
**BRILLIANT UPGRADE PROJECT
RAINBOW TROUT RADIO TELEMETRY
PROGRAM IN BRILLIANT HEADPOND
2000 - 2001**



Prepared for

COLUMBIA POWER CORPORATION

Suite 200, 445 - 13th Avenue
Castlegar, British Columbia
VIN 1G1

by

GOLDER ASSOCIATES LTD.

201 Columbia Avenue
Castlegar, British Columbia
VIN 1A2

Phone: (250) 365-0344

Fax: (250) 365-0988

June 2002

BRILLIANT UPGRADE PROJECT

**RAINBOW TROUT RADIO TELEMETRY
PROGRAM IN BRILLIANT HEADPOND**

2000 - 2001

Prepared for

COLUMBIA POWER CORPORATION
Suite 200, 445 - 13th Avenue
Castlegar, British Columbia
V1N 1G1

by

GOLDER ASSOCIATES LTD.
201 Columbia Avenue
Castlegar, B.C.
V1N 1A2
Phone: (250) 365-0344
Fax: (250) 365-0988

June 2002

Cover photo: Aerial view from Shoreacres (looking downstream) of the confluence of the Slocan River (entering from centre right) and Brilliant headpond on the Kootenay River.

Suggested Citation: Golder Associates Ltd. 2002. Rainbow Trout Radio Telemetry Program in Brilliant Headpond, 2000 - 2001. Report prepared for Columbia Power Corporation, Castlegar, B.C. Golder Report No. 002-8832F: 22 p. + 3 app

EXECUTIVE SUMMARY

Golder Associates Ltd., on behalf of Columbia Power Corporation (CPC), conducted a rainbow trout radio telemetry program in Brilliant headpond from September 2000 to October 2001. This study was conducted to fulfill a commitment made by CPC as part of the Fish and Fish Habitat Mitigation and Compensation Plan for the proposed Brilliant Upgrade Project. The intent of the program was to determine whether rainbow trout in the upper and lower headpond represent one or more discreet populations, to assist in determining the origin of rainbow trout stocks in the headpond, to assess the relative degree of risk that project-related entrainment represents to the rainbow trout population, and to identify important rainbow trout habitats within the study area.

During the present study, 29 rainbow trout were implanted with radio transmitters in September and October 2000. Weekly ground-based tracking sessions were conducted throughout the September 2000 to October 2001 study period. In addition, aerial tracking surveys were conducted five times and boat-based tracking was conducted twice during the study period. Two rainbow trout were never detected after November 2000; the tags in these fish were suspected to have malfunctioned. Only two rainbow trout were entrained through Brilliant Dam. The timing of their entrainment (i.e., shortly after release) and the movement patterns exhibited by these fish prior to entrainment strongly suggested post-surgical mortality. Overall risk of the adult rainbow trout population to entrainment was rated as low and the data suggested entrainment impacts on the population were likely less than predation by ospreys (i.e., four radio-tagged fish were suspected to have been killed by ospreys).

Of the 25 tagged fish that were monitored over the entire year, 17 (68%) spent some portion of their time-at-large in the Slocan River, 9 (36%) moved into the Slocan River on more than one occasion, and 3 (12%) spent over 50% of their days-at-large in the Slocan River. Eight (32%) rainbow trout were located in the vicinity of known rainbow trout spawning areas in the Slocan River during the mid-March to May spawning period. Based on their locations during tracking surveys, all of the radio-tagged rainbow trout spent at least one-third of their time in Brilliant headpond and six fish (24.0%) spent all of their time in the headpond.

Based upon information collected during the present study and previous studies, there are apparently two rainbow trout stocks within the study area. These are: 1) Slocan Lake resident (lacustrine) and 2) Slocan River/Brilliant headpond resident (riverine). Rainbow trout that reside in minor tributaries to the headpond may form an additional stock, but this could not be confirmed by results of the present study. Rainbow trout in the Slocan River and in Brilliant headpond may represent different sub-populations, but based on the overlap between when and where the two groups spawn, they do not appear to represent distinct stocks.

Several important rainbow trout habitats in Brilliant headpond and the Slocan River were identified during the present study. Within Brilliant headpond, important feeding habitats included Slocan Pool and the areas in the vicinity of

tributary mouths (Slocan River, Glade Creek, McPhee Creek, and Little McPhee Creek). Rainbow trout also were present at Slocan Pool, the mouth of the Slocan River, and the mouth of Glade Creek during the spawning period. This may imply these areas were used for spawning by headpond rainbow trout, but this supposition was not confirmed in the present study. The Slocan River provided important feeding and spawning habitats for the population of rainbow trout that resides in Brilliant headpond.

The study results suggested that the Slocan River provides important spawning and feeding habitat for members of the population in Brilliant headpond. On this basis, the Slocan River appears to represent a suitable location to construct habitat enhancement works that are designed to compensate for rainbow trout entrainment losses related to the Brilliant Upgrade Project.

ACKNOWLEDGEMENTS

The following people are gratefully acknowledged for contributions of information and assistance during this study.

Franca and Tony Plonica - Property owners along Brilliant headpond

John Bell - Ministry of Water, Land, and Air Protection, Nelson, BC

Steve Arndt – Columbia Basin Fish and Wildlife Compensation Program, Nelson, BC

Gerry Oliver – G.G. Oliver and Associates, Cranbrook, BC

James and Jeremy Baxter – Baxter Environmental, Nelson, BC

Marlene Machmer – Pandion Ecological Research, Nelson, BC

The following employees of **Golder Associates Ltd.** contributed to the collection of data and preparation of this report.

Larry Hildebrand	Senior Fisheries Biologist/Managing Associate, Editor
Dana Schmidt	Senior Scientist/Project Advisor
Lynn Westcott	Fisheries Biologist/Co-editor
Mike Hildebrand	Fisheries Biologist/Author
Bronwen Lewis	Fisheries Biologist
Bob Chapman	Biological Technician
Edward Lem	Biological Technician
Chris King	Biological Technician
Dustin Ford	Biological Technician
Demitria Burgoon	Biological Technician
Marilyn James	Local Assistant
David Alexis	Local Assistant
Irene Laporte	Word Processor

Special thanks are extended to Marilyn James who conducted the majority of the tracking program. Her dedication to the task and her determination to find the fish contributed substantially to the success of this study.

TABLE OF CONTENTS

	Page #
EXECUTIVE SUMMARY	i
ACKNOWLEDGEMENTS.....	iii
LIST OF TABLES	v
LIST OF FIGURES.....	v
1.0 INTRODUCTION.....	1
1.1 BACKGROUND.....	1
1.2 PURPOSE	3
1.3 STUDY AREA.....	3
1.4 STUDY PERIOD.....	7
2.0 METHODS.....	8
2.1 PHYSICAL PARAMETERS	8
2.1.1 Discharge.....	8
2.1.2 Water Temperature.....	8
2.2 RAINBOW TROUT SAMPLING	8
2.2.1 Capture Method.....	8
2.2.2 Life History Data.....	9
2.2.3 Tagging Protocols	9
2.2.3.1 Floy Tagging	9
2.2.3.2 Radio Tag Implantation.....	9
2.2.4 Tracking	10
3.0 RESULTS AND DISCUSSION.....	12
3.1 PHYSICAL PARAMETERS	12
3.1.1 Discharge.....	12
3.1.2 Water Temperature.....	12
3.1.3 Habitat Conditions	12
3.2 DISTRIBUTION AND RELATIVE ABUNDANCE IN THE CATCH.....	14
3.3 LIFE HISTORY DATA	14
3.4 FISH MOVEMENTS	15
3.4.1 General Movement Patterns	15
3.4.2 Spawning Related Movements	17
3.5 STOCK STATUS.....	18
3.6 ENTRAINMENT	19
3.7 IMPORTANT HABITATS	20
4.0 CONCLUSION	21
5.0 LITERATURE CITED.....	23
APPENDIX A FISH CAPTURE DATA	
APPENDIX B RAINBOW TROUT MOVEMENT DATA	
APPENDIX C BRILLIANT HEADPOND RAINBOW TROUT STOCKING INFORMATION	

LIST OF TABLES

	Page #
Table 1.1 Sampling schedule for the Brilliant Upgrade Project rainbow trout radio telemetry program.	7
Table 3.1 Mean, minimum, and maximum length-at-age, and standard deviations for rainbow trout implanted with radio tags in Brilliant headpond, 2000.	15

LIST OF FIGURES

	Page #
Figure 1.1 Overview of the Brilliant headpond study area.	2
Figure 1.2 Brilliant headpond study area and sample site locations, 2000-2001.	5
Figure 1.3 Slocan River study area and sample site locations, 2000-2001.	6
Figure 3.1 Mean daily water temperature in Brilliant headpond and discharge at Brilliant Dam, 1 September 2000 to 30 September 2001.	13
Figure 3.2 Length-frequency distribution for rainbow trout sampled for general life history information ($n = 65$) in Brilliant headpond during the 2000-2001 radio telemetry program.	14

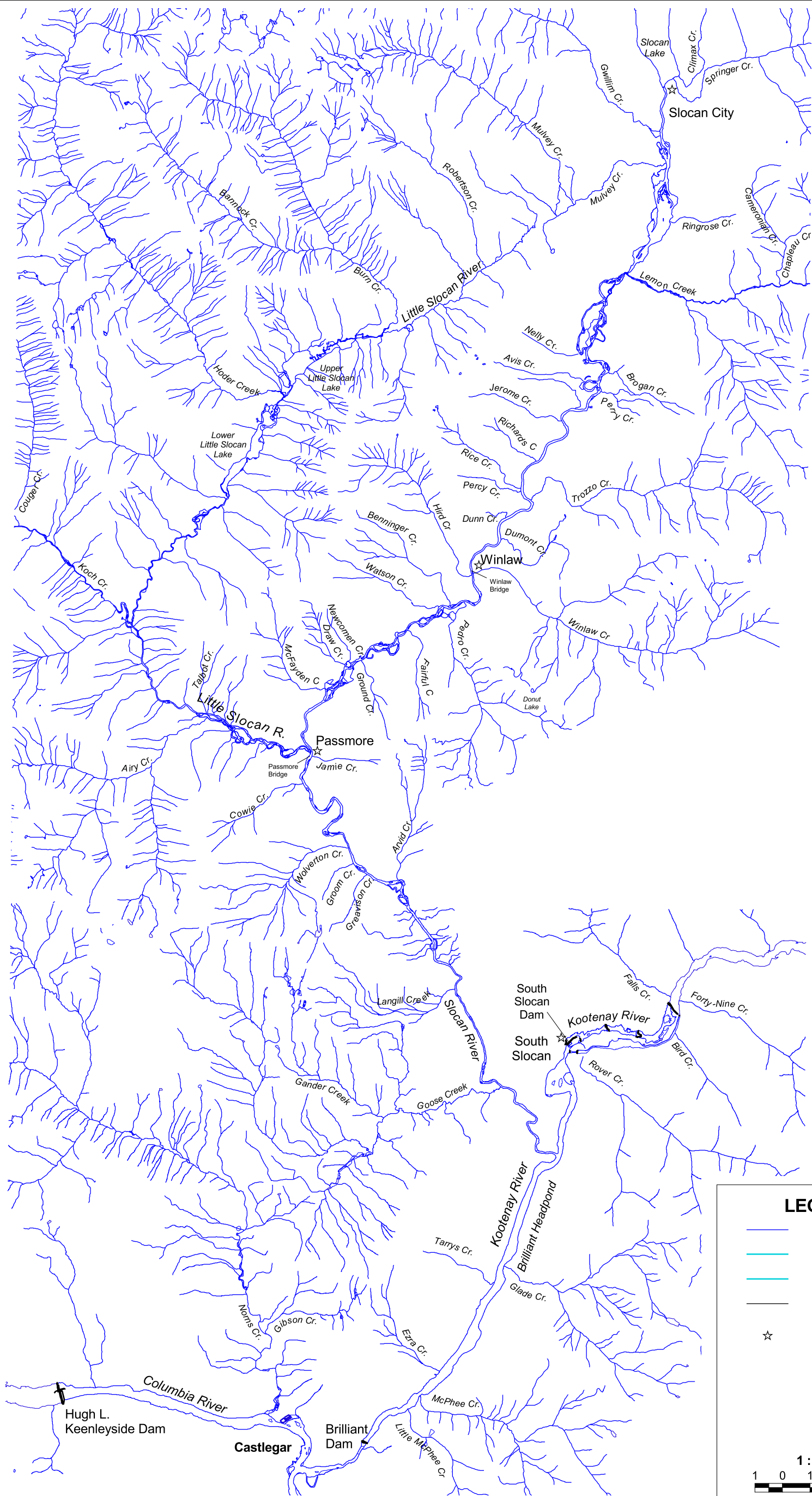
1.0 INTRODUCTION

1.1 BACKGROUND

In 1996, Columbia Power Corporation (CPC) purchased Brilliant Dam, located on the lower Kootenay River, from Cominco Ltd. (Figure 1.1). Shortly thereafter, CPC began investigating the feasibility of increasing hydroelectric generation capacity at this facility. This development, initially termed the Brilliant Redevelopment Project, consists of two separate components: the Brilliant Upgrade Project, which involves upgrades to the turbines in the existing powerhouse (scheduled for completion in December 2002), and the proposed Brilliant Expansion Project, which will involve future construction of an additional powerhouse adjacent to the existing dam. Both of these projects are designed to generate additional electricity from water that is currently spilled at Brilliant Dam.

The permitting process for the Brilliant Upgrade Project was initiated in 1997 and the main fisheries related impact identified for the project was the entrainment of headpond resident fish species. The pre-upgrade powerhouse flow capacity was 510 m³/s and the post-upgrade capacity will be 611 m³/s (CPC 2000). This means that more water will flow through the upgraded powerhouse, and therefore increased numbers of fish may also be entrained. Since mortality rates are believed to be higher for fish entrained through turbines than over spillways, entrainment mortality of fish may also increase. The primary fish species of recreational and cultural value in the Brilliant headpond is rainbow trout and therefore, in consultation with the regulatory agencies, CPC developed a conceptual plan to compensate for the incremental increase in entrainment the project would potentially cause. The details of this plan are provided in Section V, Appendix D of the Brilliant Upgrade Project Water Licence Application Support Documentation, Attachment No. 6, Addendum.

The development of the rainbow trout entrainment compensation plan was divided into several phases. Phase 1 involved the preliminary identification of potential tributary sites within the headpond and the lower Slocan River where habitat enhancements could potentially be constructed to produce the habitat required to support the compensation targets of rainbow trout. Results of the office-based Phase 1 investigations identified three candidate tributaries: McPhee and Glade creeks (tributaries to the headpond) and Goose Creek (a tributary to the lower Slocan River). Subsequently, Phase 2 field investigations were conducted to verify the suitability of these streams and identify potential enhancement sites. These studies resulted in the elimination of McPhee and Goose creeks as potential candidates due to reasons of excessive stream gradient and human development impacts, respectively. Glade Creek was deemed to have some potential for enhancement work but there was some concern that the compensation targets (provision of spawning habitat for 50 spawning pairs or rearing habitat for 500 age 1+ juveniles) could not be met in the relatively small section of the creek that was suitable for enhancement. There was also some uncertainty as to whether habitat enhancements in Glade Creek would actually result in benefits to the headpond rainbow trout population since the life history strategies of the headpond population were unknown. As a result of these concerns and in an attempt to provide compensation



LEGEND

- River
- Lake
- Reservoir
- Dam Structure
- Settlements

N

Scale
1 : 150,000

1 0 1 2 Kilometres

PROJECT No. 002-8832		
DESIGN	MH	25 Mar. 2002
GIS	EL	25 Mar. 2002
CHECK	MH	24 May 2002
REVIEW	EL	24 May 2002

FIGURE 1.1

TITLE

Overview of the Brilliant Headpond Study Area

PROJECT

Brilliant Upgrade Project

Brilliant Headpond
Rainbow Trout
Radio-Telemetry Program
2000-2001



where the greatest benefits to the headpond population would be realized, CPC proposed to conduct a radio-telemetry program to identify movement patterns and important habitats of rainbow trout in Brilliant headpond.

1.2 PURPOSE

The specific objective of the present study was to monitor movements of rainbow trout in Brilliant headpond and the Slocan River in an attempt to:

- determine whether rainbow trout in the upper and lower headpond represent one or more discrete populations;
- provide information that may assist in the determination of the potential origin of rainbow trout stocks in the headpond;
- assess the relative degree of risk that project related entrainment losses represent to the rainbow trout population in Brilliant headpond and to the population in the lower headpond in particular; and
- identify important habitats for rainbow trout populations that reside in the upper and lower portions of the headpond.

This information will be used in the development of the final rainbow trout compensation plan (provided under separate cover) for the Brilliant Upgrade Project.

1.3 STUDY AREA

The Kootenay River originates in the Rocky Mountains in southeastern British Columbia. The river flows south into Montana, where Libby Dam forms the Koocanusa Reservoir. The river then flows in a northwesterly direction through northeast Idaho and into Kootenay Lake in British Columbia. The West Arm of Kootenay Lake drains via the Kootenay River, which flows southwest through a series of dams into Brilliant headpond (Figure 1.1). The Kootenay River enters the Columbia River 2.8 km downstream from Brilliant Dam at the City of Castlegar.

At the Glade Ferry crossing on Brilliant headpond, the Kootenay River has a drainage area of 45 469 km² (WSC 1976). This represents approximately 32 percent of the total Columbia River drainage area measured above the confluence of the Columbia and Kootenay rivers.

Brilliant headpond is approximately 18 km in length, with a volume of 5.5×10^7 m³ and a surface area of 5.5×10^6 m² (BC Hydro 1984). The headpond has a mean annual inflow of 883 m³/s and a water retention time of approximately one day at a mean daily flow of 510 m³/s. The headpond is operated as a run-of-the-river type reservoir and is situated in a narrow, mostly forested valley. The banks are composed mainly of steeply sloping parent bedrock material, except in the middle portion where the banks have lower slopes and bank materials composed primarily of unconsolidated till. Excluding developed areas (e.g., Glade and Shoreacres), the banks and valley walls are generally forested to near the full pool elevation.

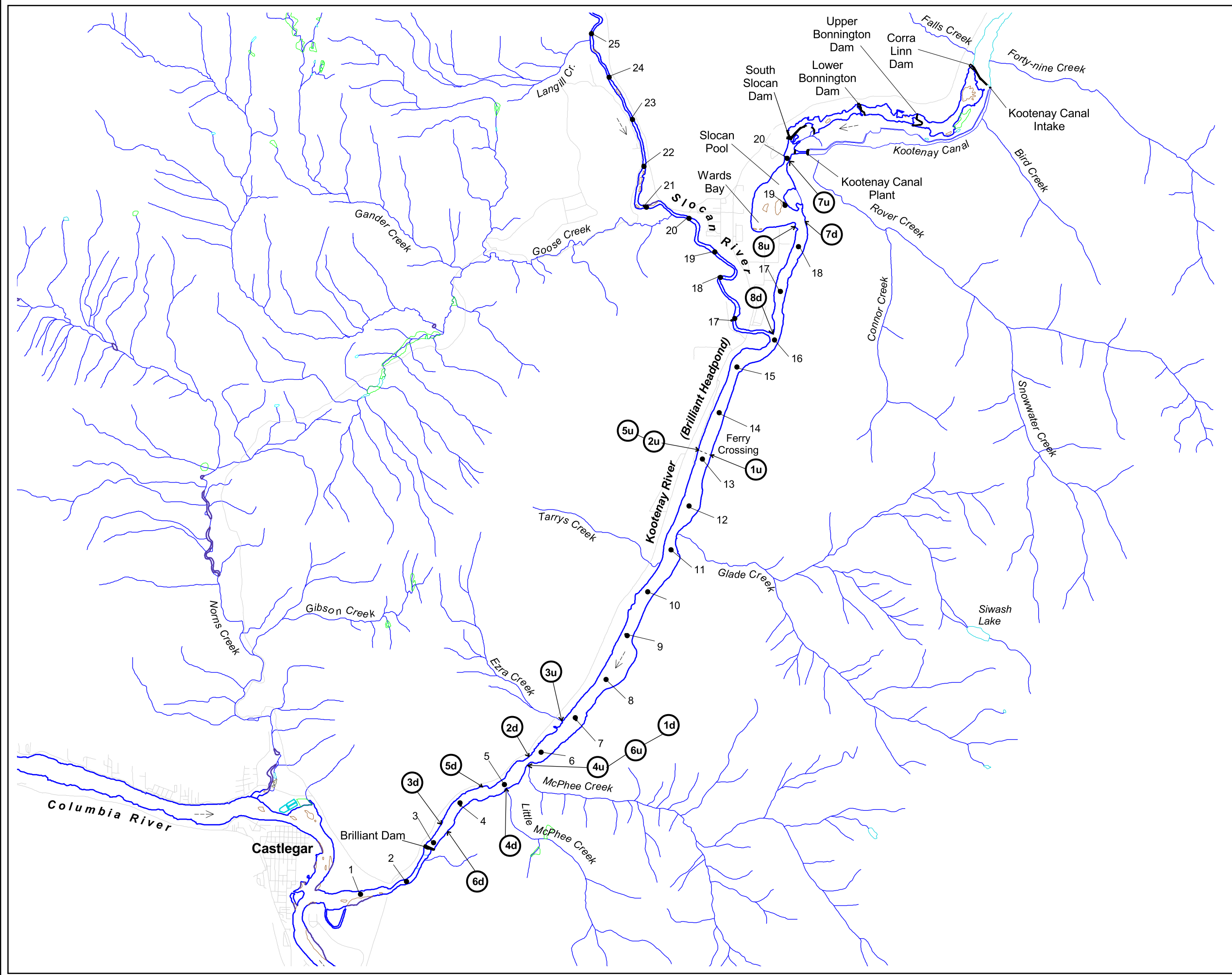
South Slocan Dam and the Kootenay Canal Plant form the upstream boundary of Brilliant headpond (Figure 1.2). The 1.0 km section below these powerplants consists of a fast flowing and deep channel, confined by a narrow canyon with steep bedrock banks. Abundant instream cover for fish is available, although littoral area is limited and macrophyte growths are sparse. Below the outlet of the canyon, the valley opens up into the Wards Bay area, the widest point (approximately 1.0 km) in the headpond. Slocan Pool, situated in the upper section of the Wards Bay area, is a large scour hole formed at the outlet of the confined canyon section, with depths to 20 m. The headpond downstream from this area is generally shallow (maximum depths of 10 to 12 m) and exhibits a braided channel form with a treed island and shallow shoals. Extensive macrophyte growth occurs in the area in the late spring to early fall period.

