Columbia River Project Water Use Plan

Lower Columbia River Fish Management Plan

Implementation Year 4

Reference: CLBMON-48

Lower Columbia River: Whitefish Life History and Egg Mat Monitoring Program: Year 4 Summary Report

Study Period: September 2011 to April 2012

Golder Associates Ltd.
Brad Hildebrand – Project Manager and Author
bhildebrand@golder.com

December 20, 2012

December 20, 2012

CLBMON-48: LOWER COLUMBIA RIVER

Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program: Year 4 Data Report

Submitted to:
Dr. Guy Martel
Contract Manager
BC Hydro
601 - 18th Street
Castlegar, BC V1N 2N1

Report Number: 11-1492-0111

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REPORT

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Cover Photo: Downstream view of retrieval floats on egg collection mats deployed along the mainstem bank of the CPR Island Mountain Whitefish spawning area, December 6, 2011.

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Executive Summary

Mountain Whitefish (*Prosopium williamsoni*) are the most abundant sportfish in the lower Columbia River (defined as the Columbia River from Hugh L. Keenleyside Dam [HLK] to the Canada-US Border) and use this area for all life history functions. Results of previous studies conducted by BC Hydro raised concerns by regulatory agencies about the effects of river regulation on Mountain Whitefish reproductive success in the lower Columbia River. These concerns led to the development and initiation of BC Hydro's Whitefish Flow Management (WFM) program in the winter of 1994 - 1995 and a series of subsequent intensive studies on Mountain Whitefish life history characteristics between 1995 and 1999. In 2008, BC Hydro initiated the five year CLBMON-48 study program to update information on juvenile Mountain Whitefish abundance and distribution and adult Mountain Whitefish spawning activity in the lower Columbia River. This data report describes the study components conducted, the methods used, and a brief description of the results obtained during Year 4.

Sex ratios, age-at-maturity, and fecundity estimates for the current Mountain Whitefish population were obtained and used to provide more representative estimates of spawner abundance and Potential Egg Deposition (PED). The current sex ratio of 1 male:1.14 females was within the range reported for previous studies. The proportions of mature age-2 and older fish were similar or higher than previous studies in the Columbia River. Of the mature females examined in the present study (2011), 30% were spent, all of which were captured in the upper and middle sections of the study area. The mean fecundity of 9404 eggs/female was very similar to the 9514 eggs/female determined in the 1994 - 1995 study. However, substantial increases in the estimated abundance of Mountain Whitefish adults were observed between the 1990s study and Years 2 to 4 of the present study. This may indicate a substantial increase in potential egg production of the current Mountain Whitefish population.

In Year 4, the onset and peak of Mountain Whitefish spawning in the lower Columbia River at the CPR Island area occurred over temporal and temperature ranges similar to those recorded in previous study years. Egg deposition occurred in essentially the same locations and within the same habitat parameters of depth, substrate composition, and surface velocity as documented during previous studies. The patterns of egg deposition recorded during the present and previous studies indicate a high use of the shallow nearshore habitats in these areas for spawning. Eggs deposited within shallow nearshore areas are at risk of stranding during periods of reduced flow in the Columbia or Kootenay rivers over the course of the egg incubation period, although BC Hydro attempts to limit egg mortality through detailed flow management during this period. In the lower section of the study area, the highest catch rates were documented during the first week of sampling, which suggested that peak spawning in the lower section occurred prior to the onset of sampling. In the lower section, the low numbers of eggs collected and the insufficient data from past spawning activity upon which comparisons can be drawn precluded a detailed analysis of spawn timing and egg depositional patterns.

Exploratory egg grids at Tin Cup and Kinnaird rapids confirmed similar levels of egg deposition as was documented in previous study years. The documented rates of egg stranding at CPR Island area suggested a continued high rate of egg deposition in this area over the years sampled. In the Kootenay River, HLK flow reductions related to the initiation of Rainbow Trout Protection flows did not dewater substantial shoreline areas in the Kootenay River; therefore, the majority of deposited Mountain Whitefish eggs remained wetted.

The current state of knowledge, relating the effects of flow management on the various life history stages of Mountain Whitefish is presented in Table EI.

Table EI: CLBMON-48 Year 4: STATUS of OBJECTIVES, MANAGEMENT QUESTIONS and HYPOTHESES.

Study Objective	Management Question	Management Hypotheses	Year 4 (2010) Status
Obtain current sex ratios, age-at-maturity and fecundity of adult Mountain Whitefish in the lower Columbia and lower Kootenay rivers.	What is the seasonal timing of whitefish spawning in the lower Columbia and lower Kootenay rivers? To what extent does the timing and intensity of spawning vary from year to year? Is the timing or intensity of spawning associated with flow management?	The seasonal timing of spawning by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.	Sex ratios and mean fecundity from present study closely resemble estimates from studies conducted in the mid-1990s. Data collected suggests that presently, a greater proportion of Mountain Whitefish are maturing earlier than in previous study years. Therefore, this management hypothesis cannot be rejected with the current dataset.
Quantify the periodicity (timing), intensity and distribution of Mountain Whitefish spawning at two locations on the Columbia River (CPR Island spawning area and the lower section of the study area) during the December, January, and February spawning period.		The seasonal timing of spawning by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.	Five years of data available on spawn timing CPR Island key spawning areas in the upper study area and one year of data in the lower section. Data suggests consistent high use of key areas on yearly basis with some variation in timing and intensity among years. Timing and intensity is likely related to temperature, which previous studies have shown is not affected by flow management. Therefore, this management hypothesis cannot be rejected with the current dataset.
Document the spatial extent and physical characteristics of whitefish spawning areas in these two spawning areas.	What is the spatial distribution of whitefish spawning activities in the lower Columbia and lower Kootenay Rivers? Is there inter-annual variation in spawning habitat use? Is the spatial distribution of spawning locations associated with flow management?	The distribution of spawning habitat used by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.	Identified key spawning areas in upper section of study area and several low use spawning areas in middle and lower sections. There is a limited degree of inter-annual variation in spawning habitat use within key spawning areas and egg catch rates have remained relatively high in these areas in all study years. Therefore, this management hypothesis cannot be rejected with the current dataset.
	What are the physical and hydraulic characteristics of whitefish spawning and egg incubation habitats?	The physical characteristics of spawning habitats of Mountain Whitefish in the lower Columbia and lower Kootenay rivers do not differ significantly between years.	Multiple years of data collected on the physical characteristics at the key spawning areas. One year of data collected for secondary spawning areas in the middle and lower sections of the study area. Although there are variations between years in the physical characteristics of spawning habitats in the key areas, significant differences between years have not been documented. Therefore, this management hypothesis cannot be rejected with the current dataset.
Document the vertical distribution (depth) of Mountain Whitefish eggs in these spawning areas.	What is the pattern of egg dispersal at spawning locations? What is the vertical distribution of eggs in the river channel? Is the spatial distribution of eggs related to flow management?	The vertical distribution of Mountain Whitefish eggs in the river channel of the lower Columbia and lower Kootenay rivers does not differ significantly between years.	Multiple years of data are available on vertical distribution patterns of eggs deposited at key spawning areas. One year of data collected for secondary spawning areas in the middle and lower sections of the study area. Although there are variations in the vertical distribution of egg deposition between years, significant differences between years have not been documented. Therefore, this management hypothesis cannot be rejected with the current dataset.
Document egg stranding in the upper section of the lower Columbia River during flow reductions from HLK.		The vertical distribution of Mountain Whitefish eggs in the river channel of the lower Columbia and lower Kootenay rivers does not differ significantly between years	Similar rates of egg deposition confirmed in secondary spawning areas. Data collected in key spawning areas indicates high use of shallow nearshore habitats for spawning, and substantial risks of stranding eggs in these areas during discharge reductions. Therefore, this management hypothesis cannot be rejected with the current dataset.
Identify and characterize the rearing habitats utilized by larval mountain whitefish prior to the scheduled discharge reductions to reach Rainbow Trout protection flows; and, determine if the scheduled flow reductions displace the larvae to different rearing habitats.	What habitats are juvenile whitefish using in the lower Columbia and lower Kootenay rivers? Is it possible to develop and implement a reliable program for indexing the young-of-the-year abundance as a measure of fish cohort strength?	Young-of-the-year whitefish consistently use near-shore habitats and can be monitored to provide a reliable index of survival in the first year of life in the lower Columbia and lower Kootenay rivers.	Flow reductions to reach Rainbow Trout protection flows occurred prior to peak hatching of Mountain Whitefish eggs. As a result, data to assess larval habitat use and determine if the reductions would displace larvae was not obtained. Although data was not collected to test this management hypothesis in the current study year, it was rejected in Year 3 (2010 – 2011) of this program.

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Bradley Hildebrand, B.Sc.	Intermediate Fisheries Biologist, Author
Larry Hildebrand, B.Sc., R.P.Bio.	Senior Fisheries Biologist, Editor
Mike Hildebrand, B.Sc., R.P.Bio.	Intermediate Fisheries Biologist
Dustin Ford, B.Sc., R.P.Bio.	Intermediate Fisheries Biologist
Demitria Burgoon, B.Sc.	Intermediate Fisheries Biologist
David Roscoe, M.Sc.	Junior Fisheries Biologist
Steve Whitehead, Tech. Dipl.	Biological Technician
Chris King, Tech. Dipl.	Biological Technician
Megan Crozier, Tech. Dipl.	Biological Technician
Ron Giles	Warehouse Technician

The following employees of **OKANAGAN NATION ALLIANCE** contributed to the collection of data.

Natasha Audy, Tech. Dipl.	Certified Technician

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1.0 INTRODUCTION

1.1 Background

Mountain Whitefish (*Prosopium williamsoni*) are the most abundant sportfish in the lower Columbia River (LCR; defined as the Columbia River from Hugh L. Keenleyside Dam [HLK] to the Canada-US Border and including the lower Kootenay River below Brilliant Dam [BRD]). This species uses this area for all life history functions (Hildebrand and English 1991; R.L. & L. 1995). Although Mountain Whitefish do not support a recreational fishery in the LCR, they do represent an important indicator species in this ecosystem. Results of studies conducted by BC Hydro in the early 1990s raised concerns by the environmental regulatory agencies (i.e., BC Ministry of Environment, Lands and Parks; Department of Fisheries and Oceans Canada) about the effects of river regulation on Mountain Whitefish reproductive success in the LCR. Water level fluctuations associated with dam operations on both the Columbia and Kootenay rivers can negatively impact whitefish spawning success by exposing incubating embryos when water levels recede. In addition, armoured substrates found in regulated systems like the LCR have been identified as potentially detrimental to whitefish egg survival by decreasing the egg retention capabilities of incubation habitat. Flow regulation of the LCR may also affect whitefish spawning behaviour, hatch periodicity, and hatch success through the modification of flows that may provide essential spawning and hatching cues. Finally, flow fluctuations may also affect larval and juvenile Mountain Whitefish habitat use, which prefer nearshore rearing habitats with relatively low velocities and gradients (R.L. & L. 2001a).

These concerns led to the development and initiation of BC Hydro's Whitefish Flow Management (WFM) program in the winter of 1994 - 1995. A series of intensive studies on Mountain Whitefish life history characteristics were subsequently conducted annually between 1995 and 1999 (R.L. & L. 1997, 1998a, 1998b, 1999, 2000, 2001b). Since 2001, Mountain Whitefish have been one of three index species examined annually during BC Hydro's Large River Fish Indexing Program (LRFIP; CLBMON-45), a long-term study designed to track abundance metrics and where possible, relate changes in these metrics to biotic (e.g., changes in predator abundance) or abiotic (e.g., changes in river regulation patterns) factors (Golder 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009b, 2010b). The LRFIP has successfully indexed adult and sub-adult cohorts of Mountain Whitefish and has allowed the identification of relative year-class strength and the calculation of abundance estimates for these cohorts.

In 2008, as part of BC Hydro's LCR Water Use Plan (WUP), BC Hydro initiated Year 1 of a proposed five year CLBMON-48: Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program (hereafter referred to as CLBMON-48). The purpose of this program was to update information on juvenile Mountain Whitefish abundance and distribution and adult Mountain Whitefish spawning activity in the LCR. This information is needed to inform management actions related to the effects of flow regulation on Mountain Whitefish recruitment success.

This report presents data from Year 4 (2011 - 2012 field season) of the five year CLBMON-48 study program. Results from this work will improve the understanding of Mountain Whitefish reproductive ecology and juvenile rearing in the LCR and will help guide future management actions.

1.2 Management Questions, Hypotheses, and Study Objectives

As stated in the CLBMON-48 Terms of Reference (BC Hydro 2007), the overarching objective of this monitoring program is to:

Collect and refine data regarding the location, timing and depth distribution of Mountain Whitefish spawning in the lower Columbia River below Hugh L. Keenleyside (HLK) Dam to improve annual estimates of egg mortality.

The specific management questions associated with the CLBMON-48 monitoring program are:

1. *What is the spatial distribution of whitefish spawning activities in the lower Columbia and lower Kootenay Rivers? Is there inter-annual variation in spawning habitat use? Is the spatial distribution of spawning locations associated with flow management?*
2. *What are the physical and hydraulic characteristics of whitefish spawning and egg incubation habitats?*
3. *What is the seasonal timing of whitefish spawning in the lower Columbia and lower Kootenay rivers? To what extent does the timing and intensity of spawning vary from year to year? Is the timing or intensity of spawning associated with flow management?*
4. *What is the pattern of egg dispersal at spawning locations? What is the vertical distribution of eggs in the river channel? Is the spatial distribution of eggs related to flow management?*
5. *What are the pre-spawning and post-spawning seasonal movement patterns of whitefish? How do patterns of sub-adult and adult migration affect the interpretation of annual index monitoring programs?*
6. *What habitats are juvenile whitefish using in the lower Columbia and lower Kootenay rivers? Is it possible to develop and implement a reliable program for indexing the young-of-the-year abundance as a measure of fish cohort strength?*

To address the primary management questions above, six hypotheses will be tested using data collected during the monitoring program. The first four hypotheses are stated as nulls in order to test the assumptions of the current Mountain Whitefish Egg Mortality Model (R.L. & L. 2003). These null hypotheses are:

Ho_1: The distribution of spawning habitat used by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.

Ho_2: The physical characteristics of spawning habitats of Mountain Whitefish in the lower Columbia and lower Kootenay rivers do not differ significantly between years.

Ho_3: The seasonal timing of spawning by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.

Ho_4: The vertical distribution of Mountain Whitefish eggs in the river channel of the lower Columbia and lower Kootenay rivers does not differ significantly between years.

The final two hypotheses are more general, in support of the development of monitoring programs for adult and juvenile Mountain Whitefish, and the interpretation of collected data. These hypotheses are:

Ho_5: Whitefish undertake significant migrations in the lower Columbia and lower Kootenay rivers during pre-spawning and spawning periods, such that stock assessment conducted in Sept/Oct does not accurately reflect the spawning abundance abundance/characteristics.

Ho_6: Young-of-the-year whitefish consistently use near-shore habitats and can be monitored to provide a reliable index of survival in the first year of life in the lower Columbia and lower Kootenay rivers.

The Year 4 study program was intended to obtain information adult Mountain Whitefish sex ratios and fecundity, adult Mountain Whitefish spawning activity and egg deposition, egg stranding, as well as emergent larval habitat. This information is needed to inform management actions related to the effects of flow regulation on Mountain Whitefish recruitment success in the LCR. The specific objectives of CLBMON-48 Year 4 were:

1. *Obtain current sex ratios, age-at-maturity and fecundity of adult Mountain Whitefish in the lower Columbia and lower Kootenay rivers. (Management Question 3).*
2. *Quantify the periodicity (timing), intensity and distribution of Mountain Whitefish spawning at the CPR Island index site on the Columbia River during the December, January, and February spawning period. (Management Question 3).*
3. *Quantify the periodicity (timing), intensity and distribution of Mountain Whitefish spawning in the lower section of the Columbia River during the December, January, and February spawning period. (Management Question 3).*
4. *Document the spatial extent and physical characteristics of whitefish spawning areas in these two spawning areas. (Management Questions 1 and 2).*
5. *Document the vertical distribution (depth) of Mountain Whitefish eggs in these spawning areas. (Management Question 4).*
6. *Document egg stranding in the upper section of the lower Columbia River during flow reductions from HLK (Management Question 4).*
7. *Identify and characterize the rearing habitats utilized by larval Mountain Whitefish prior to the scheduled discharge reductions to reach Rainbow Trout protection flows; and, determine if the scheduled flow reductions displace the larvae to different rearing habitats. (Management Question 6).*

The scope of CLBMON-48 Year 4 included:

1. *Work in conjunction with the CLBMON-45: Lower Columbia River Fish Population Indexing Survey program to obtain sex and fecundity data from the whitefish population to increase the accuracy of Potential Egg Deposition (PED) estimates.*
2. *Conduct systematic sampling for Mountain Whitefish eggs at the CPR Island index location and the lower section of the Columbia River, to estimate local timing of spawning and spatial dispersal patterns of eggs and supplement data collected in Years 2 and 3.*

3. *During flow reductions from HLK and/or BRD, conduct post peak spawning egg stranding surveys during flow reductions at the two index spawning areas (CPR Island and the Kootenay River), as well as the two spawning locations included in the current Mountain Whitefish Egg Loss Model. This would allow for comparisons of stranding rates between spawning areas and study years.*

4. *Conduct larval stranding surveys after a flow reduction at HLK to obtain additional information on larval Mountain Whitefish biology and habitat use.*

1.3 Study Design and Rationale

Since 1990, Golder has used a wide variety of fish capture/observation techniques to capture fish and document fish life history and habitat use patterns in the LCR. The results of previous study programs on Mountain Whitefish distribution, movements, spawning behaviour, habitat selection, and early life stage biology in the LCR, plus the primary literature reviewed during and subsequent to these studies, formed the basis for the CLBMON-48 Year 4 study approach and design. A comprehensive summary of the main sample methods used in previous studies and their effectiveness at capturing juvenile Mountain Whitefish are provided in the CLBMON-48 Year 1 report (Golder 2009a).

1.3.1 Data Gap Analysis

The first study component conducted in Year 4 was a data gap analysis. This analysis was conducted to provide the following:

- the current state of knowledge on Mountain Whitefish life history in the Columbia River and how it is affected by flow management;
- to identify gaps within that dataset; and,
- to focus sampling effort in the remaining study years (4 and 5).

The CLBMON-48 Year 4 study program was designed to incorporate the following study components that were considered as the highest priority based on the data gap analysis.

- obtaining sex, maturity and fecundity data from the Whitefish population to increase the accuracy of Potential Egg Deposition (PED) estimates (Section 1.3.2);
- egg collection mat sampling (Section 1.3.3);
- D-ring program to test for egg drift (Section 1.3.4);
- egg stranding surveys (Section 1.3.5); and,
- larval Mountain Whitefish sampling (Section 1.3.6).

1.3.2 Adult Mountain Whitefish Sex Ratio, Fecundity, and Age-at-Maturity Sampling

As a measure of present spawning intensity (PED), and to provide data on sex ratio, fecundity, and age-at-maturity for the present Mountain Whitefish population, 90 Mountain Whitefish were sacrificed during the 2011 CLBMON-45 Lower Columbia River Fish Population Indexing Program (LRFIP). These data also allowed comparisons with similar data collected during the 1990's to identify if substantial changes to these population metrics have occurred and if these changes could be related to hydro operations.

1.3.3 Mountain Whitefish Spawning Studies

1.3.3.1 Egg Collection Mat Sampling

The Mountain Whitefish spawn monitoring component of CLBMON-48 was designed to provide data for comparison with results of past spawning studies in the area (R.L. & L. 1997, 1999, 2000 and 2001a). In order to determine if the apparent low Mountain Whitefish egg deposition rate documented in 2010 – 2011 continued into the 2011 - 2012 spawning season, egg collection mat sampling was conducted in the CPR Island key spawning area.

Mountain Whitefish spawning in this area was examined in the mid-1990s and in Years 2 and 3 of the present program. Year 4 sampling provided another year of data and allowed a more refined comparison of spawning timing, intensity and distribution between study years. As egg deposition rates in the Kootenay River key spawning area have been consistently high in all previous study years, spawning at that site was not assessed in Year 4. This allowed for the allocation of more sample effort to assess spawning activity and intensity in other areas of the LCR not previously sampled in Years 2 and 3.

During previous studies, spawning related sampling in the lower section of the study area (Trail downstream to the Canada/US border) was limited to egg stranding surveys in response to discharge reductions from HLK and BRD. As a result, very little data had been collected on all aspects of Mountain Whitefish spawning in this section. To address this data gap, Golder conducted exploratory egg collection mat sampling in the lower section to identify spawning areas and to document timing, intensity, and habitat characteristics within those areas.

1.3.3.2 Egg Developmental Staging

In previous Mountain Whitefish spawning studies conducted in the LCR, the date of egg capture and back calculations based on the developmental stage of captured eggs were used to estimate the time of spawning (Rajagopal 1979; R.L. & L. 1997 and 2001a; Golder 2010a). In those studies, egg stages were used to calculate spawn timing and differentiate newly spawned eggs from drifting incubating eggs. In this study, egg developmental staging was also conducted to calculate spawn timing and egg drift on the egg collection mats. The spawn timing estimates were then compared to data collected in previous studies.

1.3.4 D-ring Egg Drift Sample Program

Currently, the relationship between flow increases and the re-suspension of whitefish eggs is poorly understood. Whitefish eggs that are re-suspended and displaced after their initial deposition may be exposed to factors (such as predation and mechanical damage) that increase their risk of mortality. A pilot D-ring drift net sampling program was proposed for one of the key Mountain Whitefish spawning areas (CPR Island or Kootenay site) to provide information towards understanding that relationship.

