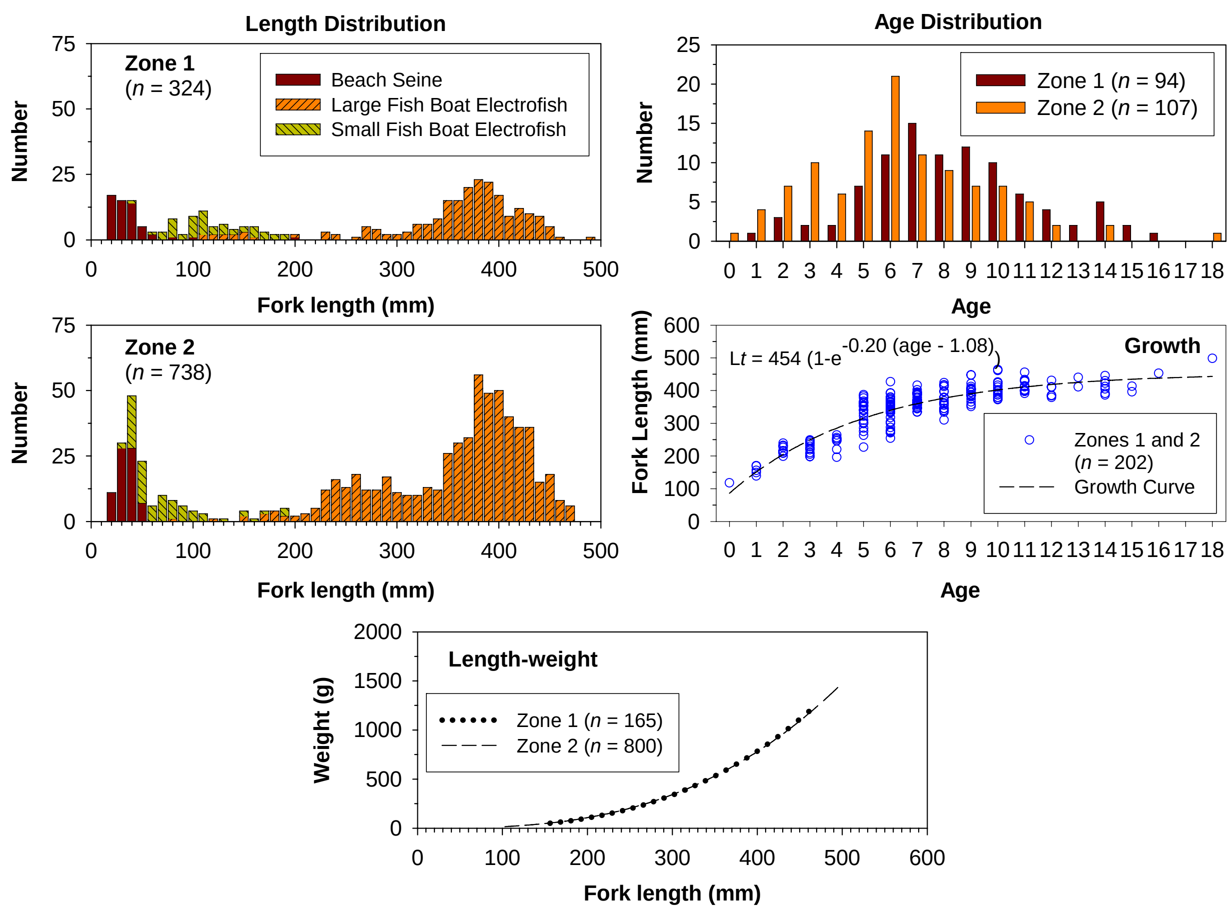

Figure 3.35 Biological characteristics of sampled longnose sucker, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses; length-weight relationship represented by power curve in place of raw data).

The results indicate that smaller, younger longnose suckers are more abundant in Zone 2 compared to Zone 1, but larger adult fish dominated the samples in both zones. Poor representation by smaller, younger longnose suckers suggests that the Peace River populations may utilize tributaries for rearing.

A visual assessment of the weight-length relationship (Figure 3.35), length-at-age, and condition-at-age summaries (Table 3.10) indicated no differences between zones. The growth curve of the combined data showed a classic von Bertalanffy growth form.

3.5.1.3 Distribution of Young Fish

The distribution of Age 0 longnose suckers was examined based on the fall sample (Figure 3.36). During spring and summer Age 0 suckers were not differentiated to species. Age 0 longnose suckers were widespread in the study area in fall and were located in all sections. They were recorded in all habitat types, but were most often encountered at tributary confluences, which suggested that these systems were major sources for recruitment.

Table 3.10 Mean length-at-age and condition-at-age of longnose sucker in Zone 1 and Zone 2, Site C Peace River Fish Inventory 2009.

Age	Fork Length				Condition (*K*)			
	Zone 1		Zone 2		Zone 1		Zone 2	
	n	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**
0			2	70.0 ± 206.5				
1	1	156.0	4	156.8 ± 21.2	1	0.95	4	1.20 ± 0.09
2	3	218.0 ± 22.9	7	219.1 ± 12.1	2	1.16 ± 0.02	7	1.20 ± 0.05
3	2	221.5 ± 101.1	10	225.4 ± 12.3	2	1.28 ± 0.41	10	1.20 ± 0.04
4	2	260.0 ± 17.2	6	235.5 ± 22.7	2	1.28 ± 0.03	6	1.26 ± 0.11
5	7	313.4 ± 31.3	14	339.6 ± 25.8	7	1.23 ± 0.08	14	1.19 ± 0.06
6	11	335.9 ± 23.2	21	340.9 ± 20.4	11	1.25 ± 0.06	21	1.22 ± 0.06
7	15	368.7 ± 13.3	11	370.9 ± 11.3	15	1.24 ± 0.05	11	1.23 ± 0.06
8	11	361.0 ± 24.1	9	384.4 ± 15.1	10	1.25 ± 0.04	9	1.25 ± 0.07
9	12	397.3 ± 18.8	7	393.0 ± 16.3	12	1.29 ± 0.05	7	1.23 ± 0.05
10	10	406.8 ± 19.5	7	403.4 ± 26.6	9	1.20 ± 0.05	7	1.25 ± 0.07
11	6	420.5 ± 23.7	5	407.2 ± 15.6	6	1.22 ± 0.03	5	1.20 ± 0.07
12	4	389.5 ± 19.3	2	421.0 ± 43.0	4	1.26 ± 0.04	2	1.06 ± 0.21
13	2	425.5 ± 62.4			1	1.16		
14	5	412.8 ± 28.9	2	413.5 ± 36.6	5	1.28 ± 0.12	2	1.21 ± 0.17
15	2	404.5 ± 36.6			2	1.24 ± 0.46		
16	1	453.0			1	1.42		
17								
18			1	498.0			1	1.19