Downstream from Wards Bay, the headpond narrows and deepens. The Slocan River, the main tributary to the headpond, enters on the west bank at Km 16 (measured upstream from the Kootenay and Columbia rivers confluence). Resident populations of rainbow trout, bull trout, and mountain whitefish are present in the Slocan system. The headpond from the mouth of the Slocan River downstream to the forebay of Brilliant Dam exhibits similar habitat characteristics. Maximum depths range from 10 to 20 m and most of the banks are steeply sloped. Extensive growths of macrophytes form dense weed beds along both shoreline margins, with the width of these beds dependent on shoreline slope. Velocities throughout the area are low to moderate.

The Slocan River originates at the outlet of Slocan Lake, northwest of Nelson, BC, and flows south for 57 km to its confluence with the Kootenay River (Brilliant headpond) at Shoreacres (Figure 1.3). It is a meandering river with a mean annual discharge of 89 m³/s (Oliver 2001). Immediately downstream of Slocan Lake the river is very wide (up to 400 m) and shallow during the spring freshet. Downstream of Lemon Creek the channel narrows (mean width 50 m) and is relatively unconfined for 15 km. Between Perry Creek and the town of Winlaw, the substrate is comprised primarily of sand and silt. The lower 30 km of the Slocan River (measured upstream from its confluence with the Kootenay River) is typified by frequent riffle/glide sequences with cobble/boulder dominated bed materials; the channel is moderately incised and usually 40 to 50 m wide (Oliver 2001).

In addition to the Slocan River, five small tributaries flow into Brilliant headpond (three on the east shore and two on the west shore). These streams exhibit precipitous lower reaches and, except for McPhee, Little McPhee, and Glade creeks (Figure 1.2), are intermittent streams that contain flow only during spring runoff or high precipitation events.

All rainbow trout sampling during the present study occurred within Brilliant headpond, between the safety boom at the forebay of Brilliant Dam (downstream end) and South Slocan Dam and Kootenay Canal Plant (upstream end). The study area for the radio tracking component included the Kootenay River from the confluence with the Columbia River to the South Slocan Dam and Kootenay Canal Plant, the Slocan River from the confluence with Brilliant headpond to the outlet of Slocan Lake, the lower reaches of Goose Creek, Lemon Creek, and the Little Slocan River, and Little Slocan Lake.



LEGEND

- (1u)** Boat Electrofishing section
- (1d)** u = upstream limit
d = downstream limit
- 00●** River Kilometre
- 2 Lane Paved Roads
- River
- Lake
- Reservoir
- Dam Structures
- Island
- Marsh or Swamp
- Sand or Gravel Bar
- ← Flow Direction

N

Scale
1 : 75,000

1 0 1 Kilometres

FIGURE 1.2

PROJECT	Brilliant Upgrade Project Brilliant Headpond Rainbow Trout Radio Telemetry Program 2000-2001	
TITLE	Brilliant Headpond Study Area and Sample Site Locations, 2000-2001	
	PROJECT No. 002-8832	
DESIGN	MH	25 Mar. 2002
GIS	EL	25 Mar. 2002
CHECK	MH	24 May 2002
REVIEW	EL	24 May 2002

Golder Associates
Castlegar, British Columbia

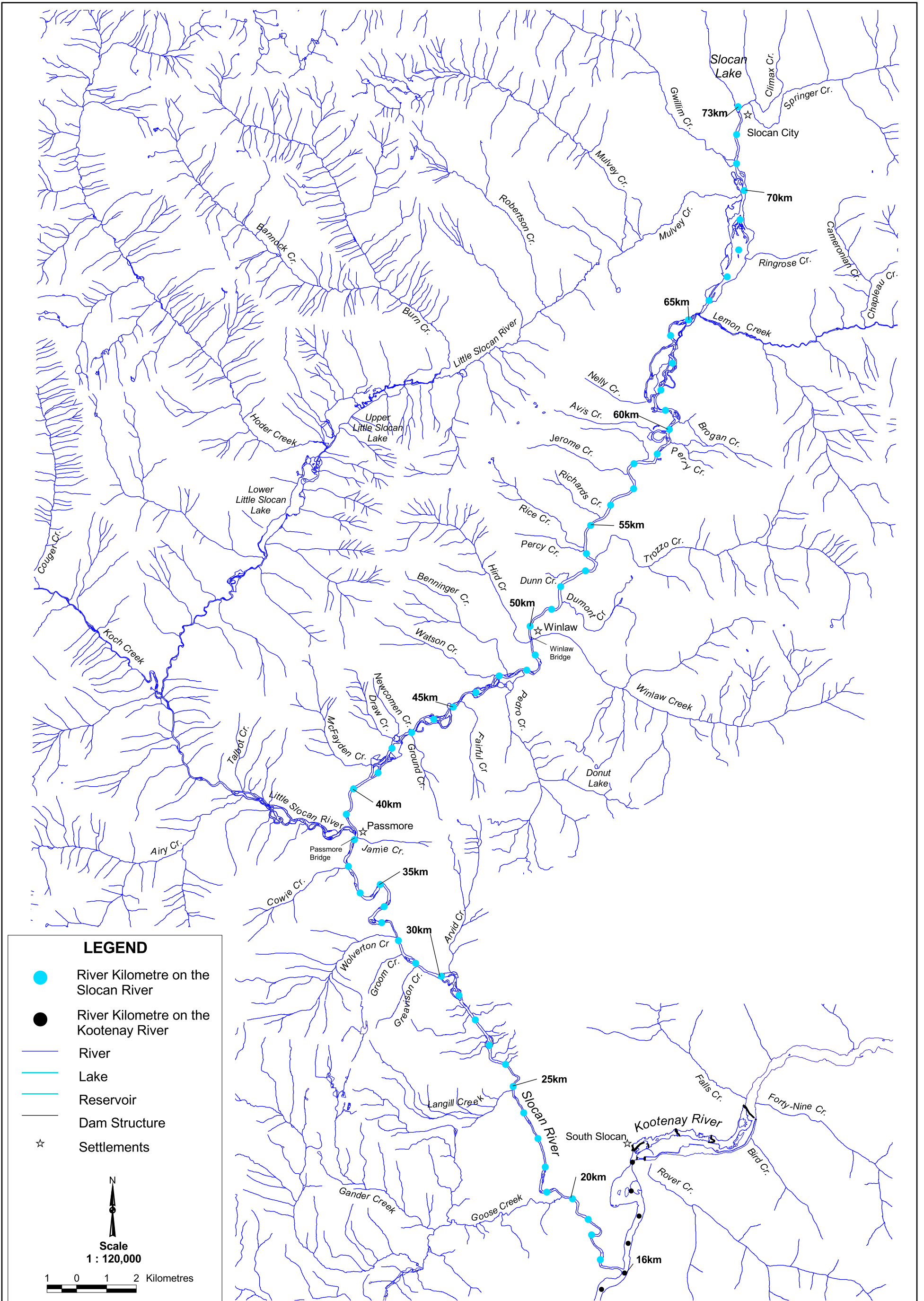


FIGURE 1.3
Slocan River
Study Area and
Sample Site Locations,
2000-2001

PROJECT
Brilliant Upgrade
Project
 Brilliant Headpond
 Rainbow Trout
 Radio-Telemetry Program
 2000-2001



PROJECT No. 002-8832		
DESIGN	MH	25 Mar. 2002
GIS	EL	25 Mar. 2002
CHECK	MH	24 May 2002
REVIEW	EL	24 May 2002

1.4 STUDY PERIOD

Boat electroshocking was the only sample method used to capture rainbow trout during the present study. Radio tracking was mainly ground-based (weekly), five radio tracking flights were completed, and two days of boat tracking were completed. A summary of the fish capture and tracking sampling schedules are provided in Table 1.1.

Table 1.1 Sampling schedule for the Brilliant Upgrade Project rainbow trout radio telemetry program.

Study Component/Date Conducted				
Fish Capture	Tag Implantation	Aerial Tracking Surveys	Boat Tracking Surveys	Ground Tracking Surveys
12 September 2000	14 September 2000	6 December 2000	9 April 2001	29 September 2000
13 September 2000	27 September 2000	2 April 2001	16 April 2001	12,18,24,25 October 2000
25 September 2000	6 October 2000	11 April 2001		2,9,14,23,30 Nov. 2000
26 September 2000	7 October 2000	9 May 2001		18,29 December 2000
5 October 2000		29 August 2001		4,8,15,23,30 January 2001
				7,16,20,27 February 2001
				8,15,20,27 March 2001
				3,10,18,23 April 2001
				3,7,11,17,24 May 2001
				1,8,15,22,28,29 June 2001
				5,12,19,27 July 2001
				3,6,14,21 August 2001
				6,13,19,27,29 Sept. 2001
				3,10,11 October 2001

2.0 METHODS

2.1 PHYSICAL PARAMETERS

2.1.1 Discharge

Stream discharge data for the mainstem Kootenay River (measured as discharge through Brilliant Dam) from 1 September 2000 to 30 September 2001 were obtained from Utilicorp Networks Canada. Daily mean discharges were calculated from the hourly data obtained. Water level data for the Slocan River during the study period was obtained from the BC Ministry of Water, Land and Air Protection/Environment Canada – River Data website 2002 (<http://scitech/pyr.ec.gc.ca/water/Map.asp>).

2.1.2 Water Temperature

Water temperatures were recorded at one hour intervals using Onset Stowaway Tidbit™ temperature loggers located in the forebay of Brilliant Dam. Two thermographs were located in the forebay to minimize the risk of data loss due to tampering or equipment failure. Data from the temperature loggers were downloaded at three-month intervals and tabulated using software provided by the temperature logger manufacturers. Daily means were then calculated from the hourly data.

2.2 RAINBOW TROUT SAMPLING

2.2.1 Capture Method

Boat electroshocking was the only method used to capture rainbow trout during the present study. This system employed a Smith-Root Inc. high-output electroshocker boat (SR18E) operated by a three-member crew (i.e., two netters positioned on a bow-mounted work platform and one boat operator). The electroshocking procedure consisted of manoeuvring the boat along the shoreline of the sample sections. The netters attempted to capture all rainbow trout stunned by the electrical field. This is an effective method for capturing fish for radio telemetry studies and has been successfully used in previous studies to investigate movements of rainbow trout and walleye in the Columbia River (Hildebrand and English 1991). Previous studies conducted in the Columbia and Kootenay rivers have shown that, due to high water clarity, boat electroshocking during daylight hours is inefficient at catching certain sportfish species such as rainbow trout (R.L. & L. 1998). Therefore, boat electroshocking in Brilliant headpond was conducted at night during the present study.

To reduce stress on captured and tagged rainbow trout, the capture component was conducted in the fall season at water temperatures below 16°C. The goal was to capture and equip 29 rainbow trout with radio transmitters (30 tags were available and one was retained as a reference tag). Five nights of boat electroshocking were required to capture enough rainbow trout of sufficient size from each of the different sections of the headpond (upper, middle, and lower) sampled. Prior to processing, captured rainbow trout were held in an on-board 210 L live-well equipped with a circulating water

exchange system. Upon completion of sampling in each boat electroshocking section, rainbow trout were processed for life history data, and marked with uniquely numbered Floy tags (if over 250 mm in fork length). Fish not retained for radio tag implantation were released. Catch-per-unit-effort (CPUE = number of fish captured per kilometre) values were calculated for rainbow trout from each sample section.

2.2.2 Life History Data

Life history data collected from captured rainbow trout included; fork length, weight, and sex (where gonads were easily visible through the incision). Scales (15 to 20 per fish) were taken as aging structures and otoliths were also taken from mortalities. These data were used to develop a length-frequency distribution for rainbow trout captured in 2000.

2.2.3 Tagging Protocols

2.2.3.1 Floy Tagging

Rainbow trout greater than 250 mm in fork length were marked with Floy™ T-bar anchor tags to provide supplemental entrainment and movement data (i.e., from angler returns and recaptures). These tags were inserted at an acute angle (so that they lie next to the body as the fish swims) just below the dorsal fin using a Dennison tagging gun. The tagging gun needle was inserted past the midline of the fish and then turned 90° to ensure that the anchor of the tag was locked in place behind the pterygiophores (dorsal fin rays) to reduce tag loss. The tag was then gently tugged to determine if it was anchored properly. If the tag was not anchored between the pterygiophores, it was reinserted until properly anchored.

2.2.3.2 Radio Tag Implantation

The radio tags used in the present study were Model MCFT-3EM internal radio transmitters manufactured by LOTEK Engineering Inc. The tags weighed 8.9 g in air and were less than 3% of the fish's body weight (the tags were between 2.0 and 2.6% of the body weight for 12 fish and under 2% of the body weight for 17 fish). The tags were 4.9 cm long by 1.1 cm diameter with a 40.0 cm long stainless steel antenna encased in a Teflon sleeve. The tags transmitted at a burst rate of 5 seconds and were rated for a minimum battery life of 399 days. The tags were coded as 1 to 6 on each of the following frequencies: 149.520 MHz, 149.540 MHz, 149.560 MHz, 149.800 MHz, and 149.760 MHz. Prior to the selection of the radio tag frequencies, noise scan surveys were conducted at Brilliant Dam (the location of the fixed radio receiver station; see Section 2.2.4). The noise scan was conducted to identify potential radio wave interference that could produce spurious signals. The frequencies selected for use in this study were those with the lowest levels of background noise.

Minimizing stress to captured fish that are used in telemetry programs is very important to reduce post-tagging mortality and to encourage the resumption of normal behaviour after release. Rainbow trout that were selected for radio tagging were held in a holding pen anchored in slowly flowing water for 12 to 36 hours (overnight) before surgical implantation was performed. This allowed the fish to reduce levels of lactic acid (resulting from capture stress) from their system and

also to digest and evacuate their stomach contents, thereby reducing their oxygen demand before surgery was performed (Mylechreest 1997).

The surgical theatre consisted of an operating trough set on a portable table. The trough kept the posterior of the fish elevated above the gills. This facilitates irrigation of the gills without contaminating the incision. The surgical instruments and radio tag were sterilized in Germaphine™, placed on a sterile surgical drape, and allowed to dry by evaporation. An anaesthetic bath was prepared by mixing 1 mL of clove oil with 3 mL of ethyl alcohol and adding this mixture to 10 L of river water in a cooler. The crewmember performing the surgery scrubbed his hands and donned sterile gloves while an assistant placed the fish in the anaesthetic bath. Fish usually reached an appropriate stage of anaesthesia after approximately three minutes in the bath.

The fish was placed on its back in the operating trough and the area where the incision would be made (just off the midventral line and about 3 cm anterior to the insertion of the pelvic fins) was swabbed once with Triadine™ to disinfect the area and once with Germaphine™ to prevent irritation potentially caused by Triadine™. The surgical drape was placed over the fish with the aperture over the area where the incision would be made. A 2 cm long incision was made into the abdominal cavity using a scalpel fitted with a curved (No. 12) blade. An 18 gauge intramuscular needle was used to pass the radio tag antenna from within the incision, through the abdominal wall, and out the side of the fish. The radio tag was inserted in the abdominal cavity, while ensuring that the antenna was not twisted or bent. The incision was then closed using three simple interrupted sutures (2-0 monofilament). Another suture was placed slightly posterior to the exit point of the radio tag antenna to hold the antenna against the side of the fish in order to prevent aggravation of the exit point. The fish was then placed in the live-well of the electroshocking boat, with the recirculating pump engaged, for a minimum of one hour, until it regained equilibrium and could swim away of its own accord.

2.2.4 Tracking

A summary of tracking dates and methods is provided in Table 1.1. The majority of radio tracking was conducted from shore, although additional surveys were conducted from fixed-wing aircraft and riverboat. All radio tracking methods utilized a Lotek SRX 400 radio receiver. Five frequencies were used for the radio tags; each frequency encompassed six tags, each with different codes.

Shore-based telemetry was performed from a truck using a radio receiver and a Yagi antenna. Tracking was conducted at approximately one-kilometre intervals (based on available access and line-of-sight) along the shoreline of Brilliant headpond. Most of these access points were located along the western shore of the headpond although trips also were made across the ferry to Glade to conduct tracking along that section of the headpond. At each access location, the five active radio frequencies were scanned using a hand-held Yagi antenna. When a signal was detected, the scan cycle was stopped until the receiver was able to decode the signal.

Aerial tracking surveys were conducted five times (Table 1.1) in the present study to supplement the shore-based tracking data, to test the effectiveness of other tracking methods, and to expand the area of coverage. A Yagi antenna was mounted the strut of each wing of the fixed-wing aircraft that was used for radio telemetry flights. A switch was installed to enable alternate scanning between antennas in order to locate tags more effectively.

Tracking was conducted from a boat on two occasions, using a hand-held Yagi antenna. The boat was allowed to drift in areas with high current velocities and was driven and stopped at approximately 500 m intervals in slower current areas. Boat-based surveys occurred subsequent to shore-based tracking in order to supplement the data obtained from the ground-based surveys and also to determine the effectiveness of the two methods in detecting fish. One boat-based tracking session was conducted over the entire length of Brilliant headpond and the other in the Kootenay River below Brilliant Dam (to check for entrained fish).

In order to more accurately identify and quantify entrainment, a fixed tracking station was set up on Brilliant Dam and commenced operation on 4 December 2000. The station consisted of a Lotek SRX 400 radio receiver/data logger and two Yagi antennas using a LOTEK ASP8 antenna switch. The receiver and switch were enclosed in a weatherproof box. The antenna switch enabled the receiver to alternate between the two antennas, one of which monitored the headpond while the other monitored the tailwater area. The receiver was equipped with Code_Log version 4.2x W16 software, which programmed the unit to cycle through each antenna on each of the five frequencies in turn. The data logger recorded each of the transmitters that could be coded out. The fixed station data logger was downloaded on a biweekly basis until it was dismantled on 13 November 2001.

3.0 RESULTS AND DISCUSSION

3.1 PHYSICAL PARAMETERS

3.1.1 Discharge

Mean daily discharges from Brilliant Dam for the period of 1 September 2000 to 30 September 2001 are presented in Figure 3.1. Discharge from Brilliant Dam generally peaks in late May or early June, declines in late June or July, and reaches baseflow conditions in late August. During late 2000 and 2001 (2001 was among the lowest water years on record), the discharge pattern from Brilliant Dam was similar to the general discharge pattern recorded since 1990 (R.L. & L. 1999), but of substantially lower overall magnitude. The peak mean daily discharge from Brilliant Dam during the present study occurred on 31 May 2001 (1336.6 m³/s) and the lowest mean daily discharge occurred on 11 April 2001 (186.9 m³/s). Discharge from Brilliant Dam exhibited moderate fluctuations (due to load factoring operations at the Kootenay Canal plant) throughout the study period.

Discharge from the Slocan River during the study period was generally below average, with only brief periods where discharge exceeded average levels because of localized precipitation events, (BC Ministry of Water, Land and Air Protection/Environment Canada – River Data website 2002: <http://scitech/pyr.ec.gc.ca/water/Map.asp>). Mean summer (1 July to 30 September) flow in the Slocan River is 95 m³/s (WSC 1977).

3.1.2 Water Temperature

Mean daily water temperatures in Brilliant headpond from 1 September 2000 to 30 September 2001 are presented in Figure 3.1. Water temperatures in Brilliant headpond generally peak in August, begin dropping in September, and are lowest in January and February. During late 2000 and 2001, water temperatures in Brilliant headpond followed a pattern similar to that observed in previous years (1990 to 1997; R.L. & L. 1999). The lowest mean daily water temperature in Brilliant headpond during 2001 was recorded on 20 February (2.6°C) and the peak water temperature was recorded on 17 August (20.2°C).