1.3.5 Egg Stranding Surveys

Egg stranding surveys were conducted during flow reductions from HLK. Surveys were conducted in the two key spawning areas (CPR Island and Kootenay River) to document egg stranding rates and provide data for comparison between study years. Exploratory surveys were also conducted at previously identified low use stranding sites (Tin Cup Rapids and Kinnaird Rapids) to confirm levels of spawning use documented in previous study years.

1.3.6 Larval Surveys

In-depth data on rearing habitats used by larval whitefish was collected in Year 2 (Spring 2010) of this program. The primary focus of larval sampling in Year 4 was to determine if flow reductions related to Rainbow Trout Protection Flows displaced rearing larvae to different habitats.

2.0 METHODS

2.1 Study Area

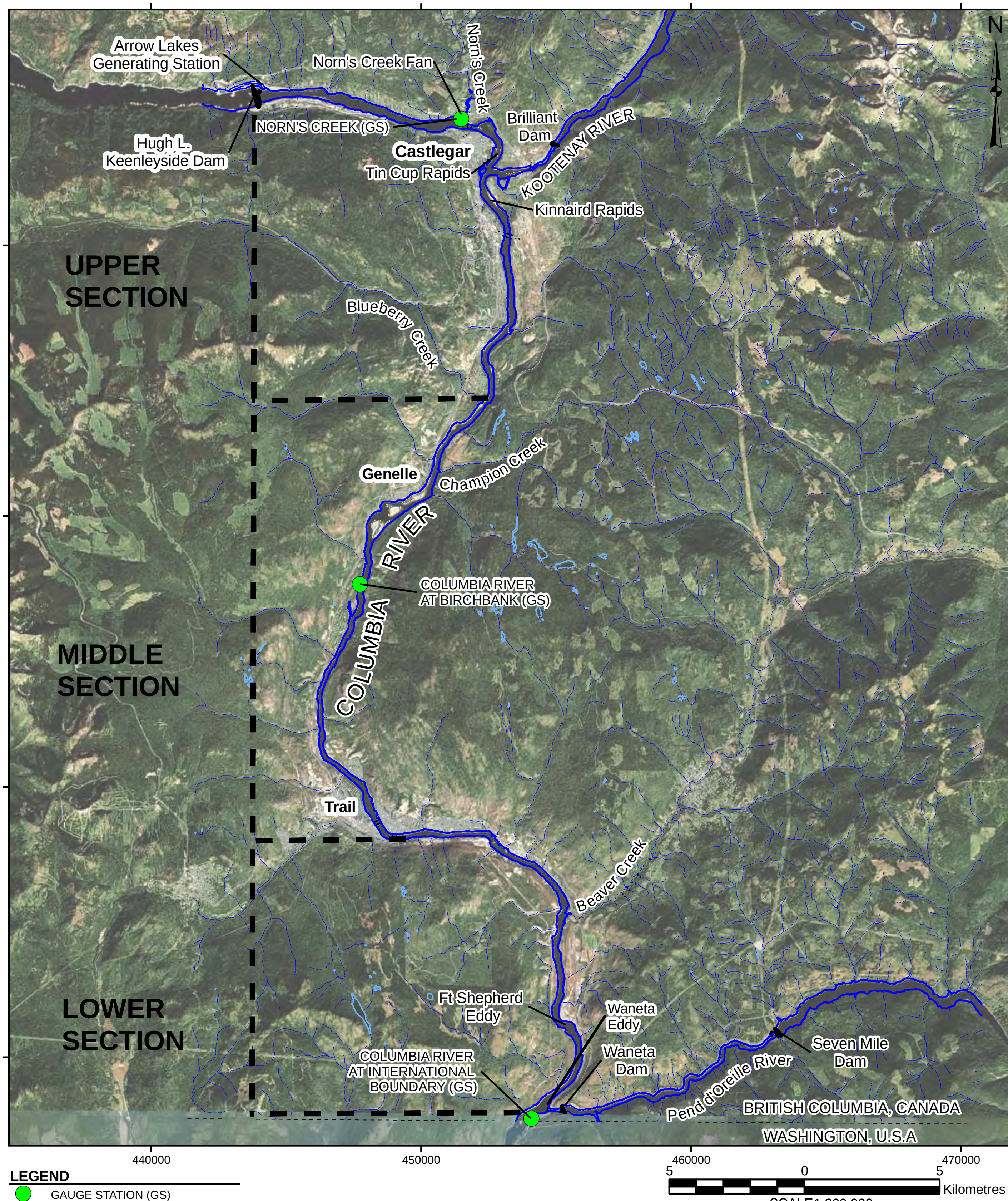
The geographic scope of the CLBMON-48 study was the approximate 56 km section of mainstem LCR from HLK to the Canada-US border (Figure 1). This included the 2.8 km length of the lower Kootenay River from BRD to the confluence with the LCR. Sampling in Year 4 was primarily focussed on the upper section of the study area, which encompasses HLK at River Kilometre (RKm) 0.0 to RKm 23.0, and included the lower Kootenay River (BRD downstream to the mouth; RKm 0.0 to RKm 2.8; Figure 2). Sampling during the Mountain Whitefish spawning season also occurred in the lower section of the study area (RKm 40.1 to the Canada-US border at RKm 56.5; Figure 3). In the present study, sampling activities were not conducted in the middle section of the study area (RKm 23.1 to RKm 40.0; Figure 1).

2.2 Study Period

Sampling chronology for all sampling activities conducted during CLBMON-48 Year 4 is provided in Table 1. Adult Mountain Whitefish gonad examination was conducted in early November 2011. Egg collection mats were deployed in early December 2011 and subsequent weekly retrieval and redeployment was conducted from early December 2011 to early February 2012. Egg stranding and larval sampling activities were conducted between early February and early April 2012.

Table 1: Chronology of sampling activities for the CLBMON-48 Year 4 (2011 - 2012) Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program.

Date(s)	Sections Sampled	Adult Mountain Whitefish Gonad Examination
November 1 to 6, 2011	All	Laboratory examination of sacrificed adult whitefish
Date(s)	**Sections Sampled**	**Egg Collection Mat and Egg Stranding Sampling Activities**
December 6, 2011	Upper	Deployment at CPR Island area
December 8, 9, 2011	Lower	Deployment in lower section of study area
December 12, 19, 28, 2011; January 3, 9, 16, 24, 2012; February 1, 2012	Upper	Retrieval, inspection and redeployment of sample gear at CPR Island area
December 8, 9, 13, 14, 21, 22, 29, 30, 2011; January 5, 6, 10, 11, 17, 19, 25, 26, 2012; February 2, 3, 2012	Lower	Retrieval, inspection and redeployment of sample gear in lower section of study area
February 7, 2012	Upper	Removal of sample gear from CPR Island area
February 8, 9, 2012	Lower	Removal of sample gear from lower section of study area
Date(s)	**Sections Sampled**	**Egg Stranding and Larval Sampling Activities**
February 4, 2012	Upper	Egg stranding surveys at Tin Cup Rapids and Kinnaird Rapids
March 29, 2012	Upper	Larval sampling
April 2, 2012	Upper	Egg stranding surveys at CPR Island and Kootenay River spawning areas



LEGEND

- GAUGE STATION (GS)
- RIVER/STREAM
- ISLAND
- SAND BAR
- ROAD
- BRIDGE

REFERENCE

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, MAY 2009.
2. TRIM BASEMAP FEATURES PROVIDED BY BC HYDRO.
3. GAUGE STATION: WWW.LRDW.CA

PROJECTION: UTM ZONE 11 DATUM: NAD 83

LOWER COLUMBIA RIVER MOUNTAIN WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

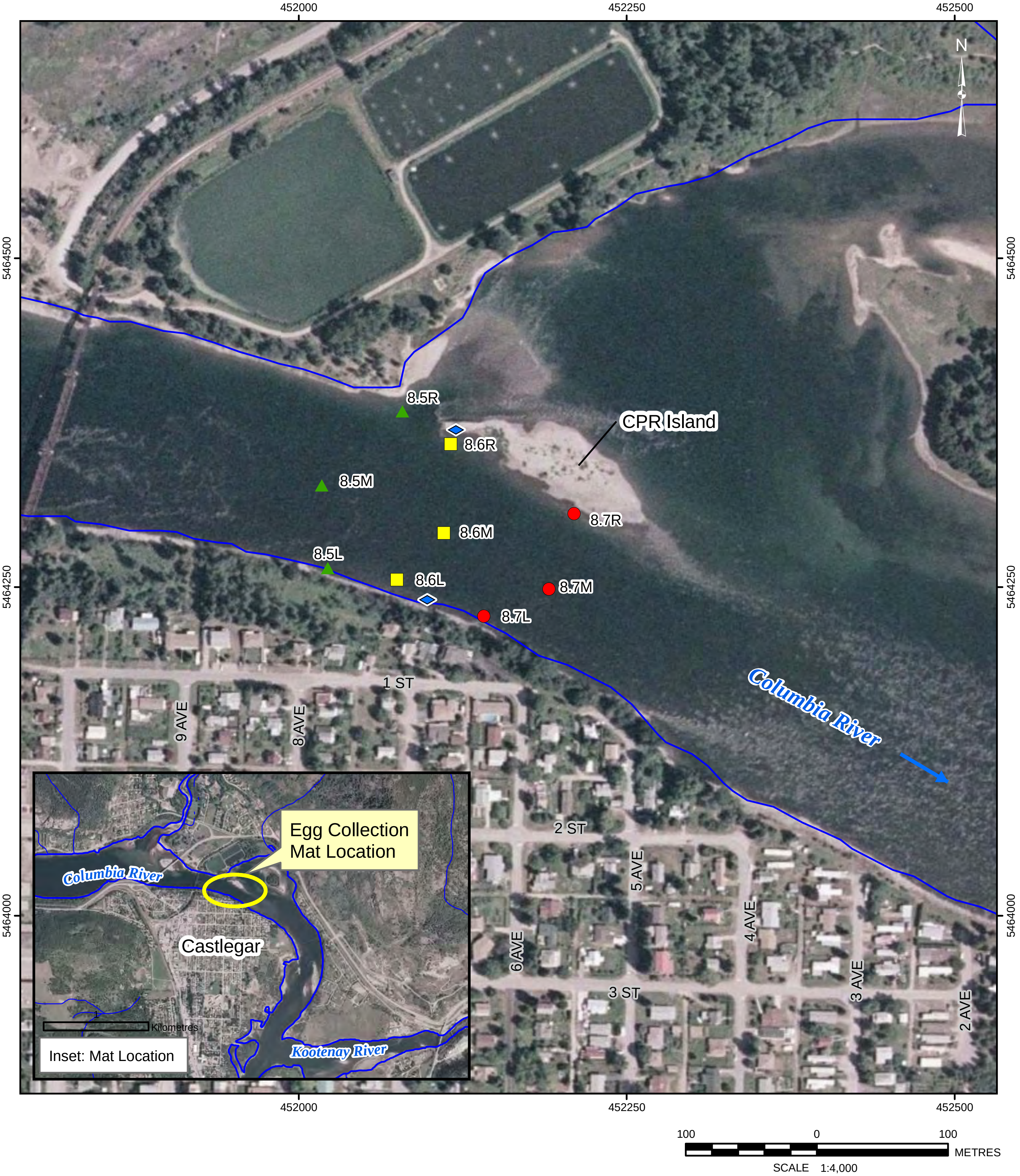
TITLE

YEAR 4
OVERVIEW OF STUDY AREA

Golder Associates

PROJECT NO. 10-1492-0111			SCALE AS SHOWN	REV. 0
DESIGN	BH	19 Sep. 2012		
GIS	JG	19 Sep. 2012	FIGURE: 1	
CHECK	BH	14 Dec. 2012		
REVIEW	LH	17 Dec. 2012		

\\cas1-s-filesrv1\data\Active\GIS\2010\10-1492-0111 MW Mats\Year 4 maps\MXD\Fig1_1014920111_Yr4_overview.mxd



LEGEND

EGG COLLECTION MAT LOCATION

- ▲ 8.5L; 8.5M; 8.5R
- ■ 8.6L; 8.6M; 8.6R
- ● 8.7L; 8.7M; 8.7R
- ◆ WATER TEMPERATURE RECORDER

EGG MAT STATIONS:

L ALONG THE LEFT UPSTREAM BANK (LUB)
M MID-CHANNEL
R ALONG RUB

REFERENCE

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, MAY 2009.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

PROJECT

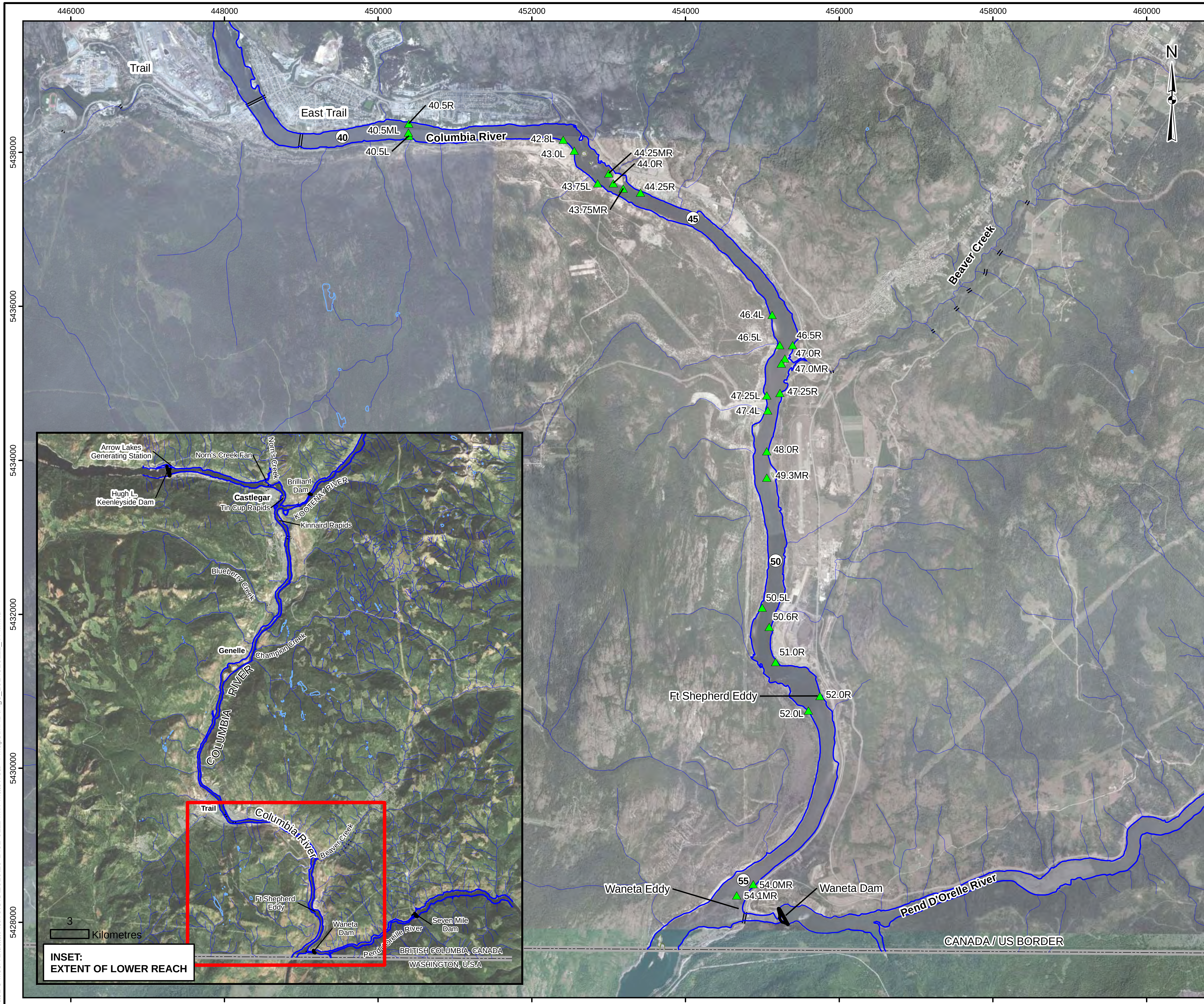
LOWER COLUMBIA RIVER MOUNTAIN WHITEFISH
LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE

YEAR 4
APPROXIMATE EGG COLLECTION MAT SAMPLE LOCATIONS
AT THE CPR ISLAND KEY SPAWNING AREA

Golder Associates

PROJECT No. 10-1492-0111			PHASE No. 2000	
DESIGN	BH	19SEPT2012	SCALE AS SHOWN	REV. 0
GIS	JG	19SEPT2012	FIGURE: 2	
CHECK	BH	14DEC2012		
REVIEW	LH	14DEC2012		



LEGEND

▲ CLBMON-48 YEAR 4 SAMPLE LOCATION

⑧ RIVER KM DOWNSTREAM OF HUGH L. KEENLEYSIDE DAM

EGG MAT STATIONS DESIGNATIONS:

- L ALONG THE LEFT UPSTREAM BANK (LUB)
- M MID-CHANNEL
- ML MID-CHANNEL NEAR LUB
- MR MID-CHANNEL NEAR THE RIGHT UPSTREAM BANK (RUB)
- R ALONG RUB

BASE MAPPING FEATURES

- LAKE
- RIVER/STREAM
- DAM

REFERENCE

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, MAY 2009.
2. TRIM BASEMAP FEATURES PROVIDED BY BCHYDRO.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

1,000 0 1,000 Metres

SCALE 1:50,000

PROJECT

LOWER COLUMBIA RIVER MOUNTAIN WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE

YEAR 4

APPROXIMATE EGG COLLECTION MAT SAMPLE LOCATIONS IN THE LOWER SECTION OF THE LOWER COLUMBIA RIVER

Golder Associates

PROJECT No. 11-1492-0111			PHASE No. 2000	
DESIGN	BH	19 Sep. 2012	SCALE AS SHOWN	REV. 0
GIS	JG	19 Sep. 2012	FIGURE: 3	
CHECK	BH	13 Dec. 2012		
REVIEW	LH	13 Dec. 2012		

\\Cas1-s-filesrv1\data\Active\GIS\2010\10-1492-0111 MW Mats\Year 4 maps\MXD\Fig3_1014920111_Yr4.mxd

2.3 Physical Parameters

2.3.1 Water Temperature

Data Collection Platforms (DCPs) equipped with Lakewood™ Universal temperature probes (accurate to ± 0.5°C) were used to obtain water temperatures from the BC Hydro monitoring station adjacent to Norn's Creek Fan and the Water Survey of Canada gauging station at Birchbank. Temperature data loggers were installed in Fort Shepherd Eddy to record the water temperature in the lower section of the study area, but they were lost due to vandalism. Therefore, LCR water temperatures for the lower section were obtained from a BC Hydro maintained temperature monitoring station at RKm 54.5.

Paired Vemco™ Minilog12 temperature data loggers (accurate to ± 0.5°C) were also deployed on each side of the river at the CPR Island spawning area. This was done to determine if cooler water from Norn's Creek influences water temperatures in the Columbia mainstem at the spawning area.

Spot measurements of water temperature were obtained at all egg collection mat sample sites at the time of sampling using a calibrated hull-mounted Airmar® digital thermometer (accurate to ± 0.2ºC).

2.3.2 Discharge

Kootenay River discharge during the study period was provided by the operators of BRD (Fortis BC) in the form of hourly spill and generation plant discharges from BRD (Figure 1). All discharge data for the LCR were provided by BC Hydro Power Records from HLK (total discharge from HLK and Arrow Lakes Generating Station [ALGS] combined) and the Water Survey of Canada Birchbank DCP.

2.4 Sex Ratio, Fecundity and Age-at-Maturity Sampling

2.4.1 Collection of Fish

During the last week of the LRFIP sampling program, 90 adult Mountain Whitefish were sacrificed from randomly selected sites within the four sections of the LRFIP study area (upper, middle and lower Columbia, and lower Kootenay). The Year 4 study plan proposed that 22 Mountain Whitefish be sacrificed from each of the four Columbia River LRFIP sections and 24 from the lower Kootenay River; however, due to the densities of adult Mountain Whitefish encountered during sampling, these targets were adjusted (see Section 3.3).

The following life history parameters were collected from sacrificed fish:

- length (to the nearest mm);
- weight (to the nearest g);
- presence of tag (recapture)
- structure for ageing (scales); and,
- spawning stage (presence of tubercles).

A Floy tag was inserted into each fish to allow identification of each fish during subsequent inspection in the laboratory. To increase the accuracy of age-at-maturity estimates, the presence of tubercles (an indication of Mountain Whitefish sexual maturity and spawning readiness) were noted during the processing of captured fish in conjunction with standard life history data. The selected fish were sacrificed and placed in a refrigerator until the next morning, when they were processed in the lab. In-depth description of LRFIP sampling, fish handling/processing, and fish aging procedures are described in the CLBMON-45 2011 annual report (Ford and Thorley 2012).

2.4.2 Laboratory Examination of Gonads

Upon inspection in the lab, all sacrificed Mountain Whitefish were eviscerated using a scalpel and surgical scissors. The internal organs were visually inspected, photographs were taken and the following data recorded for each fish:

- Floy tag colour and number;
- sex;
- presence of tubercles;
- total gonad weight (g, for females only; Appendix A, Plate 1);
- weight of 100 eggs (g);
- abnormalities of internal organs (Appendix A, Plate 2); and,
- general comments on the condition of the fish.