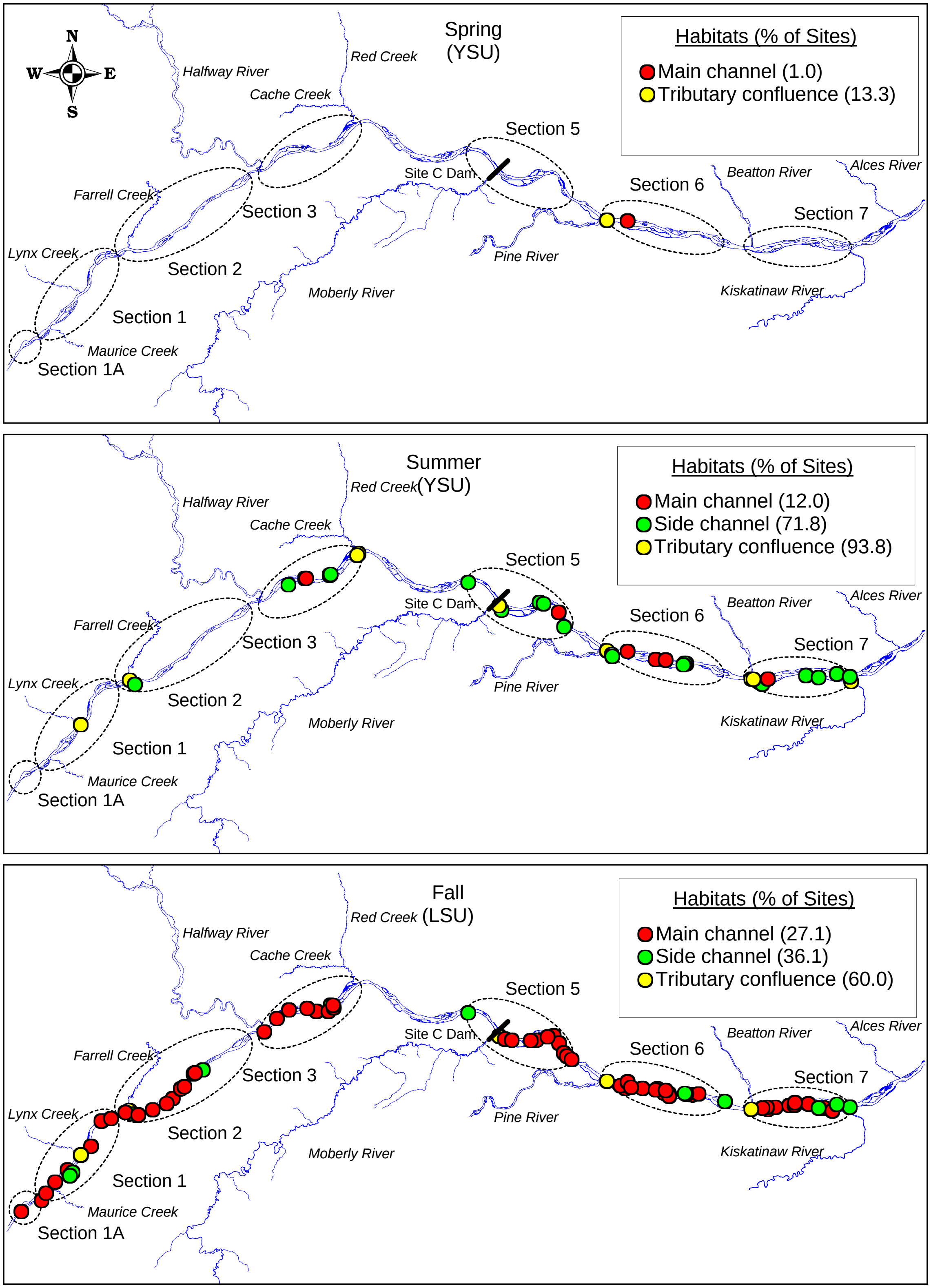

Figure 3.36 Distribution of unidentified Age 0 suckers in spring and summer and Age 0 longnose sucker in fall, Site C Peace River Fish Inventory 2009.

3.5.2 Largescale sucker

3.5.2.1 Catch Rate

Largescale suckers catch rates were lower than for longnose suckers, but largescale suckers were located in most sections and in all three habitats (Figure 3.37). Largescale suckers were absent only from main channel areas and side channel areas in Section 1A and Section 1. In main channel areas, catch rates of small and large fish were generally ≤ 5.0 fish/km.

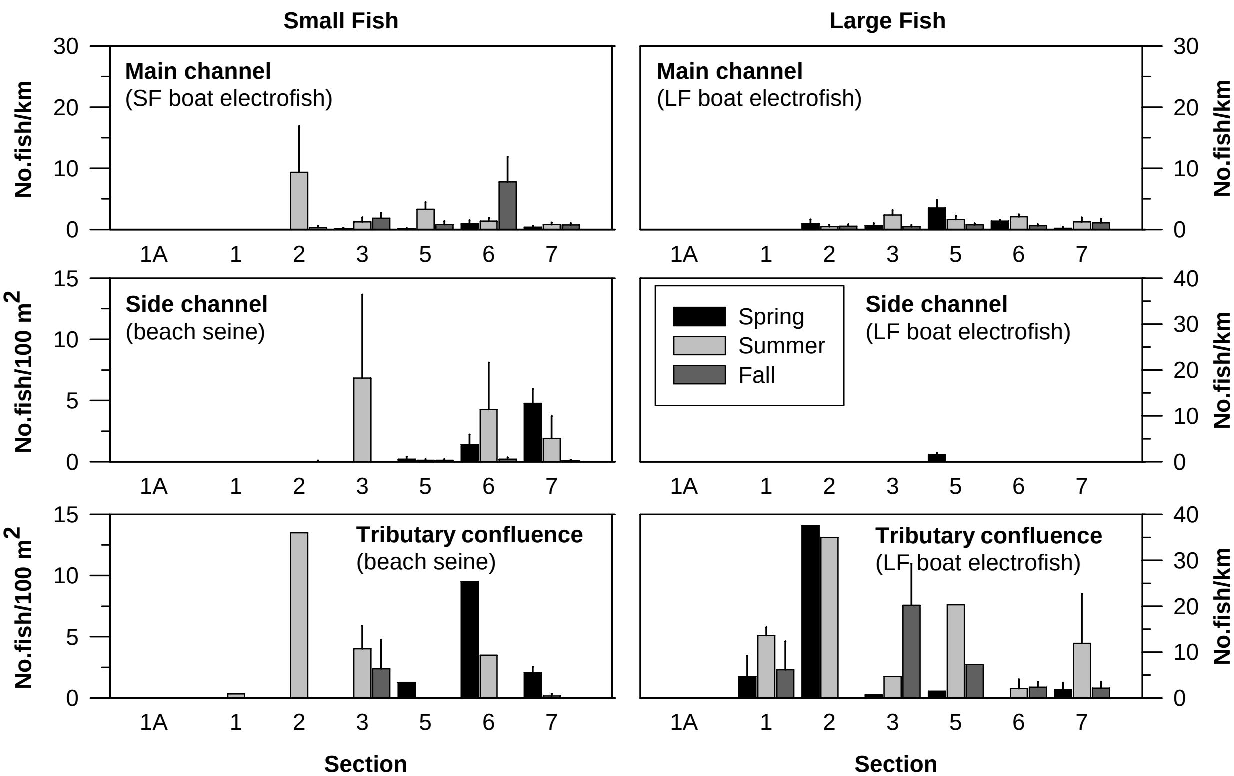

Figure 3.37 Average catch rates (± SE) of largescale suckers in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

Largescale suckers catch rates were high in tributary confluence areas. Similar to results for longnose suckers, large fish catch rates were higher at tributary confluences compared to main channel areas within each section. The highest large fish catch rates for this species were recorded in Section 2 at the Farrell Creek confluence (≥ 37.5 fish/km). Beach seine results also indicated that small largescale sucker catch rates were high at tributary confluences.

Very few large fish were encountered in side channels, but average catch rates for small fish were generally ≥ 2.5 fish/100 m^2. Similar to the longnose sucker results, this may reflect differences in habitat preference by small and large fish.

Distinct seasonal differences in largescale sucker catch rates were not recorded.

3.5.2.2 Biological Characteristics

In total, 261 largescale suckers were sampled for biological characteristics (data for Zones 1 and 2 combined). A subsample of 97 fish was used for age related metrics. Sampled fish ranged in length from 24 mm to 580 mm, ranged in weight from 28 g to 3,230 g, and ranged from Age 0 to Age 25.

The size and age distributions of largescale sucker were similar to that of longnose suckers, but older fish (to Age 25) were recorded (Figure 3.38). Based on combined samples from all capture methods, the size distribution was broad and contained several modal peaks suggesting the presence of multiple age classes. The sample was dominated by smaller (≤ 150 mm length), younger fish and larger (≥ 350 mm length), older fish. The intermediate size range and age group were poorly represented.