Historical mean summer (1 July to 30 September) water temperature in the Slocan River was reported at 15.4°C (Oliver 2001). In recent years, mean summer water temperatures from 1 July to 15 September have been measured between 18.4 and 20.2°C (Oliver 2001).

3.1.3 Habitat Conditions

Habitat conditions in Brilliant headpond have been described in detail in past studies (R.L. & L. 1998 and 1999). Habitat conditions in the study area have not changed appreciably since these studies and, therefore, are not discussed in detail in this report.

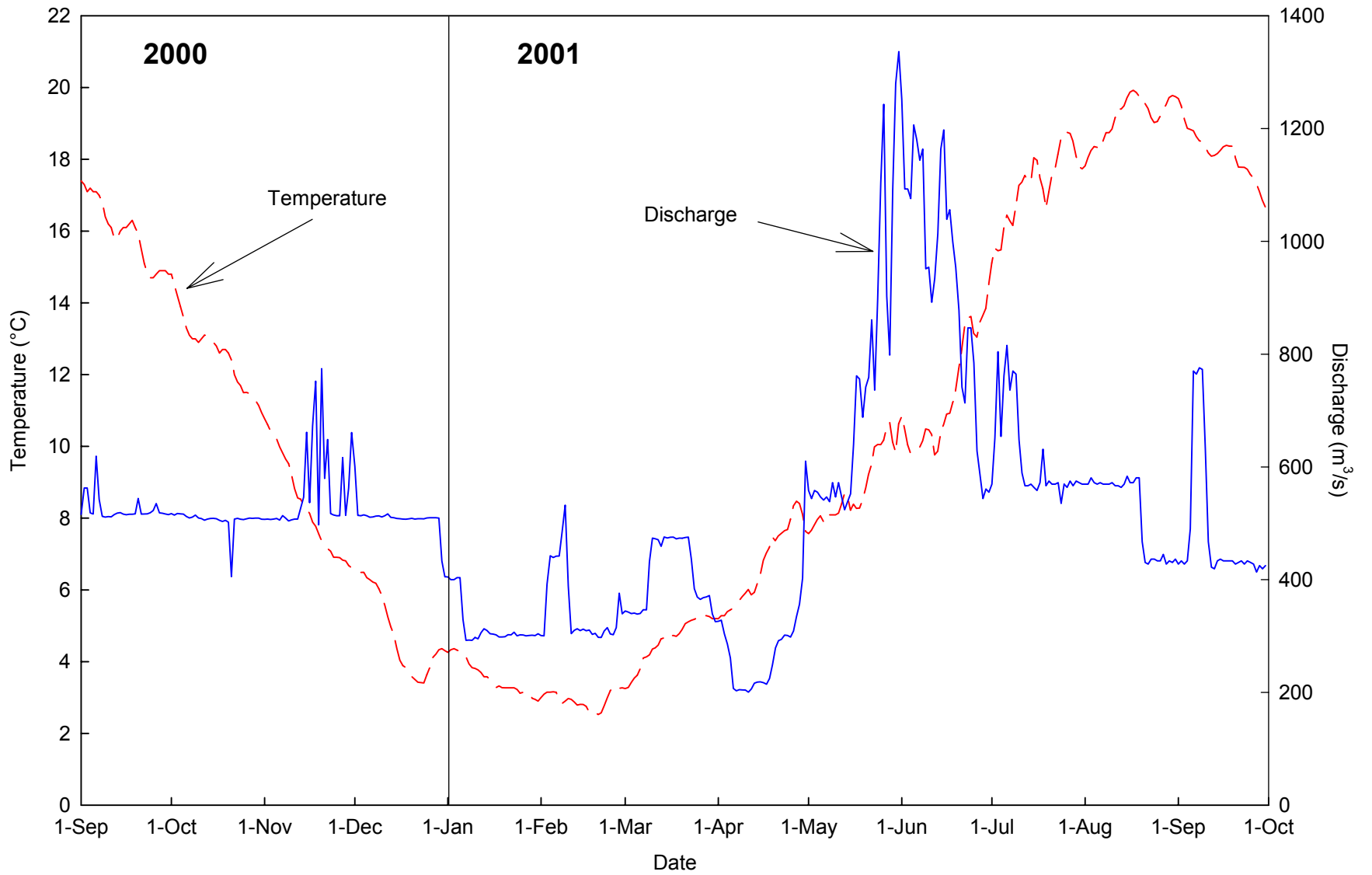


Figure 3.1 Mean daily water temperature in Brilliant headpond and discharge at Brilliant Dam, 1 September 2000 to 30 September 2001.

3.2 DISTRIBUTION AND RELATIVE ABUNDANCE IN THE CATCH

In total, 93 rainbow trout were captured in Brilliant headpond during the present study (Appendix A, Table A1). The spatial distribution of rainbow trout in Brilliant headpond during the present study was similar to that recorded in past studies (R.L. & L. 1998 and 1999). In all three studies, rainbow trout were more abundant in the upper section of the headpond and their abundance decreased with increased distance downstream from South Slokan Dam. The highest catch-rate for rainbow trout during the present study was recorded at sites ES7 and ES8 (11.7 fish/km), the furthest upstream sites (Appendix A, Table A1; Figure 1.2). The lowest catch-rate was recorded at Site ES1 (0.7 fish/km), one of the further downstream sites. The higher abundance in the upper section of the headpond was attributed to the more riverine habitat conditions in that area.

3.3 LIFE HISTORY DATA

Rainbow trout ($n = 65$) sampled for general life history information in Brilliant headpond during the present study ranged from 160 to 435 mm in fork length (FL); the largest individual weighed 993 g. Fish over 250 mm FL contributed 80.0% to the total rainbow trout catch (Figure 3.2). The abundance of fish over 250 mm FL and the large average size of fish captured (mean FL of 310 mm) reflected the selective capture of larger fish that were of a suitable size for radio tag implantation, rather than the actual population structure.

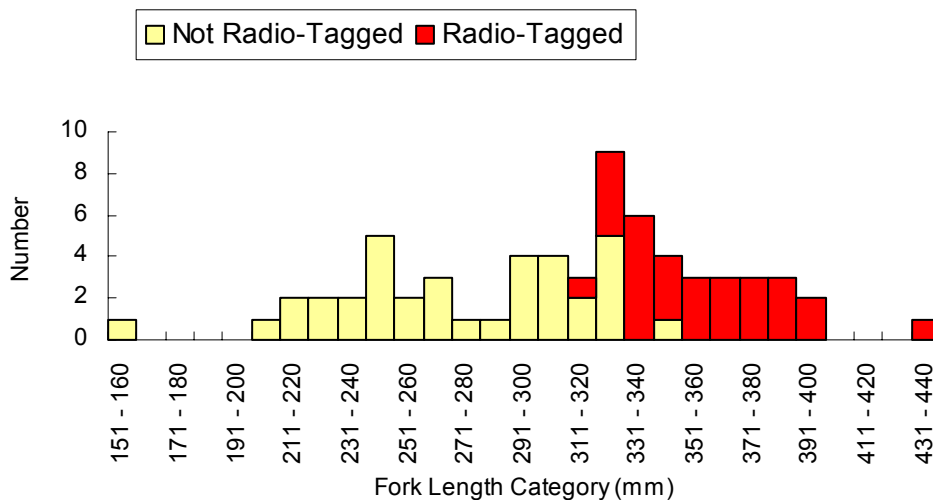


Figure 3.2 Length-frequency distribution for rainbow trout sampled for general life history information ($n = 65$) in Brilliant headpond during the 2000-2001 radio telemetry program.

The length-frequency distribution of the catch consisted predominantly of older juvenile and adult cohorts, which would suggest the main use of Brilliant headpond by rainbow trout was for holding and feeding during these life stages. Although the selection by the netters for larger fish may suggest the distribution recorded in the present study is not representative of the headpond population as a whole, previous studies have indicated a similar size distribution of the catch (R.L. & L. 1993 and 1998). These same studies also indicated that juvenile rainbow trout were more abundant near the confluence of the Slocan River and on the basis of this information, the Slocan River likely provides important rearing habitat for this species.

Age-length data for rainbow trout captured during the present study is provided in Table 3.1. Ages were only obtained from fish that were radio-tagged. The ages of four fish could not be determined because the samples obtained consisted of regenerated scales that cannot be accurately aged. All of the aged radio-tagged fish were between 4 to 6 years-of-age with the majority (45%) being age five.

Table 3.1 Mean, minimum, and maximum length-at-age, and standard deviations for rainbow trout implanted with radio tags in Brilliant headpond, 2000.

Variable	Fork Length (mm) at Age		
	4	5	6
Mean	351	348	375
Minimum	322	315	343
Maximum	388	394	435
Standard Deviation	28	22	36
<i>n</i>	7	13	5

Of the 65 rainbow trout sampled for life history information, 13 fish were sexed; nine (69%) were females and four (31%) were males. The sex distribution of the 10 radio-tagged rainbow trout was seven (70%) females and three (30%) males. Due to the small sample sizes, these ratios may not be representative of the population as a whole.

3.4 FISH MOVEMENTS

3.4.1 General Movement Patterns

During the present study, tracking sessions were not conducted every day and as a result, extended intervals of time occurred between the surveys when a particular fish was relocated; therefore, it is probable that not all of the movements undertaken by tagged fish were detected. Some fish could have made movements into the Slocan River, to spawning areas or tributaries, or to other areas of the headpond. As a result, the following discussion of results, while based on the available data, should be considered within this limitation.

Graphical presentations of movements for individual rainbow trout implanted with radio transmitters are presented in Appendix B, Figures B1 to B3. Tabular information on the specific dates and river kilometres where rainbow trout were

detected are provided in Appendix B, Table B1. In the present report, river kilometres were measured upstream from the confluence of the Columbia and Kootenay Rivers (mouth of the Slocan River = Km 16.0) using 1:20 000 TRIM layer maps. In previous studies (Baxter and Roome 1998), river kilometres were measured upstream starting from the Highway 3A bridge near the mouth of the Slocan River and were based on 1:250 000 scale maps. When locations derived from both study results were transcribed to the 1:50 000 topographic maps used for data presentation in the present study, numerous inconsistencies were found between kilometre markings used in the 1998 study and the present study. For consistency, the kilometre designations derived for the present study are used throughout this report.

Higher water temperatures often result in increased levels of stress in fish that are captured and handled. The capture and tag implantation component of the present study was specifically scheduled to take place when water temperatures in Brilliant headpond were below 16°C in order to reduce stress levels low in captured fish. The high percentage of tagged fish that remained active over the duration of the one-year study indicated that stress from the capture and tagging procedure was not a significant influence on fish mortality.

Two fish were located a few times after release and then were never subsequently located. One fish (Frequency 149.560, Code 6; Appendix B, Figure B3) was released on 6 October at Km 19.5 and subsequently relocated within one kilometre of this location on six occasions until 30 November, after which time it was never located again. Another fish (Frequency 150.780, Code 6; Appendix B, Figure B3) was also released on 6 October at Km 19.5 and was only located once again, on 18 October at Km 11.5. Considering that all other tags were subsequently located somewhere within the system (regardless of the fate of the fish), the most reasonable assumption is that these tags malfunctioned shortly after release.

Of the 27 radio-tagged rainbow trout that were tracked over the entire study period, 12 (44%) exhibited maximum upstream movements of 10 km or more, 7 (26%) exhibited maximum upstream movements of over 20 km, 3 (11%) of 30 km or more, 2 (7%) of over 40 km, and 1 (4%) of over 50 km (Appendix B, Tables B2 and B3). The average maximum upstream movement by all radio-tagged fish was 13.1 km. The furthest upstream location in the Slocan River where radio-tagged rainbow trout were detected was in the vicinity of Lemon Creek at river kilometres 67.5 (Frequency 149.540, Code 5) and 67.3 (Frequency 149.520, Code 6).

Maximum downstream movements of 10 km or more were exhibited by 14 (52%) rainbow trout, over 20 km by 4 (15%) fish, over 30 km by 3 (11%) fish, and over 40 km by 1 (4%) fish. The average maximum downstream movement for all rainbow trout was 11.9 km. The furthest downstream location where radio-tagged trout were located was Km 2.0 in the Kootenay River below Brilliant Dam.

Of the 27 radio-tagged rainbow trout that were tracked over the entire study period, 17 (63%) were detected at some time over the course of the monitoring period in the Slocan River (Appendix B, Table B3). Three (11%) rainbow trout spent over 50% of their days-at-large in the Slocan River. All of the radio-tagged rainbow trout spent at least one-third

of their time in Brilliant headpond; 26 (96%) spent over 50% of their days-at-large in the headpond and 10 (37%) spent all of their days-at-large in the headpond (i.e., were always recorded in the headpond).

Ospreys may have killed four radio-tagged rainbow trout. These were the rainbow trout with tag frequencies of 149.540 (code 5), 149.560 (code 2), 149.800 (code 5), and 150.780 (code 1) (Appendix B, Figures B1 to B3). All of these fish exhibited migrations into the Slocan River during the spawning period and were subsequently detected in the vicinity of the Goose Creek confluence (Km 21.0 – 22.0), near an active osprey nest. These tags consistently remained in this area and the high signal strength of these tags suggested they were no longer in water. Osprey are opportunistic hunters and will focus on prey species that are the most vulnerable at different times of the year, such as rainbow trout during spawning season (M. Machmer, Pandion Ecological Research, Nelson, BC, pers. comm., 2002). Osprey are capable of capturing rainbow up to 450 mm in length (M. Machmer, pers. comm., 2002) which is larger than the size of fish equipped with radio tags in the present study. Osprey on the Kootenay River have normal hunting ranges of approximately 7 km (but potentially over 20 km), are known to carry their prey distances of over 10 km, and more than one osprey will hunt in the same area if prey is abundant (M. Machmer, pers. comm., 2002).

3.4.2 Spawning Related Movements

Baxter and Roome (1998) reported the 1998 rainbow trout spawning period in the Slocan River (based on rainbow trout spawning surveys) extended from mid-March to late April. Peak spawning reportedly occurred from 14 to 20 April (data from Table 5 in Baxter and Roome 1998) but reduced levels of spawning activity were recorded on 27 April, the last date surveyed. For the purposes of this report, the rainbow trout spawning period in the Slocan River system was considered to encompass the early March to late May period. Of the 17 radio-tagged rainbow trout that spent some portion of their days-at-large in the Slocan River, 15 were located in the Slocan River during the spawning period.

Seven main rainbow trout spawning areas have been identified in the mainstem Slocan River (Baxter and Roome 1998). The locations of these areas are provided in Appendix B, Table B4, along with the corresponding river kilometres used in the present study. Of the 15 rainbow trout detected in the Slocan River during the spawning period, eight were located in the vicinity of known spawning areas: four were detected at the spawning area downstream of Slocan Park (Km 30.0), two were detected at the spawning area upstream of Vallican (Km 41.0), one was detected at the spawning area upstream of the Winlaw bridge (Km 50.0), and one was detected near both of the furthest upstream spawning areas (Km 60.0-63.3 and Km 70.1-72.8; Appendix B, Table B4). The remaining seven fish were never detected more than two kilometres upstream from the mouth of the Slocan River, but these individuals could easily have moved further upstream in the Slocan River between detection events. A summary of spawning movements and time spent in the Slocan River during the spawning period is provided in Appendix B, Table B5.

In the present study, a migration was considered to be a purposeful movement of a fish to a location where a particular action could be carried out (e.g., a movement into the Slocan River for the purpose of spawning). Of the 27 radio-tagged

rainbow trout that were tracked over the entire study period, 17 appeared to undertake a defined movement during the spawning period (either into the Slocan River or to potential spawning locations within Brilliant headpond). These movements were interpreted as spawning migrations. Rainbow trout that were radio-tagged in Brilliant headpond were located in four main areas during the spawning period: eight were detected in the Slocan River near known spawning areas; seven were detected in the vicinity of Glade Creek; seven were detected in the vicinity of the Slocan River mouth; and four were detected in the vicinity of potentially suitable spawning habitat in the Slocan Pool. The locations of a substantial number of tagged fish near potential spawning habitats in Brilliant headpond may suggest that rainbow trout spawning occurs in the headpond, although this was not verified during the present study.

3.5 STOCK STATUS

Baxter and Roome (1998) reported that two separate stocks of rainbow trout used the Slocan River for spawning purposes. All of the rainbow trout implanted with radio transmitters during their 1998 study were initially caught in the river and were considered members of the Slocan River stock. These fish spawned from the third week of March to late April. In late April, numerous larger fish (none of which were radio-tagged) were observed in spawning areas located within the upper Slocan River. These larger fish were believed to be members of a Slocan Lake (lacustrine) stock that used the upper reaches of the Slocan River for spawning and spawned later than the Slocan River stock. During Baxter and Roome's 1998 study, some rainbow trout that were radio-tagged in the Slocan River exhibited movements into Brilliant headpond and Slocan Lake. Movements of rainbow trout between the Slocan River and Brilliant headpond also occurred during the present study.

These stock groupings were based on the respective life history strategies for each population that result in detectable differences in habitat uses for major life history requisites such as spawning. Lacustrine rainbow trout in Slocan Lake spend the majority of their time feeding in the lake but a portion of the population uses the upper portion of the Slocan River for spawning. This spawning apparently occurs in relative isolation (spatially and temporally) from spawning by members of the Slocan River and Brilliant headpond resident populations of rainbow trout. Rainbow trout that reside in the Slocan River and the Brilliant headpond populations exhibit overlapping spawning, feeding and likely rearing habitats, which suggests they are members of the same stock; however, due to differences in their uses of river versus headpond habitats, they can be considered as different sub-populations. Some fish from the Brilliant headpond population, however, may also spawn in the headpond proper or in lower reaches of minor tributaries and if so, these may constitute sub-stocks; further study would be required to confirm this supposition.

Other potential stocks of rainbow trout in the headpond could originate from the BC Ministry of Water, Land and Air Protection stocking program in Brilliant headpond that has been ongoing at various levels of stocking densities since 1929 (Appendix C, Table C1). Fish have generally been released in Slocan Pool just downstream of South Slocan Dam. In recent years (since 1987) three different stocks have been planted in the headpond at a rate of 15,000 yearlings annually. These are the Premier Lake stock (1987 to 1989), the Pennask Lake stock (1990 to 1997), and the Blackwater

River stock (1998 to 2001). Rainbow trout stocking also occurs in Slocan Lake tributaries (~20 000/year) and in Little Slocan Lake (~1000 to 3000/year) (J. Bell, BC Ministry of Water, Land, and Air Protection, Nelson, pers. comm., 2001). This stocking program has been terminated and the stocking event in June 2001 was the last planned release of hatchery rainbow trout into Brilliant headpond.

In a 2001 study to estimate the size of the rainbow trout population in Brilliant headpond population (Golder Associates Ltd., unpublished data), 1406 rainbow trout were captured, of which 3 (0.2%) had an adipose clip indicating a fish of hatchery origin. The very small proportion of the resident rainbow trout population in Brilliant headpond that originates from the hatchery plants does not warrant distinction as a separate stock.

Based on their relative contribution to the population, hatchery rainbow trout appear poorly adapted to conditions in Brilliant headpond. The low numbers of hatchery fish in the catch likely reflects a high predation rate by piscivorous fish species (e.g., northern pikeminnow) and avian predators (e.g., herons and osprey). Hatchery fish may also be more susceptible to entrainment than native fish since there is no genetic basis for their adaptation to habitat conditions in the area. During the Brilliant Expansion Project pre-project biological monitoring in the Brilliant headpond and Brilliant Dam tailwater areas (Golder 2002), 83 rainbow trout were captured in the tailwater area, of which six (7.2%) were adipose clipped. Scale samples were obtained from four of these fish and were compared to scales obtained from rainbow trout without adipose clips captured in Brilliant headpond, from rainbow trout captured in the Brilliant tailwater area, and from scale samples obtained from fish raised at the Kootenay Trout Hatchery. A comparison of the first year of growth between these samples indicated that the adipose clipped rainbow trout most closely matched the hatchery fish. This supported the assumption that the adipose clipped rainbow trout caught in the tailwater area were hatchery fish, which would indicate that a portion of the rainbow trout stocked in Brilliant headpond or its tributaries are entrained, and that some survive entrainment.

3.6 ENTRAINMENT

Of the 29 radio-tagged rainbow trout monitored in the present study, two were entrained through Brilliant Dam. One of these fish (Frequency 149.800, Code 2; Appendix B, Figure B3) was released at Km 19.5 on 6 October 2000, was subsequently relocated at Km 19.0 on 18 October and by 24 October was located immediately downstream from Brilliant Dam. The other fish (Frequency 149.560, Code 3; Appendix B, Figure B1) was initially released at Km 7.5 on 27 September, was located again in this same area on 29 September, and was not located again until 9 November, at which time it was located immediately downstream of Brilliant Dam. The occurrence of both these entrainment events soon after tagging (within 18 and 12 days, respectively) and the atypical post-release movement pattern exhibited by these fish was strongly suggestive of post-surgical mortality. There was no evidence of movements by these fish after they were entrained, which indicated they were either dead when entrained or were killed during passage through the turbines.