To determine fecundity, a sub-sample of 100 eggs was weighed and used to calculate the total number of eggs based on the weight of the ovary. The program budget allowed for the total number of eggs from 3 ovaries (selected at random) to be counted to check the accuracy of the sub-sample procedure. Scales were taken from every sacrificed fish, and were mounted and aged as part of the CLBMON-45 LRFIP.

2.5 Egg Collection Mat Sampling

2.5.1 Egg Collection Mat Methodology

The egg collection mat sampling methodology for Year 4 was determined in consultation with the BC Hydro Contract Authority (D. DeRosa). Egg collection mats were used to characterize Mountain Whitefish spawning at the previously established key Mountain Whitefish spawning area at CPR Island (Figure 2) and in the lower section of the study area (between Trail and Waneta Eddy; Figure 3).

At the CPR Island area, three cross-sectional transects were established using three sets of paired egg collection mats at each transect for a total of 18 collection mats (Figure 2). In the lower section of the study area, mats were deployed in areas with similar habitat characteristics to the key spawning areas in the upper reach and where sampling was feasible. Paired egg mats sets were deployed along the left and right upstream banks, as well as mid-channel at 27 locations throughout the lower section to increase the sampling coverage; using a total of 54 mats (Figure 3). In both spawning areas, the paired sets were deployed at the following stations:

- left upstream bank (LUB) – designated with an L;
- mid-channel near LUB – designated with an ML;
- mid-channel – designated with an M;
- mid-channel near the right upstream bank (RUB) – designated with an MR; and,
- right upstream bank (RUB) – designated with an R.

Egg mats at all spawning areas were retrieved, checked, cleaned, and redeployed on a weekly basis over the course of the study. Prior to each deployment, mats were inspected and the filter material was replaced as required.

Each egg collection mat consisted of an iron frame (0.76 by 0.76 m for mid-channel sets and 0.76 by 0.91 m for shore sets) that enclosed two layers of filter material (latex-coated animal hair). The smaller mats were used for the mid-channel to facilitate deployment and retrieval. A mat set consisted of two mats joined by a 3 m long rope or cable stringer. When deployed, the mats rested on the river bottom and trapped eggs that drifted downstream (Appendix A, Plate 3). Shore-sets were secured to the shore using a shoreline. A float line was attached to the downstream mat to provide a secondary means of retrieval in case the shoreline failed or became snagged. The mid-channel sets consisted of an anchor system and a 30 m long steel cable that connected the anchor system to the paired egg collection mats. A float line with approximately 20 m of rope was attached to the downstream mat to enable retrieval by boat. Another float line with approximately 20 m of rope was also attached to the anchor system to allow for removal of the anchor system at the end of the project. Carabineers were used at both the float line and steel cable attachment points to allow quick removal of the mats and float line upon retrieval. Once the mat set was detached, the float line was attached to the anchor cable to allow the cable to be retrieved when the mats were ready for re-deployment.

The egg collection mats were retrieved by either untying the shore line or retrieving the float line. The mats were then pulled off the river bottom (either by hand or by an electric winch mounted on the bow of the boat) and brought on board the jet drive river boat. The egg collection mats were then inspected and all collected whitefish eggs were removed using forceps and placed in preservative (Section 2.5.2) for later staging. During the collection process, numbers of eggs collected on each mat, set time and date, retrieval time and date, surface velocity (measured using a Marsh McBirney Flo-Mate velocity meter), substrate size (estimated by inspection with a view tube), and depth (determined by the boat mounted echo sounder) were recorded on standardized field forms.

2.5.2 Egg Preservation

Viable whitefish eggs collected were preserved in Stockard's solution for developmental staging at a later date. A random subsample of up to 30 eggs per mat was preserved. Eggs from each mat set were preserved in separate plastic vials externally labelled to identify the date of capture, sample location, number of eggs preserved, preservative used, project number, and field crew that collected the eggs. The data were also written on waterproof internal labels placed inside the vials.

2.5.3 Egg Developmental Staging

All preserved eggs were staged in a laboratory using a dissecting microscope and classified according to egg developmental stages adapted from Vernier (1969) and Rajagopal (1979). To define egg developmental stages, collected eggs were first staged according to the 35 developmental stages described in Vernier (1969), as this reference provides a detailed breakdown of rainbow trout egg development, which is applicable to general salmonid egg development. The staged eggs were then compared to the 11 specific Mountain Whitefish egg developmental stages described by Rajagopal (1979) to determine the required accumulated thermal units (ATUs; one thermal unit equals 1^{o}C above 0^{o}C for a 24 hour period; Table 2) to reach each stage.

To estimate the spawn timing of collected eggs (herein referred to as spawning events), the water temperatures recorded at the spawning sites were compared to the ATUs required to reach the developmental stages of the collected eggs. As thermal units accumulate slowly over the incubation period, eggs from each developmental stage were considered to be from different spawning events. Any further reference to egg developmental stages in this report is based on the stage classification system described by Rajagopal (1979; Table 2).

Table 2: Comparison of egg developmental stages listed in Rajagopal (1979) and Vernier (1969) and ATUs required to attain each developmental stage.

Developmental Stages Described in Rajagopal (1979)	Developmental Stages Described in Vernier (1969)	ATUs Required to Reach Developmental Stage	Stage Description
1	1	0	Fertilization
2	2 - 9	2	Animal pole rotates to top of egg
3	10 - 12	18	Blastodisc prominently raised up on the yolk
4	13 - 16	66	Germinal layer evident
5	17 - 20	120	Embryo clearly outlined on the surface of yolk
6	21	150	Pigment appears in the eyes
7	22 - 25	216	Eyes fully pigmented and chromatophores appear on body
8	26	240	Embryo forms an almost complete circle on yolk
9	27 - 28	318	Embryo forms approximately 1.5 circles over yolk
10	29 – 30	444	Hatching
11	31 - 35	unspecified	Post hatch

2.5.4 Optional D-ring Sampling

To date, D-ring sampling has not been conducted as part of the CLBMON-48 program. In Year 1 (winter 2008 - 2009), the study plan included a pilot D-ring program that would be conducted within one selected Mountain Whitefish spawning area during the spawning season to assess egg drift following a flow increase of at least 142 m^{3}/s. The flow regime during the 2008 - 2009 spawning period did not provide the necessary flows increase required to implement the D-ring program. The D-ring sampling was not included in the Year 2 spawning program, but was included in the Year 3 and 4 study plans; however, the flow regime during these years did not provide a sufficient flow increase to warrant implementation.

2.6 Egg Stranding Surveys

Immediately after notification from BC Hydro of flow reductions from HLK, Golder dispatched crews to examine dewatered shoreline areas for Mountain Whitefish eggs. Egg stranding surveys were conducted at Tin Cup Rapids and Kinnaird Rapids to determine if spawning use at these locations (as determined by egg densities) was similar to that recorded in previous years (Table 1). Upon arriving at each site, the crew randomly placed 10 egg grids within the dewatered zone at each location. The larger substrate was then inspected and removed from each grid until only sand and fines remained. All eggs encountered were inspected to determine if they were viable, enumerated and then returned the mainstem Columbia. Prior to leaving the site, the crew replaced all removed substrate back into each grid.

Egg stranding surveys were conducted in the CPR Island and Kootenay River key spawning areas in the same manner as in Years 2 and 3 of the present program (Table 1), and two randomly selected transects were established within each area (measured parallel to the exposed shoreline). Each transect was set perpendicular to the shoreline and extended from the water's edge to the top of the dewatered zone (Appendix A, Plate 4). Along each transect, the substrate was removed and stranded Mountain Whitefish eggs were enumerated. The total length, dominant substrate size (using a modified Wentworth classification system), transect width (10 cm if substrate was gravel, 20 cm if substrate was cobble), distance of stranded eggs from the shoreline, condition of stranded eggs, and slope along the transect were also recorded.

2.7 Emergent Larval Surveys

The CLBMON-48 Spring 2012 Larval Mountain Whitefish Sampling Program had two main goals:

1) Identify and characterize the rearing habitats utilized by larval whitefish prior to the scheduled flow reductions.
2) Determine if flow reductions during the initiation of scheduled Rainbow Trout Protection Flows resulted in the displacement (to different habitats) or stranding of larval whitefish.

The study plan called for sampling to be conducted prior to the onset of flow reductions from HLK required to implement the Rainbow Trout Protection Flows in April 2012. Based on data collected during previous CLBMON-48 sample years, the following locations were initially selected for assessment (listed in upstream to downstream order):

- left downstream bank adjacent to Zellstoff-Celgar;
- Norn's Fan;
- Waldie's Island;
- Kootenay River Oxbow area;
- Sandbar Eddy; and,
- Genelle.

However, initial observations conducted on March 29, 2012 prior to the flow reductions at HLK, failed to identify individuals and/or concentrations of larval whitefish at the two most upstream sites (i.e., near Zellstoff-Celgar and at Norn's Creek Fan). For the reasons discussed in Section 3.6, this result led to the cancellation of the remainder of the larval sampling study component.

2.8 Data Analyses

2.8.1 Updated Sex Ratios, Fecundity, and Age-at-Maturity Estimates

The sex ratio for adult Mountain Whitefish was determined by examining the sex of the 90 Mountain Whitefish sacrificed in the present study. This ratio was then compared to sex ratios obtained in previous studies. To estimate female fecundity, all ovaries were weighed and a subsample of 100 eggs from each ovary also was weighed. These data were then used to obtain an estimated fecundity using the following formula:

Estimated fecundity = (Total ovary weight/weight of 100 egg subsample) X 100

Absolute fecundity (actual number eggs/female) was determined for three females by enumerating all eggs in their ovaries. The actual number eggs/female from these three fish was compared to the estimated fecundity for these same fish to check the accuracy of the estimated values. This comparison indicated that the absolute fecundity was consistently lower (between 8.2% and 18.6%) than the estimate value. This difference was due to the presence of ovarian tissues (i.e., not eggs) in the weighed ovaries. As a result, a correction factor of -12.3% (average of the differences of the three samples) was applied all the fecundities estimated using gonad weight. The corrected fecundity values were then used in conjunction with the sex ratio and the LRFIP abundance estimates from 2009 – 2011 to calculate Potential Egg Deposition (PED) within the study area.

Age-at-maturity was determined by comparing the maturity of the sacrificed fish examined in the lab to their age as determined from collected scales (Section 2.4.2). The age of the youngest fish that had fully developed gonads and would spawn in the 2011 – 2012 spawning season determined the age at which fish in the present population were considered spawners.

2.8.2 Mountain Whitefish Spawning

2.8.2.1 Spawner Abundance

An estimate of the potential number of spawning Mountain Whitefish in the LCR during the 2011 - 2012 spawning period was calculated using the 2011 LRFIP adult Mountain Whitefish abundance estimates (Ford and Thorley 2012). The current age-at-maturity and sex ratio data (Section 2.8.1) were applied to each of the LRFIP 2009 - 2011 Hierarchical Bayesian Mountain Whitefish abundance estimate to calculate overall spawner abundance and abundance of the female spawning cohort (Section 3.3.4).

2.8.2.2 Cumulative New Egg Counts

The proportion of newly spawned eggs captured on the egg collection mats was calculated to determine egg deposition patterns and the cumulative distribution of egg catch during the Year 4 sample program. Mountain Whitefish eggs that were in developmental stage 4 or greater were classified as later stage eggs that had drifted onto the mats, as based on the ambient water temperatures, the time required for eggs to reach stage 4 being longer than the time interval between checking and redeployment of egg mats at each sample site. The number of newly spawned eggs collected was based on the number of later stage eggs collected subtracted from the overall catch on each mat.

3.0 RESULTS

3.1 Water Temperature

Water temperatures in the middle section of the LCR (Birchbank Gauging Station; Figure 1) decreased steadily from about 17.6°C on September 1, 2011 to a low of 2.5°C on February 16, 2012 (Figure 4). Temperatures were similar (i.e., typically varied by less than 2.0 °C) in all river sections but were slightly cooler at the Norn's DCP gauge (Figure 1) in the upper section compared to temperatures in the middle section. Water temperatures in the lower section at Waneta Eddy were slightly warmer than upstream areas during the fall period but were cooler during winter (Figure 4). The higher variability in hourly average temperatures in the lower section is related to daily load shaping activities of Waneta Dam on the Pend d'Oreille River, whose operations have an effect on temperatures recorded at the Waneta Eddy site.

During the adult Mountain Whitefish collection, water temperatures decreased over the course of the sample period, but experienced a sharp increase in the middle of this study component (Figure 4). This change occurred during a period of increased discharge from HLK (Figure 5).

During the egg collection period, water temperatures at both the upper and lower river sections gradually decreased over the course of the egg collection mat program (Figure 4). In the upper section, water temperatures declined from 5.2°C at the start of egg collections on December 6, 2011, and declined to 2.7°C by January 19, 2012. Thereafter, temperatures rose slightly in mid-February, declined slightly in late February and early march before steadily increasing from mid-March to mid-April (Figure 4). A similar pattern was also recorded for water temperatures at the middle and lower section of the LCR.

Over the course of the spawning period, the water temperatures recorded at the left and right downstream bank temperature stations at CPR Island tracked very closely with each other (Figure 5). This indicates that the cooler water from Norn's Creek mixes with the Columbia River before it reaches the spawning area and therefore does not influence water temperatures in the CPR Island spawning area.

3.2 Discharge

Discharge in the Columbia River decreased on multiple occasions after September 1, 2011 to a low of 915 m^3/s on October 10, 2011 (HLK, Figure 6). Discharge then increased in a series of steps before remaining stable for an extended period between early December and mid-January before peaking at 1890 m^3/s on January 14, 2012. The Birchbank Gauging Station recorded daily fluctuations in discharge from mid-November to late December 2011 which was a result of load factoring at BRD.

During the collection of adult spawners, LCR discharge below HLK remained stable until increasing on November 5 (Figure 6). Discharge then remained stable for the remainder of this study component. Discharges recorded at the Birchbank Gauging station followed the same pattern. Mean hourly HLK discharge during the collection of spawners was 1241 m^3/s (range from 1194 m^3/s to 1359 m^3/s). Mean hourly discharge at the Birchbank Gauging Station was 1611 m^3/s (range from 1562 m^3/s to 1763 m^3/s). Kootenay River discharge below BRD remained stable during this study component (Figure 6). The mean hourly discharge from BRD during the collection of adult spawners was 349 m^3/s (range from 339 m^3/s to 426 m^3/s).

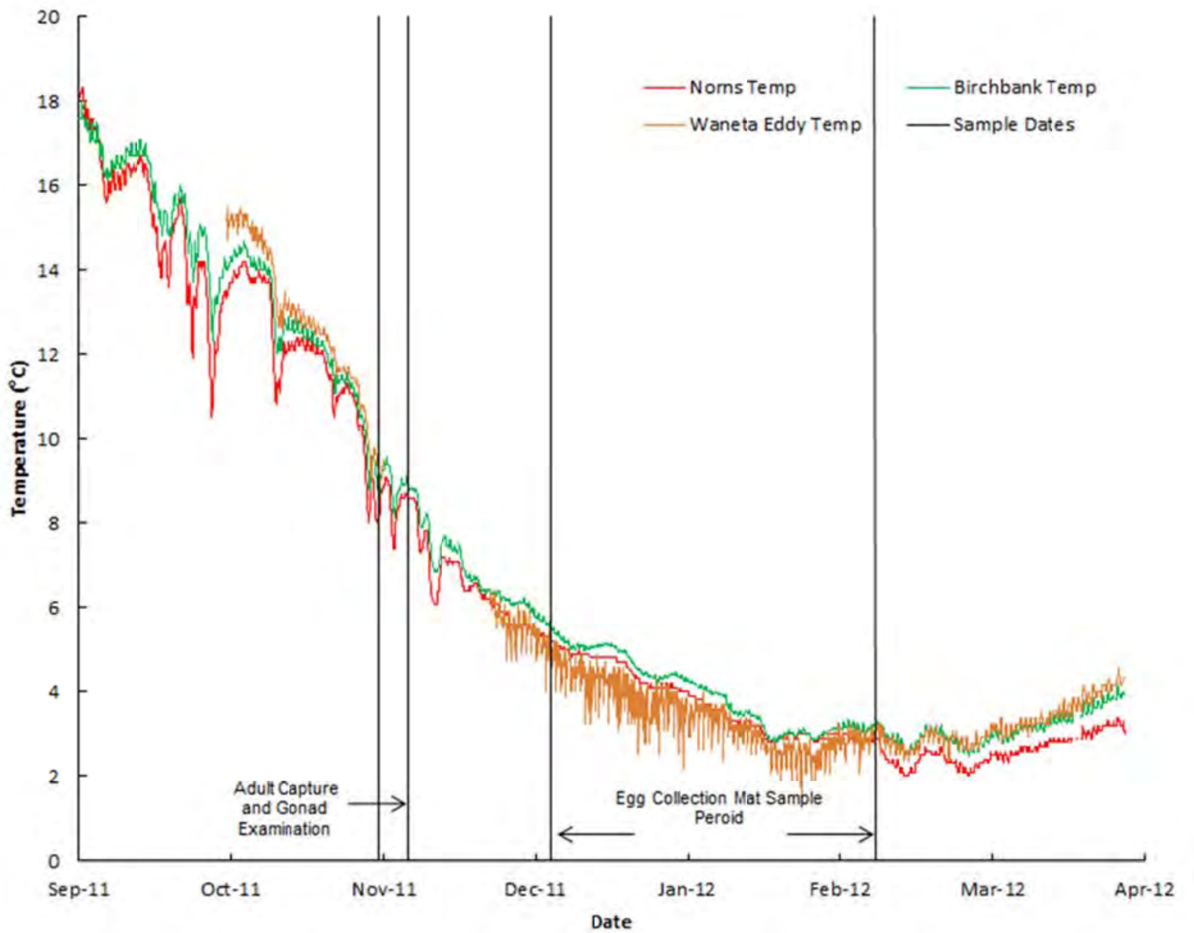


Figure 4: Hourly average water temperatures at the upper (Norn's DCP gauge and the CPR Island Mountain Whitefish spawning area [both left and right downstream banks]), the middle (Water Survey of Canada Birchbank Gauging Station), and the lower (Waneta Eddy) sections of the Lower Columbia River during Mountain Whitefish spawner and egg collection programs; September 1, 2011 to March 31, 2012. (Note: Missing temperatures from November 2 to 23, 2011 at Waneta Eddy).

During the egg collection mat study component, LCR discharge below HLK exhibited several changes (Figure 6). In the early portion of the program in early December, discharge increased sharply. Discharge remained relatively stable until mid-January, when it increased sharply and peaked. Discharge then reduced slowly until February, with the exception of two large decreases in mid and late January. From the beginning of February until the cessation of the program, discharge below HLK remained stable. Mean hourly HLK discharge over the mat program was 1557 m^3/s (range from 1175 m^3/s on February 9 to 1890 m^3/s on January 14). Discharge at the Birchbank Gauging Station followed the same general pattern as HLK discharge, with the exception of showing daily fluctuations in December as a result of BRD load shaping. Mean hourly discharge at Birchbank was 2175 m^3/s (range from 1624 m^3/s on February 6, to 2654 m^3/s on December 15).

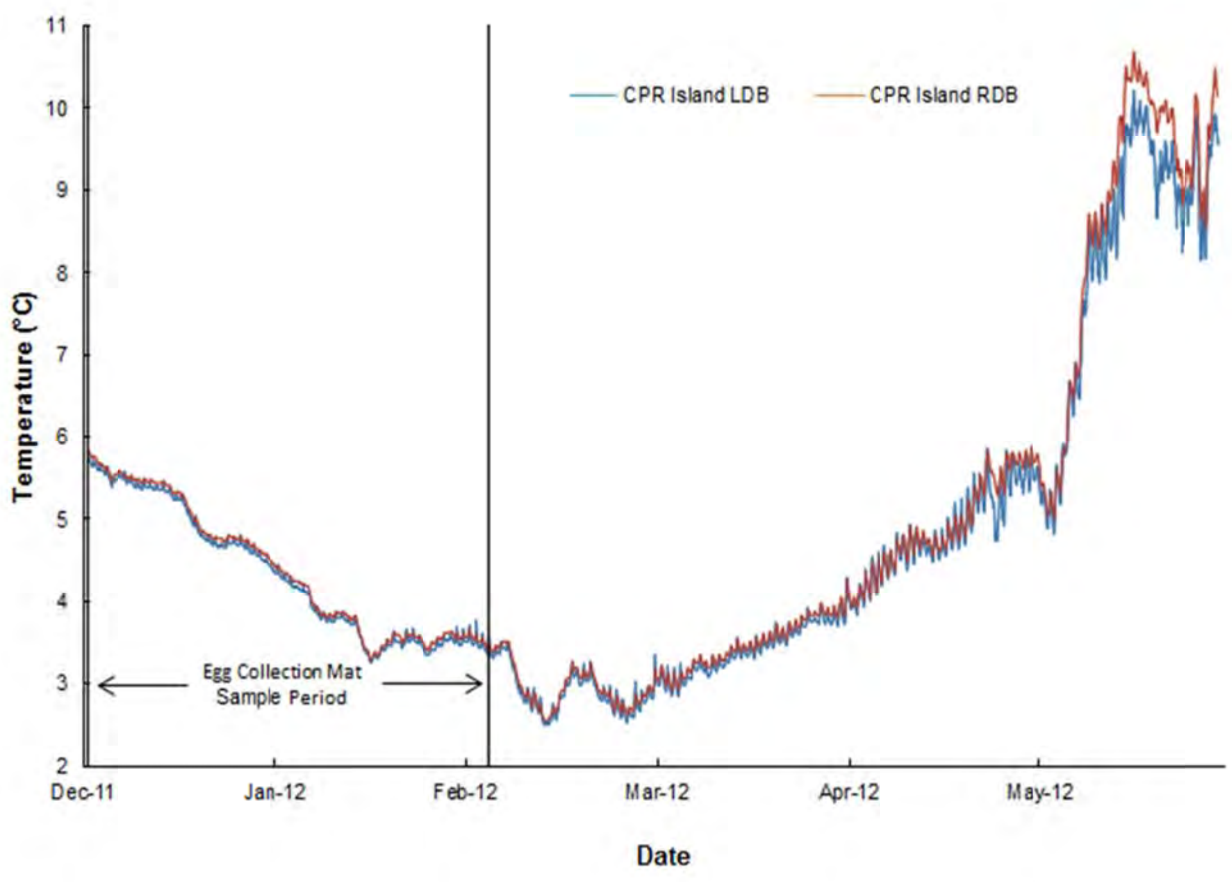


Figure 5: Hourly average water temperatures along the left and right downstream bank at CPR Island spawning area during Mountain Whitefish and egg collection programs; December 6, 2011 to March 31, 2012. (Note: Missing temperatures from November 2 to 23, 2011 at Waneta Eddy).