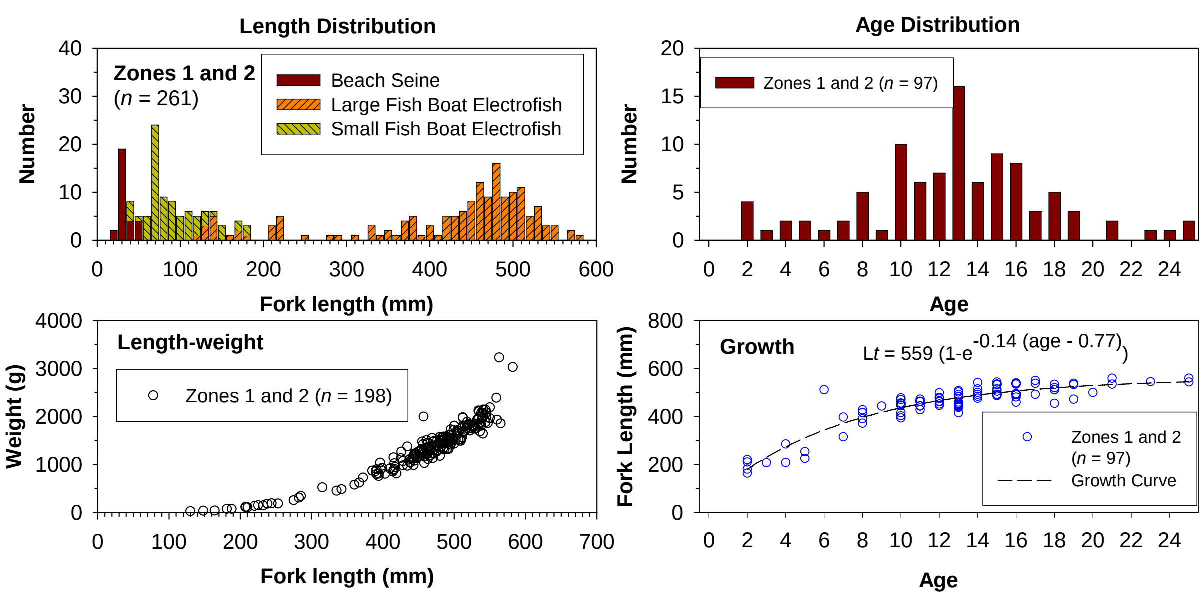

Figure 3.38 Biological characteristics of sampled largescale sucker, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

A visual assessment of the weight-length relationship indicated allometric growth, and condition-at-age summaries (Table 3.11) indicated good condition. The growth curve showed a classic von Bertalanffy growth form.

Table 3.11 Mean length-at-age and condition-at-age of largescale sucker (Zones 1 and 2 combined), Site C Peace River Fish Inventory 2009.

Age	Fork Length		Condition (*K*)	
	N	**Mean (± 95%CI)**	***n***	**Mean (± 95%CI)**
0				
1				
2	4	193.8 ± 35.8	4	1.15 ± 0.23
3	1	207.0	1	1.29
4	2	246.5 ± 165.7	2	1.39 ± 0.41
5	2	239.0 ± 60.2	2	1.22 ± 0.32
6	1	511.0	1	1.17
7	2	356.0 ± 176.4	2	1.55 ± 0.51
8	5	404.8 ± 26.2	5	1.38 ± 0.11
9	1	443.0	1	1.32
10	10	441.7 ± 19.7	10	1.33 ± 0.06
11	6	451.8 ± 16.2	6	1.28 ± 0.09
12	7	468.0 ± 16.2	7	1.28 ± 0.10
13	16	461.4 ± 14.2	15	1.33 ± 0.06
14	6	501.3 ± 23.6	6	1.23 ± 0.08
15	9	515.3 ± 16.7	9	1.25 ± 0.06
16	8	503.9 ± 24.4	8	1.26 ± 0.09
17	3	526.7 ± 56.2	3	1.31 ± 0.05
18	5	506.4 ± 34.7	5	1.35 ± 0.10
19	3	514.3 ± 67.5	3	1.25 ± 0.15
20	1	500.0	1	1.45
21	2	547.0 ± 51.6	2	1.33 ± 0.16
22				
23	1	545.0	1	1.29
24				
25	2	552.0 ± 34.4	2	1.13 ± 0.15

3.5.2.3 Distribution of Young Fish

The distribution of Age 0 largescale suckers was examined based on the fall sample (Figure 3.39). During spring and summer Age 0 suckers were not differentiated to species. Age 0 largescale suckers were relatively widespread from Section 3 downstream in fall, although they were recorded at single sites in Section 1 and Section 2. Age 0 largescale suckers were recorded in all habitat types, but were most often encountered in side channels.

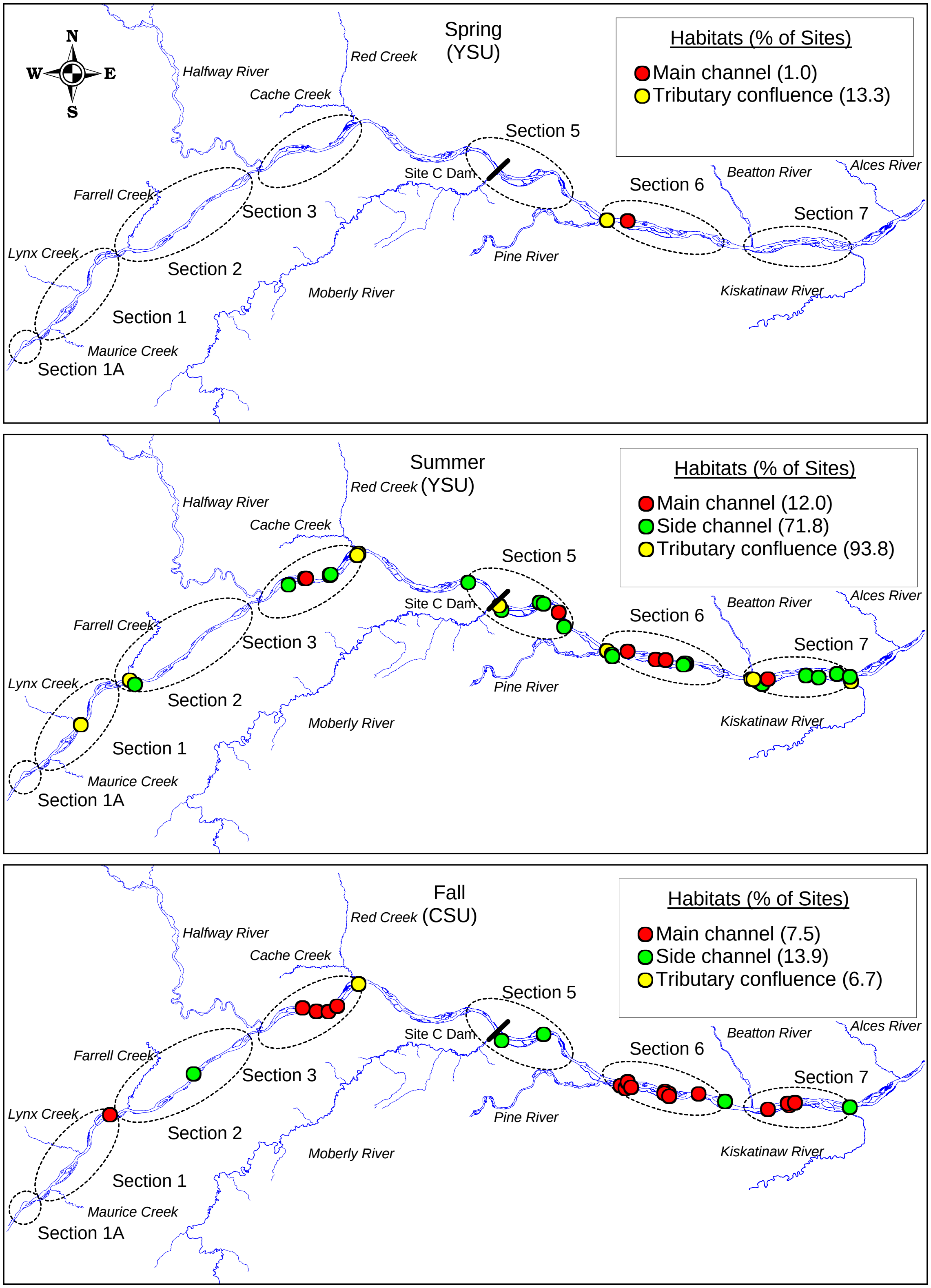

Figure 3.39 Distribution of unidentified Age 0 suckers in spring and summer and Age 0 largescale sucker in fall, Site C Peace River Fish Inventory 2009.

3.5.3 White sucker

3.5.3.1 Catch Rate

White suckers catch were not high (Figure 3.40) and white suckers were largely restricted to the downstream portion of the study area (Sections 3 to 7). White suckers were present in all three habitats. Catch rates of large white suckers were lowest in main channel areas (approximately 0.4 fish/km), intermediate at tributary confluences (approximately 1.0 fish/km), and highest in side channel areas (approximately 4.0 fish/km).

Similar patterns of catch rates were recorded for small white suckers. Seasonal differences in white sucker catch rates were not recorded.