Several rainbow trout were recorded within the lower section of the headpond but were not entrained through the dam. One fish (Frequency 149.560, Code 2; Appendix B, Figure B1) remained within 2 km of Brilliant Dam over the entire period from release in early October to late April. This fish spent most of February and March in the immediate forebay area of Brilliant Dam; during this period, this individual was consistently detected by the upstream antenna of the ground station at Brilliant Dam. This fish subsequently migrated upstream into the Slocan River during the spawning period.

In total, six fish spent some portion of their time-at-large within a few kilometres of Brilliant Dam (i.e., between McPhee Creek and the dam); none of these fish were entrained. Four of these fish were initially captured in the lower section of the headpond and were released at Km 7.5; this represented 50% of the eight fish that were released in the lower section. Only two of the seven fish tagged and released in the middle section were ever recorded downstream from McPhee Creek and only one of these (Frequency 149.520, Code 1; Appendix B, Figure B2) remained in this area for more than a week. None of the 12 fish tagged and released in the lower section of the headpond were ever recorded downstream from McPhee Creek.

3.7 IMPORTANT HABITATS

Several important habitats for headpond resident rainbow trout were identified during the present study in both Brilliant headpond and the Slocan River. Within Brilliant headpond important feeding areas included Slocan Pool and the areas near the mouths of tributaries that enter the headpond (i.e., Slocan River, Glade Creek, McPhee Creek, and Little McPhee Creek). Radio-tagged rainbow trout also were detected at Slocan Pool, the mouth of the Slocan River, and Glade Creek during the spawning period, which may imply that these areas also were used for spawning by headpond rainbow trout, although evidence to corroborate this supposition was not obtained.

The Slocan River provides important spawning habitats for some portion of the Brilliant headpond rainbow trout population. Movements during the spawning period suggested a possible use of several of the known spawning areas within the Slocan River system. The greatest use was recorded for spawning areas below Slocan Park with decreased use with increased upstream distance of the spawning area. A similar pattern was observed for those fish that used the Slocan River during other periods of the year, presumably for feeding. The lowermost five kilometres of the Slocan River appeared to receive the greatest use for feeding; other important habitats were the confluence areas of the Little Slocan River and smaller tributaries like Trozzo Creek, Lemon Creek, and Wolverton Creek.

4.0 CONCLUSION

The exact nature or origin of the rainbow trout population present in Brilliant headpond could not be conclusively determined based on the movement data obtained in the present study. However, the results of the present study suggested that the rainbow trout populations in the Slocan River and the Brilliant headpond are of the same stock. A separate lake-dwelling (lacustrine) stock resides in Slocan Lake and some members of this stock spawn in the upper reaches of the Slocan River. The Slocan River and Brilliant headpond stock appears to be more riverine in nature and conduct all their life-requisites in the river, headpond, or tributaries. The Brilliant headpond population exhibits some traits of both lacustrine and riverine populations in that the headpond, a lake-like habitat, is used mainly for feeding by the adult and sub-adult stages but a substantial portion of the population spawns in the middle and lower reaches of the Slocan River. The river also provides feeding habitat and likely rearing habitat for the headpond-based population.

The movement data also indicated that rainbow trout from the upper and lower regions of the headpond are members of the same stock. Rainbow trout from all three release groups in the lower (Km 7.5), middle (Km 12.5), and upper (Km 19.5) headpond were subsequently located during the spawning period at locations within the headpond only, as well as in the Slocan River.

The majority of the rainbow trout that were implanted with radio tags during the present study and were subsequently monitored over the entire study period spent a portion of their time-at-large in the Slocan River (17 of 27, or 63%). Nine made multiple entries into the Slocan River. The use of the Slocan River by headpond resident fish may have been underestimated since several fish may have entered the Slocan River or entered it on more than one occasion and these movements may not have been detected between tracking surveys.

Ten radio-tagged rainbow trout were detected only in Brilliant headpond during the present study. For two of these fish, the radio tag was suspected of malfunctioning early in the survey period. Two of the tagged rainbow trout were subsequently located downstream of Brilliant Dam indicating they had been entrained through the dam. Based on the timing of these movements (i.e., within three weeks of tagging and release) and the atypical movement pattern (rapid and uni-directional), there was a reasonable probability these fish died due to complications resulting from the tagging procedure and were not voluntarily entrained through the dam. Several other fish (all tagged and released in the lower section of the headpond) frequented the lower headpond region and some entered the forebay area (within 100m) of the dam; none of these fish were entrained. None of the fish tagged and released in the middle and upper sections of the headpond were ever recorded within 2.0 km of the dam. These data indicate the overall risks of entrainment for adult rainbow trout in Brilliant headpond were low. Therefore, entrainment is not considered a significant factor regulating the rainbow trout population in Brilliant headpond because of the relatively low numbers of fish possibly entrained and

because the majority of rainbow trout in the system do not utilize the lower section of the headpond near the face of the dam.

Evidence obtained in the present study suggests that osprey predation may have a substantial impact on the rainbow trout population in Brilliant headpond. The four fish suspected of falling victim to predation represented 16.0% of the total radio-tagged population (n = 25; excludes the two tags that likely malfunctioned and the two fish that were entrained). This mortality rate could have a substantial effect on the adult rainbow trout population in the headpond, especially if a sizeable proportion of these fish were killed before they could spawn.

The BC Ministry of Water, Land and Air Protection rainbow trout stocking program in Brilliant headpond does not appear to contribute significantly to the overall population. Reasons for the low composition of hatchery stock in the overall population are not well understood but are likely mainly related to elevated predation rates by fish and avian predators. Another possible factor is stocked fish may exhibit higher levels of entrainment out of the system (due to a low adaptability to existing habitat conditions in the headpond).

Important feeding and spawning habitats for headpond resident rainbow trout were identified in the present study. These include several potential spawning and feeding areas in the Slocan River and feeding habitats in Brilliant headpond. During the spawning period, several tagged rainbow trout did not apparently leave the headpond and were located near areas in the headpond with potentially suitable spawning habitat. This suggests that either some members of the population do not spawn annually or that spawning may occur in areas other than the Slocan River.

The study illustrated that the rainbow trout population in Brilliant headpond exhibited a substantial use of the lower and middle reaches of the Slocan River for spawning and feeding. Although not investigated in the present study, there is a high likelihood that these reaches of the Slocan River also are used for rearing by the progeny of the headpond population. These factors indicate that the mainstem Slocan River would be a suitable candidate for enhancement options to compensate for potential rainbow trout entrainment losses that may result from the Brilliant Upgrade Project.

5.0 LITERATURE CITED

- Baxter, J.S., and R. Roome. 1998. Migratory, overwintering and spawning behaviour of rainbow trout (*Oncorhynchus mykiss*) in the Slocan River, British Columbia. Prepared for Ministry of Environment, Lands and Parks, Nelson, BC. Prepared by James Baxter and Robyn Roome, Fisheries Consultants, Nelson, BC. 24 p. + app.
- BC Hydro. 1984. Keenleyside-Murphy Project, Brilliant Reservoir – fish and aquatic habitat observations. Environmental and Socio-Economic Services, Engineering Services Division. Report No. ESS-102.
- Columbia Power Corporation (CPC). 2000. Brilliant Upgrade Project, Parameters and Procedures for Operation of the Works.
- Golder Associates Ltd. 2002. Brilliant Expansion Project – Pre-project biological monitoring in the Brilliant headpond and Brilliant Dam tailwater areas, 2000 – 2001. Report prepared for Columbia Power Corporation, Castlegar, BC. Golder Report No. 0128971D.
- Hildebrand, L., and K. English. 1991. Lower Columbia development - Lower Columbia River fisheries inventory, 1990 studies. Volume I. Main Report Prepared for BC Hydro, Environmental Resources by R.L. & L. Environmental Services Ltd. and LGL Limited. 170 p. + 7 app.
- Mylechreest, P. 1997. Surgical implantation of radio tags in rainbow trout. Prepared for British Columbia Ministry of Environment, Lands and Parks.
- Oliver, G.G. 2001. Slocan River rainbow trout population assessment – 2000. Report prepared by G.G. Oliver and Associates for Columbia Kootenay Fisheries Renewal Partnership and British Columbia Ministry of Environment, Lands and Parks. 23 p. + app.
- R.L. & L. Environmental Services Ltd. 1993. Brilliant expansion feasibility study, 1992 fisheries study. Results and preliminary impact assessment. Report prepared for BC Hydro, Environmental Resources. R.L. & L. Report No. 351D: 42 p. + 2 app.
- R.L. & L. Environmental Services Ltd. 1998. Fisheries studies in the lower Kootenay River, 1990-1993 results. Report prepared for Columbia Power Corporation. R.L. & L. Report No. 379F: 59 p. + 4 app.
- R.L. & L. Environmental Services Ltd. 1999. Brilliant Expansion Project: Summary of aquatic inventory data of the Kootenay system near Brilliant Dam. Report prepared for Columbia Power Corporation, Castlegar, BC. R.L. & L. Report No. 552F: 72 p. + 3 app.
- Water Survey of Canada (WSC). 1976. Inland Waters Directorate historical streamflow summary, British Columbia.
- Water Survey of Canada (WSC). 1977. Inland Waters Directorate historical streamflow summary, British Columbia.

APPENDIX A

FISH CAPTURE DATA

Table A1 Summary of boat electrofishing catch and catch-per-unit-effort (*CPUE*=no. fish/km) in Brilliant headpond, 12 September to 5 October 2000.

Site	Sample Date	Length (km)	Number of Rainbow Trout Caught (<i>CPUE</i> =no. fish/km)	
			No.	<i>CPUE</i>
ES1	12-Sep-00	7.2	5	0.7
ES2	13-Sep-00	7.1	18	2.5
ES3	25-Sep-00	3.5	10	2.9
ES4	25-Sep-00	0.7	3	4.3
ES5 & ES6 ^a	26-Sep-00	11.7	9	0.8
ES7 & ES8 ^a	5-Oct-00	4.1	48	11.7
Total		34.3	93	2.7

^a Sites combined for analysis.

APPENDIX B

RAINBOW TROUT MOVEMENT DATA

Explanation of Figures B1 to B3

Figures B1, B2, and B3 illustrate movements of radio-tagged rainbow trout within Brilliant headpond and the Slocan River. Tracking sessions were conducted on a weekly basis during the present study and periods of time ranging from days to months sometimes passed without a particular fish being detected; therefore, it is probable that some of the movements undertaken by these rainbow trout were not detected by the tracking crew.

The following provides an explanation of symbols used in Figures B1 to B3:

- The text above the figures refers to specific geographical locations within the study area:
 - dotted vertical lines represent locations in Brilliant headpond;
 - dashed vertical lines represent locations in the Slocan River.
- The symbols within the figures represent locations and dates rainbow trout were detected:
 - shaded diamonds represent the release location for that fish;
 - shaded circles represent detections within Brilliant headpond;
 - open circles represent detections within the Slocan River;
 - open squares with crosshairs represent detections at the mouth of the Slocan River.
- A line that changes direction at the vertical dotted line representing the Slocan River mouth but does not have a symbol, indicates that the fish moved into or out of the river, but was not detected right at the mouth of the Slocan River.

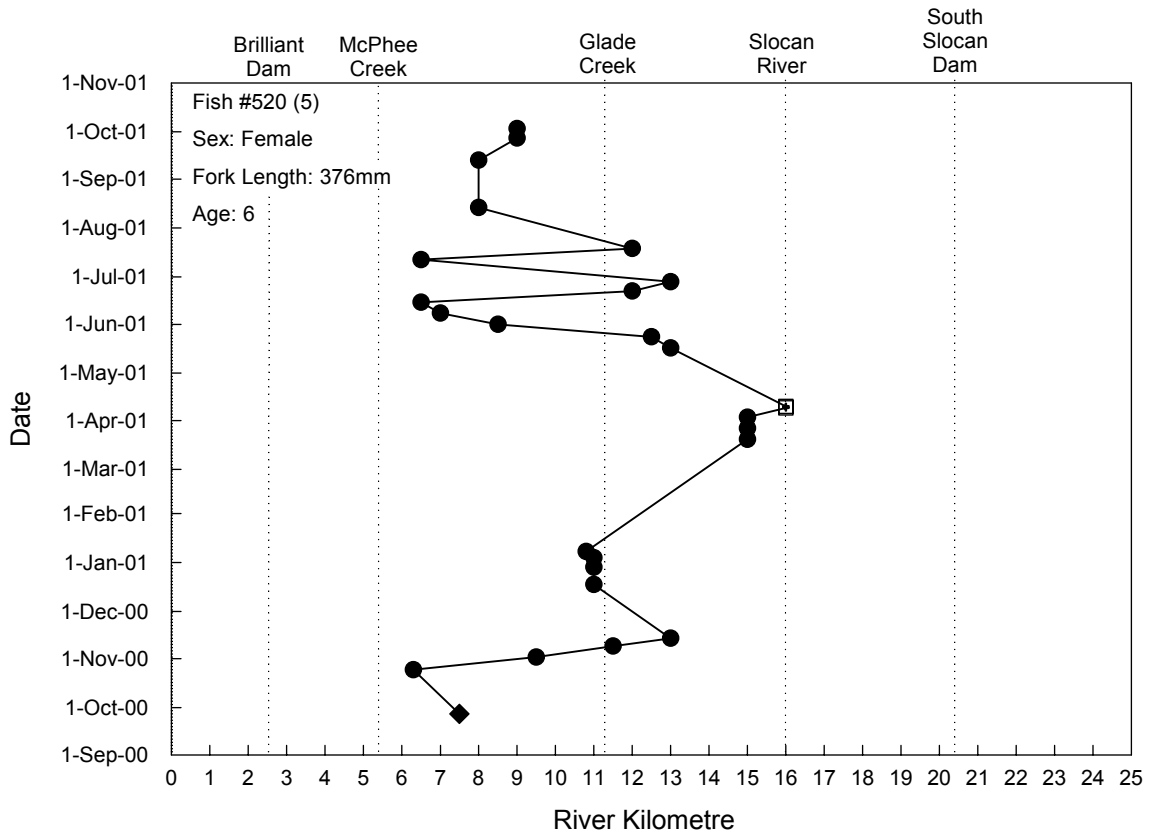
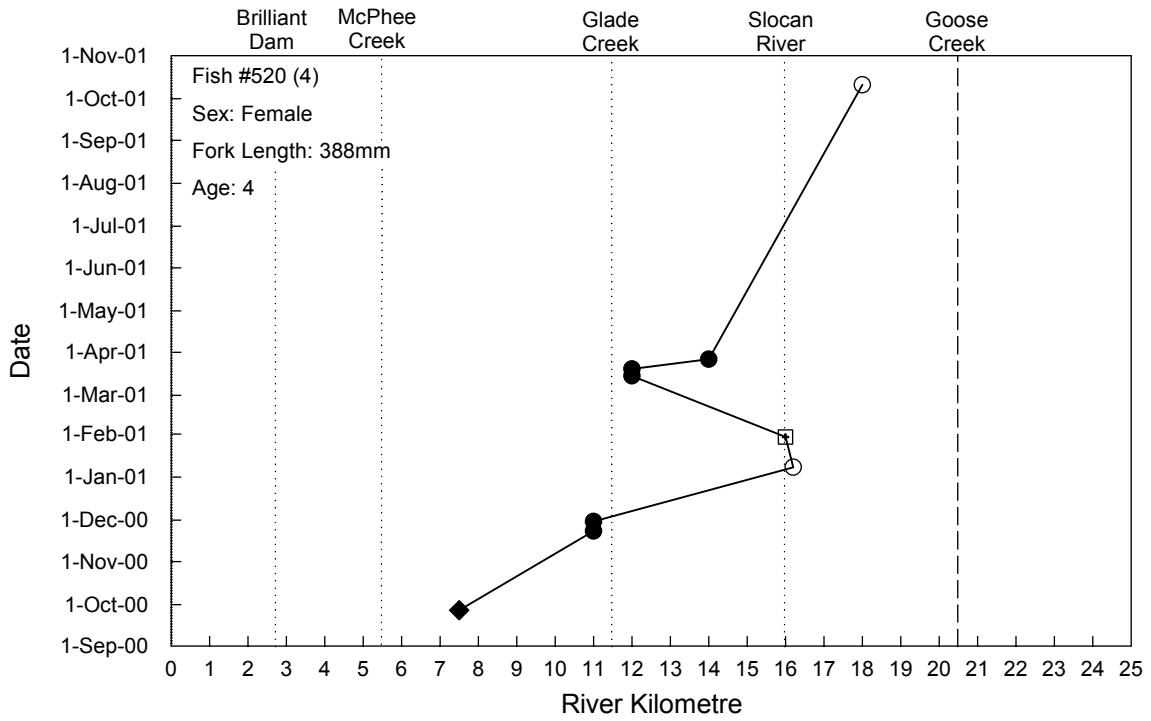


Figure B1 Movement in Brilliant headpond and the Slocan River of radio-tagged rainbow trout released at Kilometre 7.5 (lower headpond), September 2000 to November 2001.

Continued...

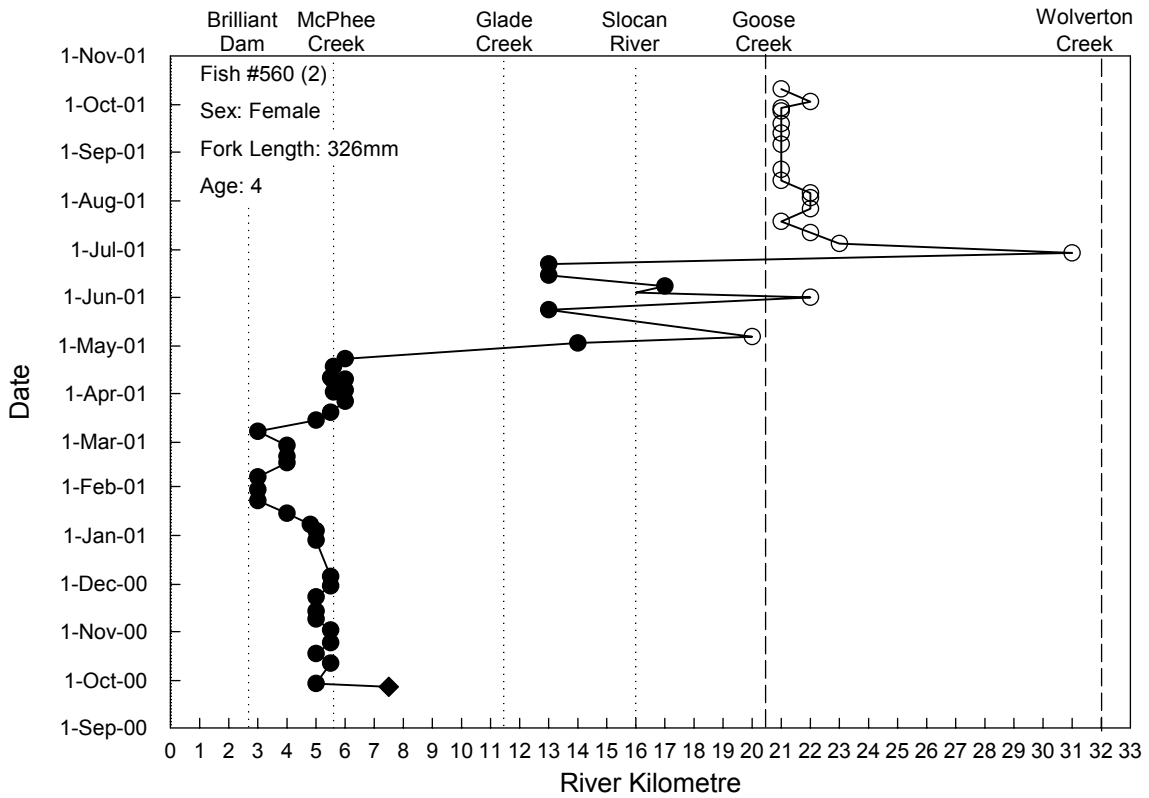
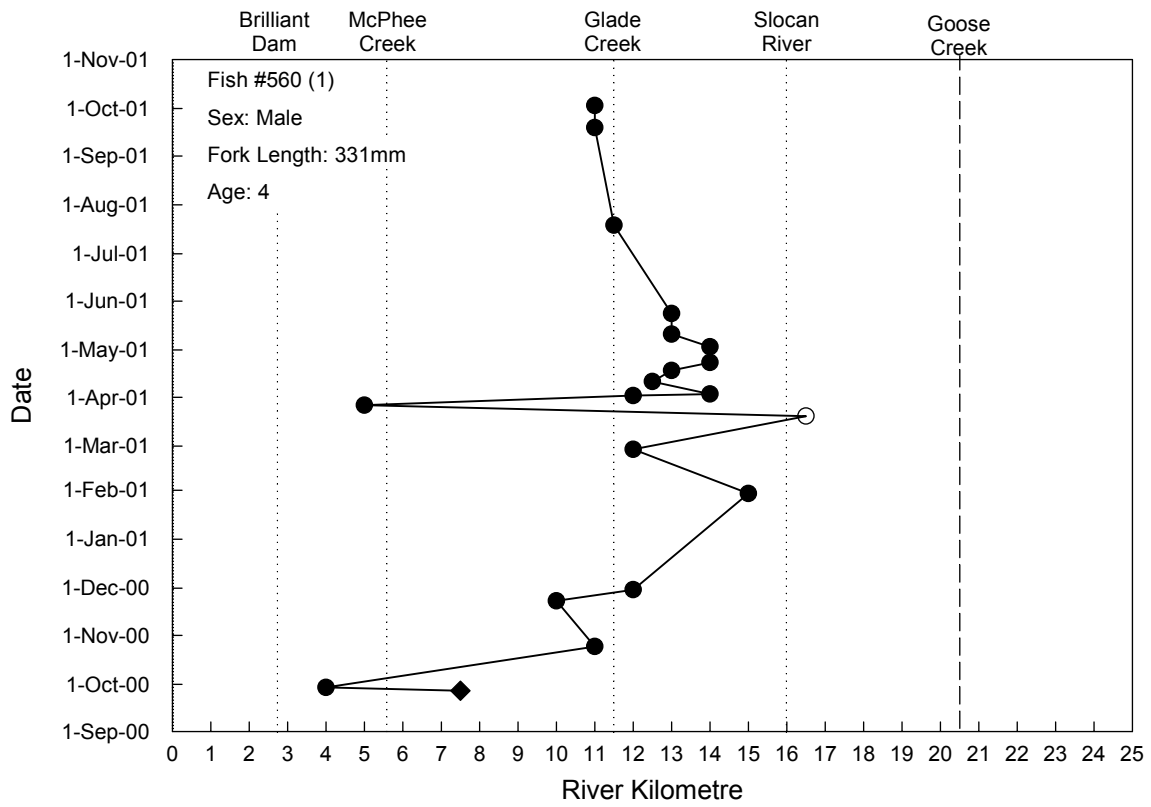


Figure B1 Continued.