Mean hourly discharge of the Kootenay River below BRD was 582 m^3/s (range from 419 m^3/s on January 30 to 1001 m^3/s on December 20; Figure 6). Hourly discharge from BRD fluctuated substantially through December due to load shaping, but remained relatively stable with only a few fluctuations from late December to mid-February. Discharge from BRD decreased slightly in mid and late January, with a period of relatively stable flows in between the reductions. After the discharge decrease in late January, flows remained relatively stable until the cessation of the egg collection mat program.

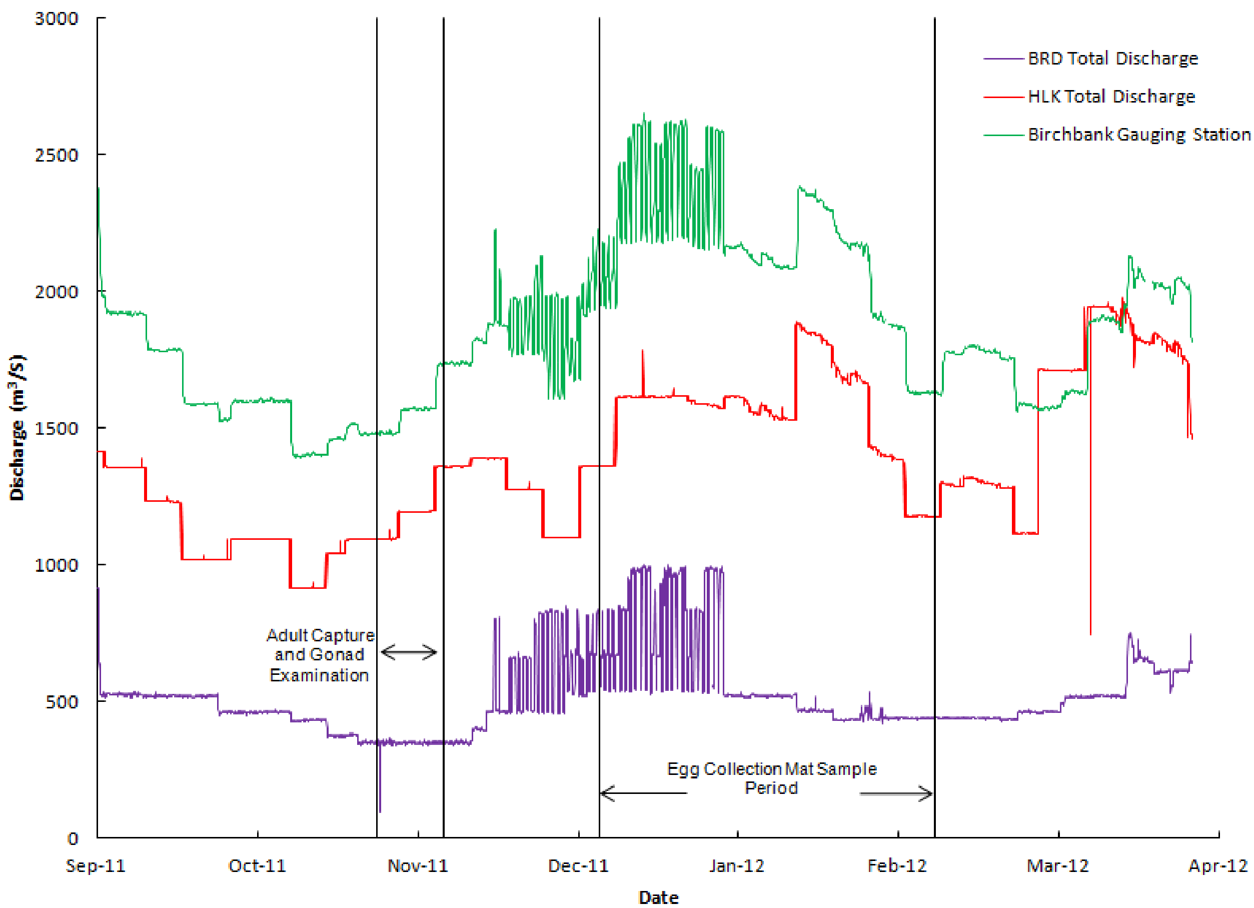


Figure 6: Mean hourly discharge of the Columbia River at Hugh L. Keenleyside Dam (HLK), and at the Water Survey of Canada Birchbank Gauging Station, and the Kootenay River below Brilliant Dam (BRD) during Mountain Whitefish spawner and egg collection programs; September 1, 2011 to March 31, 2012. (Note: Large decrease in HLK discharge in early March was due to gate changes at the dam).

3.3 Mountain Whitefish Spawning

The number of adult Mountain Whitefish spawners that were captured and sacrificed during the LRFIP study program is provided by sample area in Table 3. Differences from the initial proposed sample sizes are due to the low availability of adults in the lower section. As a result, the sample sizes from the other sections were increased to meet the combined target of 90 adults. The data collected from these fish provided the basis for the age-at-maturity, sex ratio, and fecundity estimates (Sections 3.3.1, 3.3.2, and 3.3.3 respectively) for the current Mountain Whitefish population.

Table 3: Proposed and actual numbers of adult Mountain Whitefish captured during the Large River Fish Indexing Program in the LCR, 2011.

LRFIP Section	Proposed Sample Size	Actual Sample Size
Upper Section	22	31
Kootenay Section	24	28
Middle Section	22	25
Lower Section	22	6
Total	**90**	**90**

3.3.1 Age-at-Maturity Estimates

Of the 90 Mountain Whitefish examined to determine age-at-maturity, all age -1 (*n* = 2) fish were immature. At age-2 (*n* = 12), 86% of females and 60% of males had reached maturity (Figure 7). This is similar to findings of the 1994 – 1995 study, where of the age-2 fish examined, 56% of males (*n* = 18) and 71% of females (*n* = 21) were mature; in the 1995 – 1996 study, the one age-2 fish examined (a female) was mature (R.L. & L. 2001a). In the present study, all fish age-3 and older were mature, similar to results of the 1995 – 1996 study. In the 1994 – 1995 study, age-3 to 5 fish had between 78% and 95% maturity rates (R.L. & L. 1995, 2001a).

Of the 46 mature females examined, 14 were spent (Appendix B, Table B1). Of the spent fish, 12 had loose eggs in their body cavity, which was indicative of recent spawning activity.

3.3.2 Sex Ratio

The sex ratio of the 90 fish examined was 1 male:1.14 female (48 females and 42 males). This is within the range of sex ratios reported in previous studies in the LCR, and most closely resembles ratios obtained in the 1990 – 1991 and 1995 – 1996 study years (Table 4). With the exception of the 1995 – 1996 study year (when the sex ratio was equal), females have made up a greater portion of the spawning population than males. The differences in sex ratios between study years may also reflect variations in spatial and temporal distributions of each sex during the sample period.

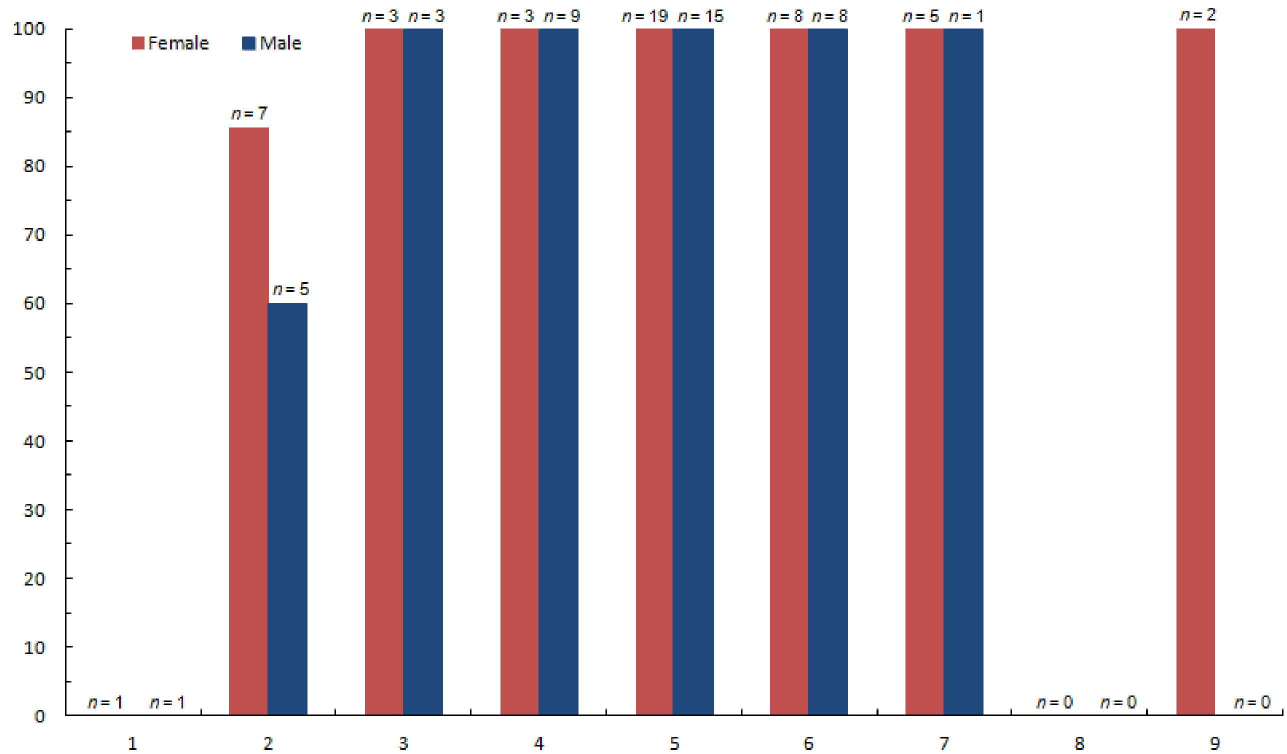


Figure 7: Age-at-maturity for Mountain Whitefish from the Lower Columbia River study area, October to November 2011.

Table 4: Mountain Whitefish sex ratios from past and present studies on the Lower Columbia River.

Study Year	Males:Females	Sample Size
1980 – 1981 (Ash et al. 1981)	1:1.4	43
1990 – 1991 (Hildebrand and English 1991)	1:1.25	363
1994 – 1995 (R.L.&L. 2001a)	1:1.8	246
1995 – 1996 (R.L.&L. 2001a)	1:1	240
2011 – 2012 (present study)	1:1.14	90

3.3.3 Fecundity Estimates

The corrected mean fecundity estimate was 9404 eggs/female, within a range of 2582 to 18 753 eggs/female (Table 5; Appendix B, Table B1). These corrected values were used to calculate Potential Egg Deposition (PED; Section 3.3.9.1). If warranted, these fecundity estimates could be further refined by examining their relationship with life history characteristics (i.e., length, weight, and condition factor) in the Year 5 interpretive report.

Table 5: Comparison of absolute and estimated fecundities of mature female Mountain Whitefish from the Lower Columbia River, October and November 2011.

Sample Number	Fish Length (mm)	Fish Weight (g)	Weight of 100 eggs (g)	Weight of entire ovaries (g)	Total estimated number of eggs	Total enumerated number of eggs	Difference (%)
3	426	1295	1.4	274.3	19593	17792	10.1
33	352	556	1.2	67.4	5617	4736	18.6
50	403	562	1.4	60.2	4300	3974	8.2
Average Percentage Difference (Estimated Total Egg Count Correction Factor)							**12.3**

3.3.4 Spawner Abundance

As part of the 2011 LRFIP, adult (age-2 and older) Mountain Whitefish abundance was estimated at 81 795 fish (95% Credibility Intervals [CI] 50 188 – 149 028) using a Hierarchical Bayesian model (Ford and Thorley 2012). The LRFIP also provided Mountain Whitefish adult abundance estimates for the CLBMON-48 Year 2 and 3 spawning seasons. The current estimate is much higher than the 1994 - 1995 total Mountain Whitefish abundance estimate of 42 600 adult fish (95% CI = 33 800 to 57 500; R.L. & L. 2001a), approximately 20 000 fish lower than the 2009 estimate, and very similar to the 2010 estimate (Table 6; Golder 2010b and 2011b). The 1994 - 1995 Mountain Whitefish population was estimated using a modified Schnabel estimation procedure and, therefore, caution in the interpretation and comparison of populations between studies is advised.

As described in Section 2.8.2.1, the sex ratio calculated in Year 4 (1 male:1.14 females) was applied to the 2009, 2010, and 2011 adult Mountain Whitefish abundance estimates from the LRFIP to calculate numbers of male and female spawners. To calculate total spawners, we assumed that all fish in the adult abundance estimate were mature. Although not all age-2 fish were mature (86% of females and 60% of males), this assumption was required because the proportion of age-2 fish in the adult population is unknown. At the time this document was created, the LRFIP had not generated the 2012 proportion of age-2 fish in the population. Consequently, the total spawner estimates presented in Table 6 (Years 2, 3, and 4) slightly overestimate actual spawner abundance. This bias is relatively small considering the potential range of spawner abundance in any given year.

3.3.5 Spawner Distribution

Mountain Whitefish distribution based on Year 1 telemetry data has been summarized in previous reports (Golder 2009b and 2010a). Also included in the Year 2 analysis were data collected during the Year 2 egg mat study component, as well as 2009 LRFIP Mountain Whitefish CPUEs. In the present study, the distribution of Mountain Whitefish spawners within the study area in the 2011 - 2012 spawning season was estimated using:

- 2011 LRFIP results; and,
- egg deposition patterns determined from egg collection mat sampling (Section 3.3.6).

Table 6: Adult Mountain Whitefish abundance estimates and calculated total spawner abundance in the Lower Columbia River; 1994 – 1995, 2009 – 2010, 2010 - 2011, and 2011 - 2012 spawning seasons.

Study Year	Model Used	Adult Abundance Estimate (95% CI)	Number of Mature Females (95% CI)	Number of Mature Males (95% CI)	Total Spawner Abundance (95% CI)
1994 - 1995	Modified Schnabel	42 600 (33 800 – 57 500)[a]	23 700 (18 800 – 32 000)	14 300 (11 300 – 19 200)	38 000 (30 100 – 51 200)
Year 2 (2009 – 2010)	Hierarchical Bayesian	101 200 (61 600 – 177 100)[b]	57 700 (35 100 – 100 900)	43 526 (26 500 – 76 200)	101 200 (61 600 – 177 100)
Year 3 (2010 – 2011)	Hierarchical Bayesian	81 400 (49 600 – 146 600)[c]	46 400 (28 300 – 83 500)	35 000 (21 300 – 63 000)	81 400 (49 600 – 146 600)
Year 4 (2011 – 2012)	Hierarchical Bayesian	81 800 (50 200 – 149 000)[d]	46 600 (28 600 – 85 000)	35 200 (21 600 – 64 100)	81 800 (50 200 – 149 000)

[a] Based on data from R.L. & L. 2001a
[b] Based on 2009 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[c] Based on 2010 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[d] Based on 2011 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.

In previous studies, areas of high Mountain Whitefish holding and feeding use identified in the study area generally corresponded to the same areas used for spawning (R.L. & L. 1995, 2001a). The upper section received the greatest use for holding, feeding, and spawning, with lesser use of middle (Genelle) and lower sections (Beaver Creek, Fort Shepherd Eddy, and Waneta Eddy; R.L. & L. 1995, 2001a).

The LRFIP Phase 9 (2009) and Phase 10 (2010) results indicated that some adult Mountain Whitefish initiated movements out of holding and feeding areas to spawning areas in the upper section as early as late October (Golder 2010b and 2011b). This was not evident in 2011 (Ford and Thorley 2012), as catch rates in each site within the upper section exhibited different patterns over the course of the study (Appendix B, Figure B1). In the middle section, LRFIP catch rates decreased over the course of 2011, which suggested that adults moved out of this area prior to the spawning period (Appendix B, Figure B2). Catch rates of adult Mountain Whitefish at LRFIP sample sites in the lower section did not follow similar patterns to previous studies. The highest catch rates in the lower section were at RKm 49.0 (Appendix B, Figure B3).

3.3.6 Egg Collection Mat Sampling

Egg collection mat sampling in the upper and lower sections occurred from December 6, 2011 to February 9, 2012 (Table 1). The overall catch-per-unit-effort (CPUE) was 0.19 eggs/24 mat-hours (105 002 mat-hours of effort collected 851 Mountain Whitefish eggs; Appendix C, Table C1). Mountain Whitefish eggs at the CPR Island spawning area were first collected on December 12, 2011 and last collected on February 7, 2012. The largest catch from a single set was 51 eggs at 8.7R at CPR Island on January 3 (6.0% of the total egg catch at this site over the entire study). In the lower section, eggs were first collected on December 13 and last collected on February 2. The largest catch recovered from a single set was 28 eggs at 48.0R on December 21 (15.6% of the total egg catch in the lower section over the entire study).

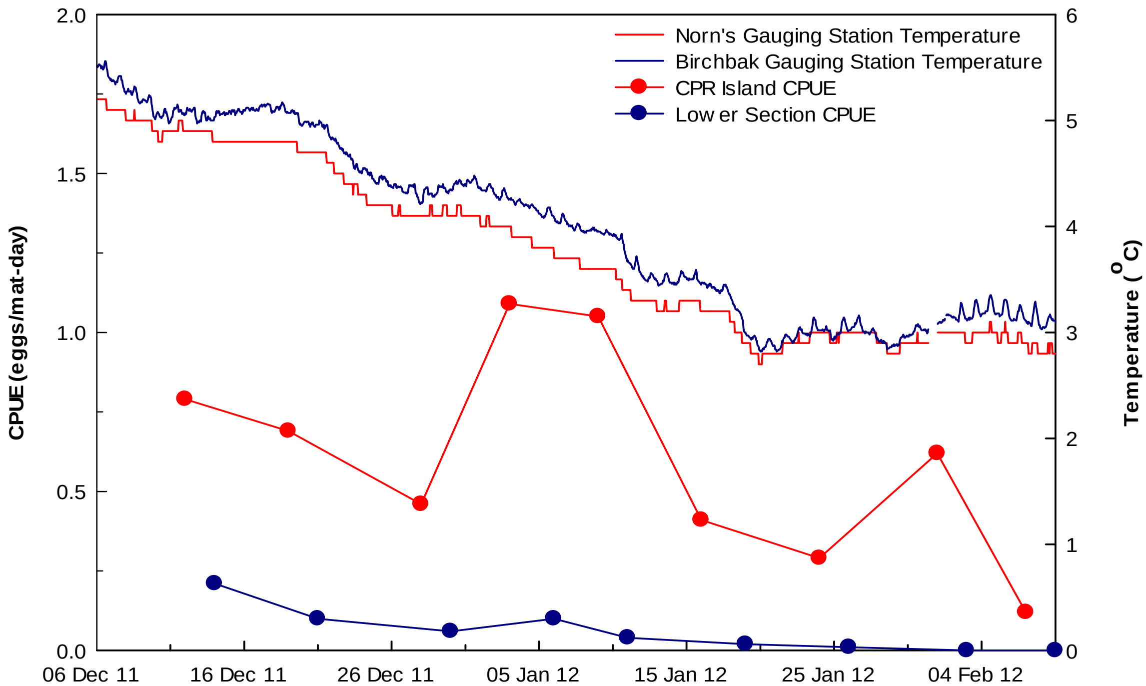
The majority (79.0%) of eggs collected were from CPR Island (*n* = 672 eggs) at a CPUE of 0.59 eggs/24 mat-hours over a deployment duration of 72 366 mat-hours (Appendix C, Table C2). The remaining 21% (n = 179 eggs) were collected in the lower section at a CPUE of 0.05 eggs/24 mat-hours over a deployment duration of 78 349 mat-hours (Appendix C, Table C3). Over the course of the study, 773 (90.8% of the total catch) Mountain Whitefish eggs were preserved for developmental staging (Appendix C, Tables C4 and C5).

3.3.7 Spawning Periodicity, Timing, and Intensity

A summary of Year 4 egg collection mat sampling effort and egg catches is provided in Appendix C, Tables C1 to C3. The first detection of Mountain Whitefish spawning at CPR Island occurred on December 12, 2011, with the collection of one egg at developmental stage 8 (Appendix C, Table C4). Based on the ATUs required to reach this developmental stage, this egg was likely spawned on or about November 18, 2011. The last spawning event at CPR Island was documented on February 7, 2012 with the collection of three eggs at developmental stage 2; this spawning event likely occurred on that date. Catch rates at CPR Island decreased slightly from the onset of the study before increasing sharply in early January. This was followed by relatively stable catch rates until mid-January, when catch rates declined through the end of January before increasing again in early February (Figure 8). This bimodal pattern was not documented in previous studies (R.L. & L. 2001a; Golder 2010a and 2011a) although sharp declines in catch rates after peak spawning were observed in all study years (both in the 1990's and the present study).