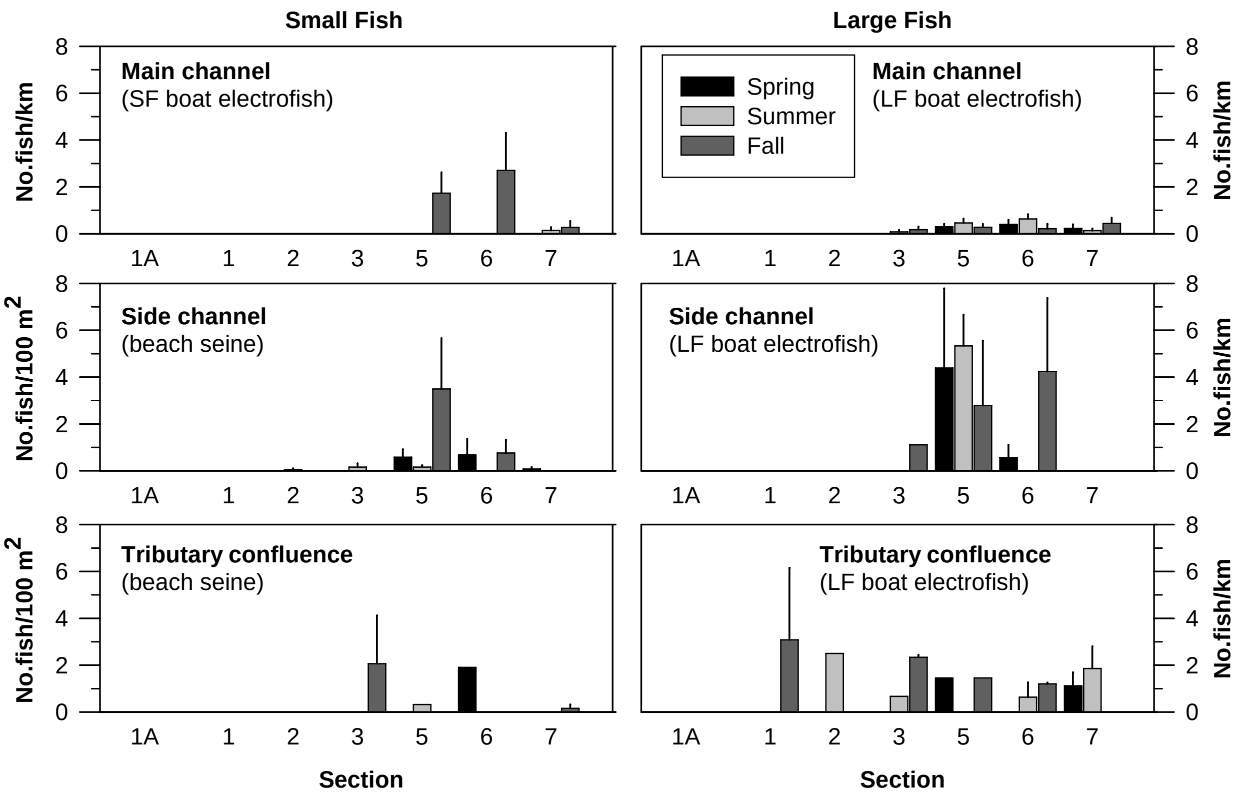

Figure 3.40 Average catch rates (± SE) of white suckers in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009 (small fish ≤ 200 mm fork length and large fish > 200 mm fork length; SF – small fish method, LF – large fish method).

3.5.3.2 Biological Characteristics

In total, 213 white suckers were sampled for biological characteristics (Figure 3.41). Sampled fish ranged in length from 25 mm to 457 mm and ranged in weight from 22 g to 1,316 g. Data from both zones were combined for analyses and the white sucker sample was not aged. Based on combined samples from all capture methods, the size distribution of white sucker was similar to size distributions of longnose sucker and largescale sucker. It contained a large range of lengths and contained several modal peaks suggesting the presence of multiple age classes. The sample was dominated by smaller fish (≤ 150 mm length) and larger fish (≥ 350 mm length) while the intermediate size range was poorly represented.

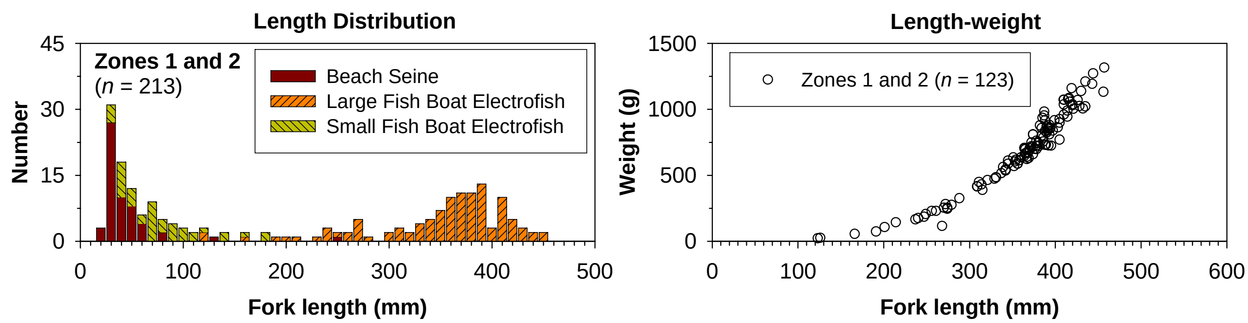

Figure 3.41 Biological characteristics of sampled white sucker, Site C Peace River Fish Inventory 2009 (Table 2.6 identifies data selected for analyses).

The weight-length relationship indicated allometric growth and condition (*K*) estimate of the sample (1.36 ± 0.05) indicated good body condition.

3.5.3.3 Distribution of Young Fish

Age 0 white suckers in fall were relatively widespread from Section 3 downstream -- age 0 fish were recorded in all sections downstream of the Halfway River (Figure 3.42). They were most frequently encountered in Section 5. Age 0 white suckers were recorded in all habitat types, but were most often encountered in side channels and tributary confluences.

3.6 MINNOW AND SCULPIN POPULATIONS

Information presented in this section includes summaries of catch rates (Table 3.12) and biological characteristics (Table 3.13) of selected minnow and sculpin populations. Raw data and summaries for all species are presented in Appendix E (catch rates) and Appendix F (biological characteristics).