Continued...

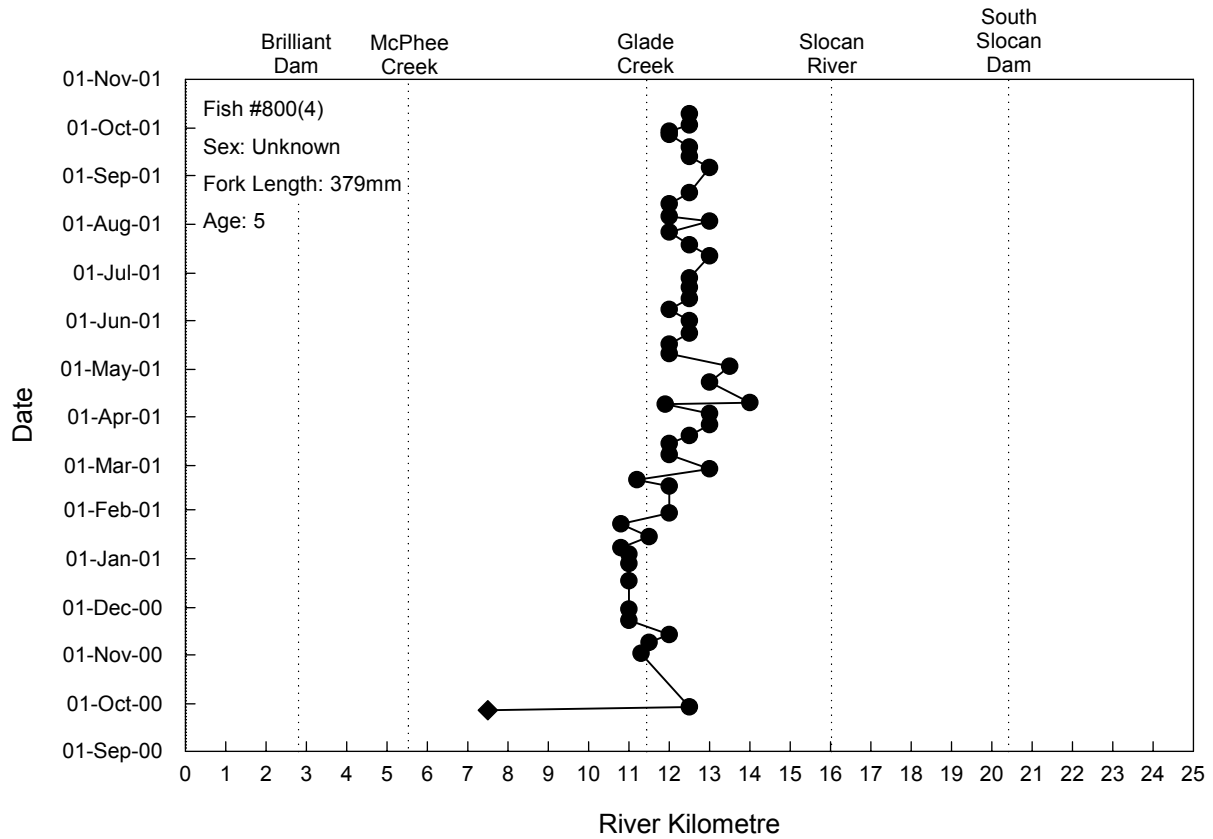
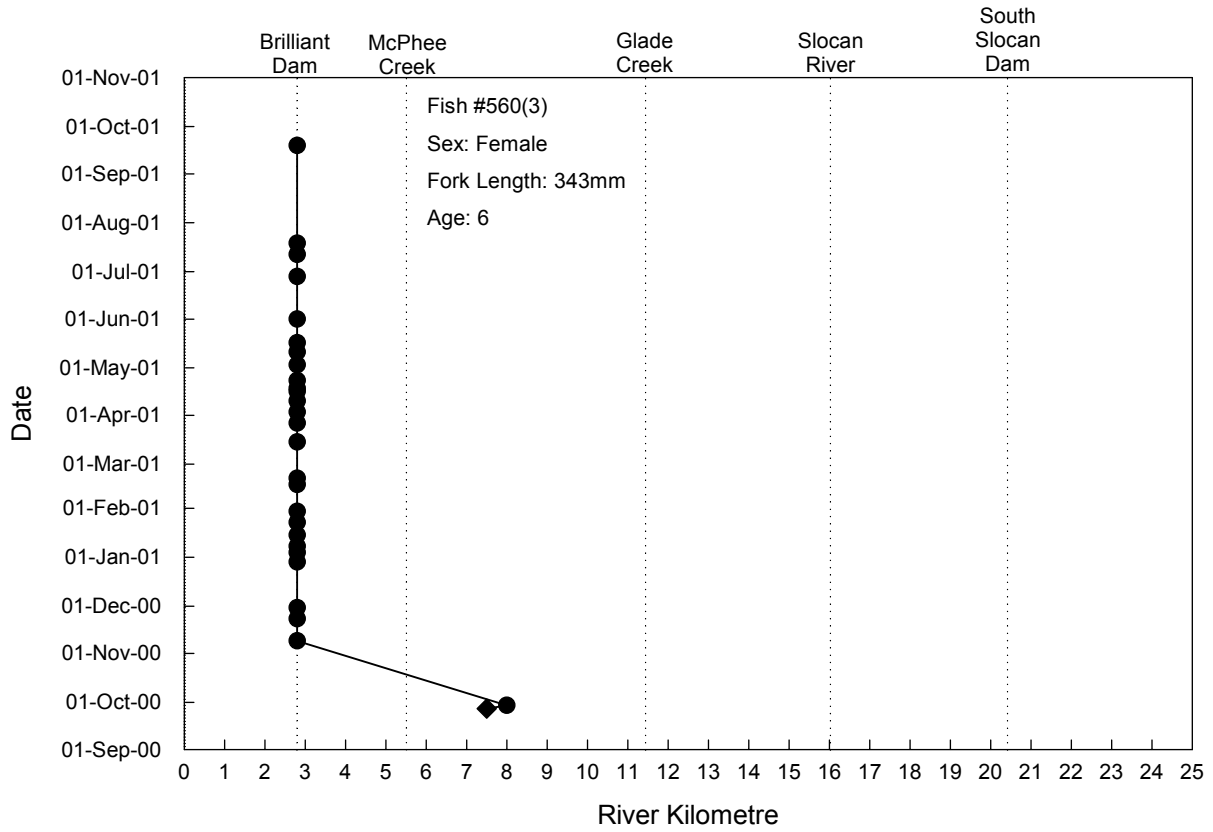


Figure B1 Continued.

Continued...

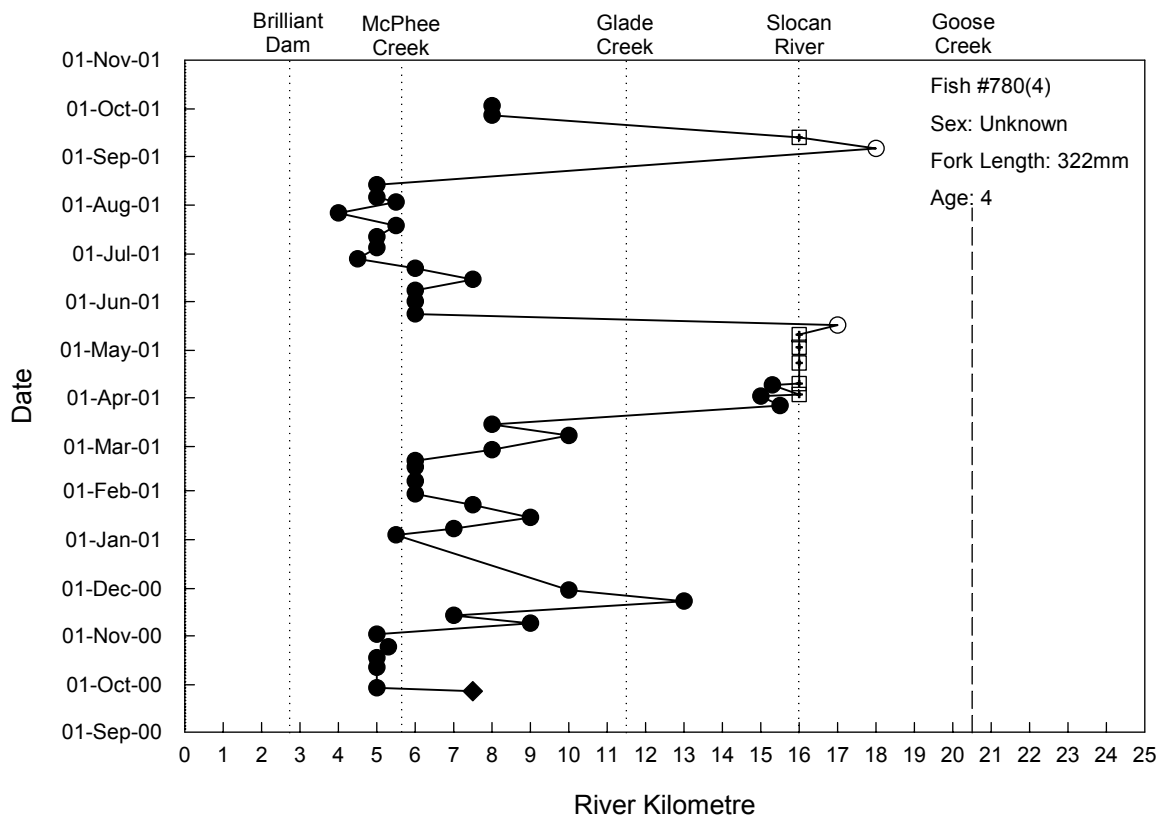
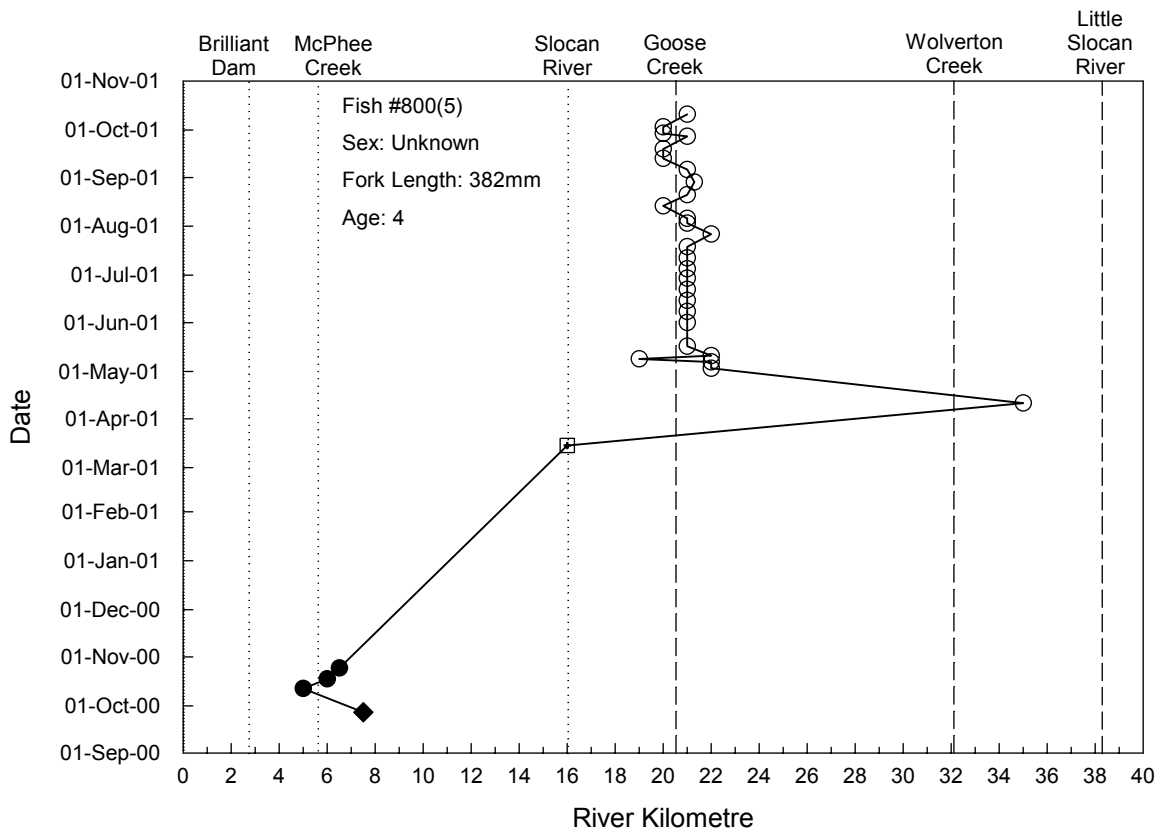


Figure B1 Concluded.

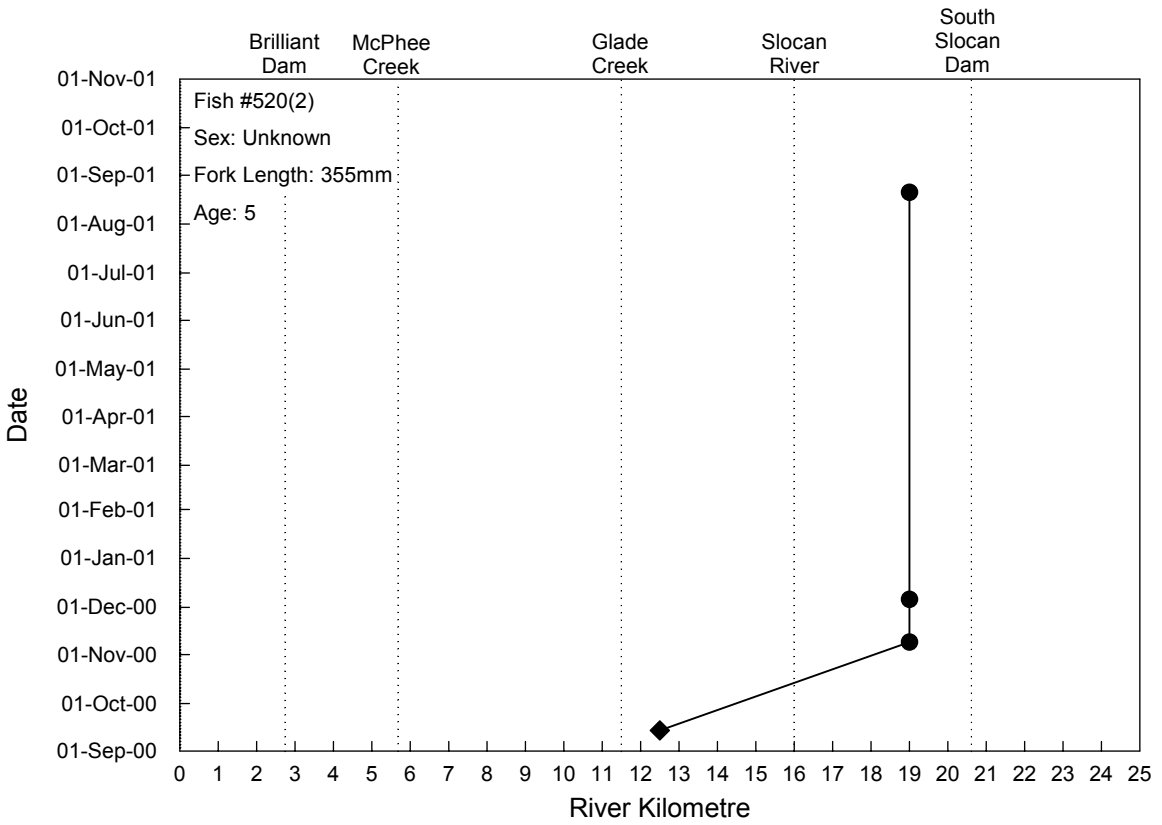
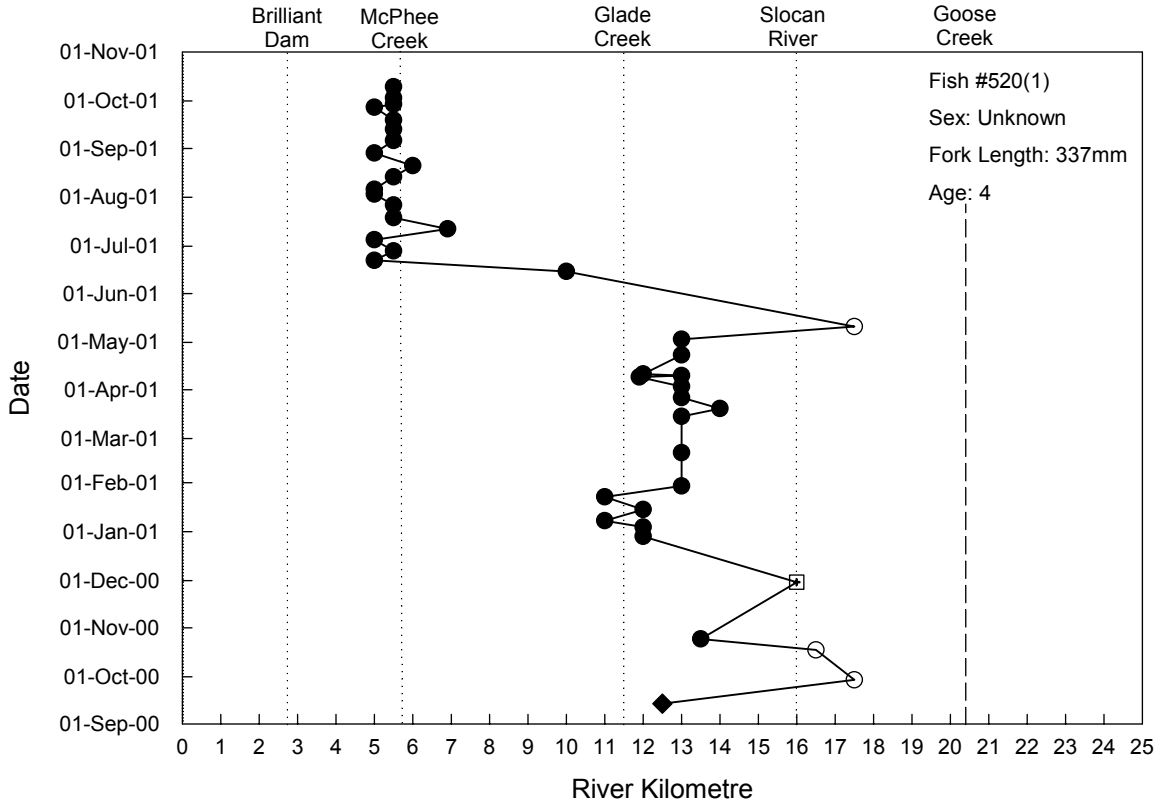


Figure B2 Movement in Brilliant headpond and the Slocan River of radio-tagged rainbow trout released at Kilometre 12.5 (middle headpond), September 2000 to November 2001.

Continued...