The earliest spawning event in the lower section was detected on December 14, 2010, with the collection of three eggs at developmental stage 8 (Appendix B, Table B5). Based on water temperatures in that section, this egg was likely spawned on or about November 7, 2011. The last recorded spawning event in the lower section was documented on January 19, 2012 with the collection of one egg at developmental stage 1, which indicated that spawning occurred earlier on that same day. Egg catch rates in the lower section were highest at the onset of the program and then exhibited a slight decline over the next two weeks. Catch rates increased during the fourth week of the program, before declining until the cessation of the program. This pattern of highest catch rates in the first week was also documented in the middle section of the study area during Year 2 (2009 – 2010) sampling (Golder 2010a).

Egg CPUEs and egg developmental staging indicated that spawning in Year 4 commenced in mid-November at CPR Island and early November in the lower section of the study area. Mean daily water temperatures at CPR Island and in the lower section at the onset of spawning were 6.5°C and 8.8°C, respectively (Figure 4). Minimum mean daily water temperature during the spawning period at the CPR site was 2.0°C in mid-February, while temperatures in the lower section reached a minimum of 2.5°C at the same time. The temperatures at CPR Island in Year 4 were similar to those recorded in the 1995 – 1996 spawning season when temperatures ranged from approximately 7°C to 2°C over the spawning seasons (R.L. & L. 2001a). In the 1994 – 1995, 2009 - 2010, and 2010 - 2011 spawning seasons, minimum mean daily temperatures during the spawning season were 3°C (R.L. & L. 2001a, Golder 2010a and 2011a).



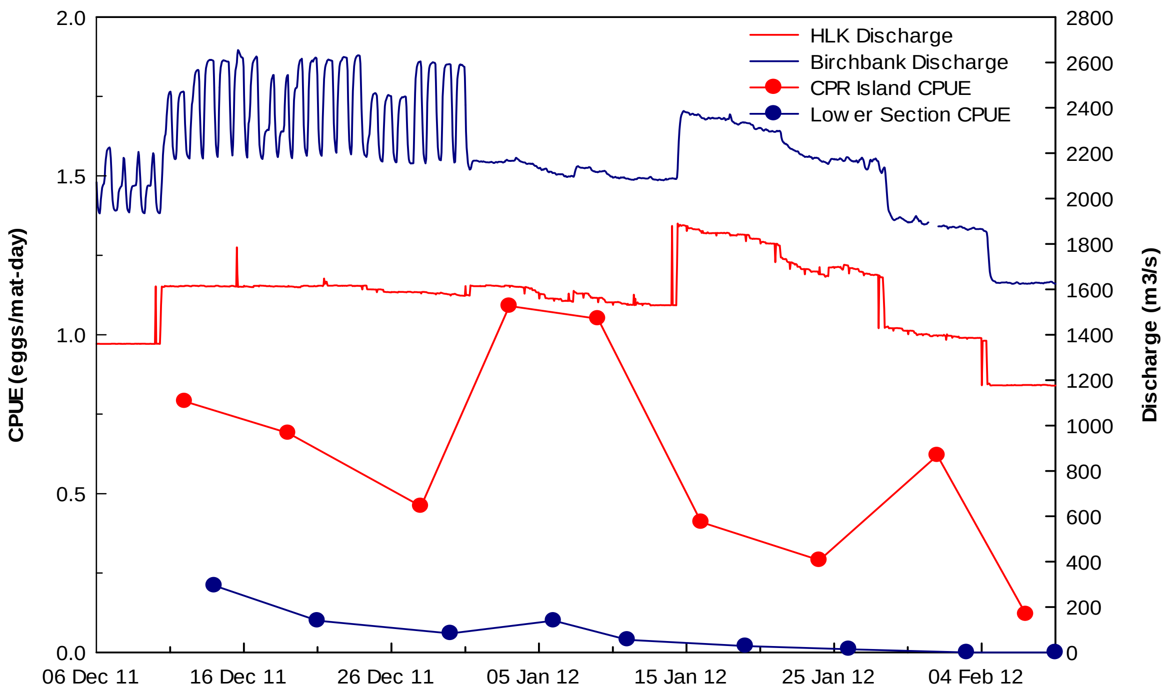


Figure 8: Daily egg collection mat CPUE (eggs/24 mat-hours) for Mountain Whitefish eggs at each pull date vs. water temperatures (upper graph) and discharges (lower graph) at egg collection mat sample areas, Lower Columbia River, 2011-2012.

Peak spawning at CPR Island area occurred in early January, while the peak in the lower section occurred in early December. Temperatures during peak spawning ranged between 3.6°C and 4.0°C at CPR Island and between 5.0°C and 5.1°C in the lower section (Figure 8). The temperature ranges at CPR Island were similar to those recorded during the peak spawning period in all studied spawning seasons (between 3.0°C and 5.0°C; R.L. & L. 2001a, Golder 2010a and 2011a).

At both sampled spawning areas, the estimated onset of spawning in Year 4 occurred during periods of stable discharge in the Columbia River (Figure 8). Peak spawning at CPR Island occurred during periods of slightly decreasing discharge. Peak spawning in the lower section occurred during a period of extended load factoring at BRD (Figure 8) although the daily fluctuations observed at the Birchbank Gauge tend to attenuate with increased downstream distance.

3.3.7.1 Egg Drift

Developmental staging of Mountain Whitefish eggs indicated that many of the eggs collected were older eggs that had been dislodged from interstitial incubation habitats and drifted onto the mats from upstream areas. The reasons for this are not fully understood but may be related to flow increases at upstream dams. Mountain Whitefish eggs in developmental stages 4 or greater were used to determine the incidence of egg drift, as the time required for eggs to reach stage 4 was longer than the time between the checking and redeployment of egg mats. In total, 125 eggs of stage 4 or greater were recovered from all egg mat locations over the course of the study; this represented 16.4% of the total eggs examined for developmental stage (Appendix C, Table C5).

3.3.8 Spawning Habitat Characterization

In general, nearshore sets sampled shallower depths than mid-channel sets (Figure 9). At CPR Island, the mean depth of nearshore sets was significantly lower than mid-channel mat sets. Conversely, mean depths recorded at nearshore sets in the lower section were slightly shallower than mid-channel sets, but overlapping standard deviations did not indicate a significant difference. Mean depths at nearshore sets were similar among all sample sites and sampled locations and ranged from 2.5 to 2.6 m. Mean depths at mid-channel sets ranged from 3.7 m in the lower section to 7.9 m at CPR Island. In the lower section, mean depths at mid-channel mat sets were significantly shallower than mid-sets at the CPR Island area (Figure 9).

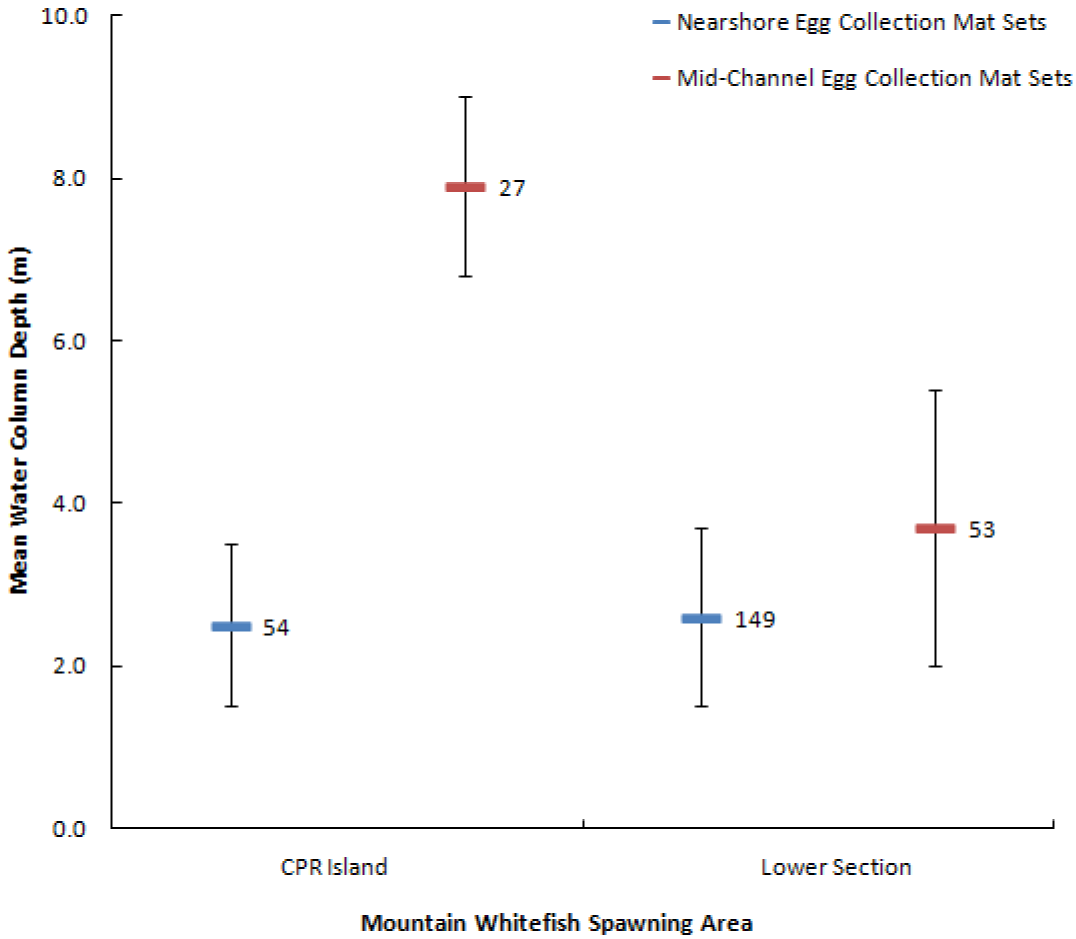


Figure 9: Summary of mean water column depth (m) at egg collection mat sites at CPR Island and the lower section of the Lower Columbia River study area, December 6, 2011 to February 9, 2012. Error bars are standard deviations. The number beside the mean value is the number of measurements collected over the sample period.

Mean water surface velocities for all mat sets at the CPR Island area appeared slightly higher than in the lower section, although overlapping standard deviations did not indicate significant differences for this habitat variable between the two areas (Figure 10). This pattern was also recorded at all mid channel locations in comparison to nearshore sets (Figure 10).

Egg collection mats were located over substrates that ranged from fines to boulder/rip-rap. In general, the majority of eggs were collected from mats set over cobbles (Appendix C, Tables C1 to C3).

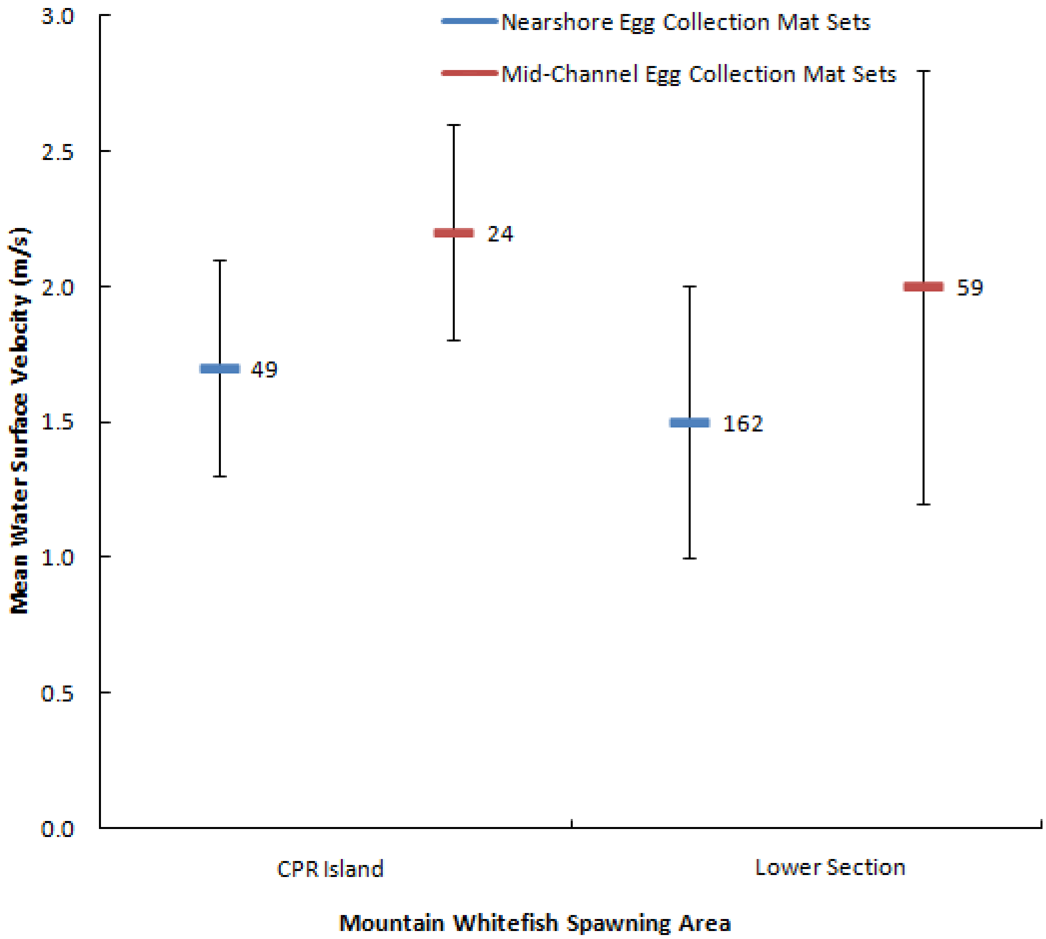


Figure 10: Summary of mean water surface velocity (m/s), at egg collection mat sites at CPR Island and the lower section of the Lower Columbia River study area, December 6, 2011 to February 9, 2012. Error bars are standard deviations. The number beside the mean value is the number of measurements collected over the sample period.

3.3.9 Mountain Whitefish Egg Deposition

3.3.9.1 Potential Egg Deposition (PED)

The PED for the 2011 – 2012 Mountain Whitefish spawning season was calculated based on the assumptions described in Section 3.3.1 to 3.3.4 and ranged from approximately 73 863 700 to 1 592 991 600 eggs (Table 7). This is very similar to the estimated 72 940 900 to 1 566 804 000 eggs deposited in 2010 - 2011, and less than the estimated 90 659 200 to 1 893 077 800 eggs deposited in 2009 – 2010 (Table 7).

Table 7: Calculation of Mountain Whitefish potential egg deposition (PED) for the Lower Columbia River, 1994 – 1995, 2009 – 2010, 2010 – 2011, and 2011 – 2012.

Study Year	Abundance Estimate (95% CI)	Number of breeding females (95% CI)	PED at minimum fecundity (95% CI)[a]	PED at mean fecundity (95% CI)[b]	PED at maximum fecundity (95% CI)[c]
1994 – 1995	42 600 (33 800 – 57 500)	23 700 (18 800 – 32 000)	1.9E+08 (1.5E+08 – 2.6E+08)	2.3E+08 (1.8E+08 – 3.0E+08)	2.6E+08 (2.1E+08 – 3.5E+08)
2009 – 2010 (CLBMON-48 Year 2)	101 200 (61 600 – 177 100)	57 700 (35 100 – 101 000)	1.5E+08 (9.1E+07 – 2.6E+08)	5.4E+08 (3.3E+08 – 9.5E+08)	1.1E+09 (6.6E+08 – 1.9E+09)
2010 – 2011 (CLBMON-48 Year 3)	81 400 (49 600 – 146 600)	46 400 (28 300 – 83 500)	1.2E+08 (7.3E+07 – 2.2E+08)	4.4E+08 (2.7E+08 – 7.9E+08)	8.7E+08 (5.3E+08 – 1.6E+09)
2011 – 2012 (CLBMON-48 Year 4)	81 800 (50 200 – 149 000)	46 600 (28 600 – 85 000)	1.2E+08 (7.4E+07 – 2.2E+08)	4.4E+08 (2.7E+08 – 8.0E+08)	8.7E+08 (5.4E+08 – 1.6E+09)

[a] 8028 eggs/female for 1994 – 1995 (R.L.&L. 2001a); 2582 eggs/female for CLBMON-48 study years.
[b] 9514 eggs/female for 1994 – 1995 (R.L.&L. 2001a); 9404 eggs/female for CLBMON-48 study years.
[c] 11 000 eggs/female for 1994 – 1995 (R.L.&L. 2001a); 18 753 eggs/female for CLBMON-48 study years.

3.3.9.2 Egg Deposition Patterns

As in previous study years, egg deposition at CPR Island was greatest along RUB and the mainstem side of the island, although relatively high use of the downstream areas along LUB also occurred (Figure 11). The plot assumes that the cumulative catch and catch-rate of newly spawned eggs was representative of egg deposition only in the immediate area surrounding each mat set (i.e., not necessarily representative of the area between mat sets). In Year 4, all mid-channel mats had overall lower egg capture rates than in Year 2. Station 8.6R was situated inside of an eddy line, which may have resulted in reduced egg deposition or capture in this area. The egg deposition patterns documented in Year 4 indicated a patchy distribution of spawned Mountain Whitefish eggs.

In the lower section of the study area, very low rates of egg deposition were documented at all egg mat locations (Appendix C, Table C3); consequently, these rates were not presented graphically. The highest overall CPUE was documented at the right upstream bank egg mat station at RKm 48.0, with relatively high overall CPUEs also documented at stations 47.0R and 49.3MR (Appendix C, Table C3). Based on this egg capture data, spawning in the lower section is apparently localized between RKm 47.0 and 49.3, with sporadic and very low amounts of spawning occurring in other areas.

LEGEND

WATER TEMPERATURE RECORDER

CUMULATIVE NEW EGG COUNT | LABELLED BY POINT ID AND OVERALL CPUE

- 12 - 41 (EGGS/24HR)
- 42 - 71 (EGGS/24HR)
- 72 - 100 (EGGS/24HR)

EGG MAT STATIONS:

L ALONG THE LEFT UPSTREAM BANK (LUB)
M MID-CHANNEL
R ALONG RUB

100 0 100 METRES

SCALE 1:4,000

REFERENCE

IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, MAY 2009.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

PROJECT

LOWER COLUMBIA RIVER MOUNTAIN WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE

YEAR 4

CULMULATIVE MOUNTAIN WHITEFISH EGG COUNTS AND OVERALL CPUE (EGGS/24MAT - HOURS) AT EGG MAT SAMPLE LOCATIONS WITHIN THE CPR ISLAND KEY SPAWNING AREA

Golder Associates

PROJECT No. 10-1492-0111			PHASE No. 2000	
DESIGN	BH	25SEPT2012	SCALE AS SHOWN	REV. 0
GIS	JG	25SEPT2012	FIGURE: 11	
CHECK	BH	14DEC2012		
REVIEW	LH	14DEC2012		

\\Cas1-s-filesrv1\data\Active\GIS\2010\10-1492-0111 MW Mats\Year 4 maps\MXD\Fig11_10149201111_Egg Cnt Yr4.mxd

3.3.9.3 Cumulative Distribution of Egg Catch

3.3.9.3.1 CPR Island Area

Newly spawned eggs accumulated at different rates at mat sets along the LUB (L) over the course of the spawning period (Figure 12) at the CPR Island area. At the stations along LUB, eggs accumulated in higher numbers and at faster rates in a downstream direction. After peak spawning, very few new eggs were collected at the remaining LUB mat sets, which suggested that the majority of spawning activity during this period had shifted away from the this bank.

At the mid-channel (M) stations, new egg captures at all mat stations followed a similar trend of slow accumulation prior to peak spawning (Figure 12). At all stations, new eggs accumulated at a slightly faster rate before the onset of peak spawning. After peak spawning in early January, new egg captures were slightly higher at the two upstream mat stations (Figure 12).

New egg captures were higher along RUB (R; mainstem bank of CPR Island) than in the M and L stations at the most downstream station (Figure 12). New eggs accumulated slowly over the course of the entire spawning season at station 8.6R. This rate of accumulation may have been affected by the large eddy at this station that was created by a metal revetment structure at the upstream end of CPR Island. At station 8.5R, new eggs accumulation followed a pattern similar to 8.7L. Prior to peak spawning, the highest rates of new egg accumulation occurred at the most upstream mat set. During the peak spawning period, new egg captures increased sharply at 8.7R. After peak spawning, new egg accumulation essentially ceased at this station (Figure 12).

3.3.9.3.2 Lower Section

Over the course of the egg mat sample program, new eggs accumulated at 13 of the 27 mat stations (Figure 13). Egg mat stations that did not capture newly spawned eggs were not included in Figure 13. Of the stations along LUB that did capture new eggs (3 out of 10), the accumulation of new eggs was very low over the sample program (Figure 13).

Of the seven mid channel egg mat stations deployed in the lower section, five stations captured newly spawned eggs (Figure 13). With the exception of the station at RKm 49.3, new egg captures over the course of the spawning season were similar in all mid-channel sets. Very slow rates of accumulation were documented at these sites over the entire sample period (Figure 13). At station 49.3MR, with the exception of the first sample week, new egg accumulation in December was similar to the other mid channel stations. In early January, a slight spike in new captured eggs at 49.3MR was documented, followed by very slow accumulation until the cessation of the program.