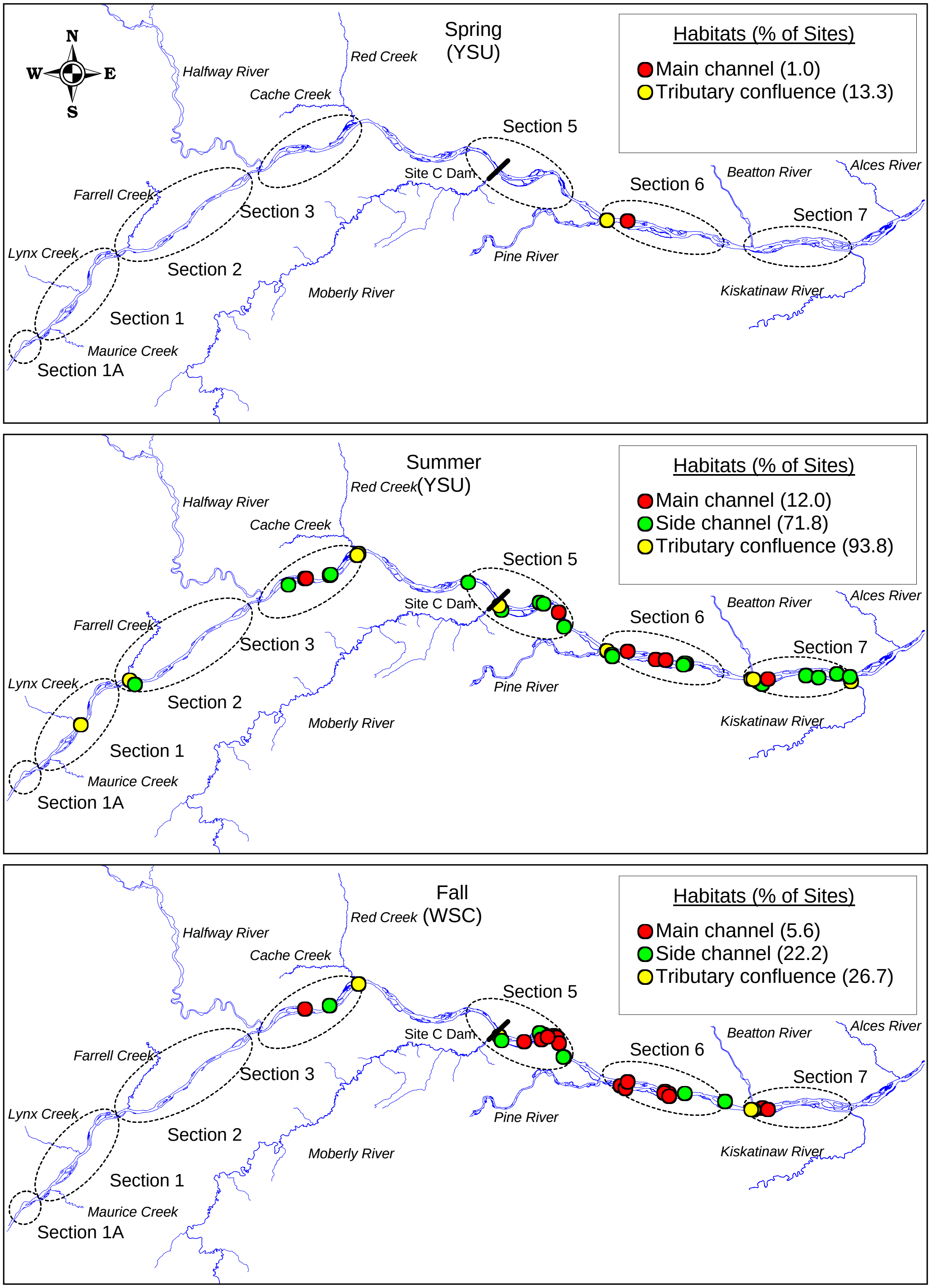

Figure 3.42 Distribution of unidentified Age 0 suckers in spring and summer and Age 0 white sucker in fall, Site C Peace River Fish Inventory 2009.

Table 3.12 Summary of minnow and sculpin catch rates, Site C Peace River Fish Inventory 2009 (all seasons and sections combined).

Group	Species	Main Channel[a]		Side Channel[b]		Tributary Confluence[c]	
		Mean	Maximum	Mean	Maximum	Mean	Maximum
Minnows[d]	Brook stickleback	0.00		< 0.01	0.32	0.00	
	Finescale dace	0.00		0.66	41.03	0.00	0.00
	Flathead chub	0.69	60.58	0.07	3.49	1.27	20.00
	Lake chub	0.74	17.31	0.92	29.21	4.50	52.38
	Longnose dace	0.68	25.93	2.74	140.60	5.73	104.13
	Northern pikeminnow	0.30	20.00	0.53	22.22	1.19	7.94
	Northern redbelly dace	0.01	1.96	0.01	0.63	0.00	
	Peamouth chub[e]					0.00[e]	
	Pearl dace	0.00		< 0.01	0.32	0.00	
	Redside shiner	5.18	68.06	17.64	455.87	32.79	146.03
	Spottail shiner	0.38	37.25	8.78	330.18	0.13	1.27
	Trout-perch	1.40	52.88	0.42	12.38	1.09	10.16
Sculpins	Prickly sculpin	1.52	31.82	0.09	1.27	0.39	3.81
	Slimy sculpin	6.04	124.44	0.06	1.27	0.10	0.95
	Spoonhead sculpin	0.02	2.13	0.00		0.01	0.32

[a] Based on small fish boat electrofisher catch; *n* = 261.
[b] Based on beach seine catch; *n* = 82.
[c] Based on beach seine catch; *n* = 25.
[d] Includes true minnows (Family Cyprinidae), trout-perch (Family Percopsidae), and sticklebacks (Family Gasterosteidae).
[e] Species captured only by large fish boat electrofisher at tributary confluence; 2 fish captured.

3.6.1 Minnows

Brook stickleback (Appendix E Figure E5), finescale dace (Appendix E Figure E6), flathead chub (Appendix E Figure E7), peamouth (Appendix E Figure E8), pearl dace (Appendix E Figure E9), and northern redbelly dace (Appendix E Figure E10) were scarce in the study area and the total number of fish of each species encountered was ≤ 21 (Table 3.13). Most of these species were more numerous in side channel or tributary confluence habitats and were recorded only in Zone 2. The only exception was peamouth, which occurred in Zone 1 at the tributary confluences of Lynx Creek (Section 1) and Halfway River (Section 3).

Lake chub (Appendix E Figure E11), longnose dace (Appendix E Figure E12), northern pikeminnow (Appendix E Figure E13), and trout-perch (Appendix E Figure E14) were more numerous (Table 3.13). Catch rates of these species also tended to be higher in side channel or tributary confluence habitats and in sections located in Zone 2. Northern pikeminnow and trout-perch were the exceptions. Northern pikeminnow were present in main channel habitats and were equally abundant in Zone 1 and Zone 2. Trout-perch catch rates were highest in main channel habitats, but the distribution of this species was restricted to Zone 2.

Table 3.13 Summary of minnow and sculpin species population length characteristics, Site C Peace River Fish Inventory 2009.

Group	Species	Length (mm)[a]		
		Sample	Median	Range
Minnows[a]	Brook stickleback	1	42	
	Finescale dace	21	27	19 – 52
	Flathead chub	141	94	32 – 221
	Lake chub	489	60	17 – 124
	Longnose dace	345	36	13 – 87
	Northern pikeminnow	303	97	24 – 552
	Northern redbelly dace	5	45	33 – 58
	Peamouth chub	2	199.5	196 –203
	Pearl dace	2	48.5	34 – 63
	Redside shiner	1,325	70	14 – 133
	Spottail shiner	283	37	17 – 177
	Trout-perch	343	46	15 – 89
Sculpins	Prickly sculpin	377	57	23 – 124
	Slimy sculpin	925	70	22 – 136
	Spoonhead sculpin	5	39	27 – 45

[a] Includes true minnows (Family Cyprinidae), trout-perch (Family Percopsidae), and sticklebacks (Family (Gasterosteidae).

Redside shiners were the most numerous minnow species encountered. Catch rates of redside shiner often exceeded 25 fish/100 m^2 in the beach seine samples from all three habitat types; however, highest catch rates were recorded at side channel and tributary confluence sites (Figure 3.43). Catch rates of this species were highest in sections located in Zone 2, but redside shiner were numerous as far upstream as Section 2 in Zone 1.

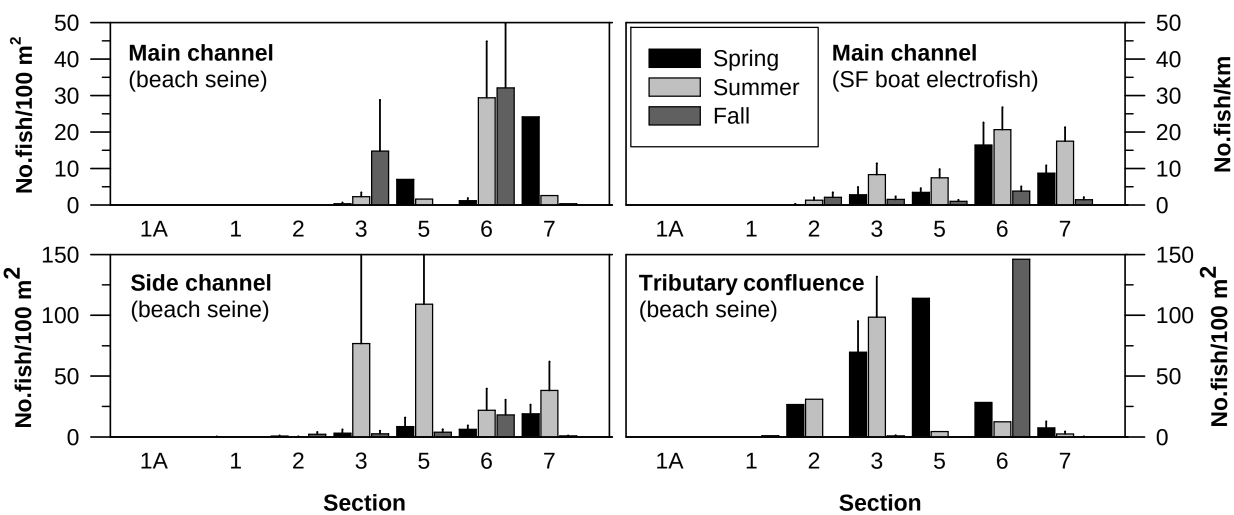

Figure 3.43 Average catch rates (± SE) of redside shiner in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009.