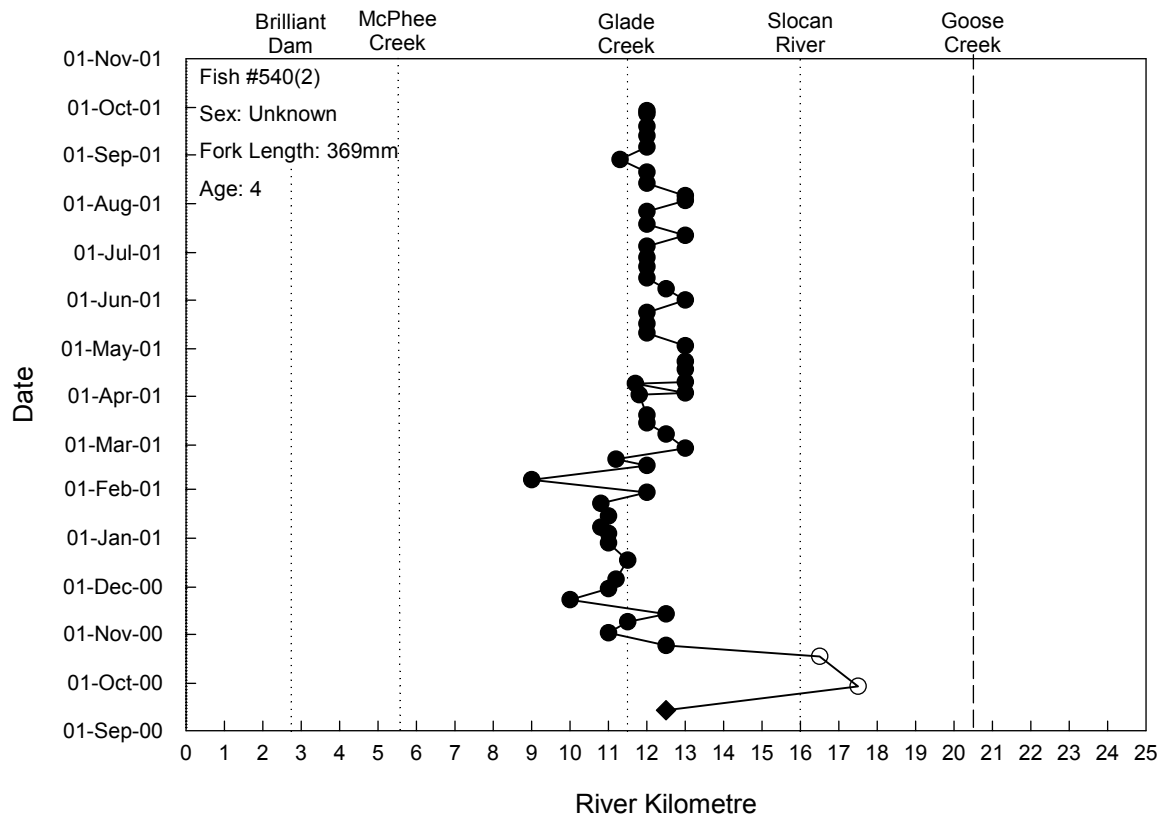
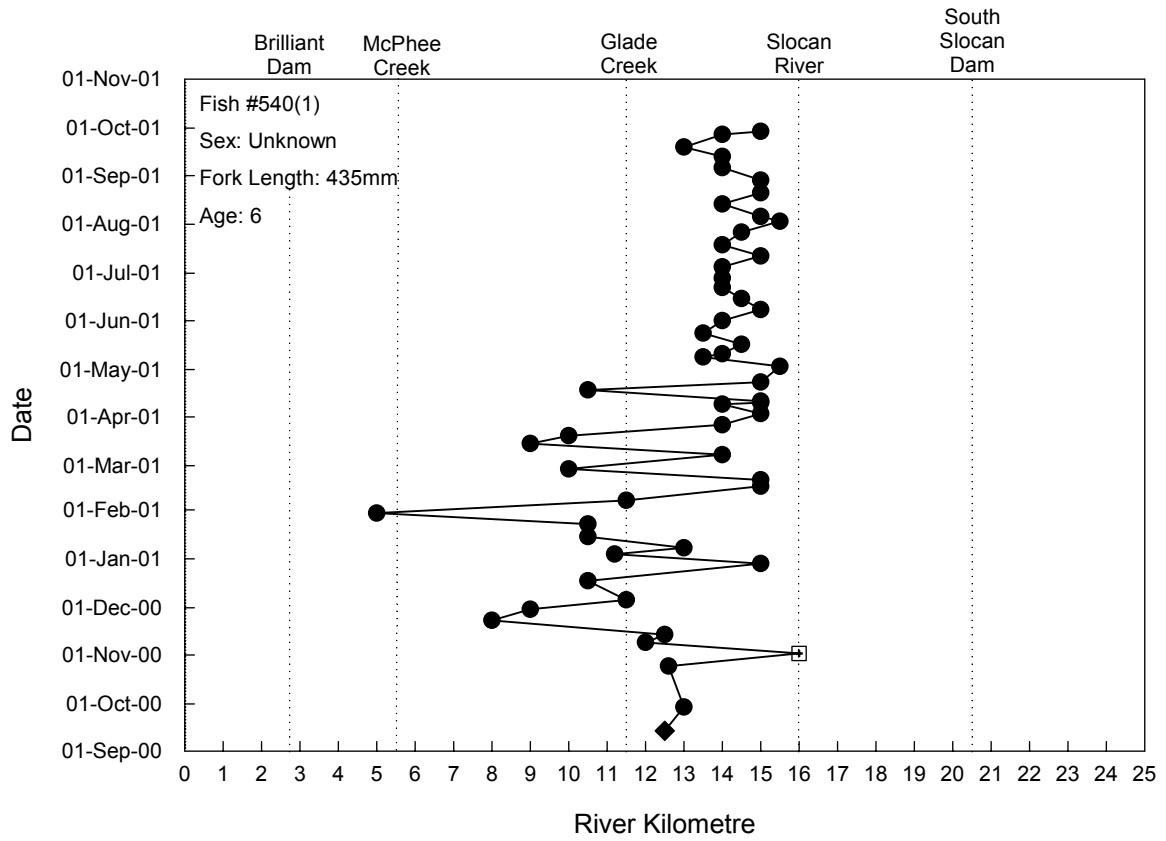


Figure B2 Continued.

Continued...

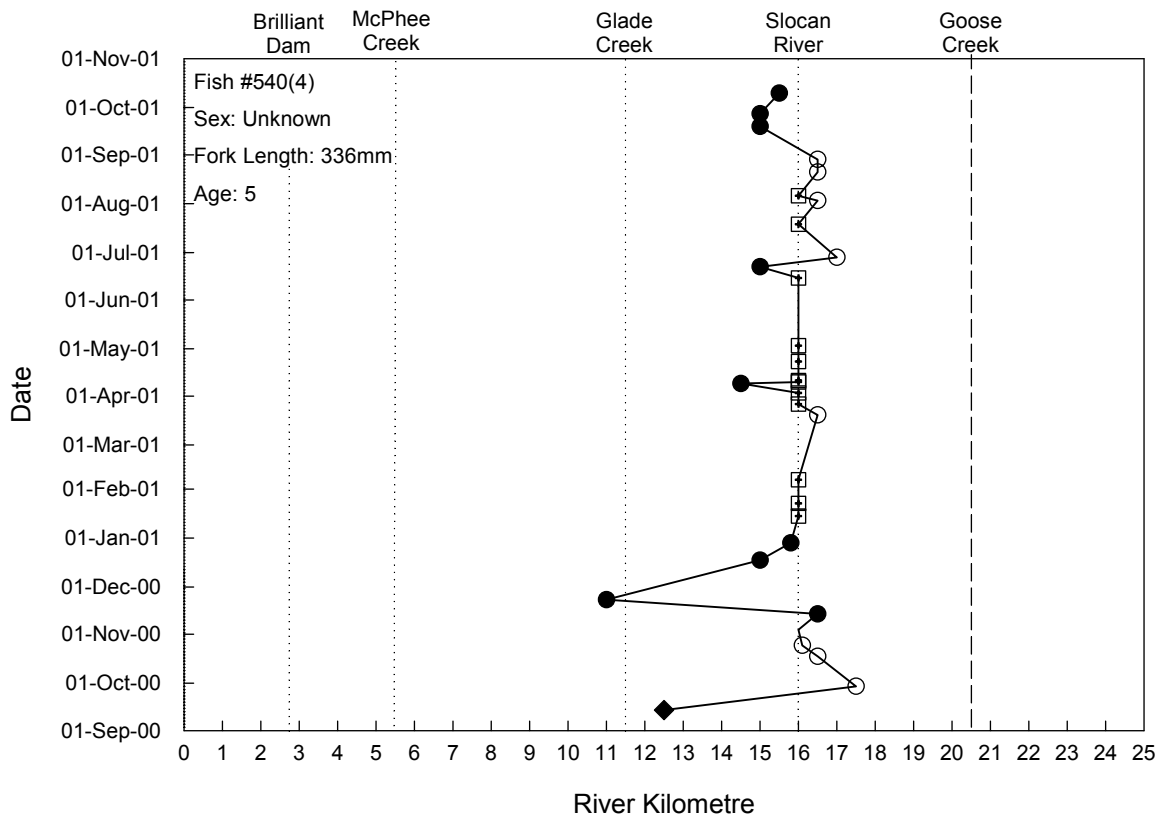
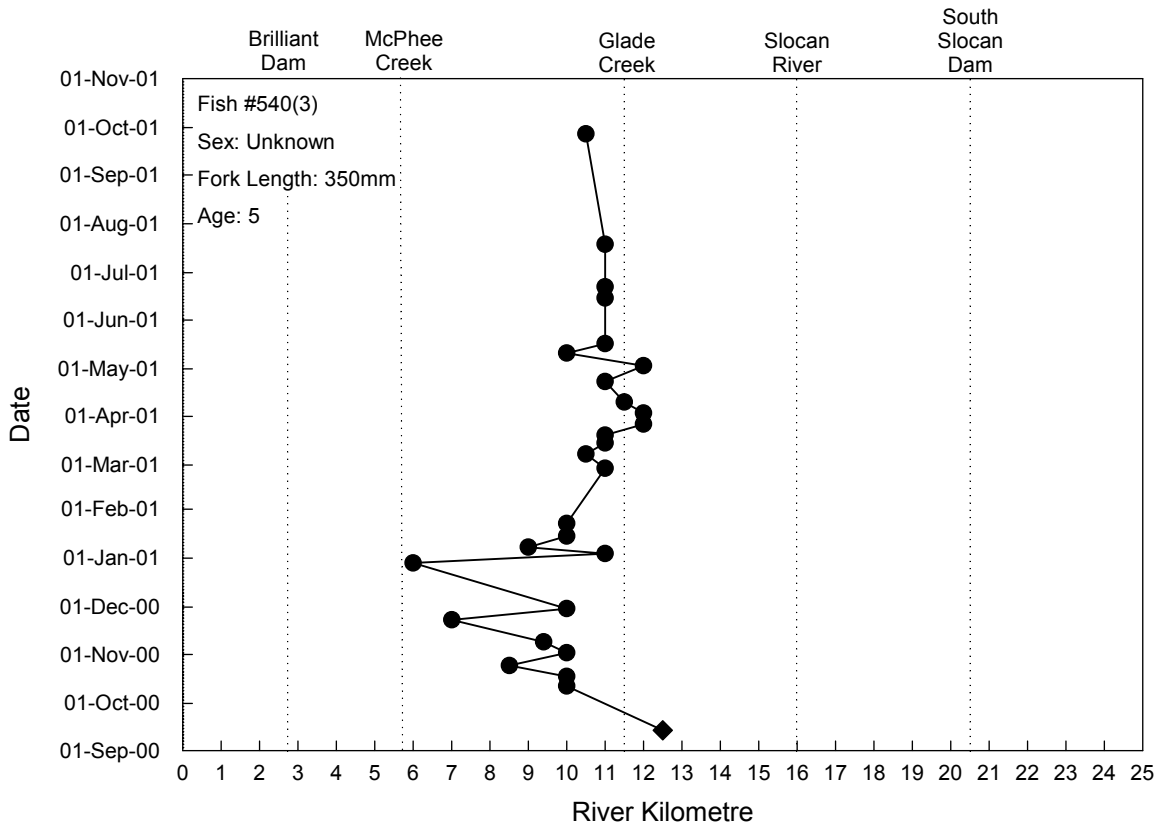


Figure B2 Continued.

Continued...

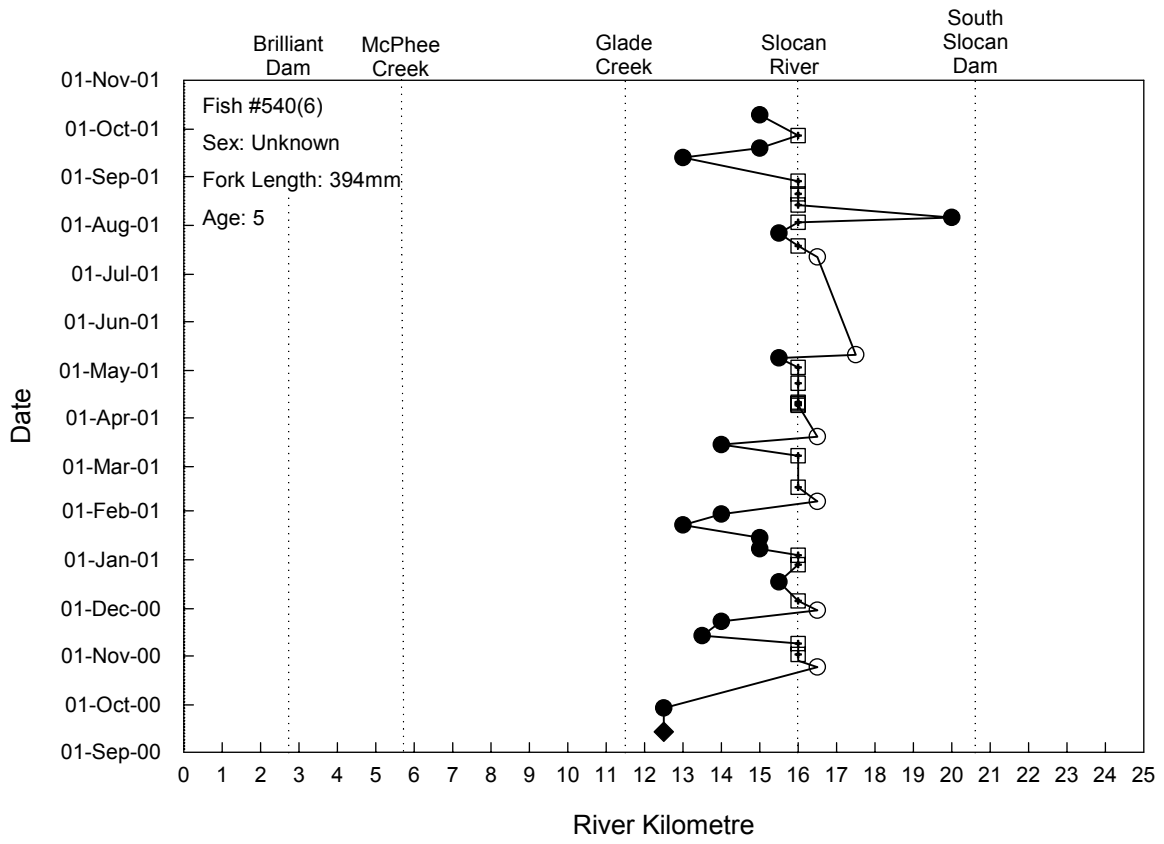


Figure B2 Concluded.

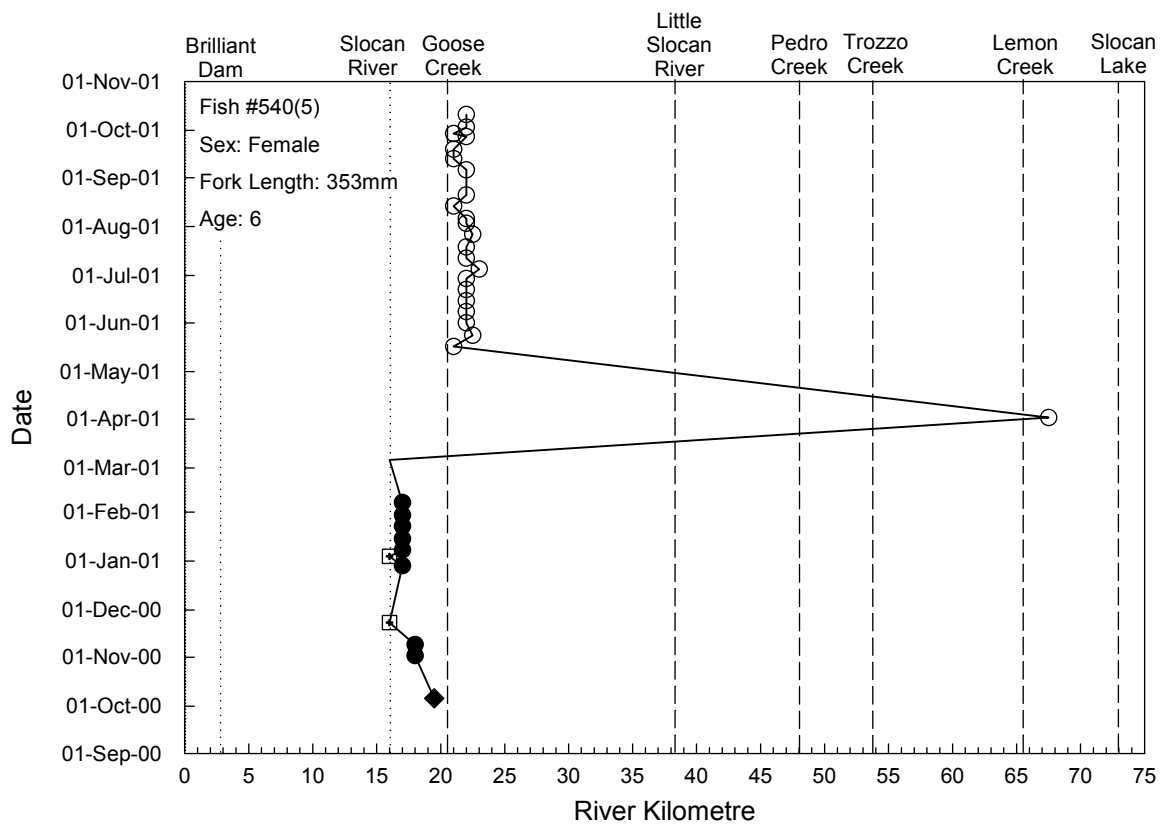
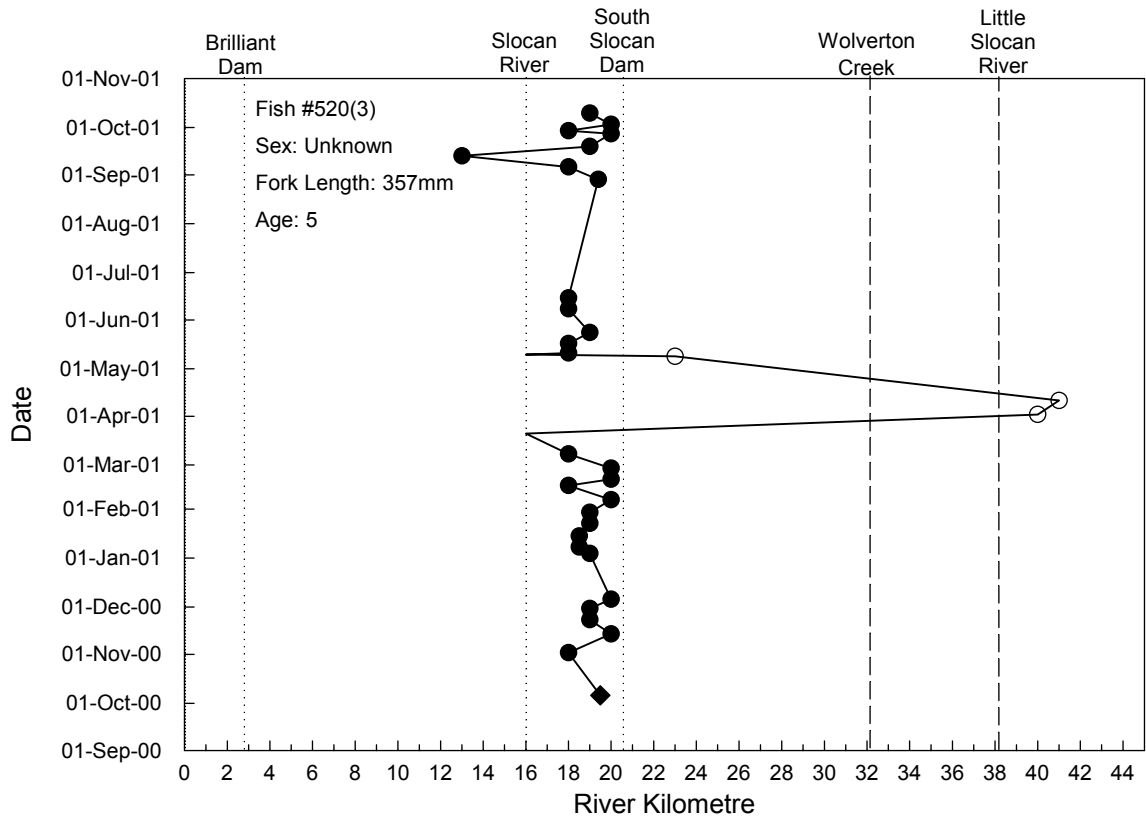


Figure B3 Movement in Brilliant headpond and the Slocan River of radio-tagged rainbow trout released at Kilometre 19.5 (upper headpond), September 2000 to November 2001.