Along the RUB, new eggs accumulated at five of the ten deployed egg mat stations (Figures 11 and 13). At the three most upstream stations that captured new eggs, accumulation was very slow over the entire sample program (Figure 13). At station 47.0R, new eggs accumulated slightly faster in December, before spiking in early January. After that, newly spawned eggs did not accumulate at this station. In the lower section, new eggs accumulated at the highest rate at station 48.0R. New eggs accumulated at this station relatively quickly in December and early January, before levelling off for the remainder of the sample period (Figure 13).

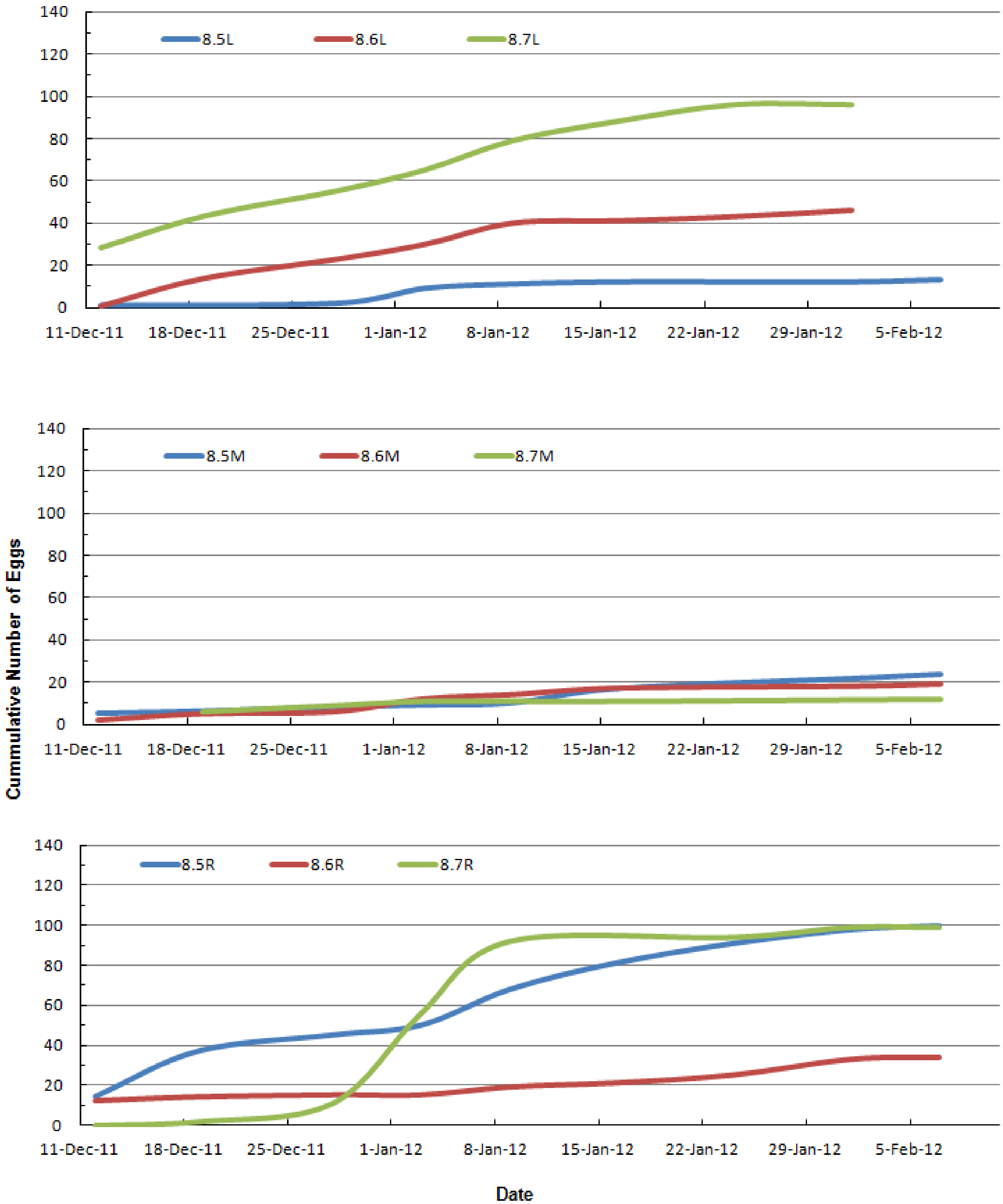


Figure 12: Accumulation of newly spawned eggs over the 2011 - 2012 Mountain Whitefish spawning season at the CPR Island spawning area, Lower Columbia River. Egg collection mat locations designated with L, M, and R were located on the left upstream bank, mid-channel, and right upstream bank, respectively.

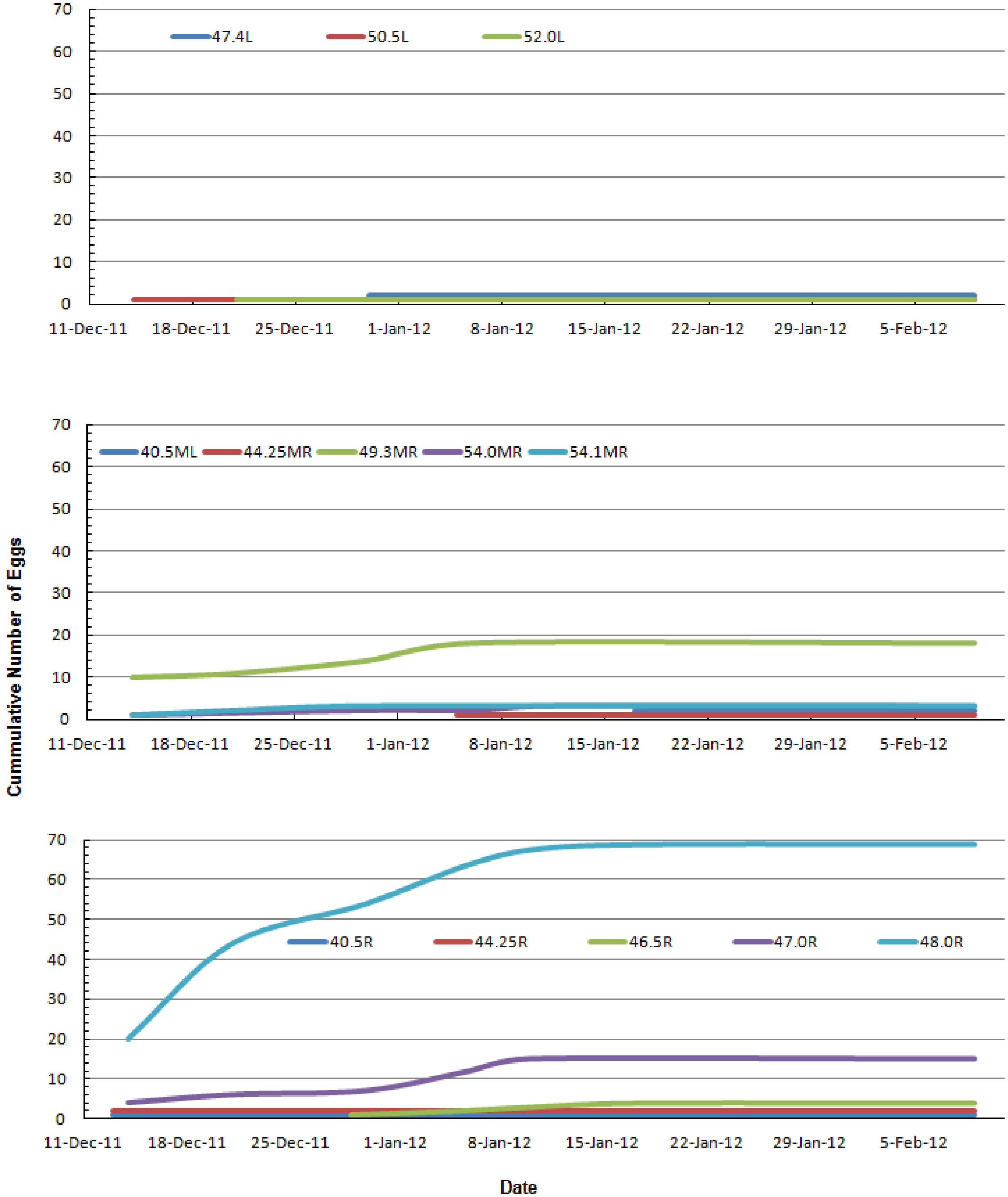


Figure 13: Accumulation of newly spawned eggs over the 2011 - 2012 Mountain Whitefish spawning season in the lower Section of the Lower Columbia River study area. Egg collection mat locations designated with L, ML, MR, and R were located on the left upstream bank, mid-channel near the left upstream bank, mid-channel near the right upstream bank, and right upstream bank, respectively.

3.4 Mountain Whitefish Egg Stranding Surveys

In the present study, index egg stranding surveys were designed to provide data to supplement the Mountain Whitefish Egg Mortality Model, and therefore, comparisons of egg stranding between years are not provided in this report. The distances of stranded eggs from the water's edge were recorded and will be incorporated in the CLBMON-47: Mountain Whitefish Egg Mortality model update.

The synoptic egg grids conducted during the stranding surveys in early February 2012 at Tin Cup and Kinnaird Rapids confirmed that Mountain Whitefish spawning use at these sites was similar to that documented in previous study years (Table 8). Very low numbers of eggs were found along recently dewatered shoreline areas of Tin Cup Rapids, which was consistent with sampling conducted in Year 2 of this program (Golder 2010a). The density of eggs found at Kinnaird Rapids in the present study was slightly higher than in Year 2, but substantially lower than densities documented at the index spawning areas (Table 8; Golder 2010a and 2011a).

During the present study, lower densities of stranded eggs were documented at CPR Island in comparison to egg stranding surveys conducted in Year 2 (Table 9). As only 100 new eggs were captured at the nearest egg mat station (8.7R; Figure 10), the high density of eggs (207 eggs/m^2) documented during the stranding surveys suggested that the Year 4 mat catch data may under-represent egg deposition at the downstream portions of CPR Island. This assumption was supported by Years 2 and 3 findings that also indicated substantial risks of stranding eggs on CPR Island during discharge reductions in the LCR.

Low densities of stranded eggs were found during the surveys in the Kootenay River (Table 9). This finding is not consistent with the higher densities of stranded eggs recorded in previous study years (Table 9; Golder 2010a and 2011a) but may reflect higher than normal water levels in the Kootenay River at the time of the surveys on April 2, 2012. Flow reductions from HLK related to Rainbow Trout protection flows did not dewater substantial shoreline areas in the Kootenay River, and as a result, the majority of deposited eggs remained wetted.

Table 8: Summary of results during Mountain Whitefish egg stranding surveys (egg grids) at Tin Cup Rapids RUB and Kinnaird Rapids RUB, Columbia River, February 4, 2012.

Date	Location and River Bank (River Kilometre Downstream from HLK)	Corresponding HEC RAS Transect	Number of Egg Grids Conducted	Area of Each Grid (m)	Total Area Sampled (m^2)	Total Number of Stranded Mountain Whitefish Eggs Found	Year 4 CPUE (eggs/m^2)	Previous Study Years' CPUE (egg/m^2)
4-Feb-12	Tin Cup Rapids RUB (10.0)	22	10	1	10	15	*1.50*	*0.20 (Year 2)*
	Kinnaird Rapids RUB (11.0)	27	10	1	10	406	*40.60*	*15.40 (Year 2)*

Table 9: Summary of results during Mountain Whitefish egg stranding surveys at the CPR Island and Kootenay River index spawning areas, Columbia River, April 2, 2012.

Date	Location and River Bank (River Kilometre Downstream from HLK)[a]	Corresponding HEC RAS Transect	Transect Number[b]	Transect Length (m)	Transect Width (m)	Total Area Sampled (m^2)	Total Number of Stranded Mountain Whitefish Eggs Found	CPUE ($eggs/m^2$)	Previous Study Years' CPUE (egg/m^2)
2-Apr-12	CPR Island (8.7)	17	1	5.0	0.3	1.5	302	*201.33*	*n/a*
			2	4.0	0.3	1.2	258	*215.00*	*n/a*
	CPR Island Total					**2.7**	**560**	***207.41***	***320.0 (Year 3)***
	Kootenay RUB (0.8K)	39	1	3.2	0.2	0.6	16	*25.00*	*n/a*
			2	3.0	0.2	0.6	16	*26.67*	*n/a*
	Kootenay River Total					**1.2**	**32**	***25.81***	***710.2 (Year 2)***

[a] Kootenay River kilometres measured upstream from Columbia/Kootenay confluence and denoted with a K. RUB = right upstream bank.

[b] Transects listed in order from upstream to downstream.

3.5 Accumulated Thermal Units (ATUs)

The ATUs required for eggs to develop to the hatch stage range from 327 to 444 for various Mountain Whitefish populations in the reviewed literature (Rajagopal 1979; R.L. & L. 2001a). This range of ATUs was used to estimate the timing of hatch of Mountain Whitefish eggs spawned in the Lower Columbia River study area. Between the first recorded spawning events in November 2011 and April 1, 2012, thermal units in both the CPR Island and lower section of the study area exhibited similar accumulation patterns (Figure 14), although eggs in the lower section acquired thermal units at a slightly faster rate. This, combined with an earlier onset of spawning would suggest that eggs in the lower section would be expected to hatch slightly earlier than those in the CPR Island site. In order to determine the pattern of ATUs experienced by eggs deposited from spawning events that occurred later in the spawning season, and to estimate hatch timing, the ATUs were calculated for every two week period from the onset of spawning until its cessation at the CPR Island and Kootenay River areas (Figures 15 and 16).

ATUs at the CPR Island area followed similar patterns over the spawning season (Figure 15). Assuming a consistent increase in ATUs, and using the range of 327 to 444 ATUs to hatch, eggs in the CPR Island area would potentially have commenced hatching between late-January and mid-March 2012 (Figure 15). Eggs spawned after December 16 would not have hatched by April 1, 2012 (i.e., when BC Hydro implements Rainbow Trout Protection Flows and discharge from HLK is typically reduced). Based on ATUs in the CPR Island area, the last eggs spawned on February 7 would not have hatched until mid to late May 2012.

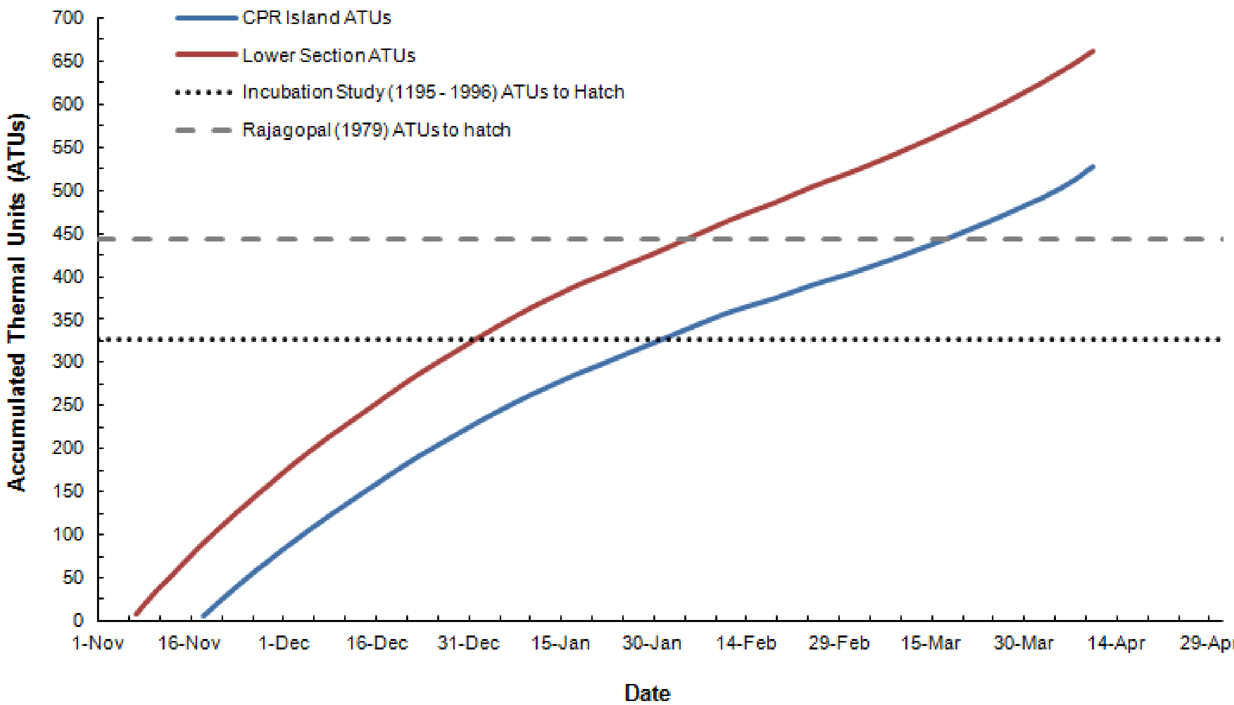


Figure 14: Accumulated thermal units (ATUs) at Mountain Whitefish spawning areas at CPR Island and the lower section of the Lower Columbia River study area, November 1, 2011 to April 30, 2011.

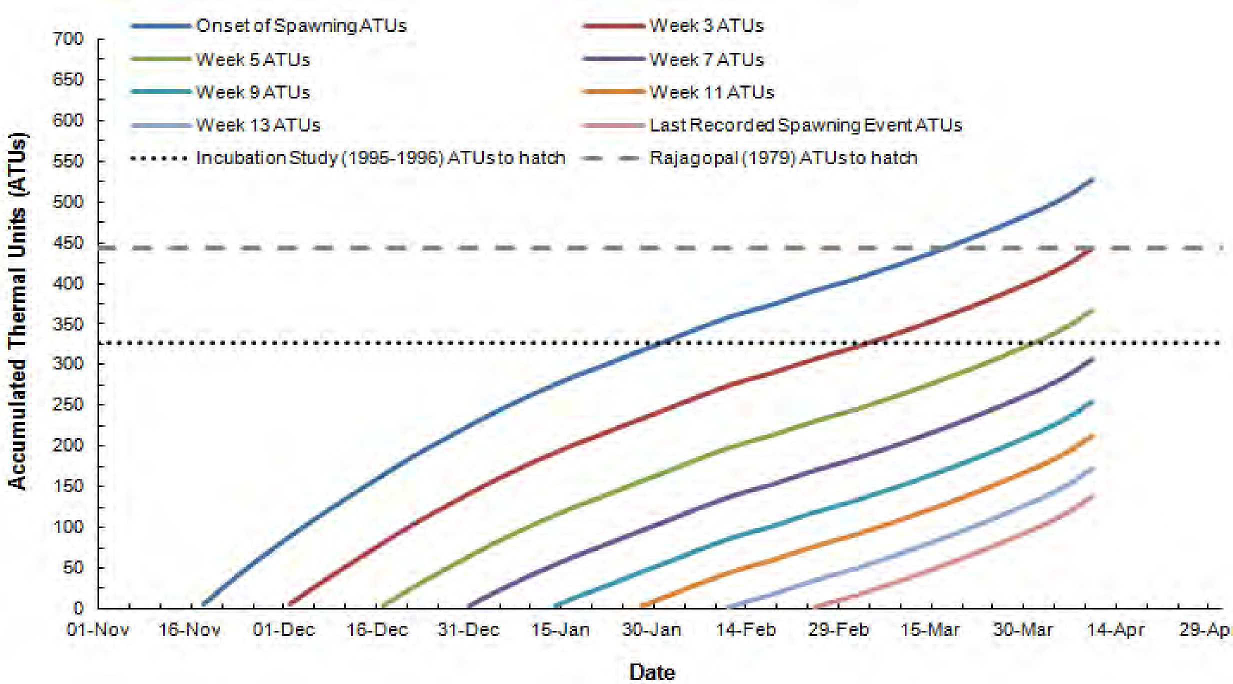


Figure 15: Accumulated thermal units (ATUs) at the CPR Island Index spawning area in two week increments, November 1, 2011 to April 30, 2012.

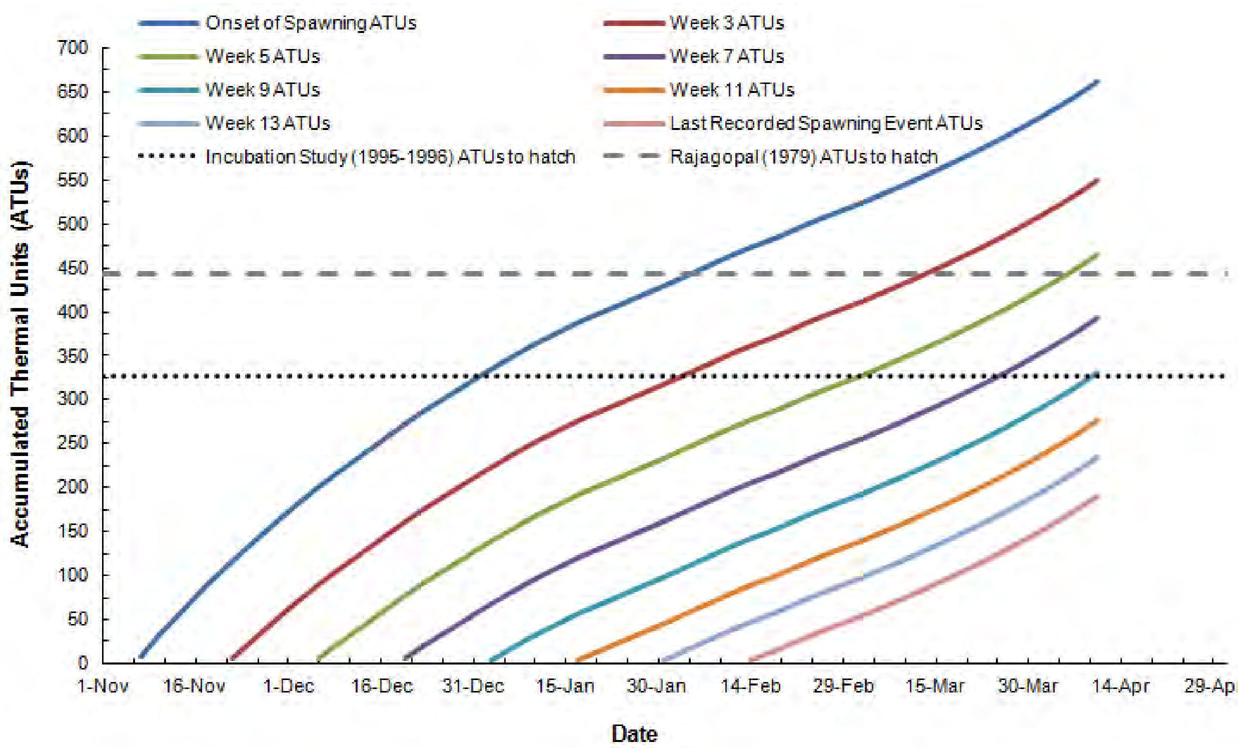


Figure 16: Accumulated thermal units (ATUs) in the Lower Section of the study area in two week increments, November 1, 2011 to April 30, 2012.