Catch rates of spottail shiners were also high. Catch rates of spottail shiner often exceeded 10 fish/100 m^2 in the beach seine samples and maximum catch rates exceeded 455 fish/100 m^2 (Appendix E Figure E15) However, spottail shiners were only numerous in side channel habitats (Figure 3.44). This species was mostly restricted to sections located in Zone 2. The one exception was the presence of fish at the confluence of the Halfway River in Section 3.

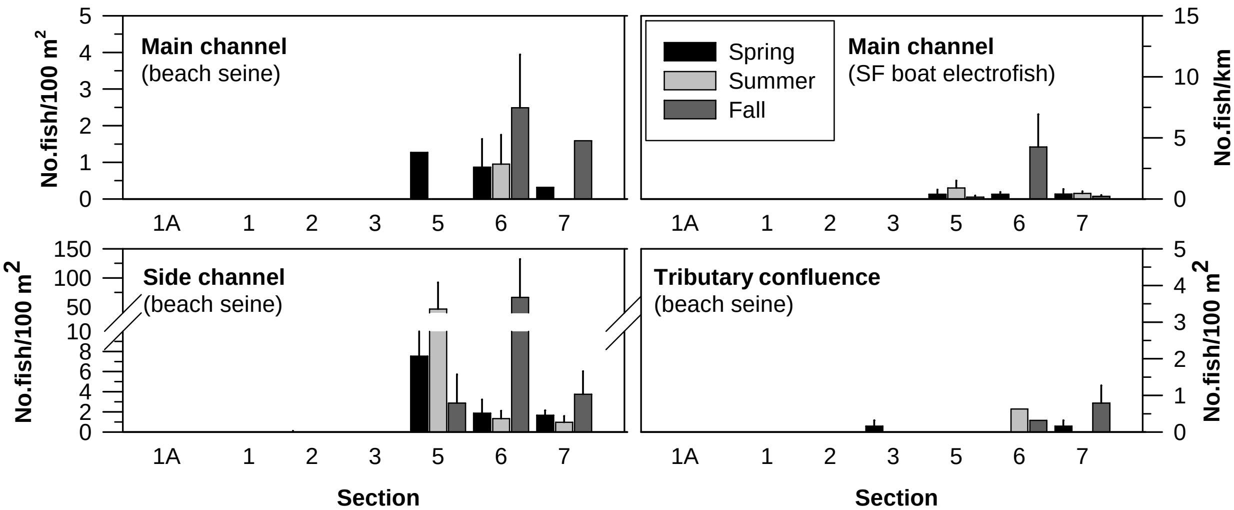

Figure 3.44 Average catch rates (± SE) of spottail shiner in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009.

3.6.2 Sculpins

Spoonhead sculpins (Appendix E Figure E16) were scarce in the study area; the total number of fish encountered was 5 (Table 3.13). This species was recorded at main channel sites in Section 3 (Zone 1) and Sections 6 and 7 (Zone 2). Spoonhead sculpins were also encountered at the tributary confluence of the Beatton River in Section 7 (Zone 2).

Slimy sculpins were the most numerous sculpin species encountered during the study. Catch rates were consistently highest in main channel habitats and often exceeded 5 fish/km in the small fish boat electrofisher catch (Figure 3.45). Catch rates of slimy sculpins in main channel habitats exhibited seasonal specific patterns. In summer, catch rates increased from upstream to downstream. In fall, catch rates were very high in Sections 1 and 3, but were generally equal in all remaining sections (1A, 2, 5, 6, and 7).

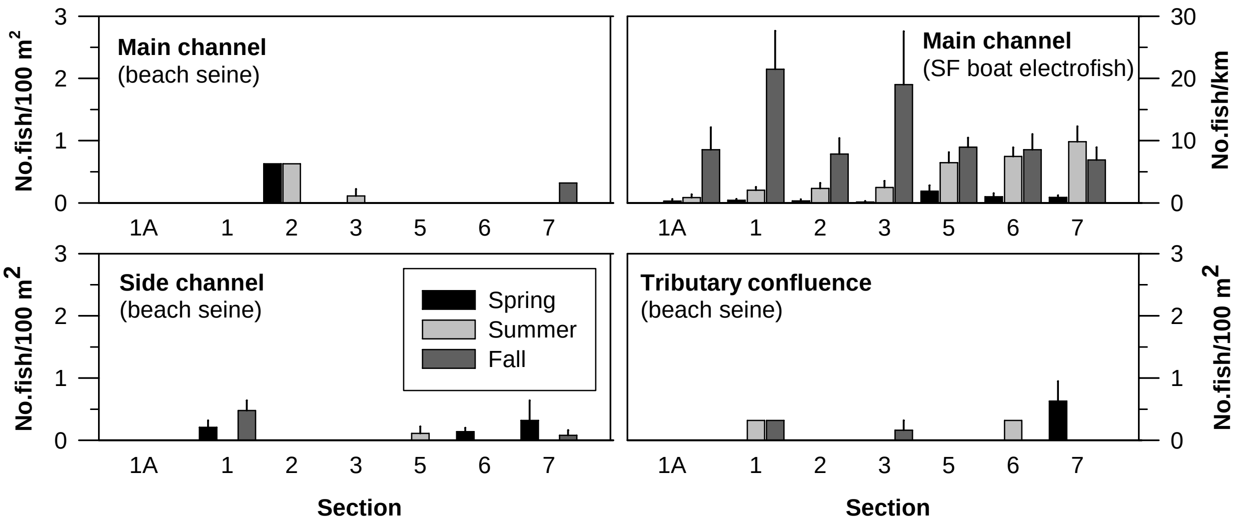

Figure 3.45 Average catch rates (± SE) of slimy sculpin in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009.

Prickly sculpins also were numerically important in the study area. Like slimy sculpin, catch rates were consistently highest in main channel habitats; they averaged 1.5 fish/km in the small fish boat electrofisher catch (Figure 3.46). Catch rates of prickly sculpins in main channel habitats declined from upstream to downstream. Catch rates were highest in Section 1A and lowest in Section 7.

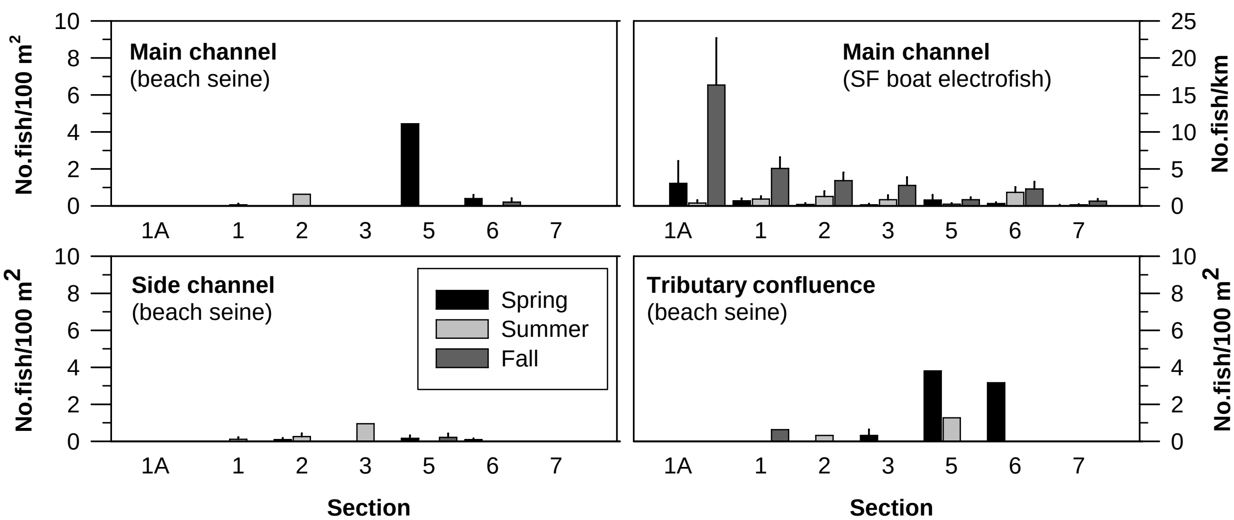

Figure 3.46 Average catch rates (± SE) of prickly sculpin in study sections during spring, summer, and fall, Site C Peace River Fish Inventory 2009.