Continued...

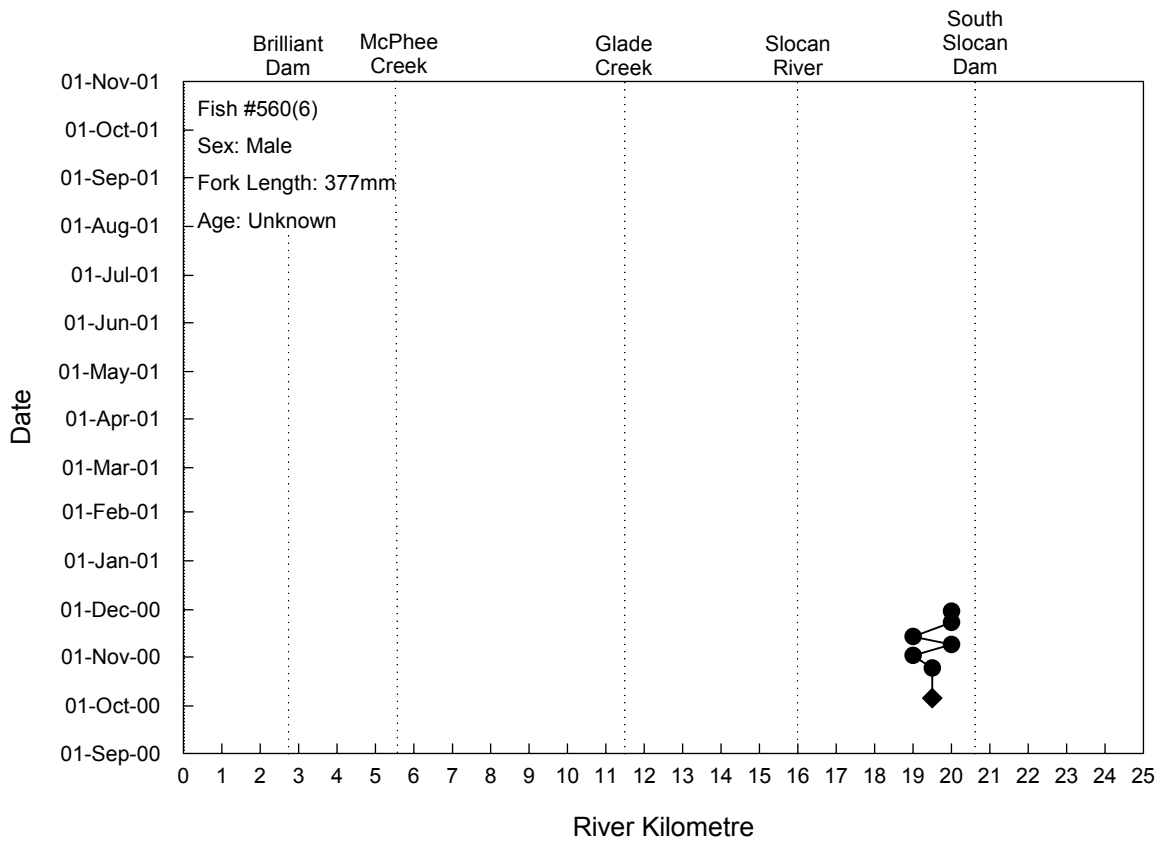
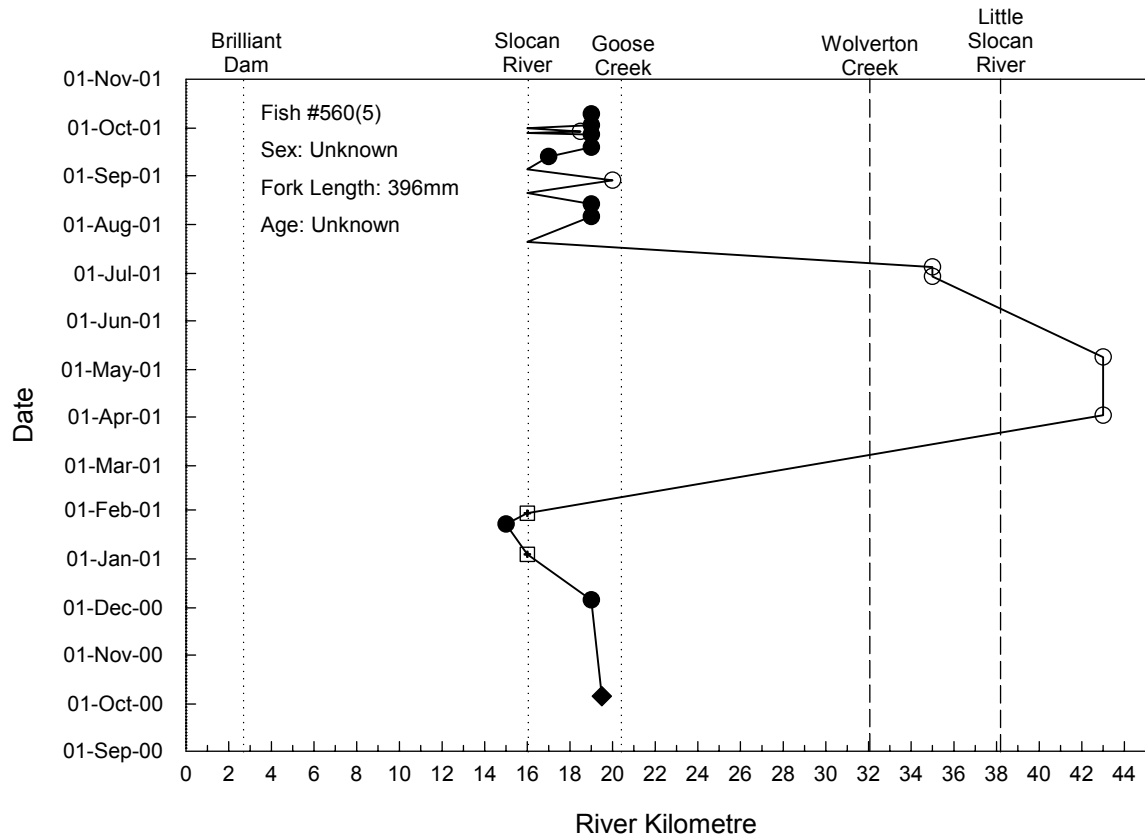


Figure B3 Continued.

Continued...

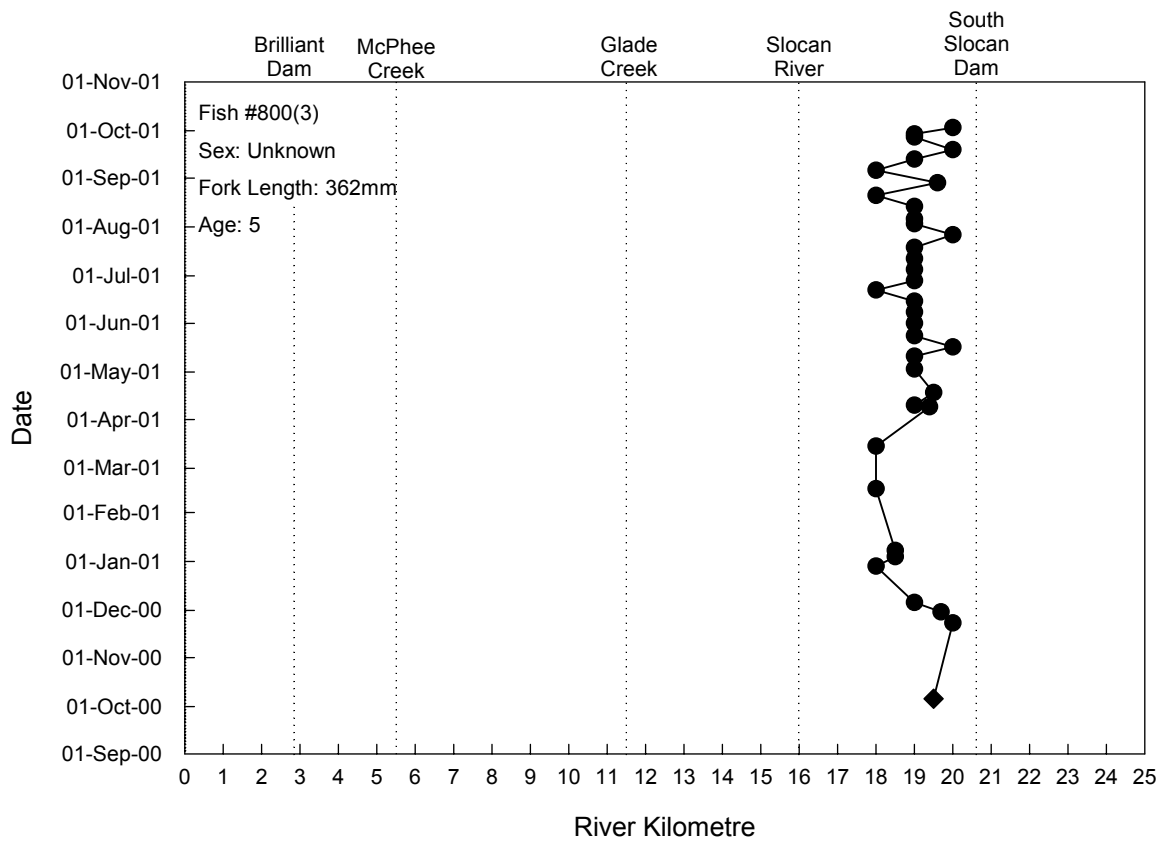
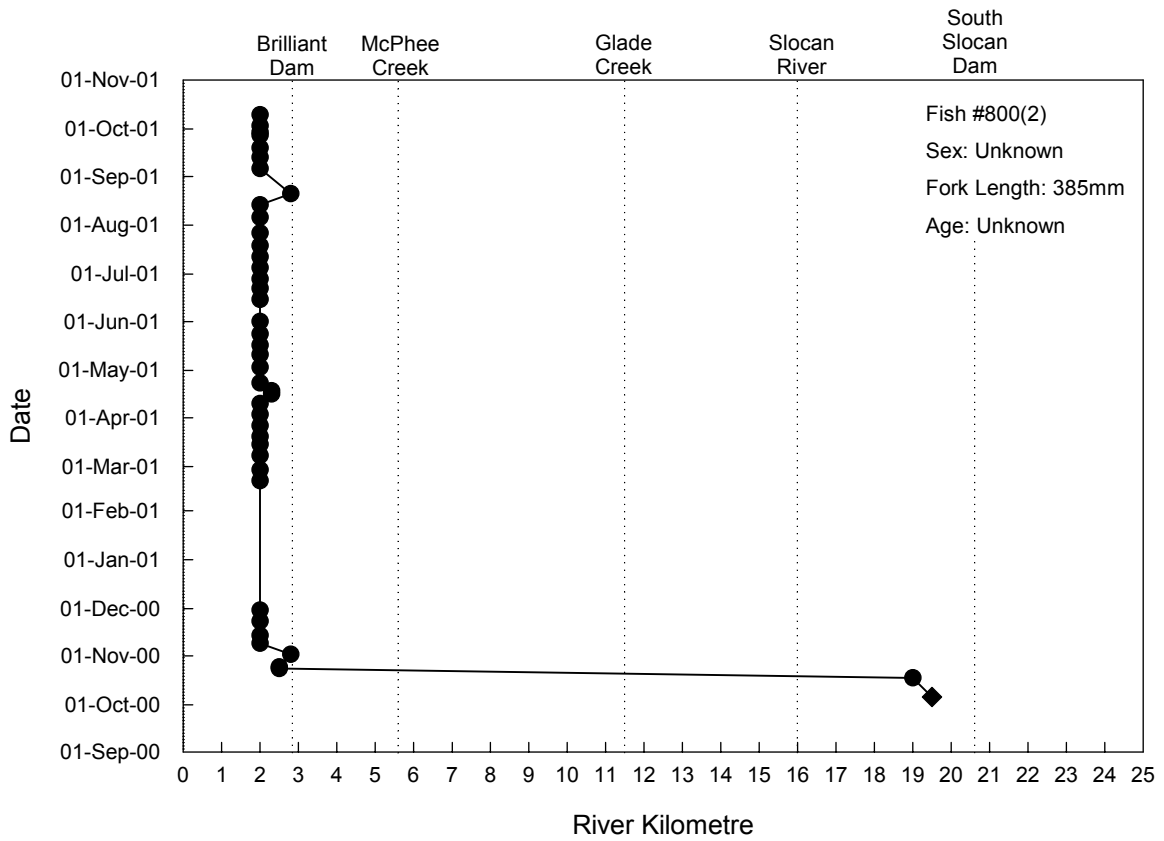


Figure B3 Continued.

Continued...

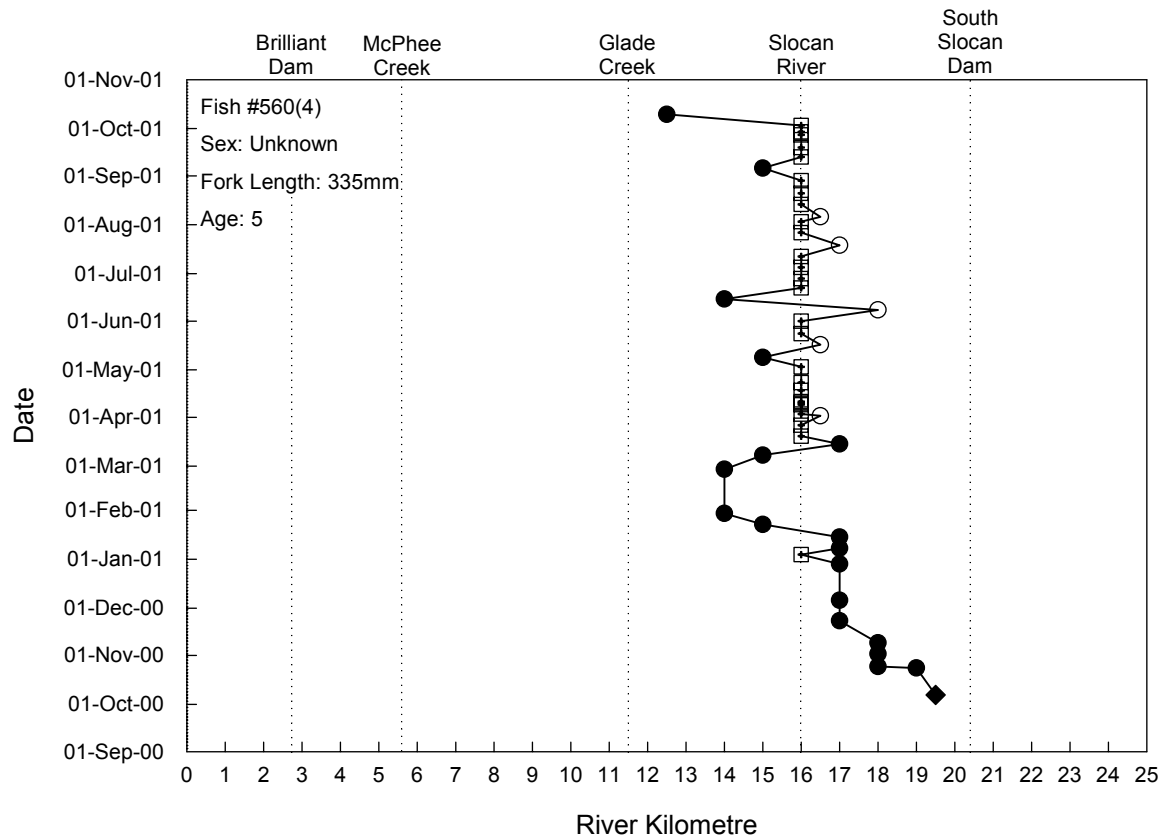
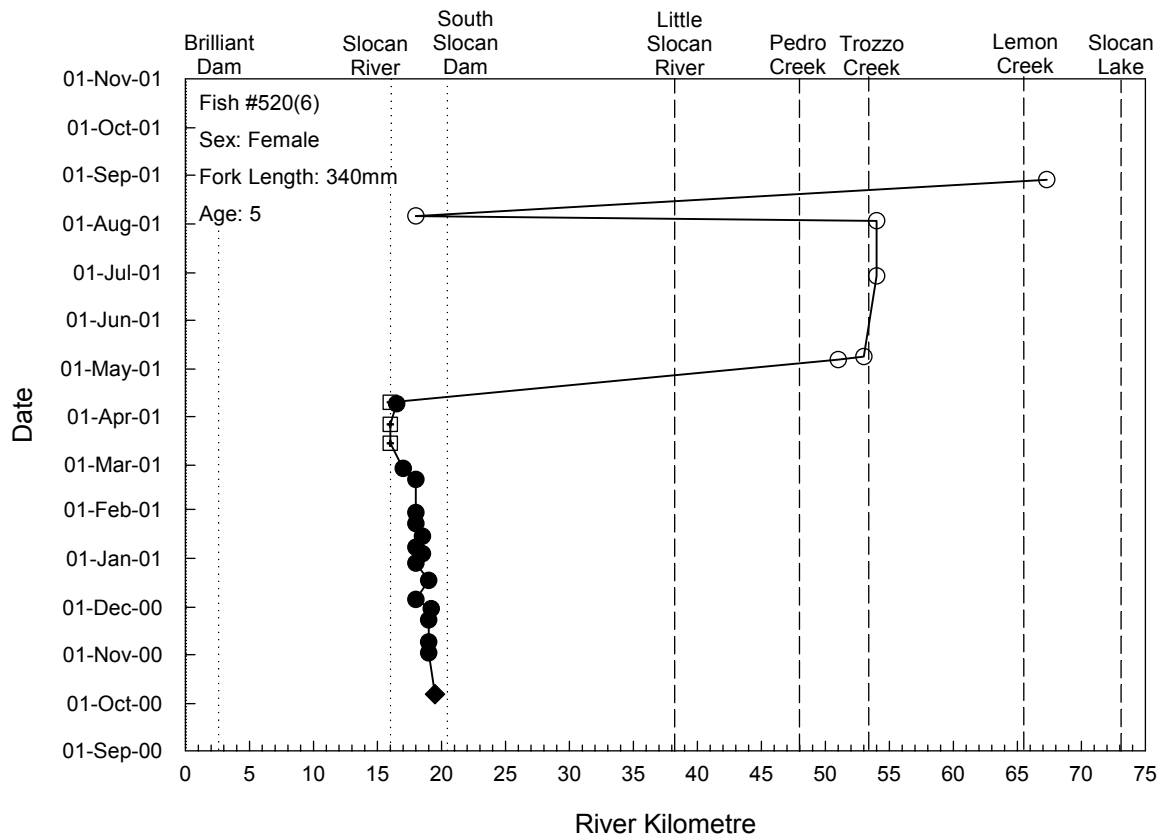


Figure B3 Continued.

Continued...