In the lower section of the study area, eggs spawned early in the season collected ATUs slightly faster than later spawned eggs, but substantial differences in the acquisition of ATUs over the spawning period were not evident (Figure 16). Based on the ATUs in the lower section and the range of ATUs required to reach hatching, eggs in the lower section could potentially have commenced hatch between late December and late January, which was about one month earlier than the predicted initial hatch timing of early spawned eggs at the CPR Island spawning area (Figure 15). Based on ATUs in the Kootenay River area, the earliest estimated hatch date of the eggs spawned on January 19 would be in late April (i.e., using the ATUs required to hatch as determined during the 1995-1996 incubation study; R.L. &.L 2001a).

3.6 Larval Mountain Whitefish Sampling

Prior to the LCR flow reductions to reach Rainbow Trout protection flows, larvae were not observed in shallow nearshore areas at either the left upstream bank adjacent to Zellstoff-Celgar or at Norn's Creek Fan. The absence of larval Whitefish from these areas prompted an examination of the ATUs that deposited eggs would have experienced to that point. Based on ATUs to the end of March, only eggs deposited prior to December 16, 2011 would have had sufficient time to develop to the hatch stage. Therefore, the majority of deposited eggs, including those deposited during peak spawning, would not have hatched by late March and the remaining pre-reduction larval stranding surveys were cancelled.

4.0 DISCUSSION

This data report does not include an in-depth analysis of the data presented; therefore, the following discussion is limited to a brief comparison of data from the present study with results from previous study years and how the additional data from Year 4 addressed the Management Objectives. Only management objectives specifically addressed by the Year 4 study program are discussed below.

4.1 Mountain Whitefish Spawning

Management Objective 1 (*Obtain current sex ratios, age-at-maturity and fecundity of adult Mountain Whitefish in the lower Columbia and lower Kootenay rivers [Management Question 3])* was achieved. Sex ratios, age-at-maturity, and fecundity estimates for the current Mountain Whitefish population were obtained and used to provide more representative estimates of spawner abundance and PED. The current sex ratio of 1 male:1.14 females was within the range of reported for previous studies, and closely resembled sex ratios obtained in the 1990 – 1991 and 1995 – 1996 study years (Hildebrand and English 1991, R.L. & L. 2001a). The differences in sex ratios between study years may reflect variations in spatial and temporal distribution of each sex during data collection.

All age-1 fish examined in the present study were immature. The proportions of mature age-2 and older fish were similar or higher than reported in previous studies (R.L. & L. 1995, 2001a). Of the mature females examined in the present study, 30% were spent, all of which were captured in the upper and middle sections of the study area. This suggests that these individuals had spawned prior to collection, but the timing of those spawning events is unknown.

The estimated fecundities (eggs/fish) for the three mature females in which absolute fecundity was obtained were positively biased. As a result, a correction factor was calculated and applied to the fecundity estimates using gonad weight. The corrected mean estimate was 9404 eggs/fish, with a minimum estimate of 2582 eggs/fish and maximum estimate of 18 753. If warranted, these fecundity estimates can be refined further by examining their relationship with life history characteristics (i.e., length, weight, and condition factor) in the Year 5 interpretive report.

The mean fecundity of 9404 eggs/female determined in the present study was very similar to the 9514 eggs/female determined for the 1994 – 1995 study (R.L. & L. 2001a). These Columbia River estimates are within the range of fecundity for BC river systems as reported by other studies (4000 - 17000 eggs/female, McPhail and Troffe 1998; 1000 – 15000 eggs/female, BC Hydro Peace/Williston Fish and Wildlife Compensation Program). Based on fecundity, the reproductive potential of the current Mountain whitefish population is similar to that recorded in the mid-1990s. However, if the increases in estimated abundances of Mountain Whitefish adults observed between the 1990s study and Years 2 to 4 of the present study are valid, then there has likely been a substantial increase in egg production potential in the current Mountain Whitefish population. The overlap in the PED estimates for the current population indicates that egg production potential has remained relatively stable between Years 2 to 4 of this study.

The age-at-maturity, sex ratios, and fecundity data from the mid-1990s were obtained during a period when the health of the Mountain Whitefish population was a concern due to pollution from a variety of industrial sources. Also, the sex ratio and proportion of mature fish from the early 1990s was skewed towards females. As a result of these issues, coupled with the high uncertainty related to abundance and PED estimates for the current whitefish population, caution in the interpretation, comparison, and use of the PED data is advised.

Management Objectives 2 and 3 (*Quantify the periodicity [timing], intensity and distribution of Mountain Whitefish spawning in the LCR and lower section of the Columbia River during the December, January, and February spawning period [Management Question 3]*) were achieved. Data collected in Year 4 on the timing and intensity of spawning supplemented data collected in Years 2 and 3 and provided comparisons between these years and between the 1990s study programs. Based on egg collection mat sampling and egg developmental staging, the timing of the onset, peak, and cessation of Mountain Whitefish spawning in the CPR Island spawning area in Year 4 did not differ substantially from previous study years.

In Year 4, the onset of spawning and the peak spawning periods at the CPR Island area occurred over temperature ranges similar to those recorded during the 1994 – 1995, 1995 – 1996, 2009 – 2010, and 2010 – 2011 spawning seasons (R.L. & L. 2001a, Golder 2010a). There is insufficient data from past spawning activity in the lower section upon which comparisons of temperature and spawn timing can be drawn.

At CPR Island, the estimated onset of spawning in Year 4 occurred during periods of stable discharge in the LCR, which is consistent with previous study years (Golder 2010a and 2011a). Also similar to Years 2 and 3 of this study, peak spawning at CPR Island in the present year occurred during periods of decreasing discharge (Golder 2010a and 2011a). The onset of spawning in the lower section occurred during stable LCR discharge, although peak spawning occurred during a period of load factoring at BRD.

Overall CPUE of eggs in the CPR Island spawning area slightly increased from 0.55 eggs/24 mat-hours in Year 3 to 0.59 eggs/24 mat-hours during the present study. These values are substantially lower than the 1.77 eggs/24 mat-hours documented in Year 2. Whether the substantial reduction in CPUEs during the two most recent spawning seasons reflects a reduction in spawning intensity or a cyclical pattern of spawning use at this location is unknown. The relatively high catch rates of eggs indicated that this area is still used extensively for spawning.

In the lower section of the study area, catch rates were highest at the onset of sampling and typically exhibited steady declines over the course of the program. This pattern, combined with the predominantly recent egg developmental stages captured during the first sample session, suggests that peak spawning in the lower section occurred prior to the onset of sampling. This result is very similar to what was documented in the middle section of the study in Year 2 of this study (Golder 2010a). This would suggest that while the majority of the mature Mountain Whitefish in the lower and middle sections migrate into the upper section to spawn, some proportion of the spawning population remains and spawns in the middle and lower sections.

Management Objective 4 (*Document the spatial extent and physical characteristics of whitefish spawning areas in these two spawning areas [Management Questions 1 and 2]*) was also achieved. Based on habitat data collected, egg deposition in Year 4 was documented at similar mean water depths, mean surface velocities, and predominant substrate types as in previous study years (R.L. & L. 2001a, Golder 2010a and 2011a). Baseline data on these habitat parameters were also collected in the lower section of the study area.

In Year 4, egg deposition patterns at the CPR Island area were highest along the mainstem side of CPR Island. The downstream mat set along LUB also collected high numbers of eggs and exhibited high CPUEs. Although this shows a relatively patchy use of the area for spawning, this pattern of egg deposition was similar to Year 2, when the downstream mats collected the highest numbers of eggs (Golder 2010a). Egg deposition in the lower section of the study area was concentrated between RKm 47.0 and 49.3 along RUB.

Management Objective 5 (*Document the vertical distribution [depth] of Mountain Whitefish eggs in these spawning areas [Management Question 4]*) was achieved. In general, the patterns of egg deposition recorded at CPR Island between Years 2 to 4 and previous studies in the 1990s indicate the vast majority of egg deposition occurs at higher elevation, shallow nearshore habitats. Eggs deposited within shallow areas are at risk of stranding during periods of reduced flow in the Columbia or Kootenay rivers over the course of the egg incubation period. This assertion is supported by the high numbers of stranded eggs recorded in the drawdown zone during past and present egg stranding surveys at CPR Island (R.L. & L. 1994, 2001a, 2001b; Golder 2010a and 2011a).

In the lower section of the study area, the low numbers of collected eggs precluded a detailed analysis of egg depositional patterns by depth. However, approximately 75% of the eggs collected in the lower section were on nearshore sets, which suggested that spawning in this section generally occurs in shallow habitats.

Approximately 16% of the eggs examined for developmental stage were later staged eggs that had re-entered the drift (Appendix C, Table C5). This proportion of late developmental eggs was slightly higher but comparable to that recorded in Years 2 and 3 (14% and 12%, respectively; Golder 2010a and 2011a).

Management Objective 6 (*Document egg stranding in the upper section of the lower Columbia River during flow reductions from HLK [Management Question 4]*) was achieved. The exploratory egg grids conducted in early February 2012 at Tin Cup and Kinnaird Rapids confirmed levels of spawning use similar to those documented in previous study years. The density of eggs found at Kinnaird Rapids was slightly higher than in Year 2, but substantially lower than densities documented at key spawning areas such as CPR Island or the Kootenay River (Golder 2010a and 2011a).

The rates of egg stranding were similar in both transects in the downstream section of the CPR Island area, which suggested a continued high rate of egg deposition in this area among years. When compared to catch rates from the egg mats, the high density of eggs documented during the stranding surveys suggested that the mats may under-represent egg deposition at the downstream portions of CPR Island. This is supported by Years 2 and 3 findings which also indicated substantial risks of egg stranding at the CPR Island area during discharge reductions in the LCR.

In the Kootenay River, the low stranded eggs densities found during the surveys were not consistent with previous study years (Golder 2010a and 2011a). In the present study, HLK flow reductions related to the initiation of Rainbow Trout Protection flows did not dewater substantial shoreline areas in the Kootenay River; therefore, the majority of deposited eggs remained wetted.

Management Objective 7 (*Identify and characterize the rearing habitats utilized by larval mountain whitefish prior to the scheduled discharge reductions to reach Rainbow Trout protection flows; and, determine if the scheduled flow reductions displace the larvae to different rearing habitats [Management Question 6]*) was not achieved. Flow reductions in the LCR to initiate Rainbow Trout Protection flows occurred prior to hatching of most Mountain Whitefish eggs. As a result, field crews were unable to obtain data on larval whitefish rearing habitats during the pre-reduction surveys and to assess how flow changes affected post-reduction habitat selection by larval whitefish.

4.2 Juvenile Mountain Whitefish

While data has been collected on nighttime habitat use of age-0 and age-1 juvenile Mountain Whitefish, little is known about habitats used in the daytime. Due to the difficulties of capturing juveniles during the day (Golder 2009a) and poor survival rates of juveniles during acoustic tag implantation in Years 2 and 3 (Golder 2010a and 2011a), it is currently unknown if this cohort occupies deeper habitats during the day where they are not susceptible to sampling by conventional methods, or whether they are present in the same habitats as used at night but are able to avoid capture. Therefore, to fully address the first part of **Management Question 6** (*What habitats are juvenile whitefish using in the lower Columbia and lower Kootenay rivers?*) the feasibility of determining the effect of flow variation on the availability and suitability of preferred habitat for larval and juvenile life history stages requires further investigation.

5.0 RECOMMENDATIONS

Recommendations for Year 5 of the CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program are as follows:

- Conduct spawner surveys and egg mat sampling at Norn's Creek mouth and immediately downstream of Hugh L. Keenleyside Dam. Anecdotal evidence suggests that spawning Mountain Whitefish may use these areas, although the degree of use currently is unknown (pertains to Management Questions 1, 2 and 3).
- Conduct D-ring sampling at the CPR Island and Kootenay River key spawning areas to assess the degree of egg drift and determine the relationship between flow changes and egg re-suspension in the drift. This should be conducted after the peak spawning period when the concentration of incubating eggs is greatest. Whitefish eggs that are re-suspended and displaced after their initial deposition may be exposed to factors (such as predation and mechanical damage) that increase their risk of mortality. The relationship between flow increases and the re-suspension of eggs is relatively unknown, and this experiment would provide information towards understanding that relationship (pertains to Management Question 4).
- Conduct systematic sampling of emerging larval Mountain Whitefish throughout the protracted hatching and emergence periods and in all sections of the study area. This would allow for the characterization of rearing habitats as well as comparisons with data collected during previous studies to assess whether the availability and suitability of these habitats are affected by flow regimes during hatch (pertains to Management Question 6).
- If sufficient funds in the Year 5 budget are available, explore the feasibility of determining the effect of flow variation on the availability and suitability of preferred nighttime habitat use for juvenile life history stages. Due to difficulties in sampling juvenile habitat use in the daytime, relating the effects of flow variation on rearing habitats may be an option to further address Management Question 4.
- Develop a Mountain Whitefish larval identification key. This does not relate directly to a management question for this program, but since such a key has not been developed for this species, this would greatly assist larval whitefish sampling programs.
- Prior to the development of the Year 5 interpretive report, meet with BC Hydro contract authority to discuss the CLBMON-48 dataset and to prioritize data analysis.

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7.0 CLOSURE

We trust that this report meets your current requirements. If you have any further questions, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Brad Hildebrand
Fisheries Biologist, Project Manger

ORIGINAL SIGNED

Larry Hildebrand
Principal, Project Director

BH/LH/cmc

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APPENDIX A

Photographic Plates

Plate 1 Obtaining the total ovary weight from a sacrificed female Mountain Whitefish.

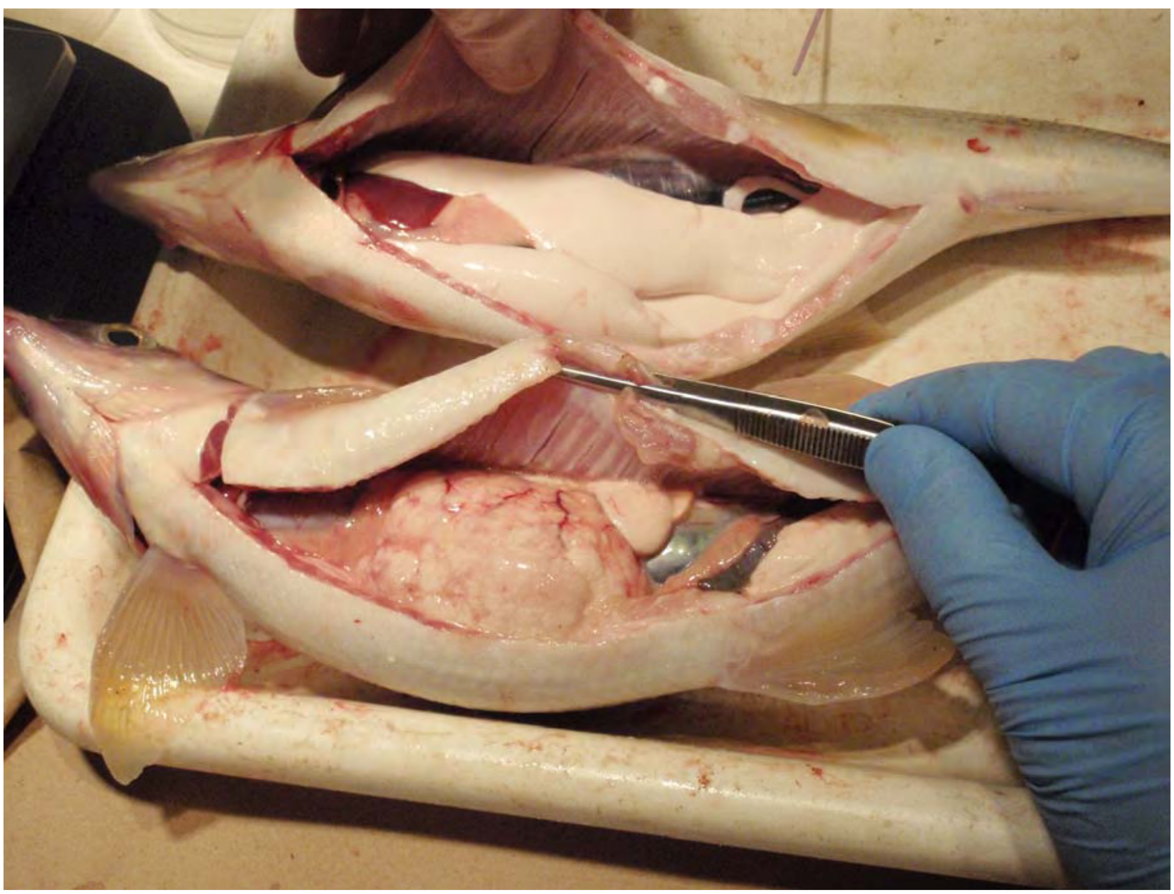


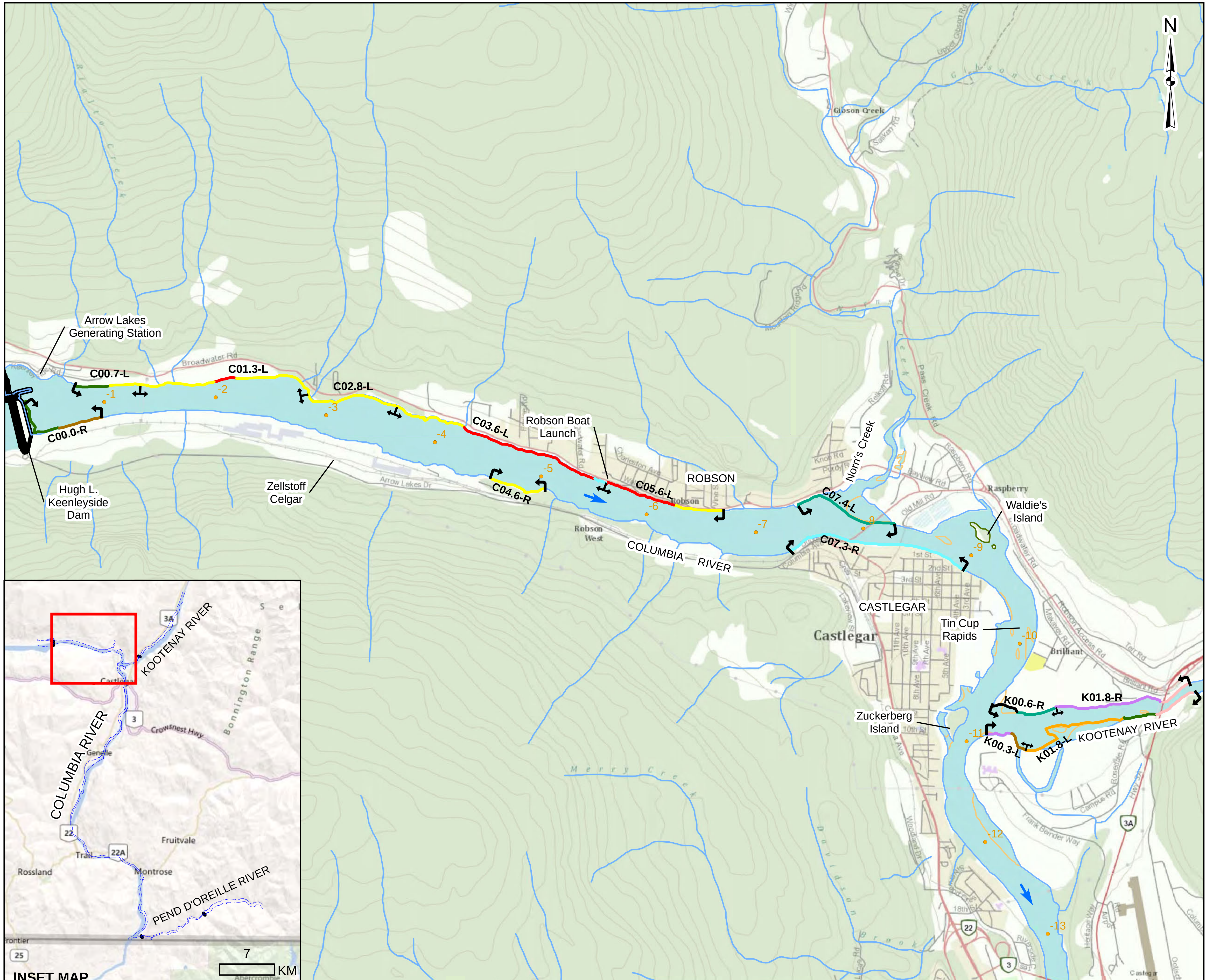
Plate 2 Comparison of normal (top) and abnormal (large tumor; bottom) mature male Mountain Whitefish gonads. Both fish were captured in the Kootenay River.