3.7 FISH COMMUNITY HEALTH

Based on the DELT index method, evidence of impairment to health (presence of deformity, erosion, lesion, or tumour) was recorded for seven species (Table 3.14). These included four sportfish (Arctic grayling, bull trout, mountain whitefish, and northern pike) and three suckers (longnose sucker, largescale sucker, and white sucker). Other species recorded during the study either had insufficient sample sizes or did not exhibit signs of poor health. These included kokanee, lake trout, lake whitefish, burbot, goldeye, walleye, and yellow perch.

Table 3.14 Summary of DELT percentages for selected large fish species collected by boat electrofisher (includes fish sampled during 2009 WLR Peace River Fish Index Project), Site C Peace River Fish Inventory 2009.

Group	**Species**	**Sample Size**	**Section**						
			1A	**1**	**2**	**3**	**5**	**6**	**7**
Sportfish	Arctic grayling	254	-	0.0	0.0	2.8	2.3	0.0	14.3
	Bull trout	361	0.0	0.0	0.0	0.0	0.0	4.3	0.0
	Mountain whitefish	19,165	0.3	0.3	0.7	0.3	0.1	1.0	1.0
	Northern pike	66	-	0.0	-	0.0	2.9	9.1	16.7
	Rainbow trout	370	-	2.6	0.0	0.6	0.0	0.0	0.0
Suckers	Longnose sucker	2,347	0.0	2.0	3.4	1.0	1.8	5.1	5.1
	Largescale sucker	527	-	0.0	3.9	2.4	3.4	6.8	5.7
	White sucker	137	-	0.0	0.0	0.0	0.0	6.7	11.8

Evidence of poor physical health differed by species and section. In the sportfish group, values ranged from 0.0% to 2.9% in Sections 1A to 5. In the suckers group, percentages ranged from 0.0% to 3.9% in Sections 1A to 5. The percentage of individuals with evidence of poor health was higher in Sections 6 and/or 7 compared to values recorded in upstream sections. The magnitude of the difference was species specific, but represented an increase from 2 to 10 times.

4.0 DISCUSSION

The results of the present study are consistent with findings by previous investigations (see Section 1.1 for list of studies). When appropriate this section makes reference to findings by other studies; however, detailed comparisons will be deferred until a second year of baseline study is completed. The following provides a preliminary interpretation of the 2009 data

4.1 ENVIRONMENTAL CONDITIONS

Environmental conditions recorded during the 2009 field program were typical of the Peace River in the study area. They reflect the combined influence of the storage reservoir - Williston Reservoir, and operations of the hydroelectric facilities GM Shrum and Peace Canyon (BC Hydro 2003). During the present study Peace River water temperatures were lower in spring and summer and higher in fall. During all seasons, high water clarity was recorded immediately downstream of the PCN Dam. When compared to historical data the Peace River flows in 2009 exhibited reduced annual peak flow and an increased annual base flow (nhc *et al.* 2009) and the power-peaking operation of GM Shrum and Peace Canyon facilities caused hourly fluctuations in discharge.

Results from the 2009 program and other studies (RL&L 2001, P&E 2002) indicate that the environmental conditions of the Peace River observed immediately downstream of the PCN Dam can be influenced by tributary inputs. High tributary flows into the Peace River can alter water temperature and water clarity and dampen the effect of the regulated flow regime. The influence of tributary inputs progressively increases from upstream to downstream due to cumulative effects of multiple tributaries (i.e., Maurice Ck., Lynx Ck., Farrell Ck., Halfway R., Cache Ck., Moberly R., Pine R., Beatton R., Kiskatinaw R.). In addition, attenuation of flow, which increases with downstream distance, also dampens the effect of the regulated flow regime.

Changes to the environmental conditions of the Peace River represent a complex continuum that can change on an hourly, daily, and seasonal basis due to the interactions between PCN Dam discharge and tributary inputs. Although the influence of hydroelectric facility operation on the Peace River lessens with distance, the effects are evident within the entire 151 km study area.

4.2 FISH COMMUNITY STRUCTURE

Species Composition

In total, 30 species were recorded in the mainstem Peace River. This number is similar to the 31 species recorded during historical studies of the Peace River (e.g., Pattenden *et al*. 1990, RL&L 2001, P&E 2002, AMEC and LGL 2006). The only species not encountered during the present study was brook trout (*Salvelinus fontinalis*). The species composition included 7 cold water sportfish, 5 cool water sportfish, 3 suckers, 3 sculpins, and 12 minnows (includes true minnows, trout-perch, and sticklebacks). In terms of numerical importance, cold water sportfish dominated, followed by suckers, minnows, sculpins, and then cool water sportfish. Mountain whitefish numerically dominated the sample, followed by longnose suckers, redside shiner, and slimy sculpin.

Several incidental or numerically scarce fish species were recorded during the study. These included lake trout and lake whitefish (cold water sportfish), brook stickleback, finescale dace, northern redbelly dace, peamouth, and pearl dace (minnows), and spoonhead sculpin (sculpins). Cool water sportfish species were not numerically abundant, even in portions of the study area where they were prevalent.

Distribution

The distribution of fish species in the study area was related to their catch rates (more numerous fish typically were more widespread) and their habitat requirements (cold water versus cool water; side channel versus main channel). In general, species diversity was lowest in the uppermost portion of the study area (Section 1A) and highest in the lowermost portion of the study area (Section 7). This pattern makes intuitive sense because habitat complexity is low in Section 1A (RL&L 2001) and the primary source of fish recruitment in this section is entrainment through the PCN Dam. In contrast, Section 7 exhibits high habitat complexity (RL&L 2001) and there are multiple recruitment sources (e.g., upstream Peace River and tributaries) including downstream sources.

Most cold water species were recorded upstream and downstream of the proposed Site C dam (mountain whitefish, bull trout, kokanee, and rainbow trout), as were most suckers (longnose sucker, largescale sucker, and white sucker), and sculpins (prickly sculpin and slimy sculpin), and some of the minnows (lake chub, longnose dace, redside shiner, and spottail shiner). The one exception to this pattern was the cool water sportfish group. Burbot, goldeye, northern pike, walleye, and yellow perch, were largely restricted to the downstream section of the study area (i.e., downstream of the proposed Site C dam).

4.3 CATCH RATE

Spatial

Although many species were widely distributed in the study area, most exhibited spatial patterns of catch rates. None of the species collected during the study were numerous in Section 1A, immediately downstream of the PCN Dam.

Catch rates of most cold water sportfish were higher upstream of the proposed Site C dam and catch rates declined downstream of this location. This was particularly true for rainbow trout and kokanee, which were abundant only in upstream sections. The one exception to this general spatial pattern was Arctic grayling. Catch rates of this species were similar upstream and downstream of the proposed Site C dam location. However, the distribution of this species was largely restricted to sections that included tributaries that were potential sources of recruitment (i.e., Section 2 – Farrell Creek; Section 3 – Halfway River; Section 5 – Moberly River; Section 6 – Pine River).

Sculpin catch rates exhibited the same spatial pattern as cold water sportfish. Prickly sculpin catch rates declined sharply downstream of the proposed Site C dam location. Slimy sculpin catch rates also declined, but this species remained abundant as far downstream as Section 7.

Suckers, minnows, and cool water sportfish exhibited a catch rate pattern opposite to that of cold water sportfish and sculpins. Catch rates of most species in these groups were higher downstream of the proposed Site C dam. This pattern was represented by the longnose sucker catch. The species was present throughout the study area, but became progressively more numerous from upstream to downstream. All cool water sportfish species catch rates were relatively high only in the downstream portion of the study area.

Seasonal

There were differences in seasonal catch, but the data were easily interpreted due to variable sampling conditions (e.g., colder water temperatures and lower water clarity in spring) and seasonal growth of younger fish into the large fish cohort (i.e., fish became large enough to capture later in the season). However, some seasonal patterns corresponded to predicted movement strategies of study area fish populations. For example, large Arctic grayling were largely absent from the spring sample, which suggested that adult fish had entered tributaries to spawn. A large concentration of adult bull trout was recorded in the Halfway River confluence area in spring, which was identical to findings made in 2008 (Mainstream 2009b). This suggested that adult bull trout may enter the Halfway River to feed or to initiate pre-spawning movements. Catch rates of adult northern pike in side channels were highest in spring indicating that fish may be utilizing this habitat for spawning.