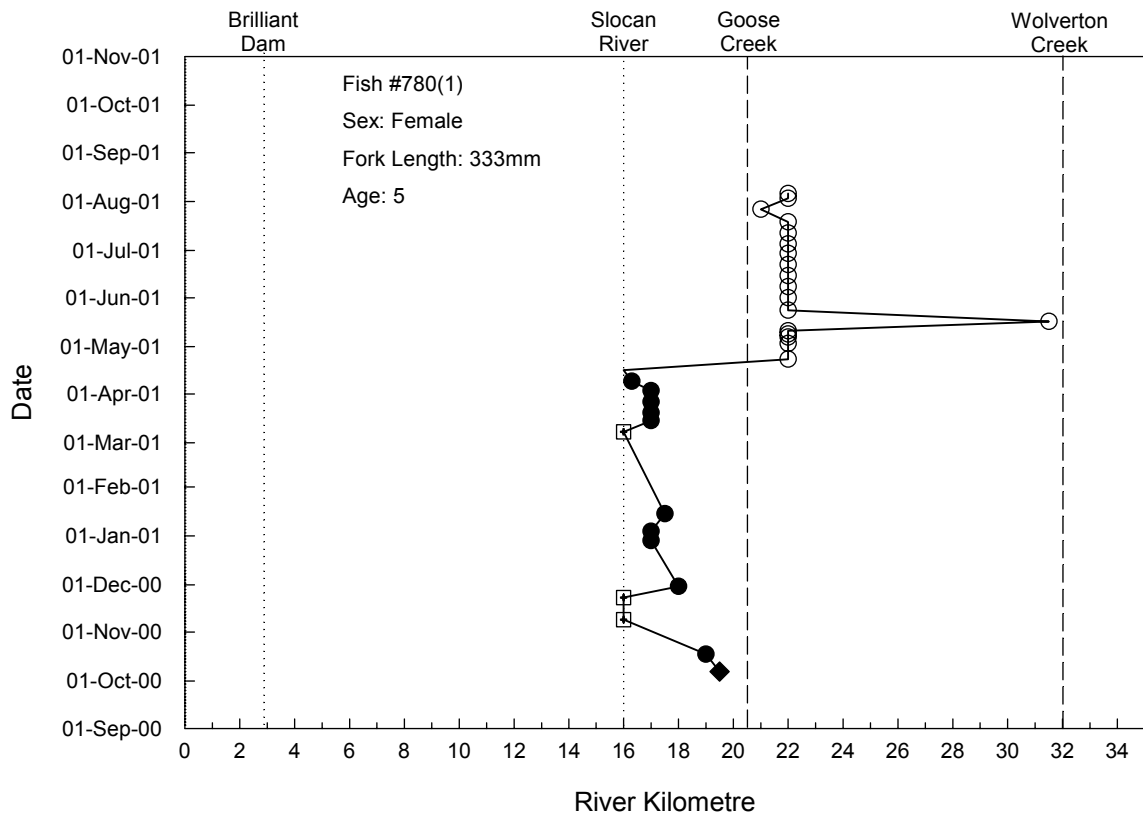
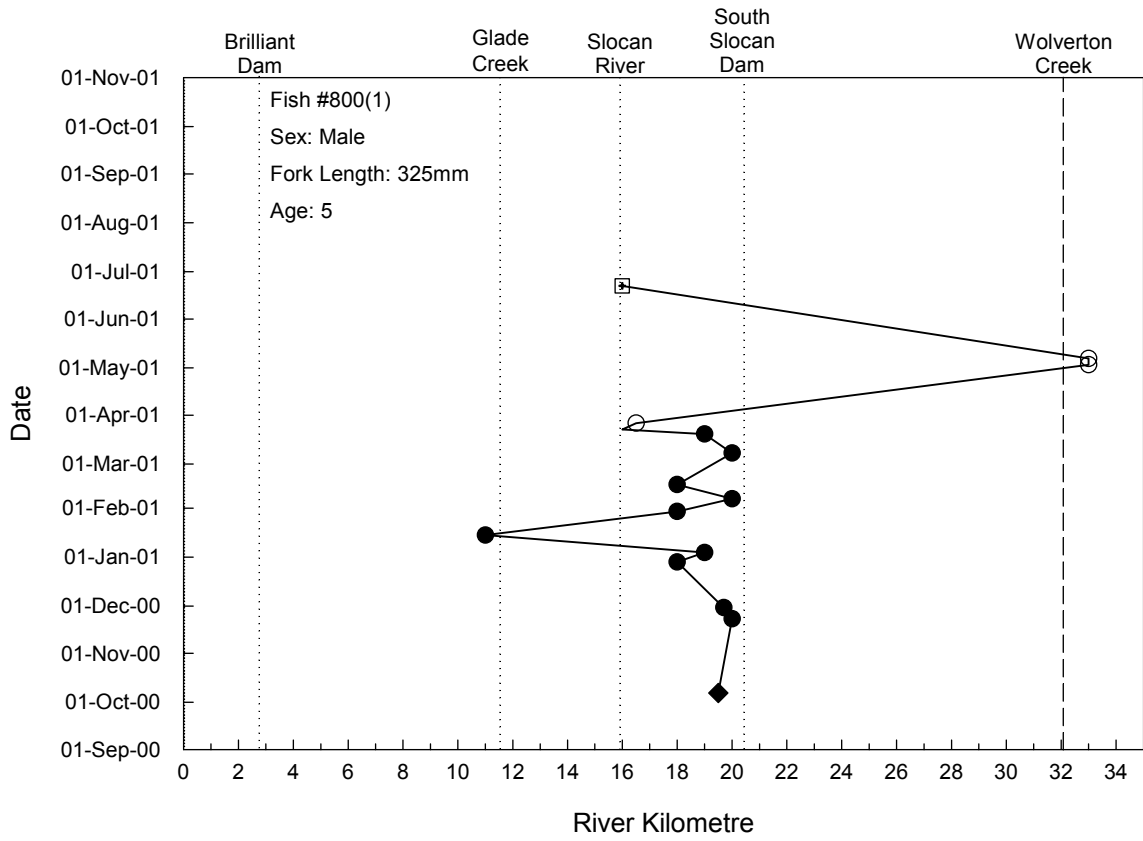


Figure B3 Continued.

Continued...

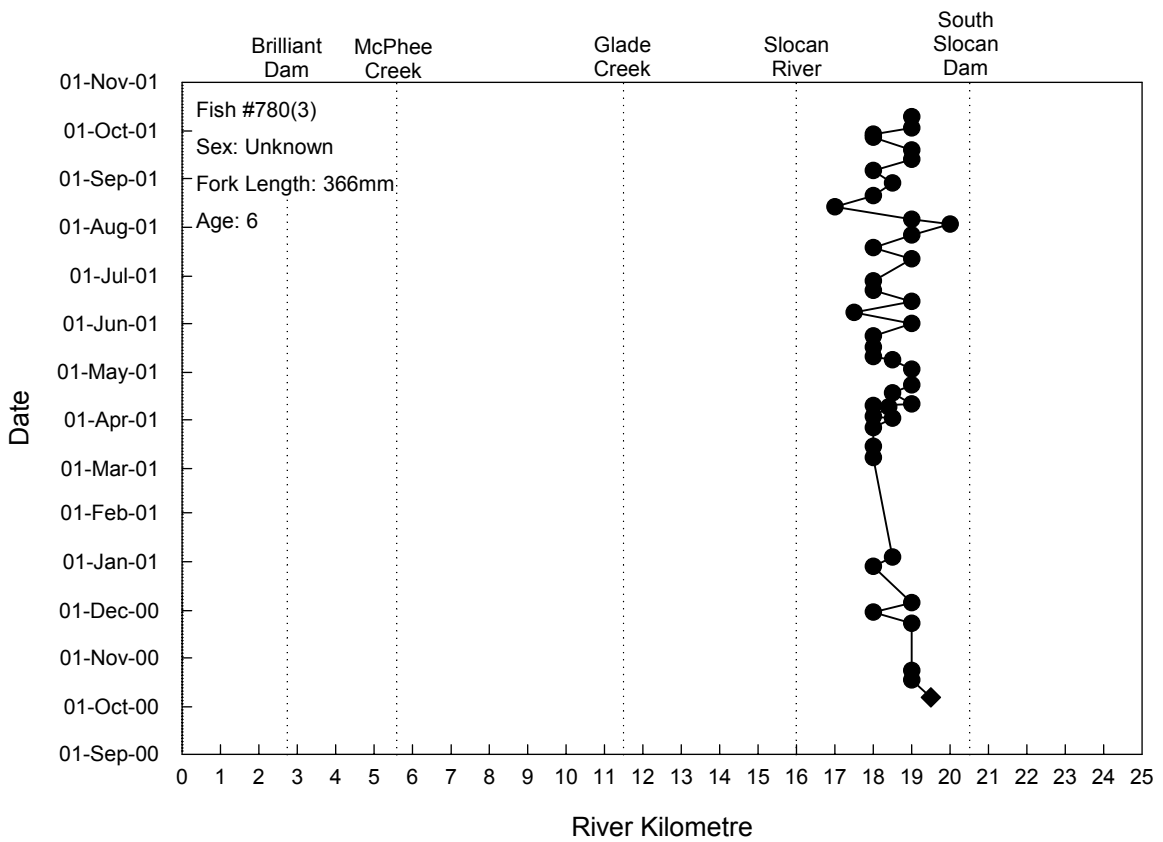
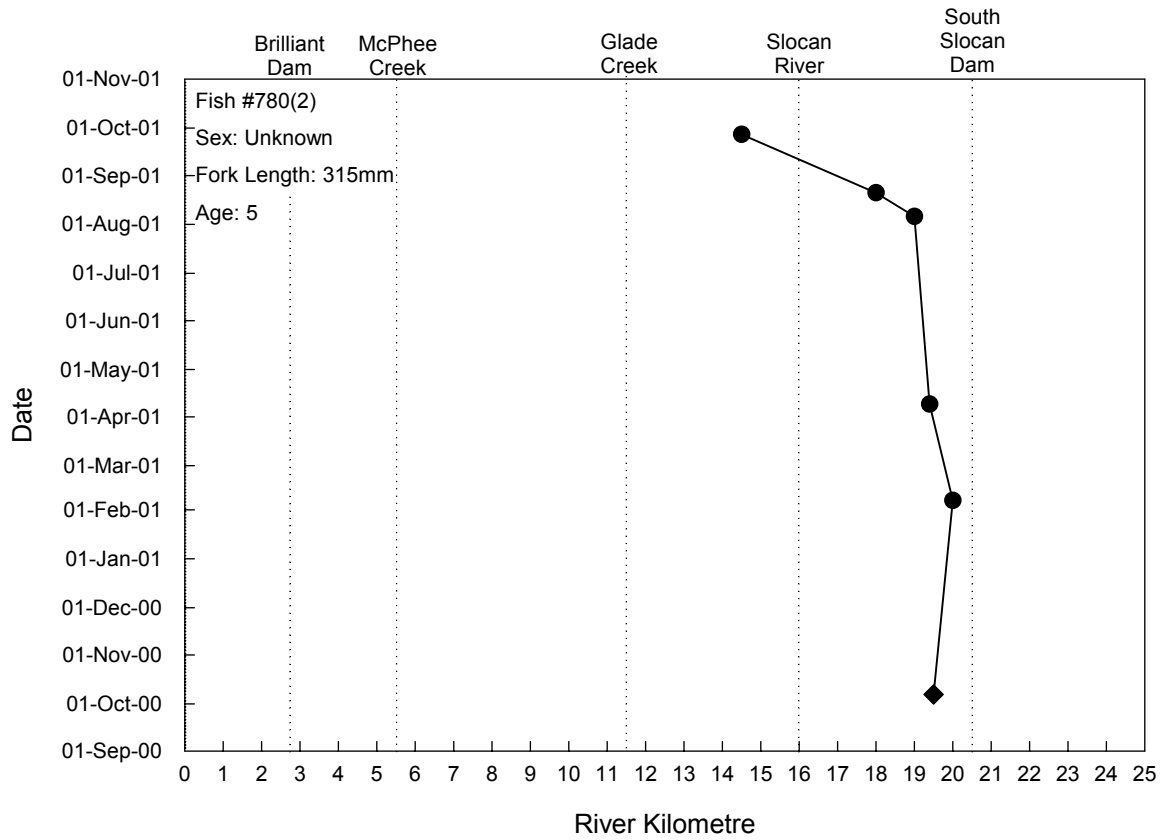


Figure B3 Continued.

Continued...

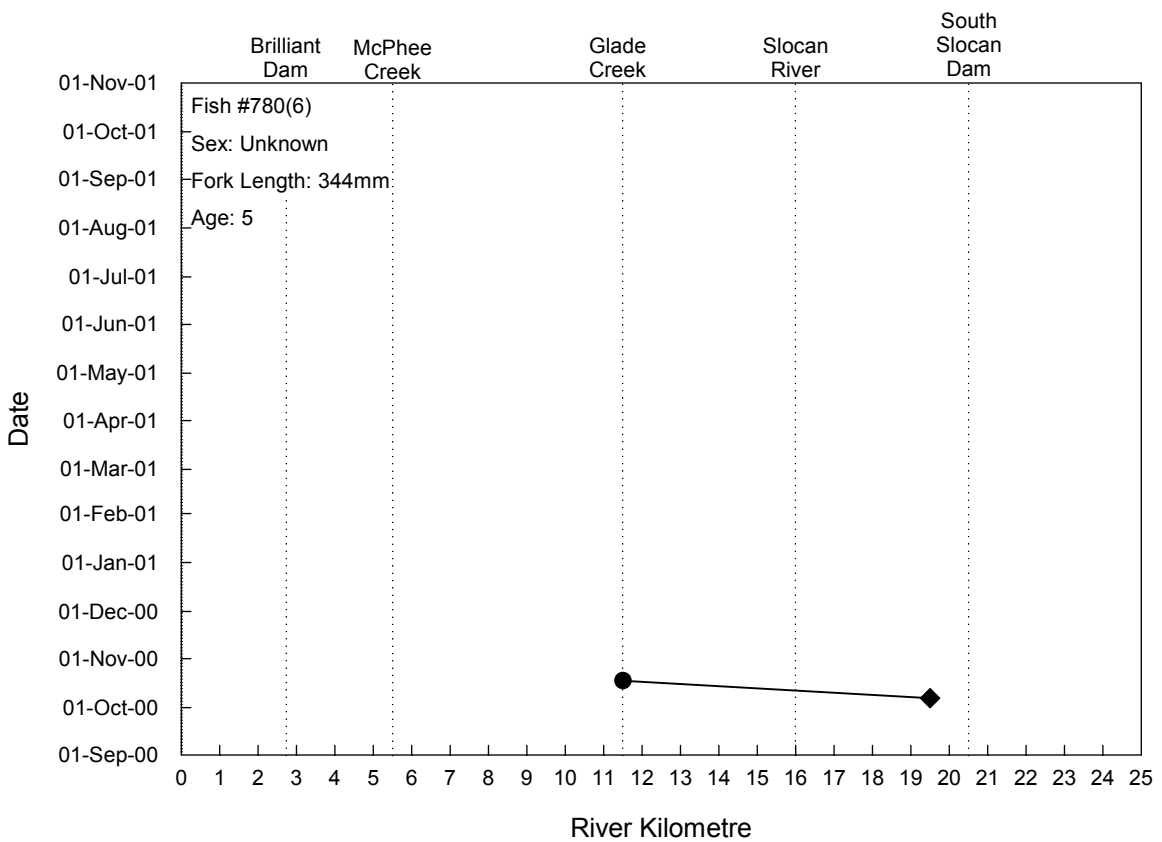
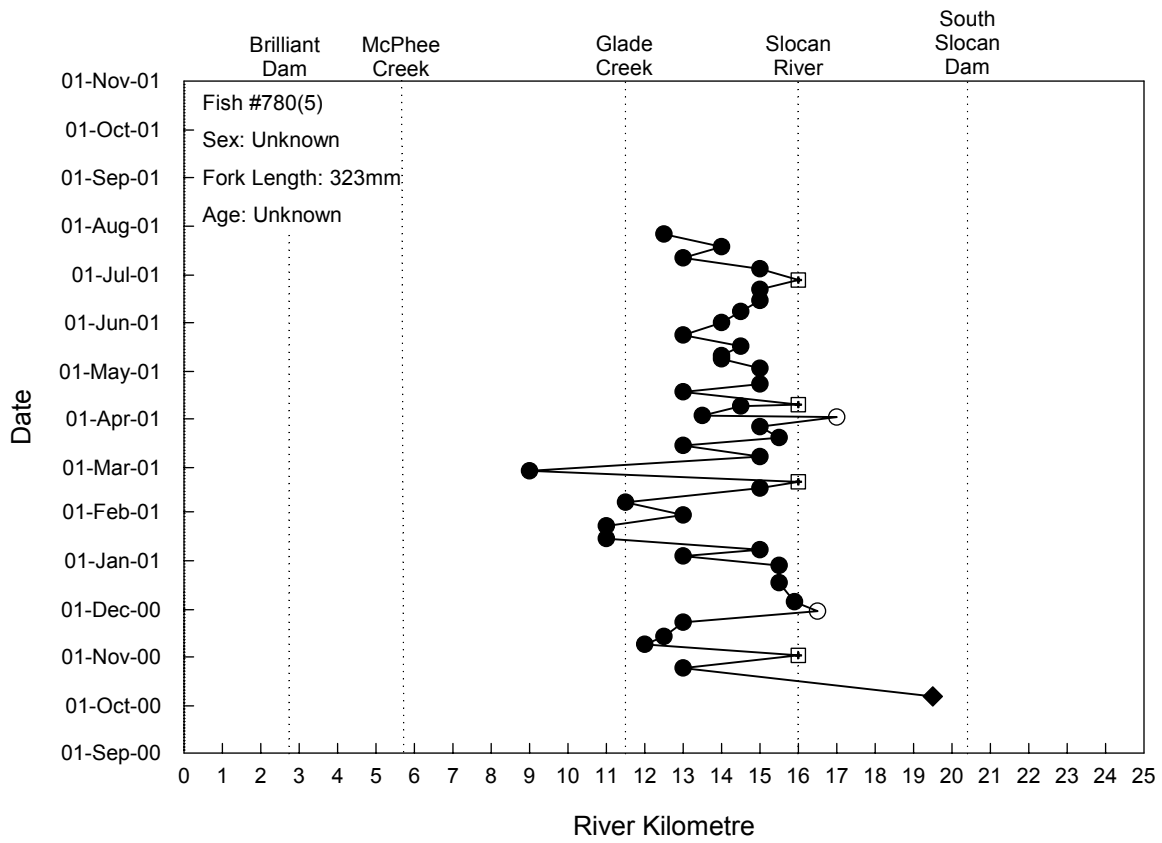


Figure B3 Concluded.

APPENDIX C

**BRILLIANT HEADPOND
RAINBOW TROUT STOCKING INFORMATION**

Table C1 Rainbow trout stocking records for fish released in Slocan Pool on the Kootenay River (Brilliant headpond), 1929 - 2001.

Release Date	Stock	Life Stage	Brood Year	Number Stocked	Average Size (g)	Mark ^a	Hatchery ^b
1-Jan-29	Lardeau River	fry		20,000			NEH
1-Jan-31	Cottonwood Lake	eyed egg		21,500			NEH
1-Jan-32	Pinantan Lake	fry		20,000			NEH
1-Jan-32	Cottonwood Lake	fry		25,000			NEH
1-Jan-33	Cottonwood Lake	fry		20,000			NEH
1-Jan-34	Cottonwood Lake	fry		30,000			NEH
1-Jan-35	Cottonwood Lake	fry		30,000			NEH
1-Jan-36	Cottonwood Lake	fry		35,000			NEH
1-Jan-37	Pennask Lake	fry		61,829			NEH
1-Jan-38	Pennask Lake	fry		50,000			NEH
1-Jan-39	Lardeau River	fry		60,000			NEH
1-Jan-46	Pennask Lake	fingerling		11,959			NEH
1-Jan-48	Pennask Lake	fingerling		37,731			NEH
1-Jan-49	Lardeau River	fingerling		6,000			NEH
1-Jan-50	Lardeau River	fingerling		30,000			NEH
1-Jan-51	Swalwell ^c	fingerling		5,180			NEH
1-Jan-55	Pennask Lake	unknown		5,500			NEH
1-Jan-56	Summerland Hatchery	fingerling		2,850	5.0		NEH
1-Jan-58	Oregon State	yearling		13,000	30.0		NEH
1-Jan-64	McLeary	fingerling		15,000	3.5		NEH
1-Jan-65	McLeary	fry		15,000	1.5		NEH
1-Jan-68	Swalwell	fingerling		15,000	15.0		KTH
1-Jan-70	Swalwell	yearling		10,000	30.0		KTH
1-Jan-72	Premier Lake	fingerling		10,000	15.0		KTH
1-May-81	Premier Lake	unknown	1980	15,000	9.3		KTH
1-Jun-82	Premier Lake	unknown	1981	1,000	10.0		KTH
1-Apr-83	Premier Lake	unknown	1982	10,000	11.0	ALM	KTH
1-Apr-84	Premier Lake	unknown	1983	3,500	8.0		KTH
1-May-84	Premier Lake	unknown	1983	1,500	11.0		KTH
1-May-85	Premier Lake	unknown	1984	20,000	5.0	ALM	KTH
1-May-86	Premier Lake	unknown	1985	5,000	7.0		KTH
1-May-86	Premier Lake	unknown	1985	10,000	10.0	ARM	KTH
1-May-87	Premier Lake	unknown	1986	15,000	3.5	ALM	KTH
1-May-88	Premier Lake	unknown	1987	15,000	6.0	ARM	KTH
19-Apr-89	Premier Lake	yearling	1988	15,000	6.0		KTH
15-May-90	Pennask Lake	yearling	1989	15,000	4.0		KTH
21-May-91	Premier Lake	yearling	1990	15,000	7.2	LM	KTH
3-Jun-92	Premier Lake	yearling	1991	15,000	6.5	RM	KTH
22-Jun-93	Pennask Lake	yearling	1992	15,000	4.8	AD	KTH
18-May-94	Pennask Lake	yearling	1993	15,000	4.9		KTH
10-May-95	Pennask Lake	yearling	1994	15,000	4.5	RM	KTH
5-Jun-96	Pennask Lake	yearling	1995	15,000	4.4	AD	KTH
11-Jun-97	Pennask Lake	yearling	1996	15,000	4.5	AD	KTH
29-Apr-98	Blackwater River	yearling	1997	15,000	9.4	ALM	KTH
2-Jun-99	Blackwater River	yearling	1998	15,000	14.1	AD	KTH
8-May-00	Blackwater River	yearling	1999	15,000	11.0	AD	KTH
22-Jun-01	Blackwater River	yearling	2000	15,000	12.5	N/A	KTH

^a ALM = adipose and left maxillary clip, ARM = adipose and right maxillary clip, LM = left maxillary clip, RM = right maxillary clip, AD = adipose clip, N/A = mark not applied.

^b NEH = Nelson Hatchery, KTH = Kootenay Trout Hatchery.

^c Swalwell = Pennask Lake stock released into Beaver Lake (i.e., second generation).