Goldeye recorded in the study area belong to a population that resides primarily in Alberta, but which migrates upstream to spawn and to feed (Mainstream 2006). The presence of a single goldeye in the study area in spring during the 2009 program suggests that a portion of the goldeye population may migrate into British Columbia to spawn.

The catch data also suggested a seasonal increase in numbers of small fish of several sportfish and sucker species. The absence of young fish (young-of-the-year and juveniles) in spring followed by an increase in catch rates during summer and fall provides an indication that these fish may be recruiting to the mainstem Peace River from tributaries or via entrainment through the PCN Dam. This seasonal pattern was recorded for Arctic grayling, kokanee, rainbow trout, longnose sucker, and largescale sucker.

<u>Habitat Use</u>
Catch rates of several fish species indicated patterns of habitat use. All cold water species and sculpin species were most frequently encountered and catch rates were highest in main channel habitats. Suckers and minnows also occurred in main channel habitats, but were more often encountered and were more numerous in tributary confluences and in side channel habitats. This apparent habitat preference by suckers and minnows was most pronounced upstream of the proposed Site C dam location.

A small number of species occurred almost exclusively in specific habitat types. Examples included spottail shiner, yellow perch, and northern pike use of side channels, as well as goldeye and walleye use of tributary confluences.

4.4 POPULATION CHARACTERISTICS

Several fish population characteristics (length and age distribution, length-weight relationship and condition, length-at-age and growth rate) were used to examine the present status of selected large fish species populations recorded in the study area. In general, the results showed that most fish populations were viable. Evidence included good representation by small and large fish, normal body condition, and good growth (based on age samples from selected species). It should be noted that the term viable does not differentiate between two recruitment strategies. The first strategy involves a self sustaining population that relies on natural recruitment through reproduction. The second strategy involves population maintenance by recruitment from upstream sources via entrainment from the PCN Dam.

Some populations were represented by a small number of fish, and as such, may be transients from populations located outside the study area. Species that fit this description include lake trout, lake whitefish, brook stickleback, finescale dace, northern redbelly dace, peamouth, pearl dace, and spoonhead sculpin. This statement should be interpreted with caution because some species may be under represented in the catch because they are not effectively captured using the methods employed by the study. This is particularly true for species such as burbot, lake trout, and lake whitefish. Young fish of the latter two species were recorded in the study area, which suggests on-site recruitment. More work is required in order to answer this question.

4.5 DISTRUBUTION OF YOUNG FISH

The seasonal distribution of young fish (Age 0, or Ages 0 and 1) provided evidence of potential recruitment sources for large fish species populations recorded in the study area. Sources of potential recruitment can be evaluated based on the predicted life history strategy of the population, the presence of recently emerged fry, the absence of young fish, and the spatial and temporal changes in the distribution of young fish. Recruitment of small fish species was not evaluated during the present study. One can assume that the presence of these fish in high numbers is an indication of a viable population given the limited mobility of small fish species.

The assessment identified tributaries as likely sources of recruitment for several cold water sportfish in the study area. These included Arctic grayling, bull trout, rainbow trout, and mountain whitefish. Within this group, the presence of recently emerged mountain whitefish fry in spring indicated that this population also spawned in the mainstem Peace River as far upstream as Section 1. Potential tributary sources for most of the cold water sportfish occur from the Pine River confluence upstream. The one exception was Arctic grayling that appeared to recruit from as far downstream as the Beatton River.

Previous investigations have established that the Halfway River system is a major spawning and rearing area for the Peace River bull trout population (Diversified 2009). The presence of young bull trout near the confluence of the Pine River suggested that fish may also recruit from this system. The Moberly River and Halfway River were thought to be major sources of recruitment for the Arctic grayling Peace River population (Pattenden *et al.* 1990, AMEC and LGL 2006). The presence of numerous Age 0 fish downstream of several tributary confluences suggested that recruitment sources are more widespread than previously thought.

Young fish of several cold water species were recorded immediately below the PCN Dam. These include bull trout, kokanee, and rainbow trout. Because it is highly unlikely that these small fish have the capability to move upstream to the PCN Dam, it is probable that they originated from upstream sources via entrainment through the PCN Dam. If so entrainment provides a source of recruitment for these fish populations.

Recruitment sources of cool water sportfish were species specific. Based on the capture of a small number of fish, walleye appear to recruit only from the Beatton River. Other studies in Alberta have documented spawning within the mainstem Peace River (RL&L 2000; Mainstream 2006); therefore, recruitment from the mainstem Peace River also may occur. Northern pike and yellow perch spawn and rear in side channel habitats. The presence of Age 0 fish of both species confirms that these populations use side channels as sources of recruitment. The 2009 data indicated that the young fish numbers were highest in side channels located in Section 5. Young burbot and goldeye were not recorded during the study. Other investigations have established that the Moberly River is an important rearing area for burbot (Maintream 2010), which makes it a likely source of recruitment for this population. Young goldeye have not been recorded in the Peace River upstream of the Smoky River confluence in Alberta (Mainstream 2006). As such, the goldeye population that uses the Peace River in the study area, likely are maintained by recruitment from downstream sources.

4.6 FISH COMMUNITY HEALTH

Large fish captured using a boat electrofisher were examined for physical health using the DELT Index method. Seven large fish species showed evidence of physical anomalies. Based on worked by Bauman *et al.* 2000, the health of fish populations upstream of Sections 6 and 7 was not impaired (DELT Index ≤ 0.5%) or was moderately impaired (DELT Index > 0.5% to 3.0%). However, DELT Index values increased for all species in Sections 6 and/or 7 to values that indicated strong (> 3.5% to 6.0%) to high impairment of health (> 6.0%). It is not known whether these data indicate natural conditions of fish populations or negative effects on fish health from anthropogenic sources that are introduced at or near the Pine River confluence (upstream boundary of Section 6).

5.0 CONCLUSIONS

The 2009 Peace River Fish Inventory collected baseline information to describe the fish community in the Peace River from PCN Dam to the British Columbia/Alberta boundary. This was accomplished by sampling eight sections distributed throughout the study area using multiple fish capture methods in a variety of habitats during three seasons. The study examined fish community structure, fish catch rates, population characteristics, and fish health. Fish also were marked with permanent tags to monitor future growth and movement patterns.

The program was successful in achieving its goal. The Peace River supports a diverse fish community that includes cold water and cool water sportfish, suckers, minnows, and sculpins. Fish community structure is not constant within the 151 km study area. There is a gradual shift from a cold water sportfish community dominated by mountain whitefish in the upstream area, to a more diverse fish community in the downstream area that is represented by multiple fish groups and species. This shift in fish community structure represents a transition from a cold, clear water fish community to a cool water fish community that contains species that are more tolerant of adverse environmental conditions (e.g., elevated fine sediment levels).

The majority of sportfish species were most numerous and resided in main channel habitats of the Peace River. A limited number of species (spottail shiner, northern pike, and yellow perch) appear to rely heavily on side channel habitats. The catch of sucker species and many minnow species suggested that tributaries are focal points for these populations.

Preliminary evidence suggests that most species in the study area are represented by viable, self sustaining fish populations. The majority likely spawn and rear in tributaries, before recruiting to Peace River populations. Data from only one species, mountain whitefish, indicated widespread spawning in the mainstem Peace River. Other large fish species (northern pike and yellow perch) rely heavily on protected side channel habitats for spawning and early rearing. A limited number of populations may be maintained by recruitment via entrainment through the PCN Dam. These include kokanee, lake trout, and lake whitefish. Only one species, goldeye, appears to be represented exclusively by adult fish, suggesting recruitment from downstream sources.

This one year of study provides a good description of the Peace River fish community. Additional work can be used to confirm these findings and to increase the certainty around future interpretation of the baseline data.

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PLATES

Plate 1 Backwater habitat located in the main channel.

Plate 4 SFN habitat located in the main channel.

Plate 2 Flat habitat located in the main channel.

Plate 5 SSC habitat located in the main channel.

Plate 3 SFC habitat located in the main channel.

Plate 6 SSN habitat located in the main channel**.**

Plate 7 Typical **f**lat habitat found in a side channel.

Plate 8 High quality oxbow habitat in a side channel.

Plate 9 Low quality oxbow habitat in a side channel.

Plate 10 Typical riffle habitat found in a side channel.

Plate 11 Tributary confluence **b**ackwater habitat.

Plate 12 Tributary confluence riffle habitat**.**