Plate 3 Underwater photo of an egg collection mat resting on river bottom after deployment, January 5, 2011 (CLBMON-48 Year 3).

Plate 4 Removing substrate to enumerate stranded Mountain Whitefish eggs within a transect at the CPR Island spawning area, April 2, 2012.

APPENDIX B

Mountain Whitefish Spawner Data Summaries



LEGEND

- RIVER KILOMETRE DOWNSTREAM OF HUGH L. KEENLEYSIDE DAM
- C00.0-R BOAT ELECTROSHOCKING SITE
- FLOW DIRECTION
- WATERCOURSE
- BREAKWATER
- DAM SECTION
- ISLAND
- SAND OR GRAVEL BAR

BANK HABITAT TYPE

- A1 - ARMOURED COBBLE/GRAVEL
- A1+A2 - ARMOURED COBBLE/GRAVEL/SMALL BOULDER
- A2 - ARMOURED COBBLE/SMALL BOULDER
- A2+A3 - ARMOURED COBBLE/SMALL/LARGE/BOULDER
- A3 - ARMOURED SMALL/LARGE BOULDER
- A4 - ARMOURED LARGE BOULDER
- A5 - BEDROCK BANKS
- A6 - MAN-MADE RIP-RAP
- BW - BACKWATER
- D1 - DEPOSITIONAL SAND/SILT
- D1+D2 - DEPOSITIONAL SAND/SILT/GRAVEL/COBBLE
- D2 - DEPOSITIONAL GRAVEL/COBBLE
- D3 - DEPOSITIONAL LARGE COBBLE
- EDDY - EDDY

REFERENCE

BASE IMAGERY FROM: ESRI, DELORME, NAVTEQ, TOMTOM, INTERMAP, IPC, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), AND THE GIS USER COMMUNITY.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

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SCALE 1:35,000

PROJECT

LARGE RIVER FISH INDEXING PROGRAM
LOWER COLUMBIA RIVER

TITLE

UPPER SECTION OF STUDY AREA
2011 SAMPLE SITE LOCATIONS

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GIS	SS/JG	19 Jun. 2012		
CHECK	DF	26 Jun. 2012		
REVIEW	LH	26 Jun. 2012		

Golder Associates

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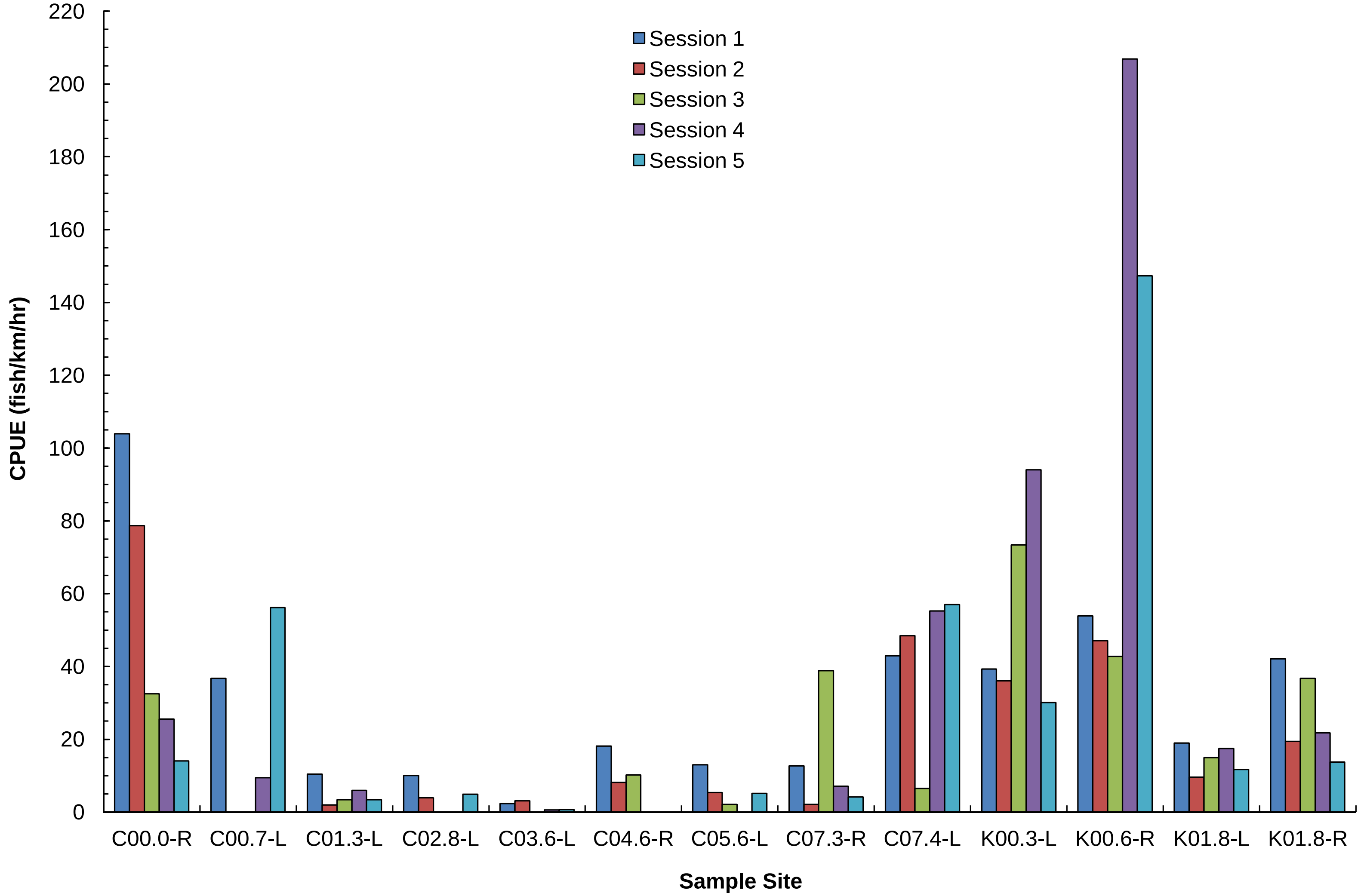
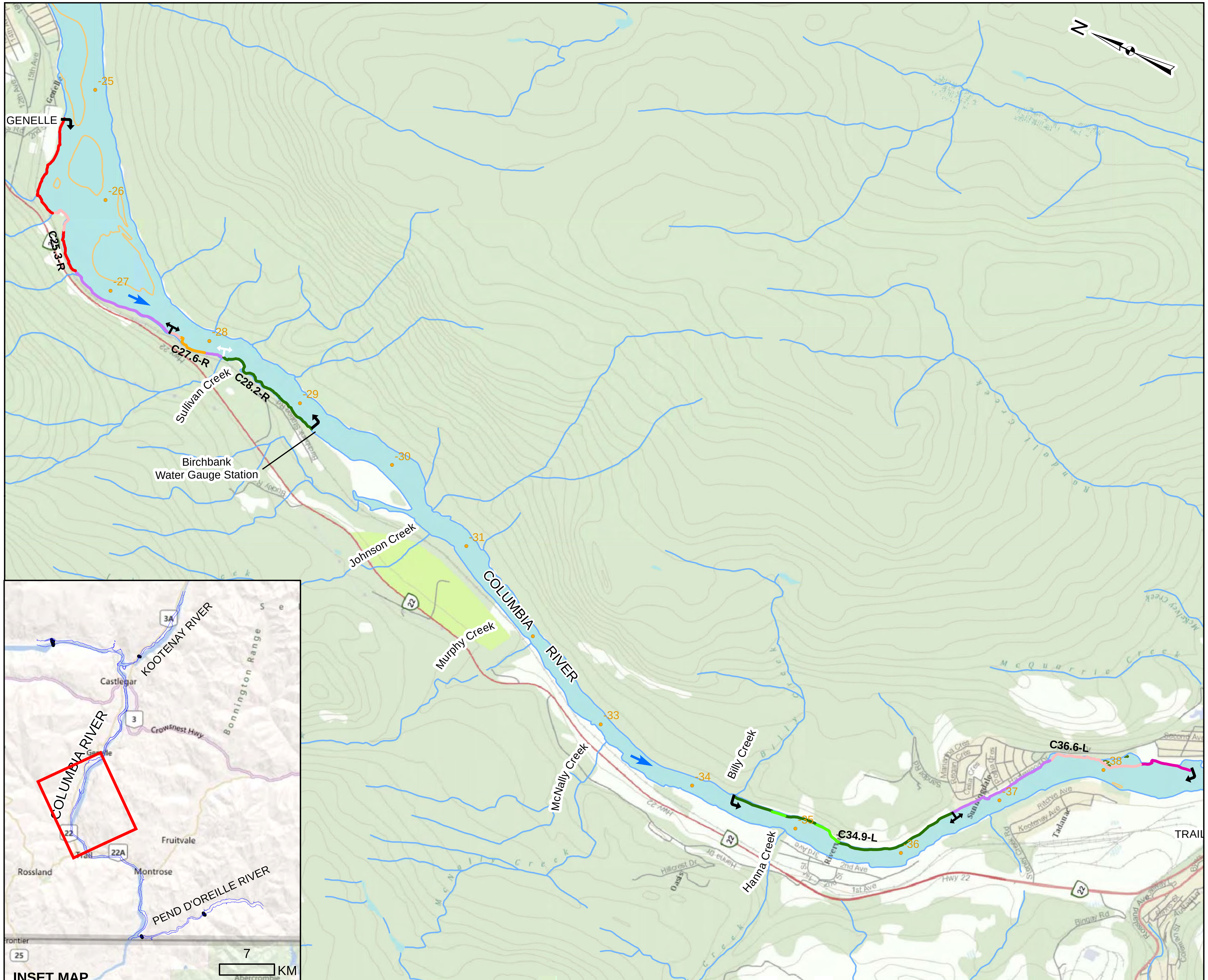


Figure B1: Adult mountain whitefish CPUEs (fish/km/hr) at boat electrofishing sample sites in the upper section of the lower Columbia River (C), including the Kootenay River (K) section, 2011 (Data from Phase 11 LRFIP; Golder 2012).



LEGEND

- RIVER KILOMETRE DOWNSTREAM OF HUGH L. KEENLEYSIDE DAM
- C00.0-R BOAT ELECTROSHOCKING SITE
- FLOW DIRECTION
- WATERCOURSE
- BREAKWATER
- DAM SECTION
- ISLAND
- SAND OR GRAVEL BAR

BANK HABITAT TYPE

- A1 - ARMOURED COBBLE/GRAVEL
- A1+A2 - ARMOURED COBBLE/GRAVEL/SMALL BOULDER
- A2 - ARMOURED COBBLE/SMALL BOULDER
- A2+A3 - ARMOURED COBBLE/SMALL/LARGE/BOULDER
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- A4 - ARMOURED LARGE BOULDER
- A5 - BEDROCK BANKS
- A6 - MAN-MADE RIP-RAP
- BW - BACKWATER
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- D2 - DEPOSITIONAL GRAVEL/COBBLE
- D3 - DEPOSITIONAL LARGE COBBLE
- EDDY - EDDY

REFERENCE

BASE IMAGERY FROM: ESRI, DELORME, NAVTEQ, TOMTOM, INTERMAP, IPC, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), AND THE GIS USER COMMUNITY.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

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SCALE 1:35,000

PROJECT

LARGE RIVER FISH INDEXING PROGRAM
LOWER COLUMBIA RIVER

TITLE

MIDDLE SECTION OF STUDY AREA
2011 SAMPLE SITE LOCATIONS

Golder Associates

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GIS	SS/JG	19 Jun. 2012		
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REVIEW	LH	26 Jun. 2012		

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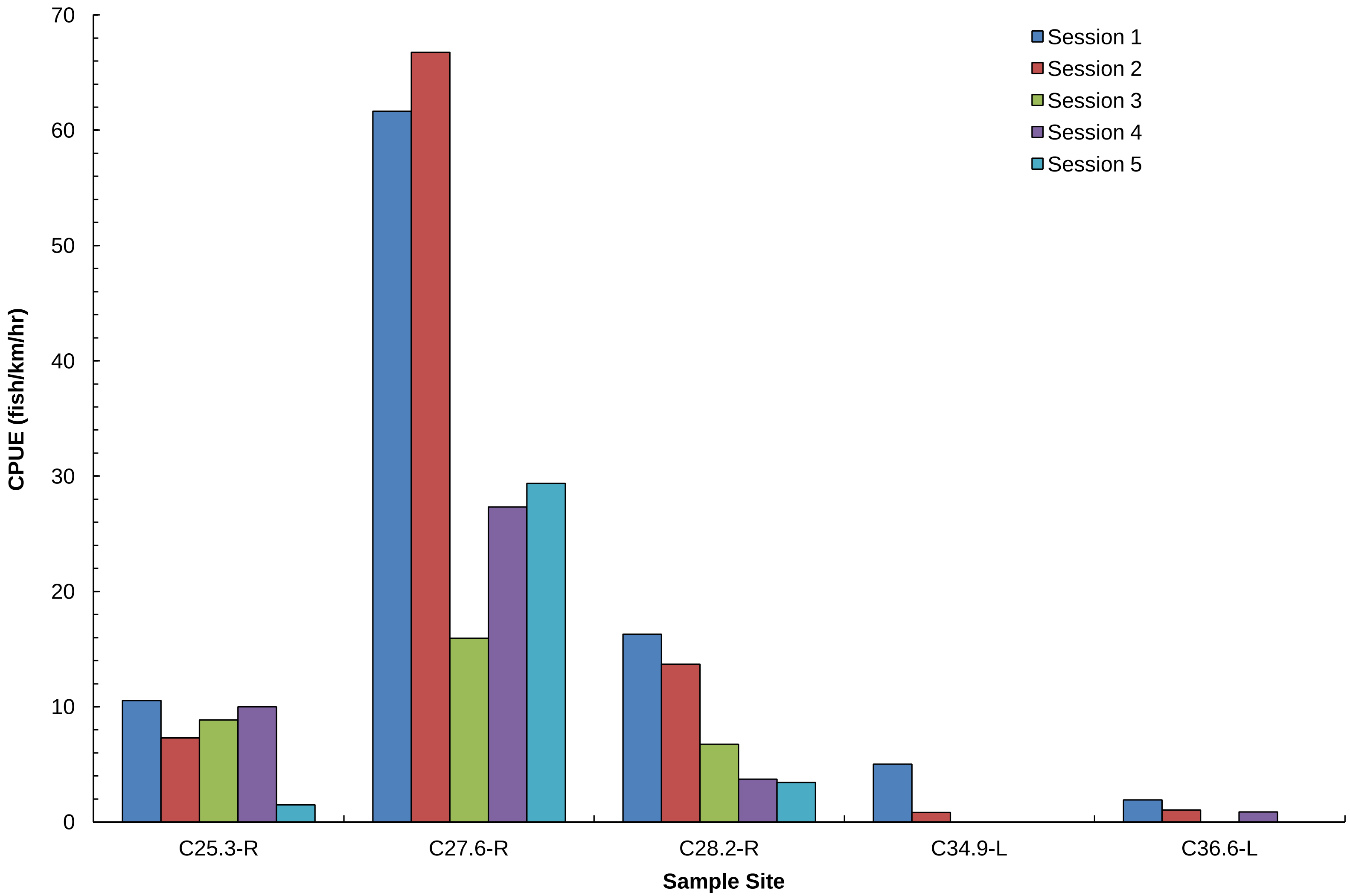
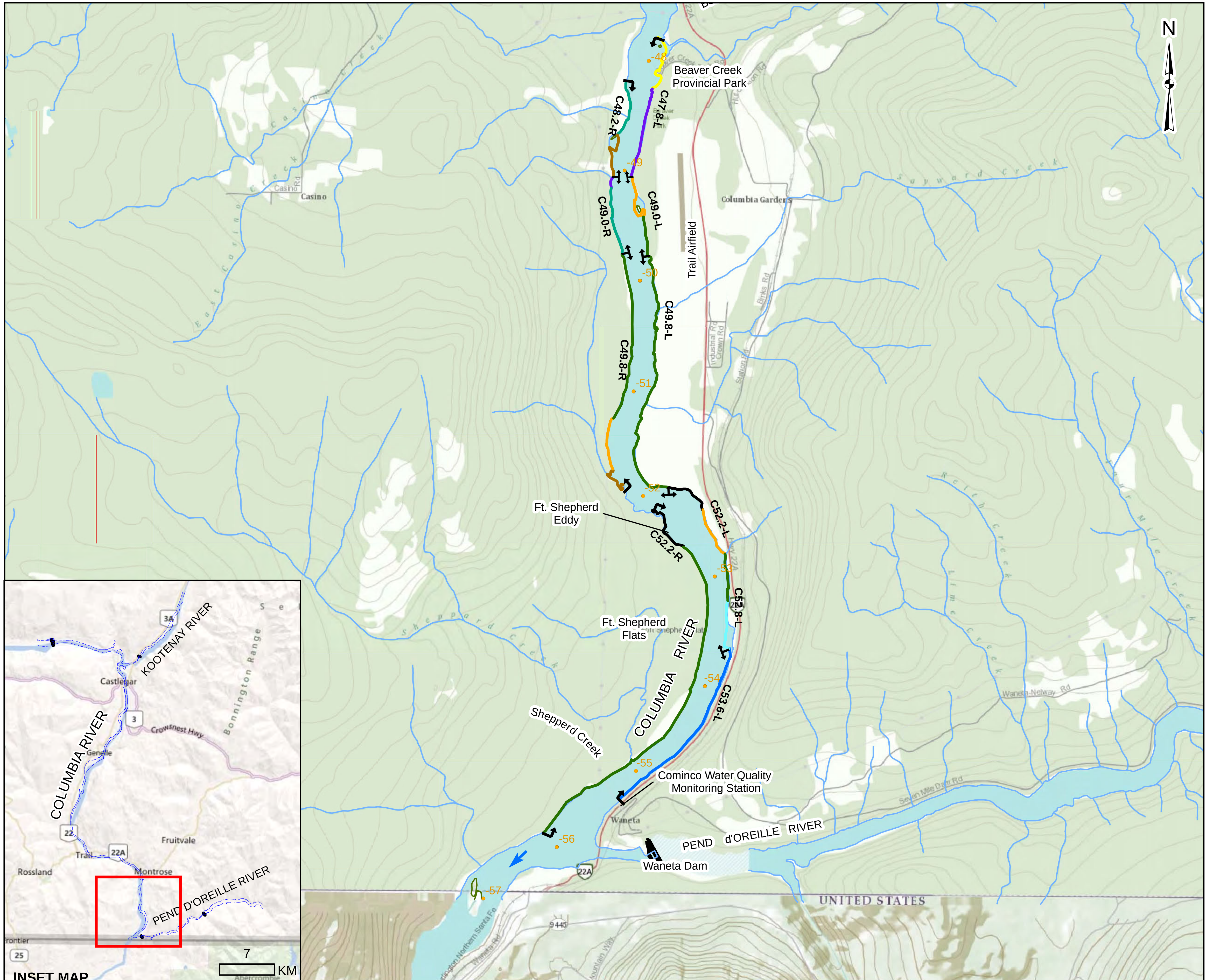


Figure B2: Adult mountain whitefish CPUEs (fish/km/hr) at boat electrofishing sample sites in the middle section of the lower Columbia River, 2011 (Data from Phase 11 LRFIP; Golder 2012).



LEGEND

- RIVER KILOMETRE DOWNSTREAM OF HUGH L. KEENLEYSIDE DAM
- C00.0-R BOAT ELECTROSHOCKING SITE
- FLOW DIRECTION
- WATERCOURSE
- BREAKWATER
- DAM SECTION
- ISLAND
- SAND OR GRAVEL BAR

BANK HABITAT TYPE

- A1 - ARMOURED COBBLE/GRAVEL
- A1+A2 - ARMOURED COBBLE/GRAVEL/SMALL BOULDER
- A2 - ARMOURED COBBLE/SMALL BOULDER
- A2+A3 - ARMOURED COBBLE/SMALL/LARGE/BOULDER
- A3 - ARMOURED SMALL/LARGE BOULDER
- A4 - ARMOURED LARGE BOULDER
- A5 - BEDROCK BANKS
- A6 - MAN-MADE RIP-RAP
- BW - BACKWATER
- D1 - DEPOSITIONAL SAND/SILT
- D1+D2 - DEPOSITIONAL SAND/SILT/GRAVEL/COBBLE
- D2 - DEPOSITIONAL GRAVEL/COBBLE
- D3 - DEPOSITIONAL LARGE COBBLE
- EDDY - EDDY

REFERENCE

BASE IMAGERY FROM: ESRI, DELORME, NAVTEQ, TOMTOM, INTERMAP, IPC, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), AND THE GIS USER COMMUNITY.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

1 0 1 KM

SCALE 1:35,000

PROJECT

LARGE RIVER FISH INDEXING PROGRAM
LOWER COLUMBIA RIVER

TITLE

LOWER SECTION OF STUDY AREA
2011 SAMPLE SITE LOCATIONS

Golder Associates

PROJECT No. 10-1492-0102			SCALE AS SHOWN	REV. 0
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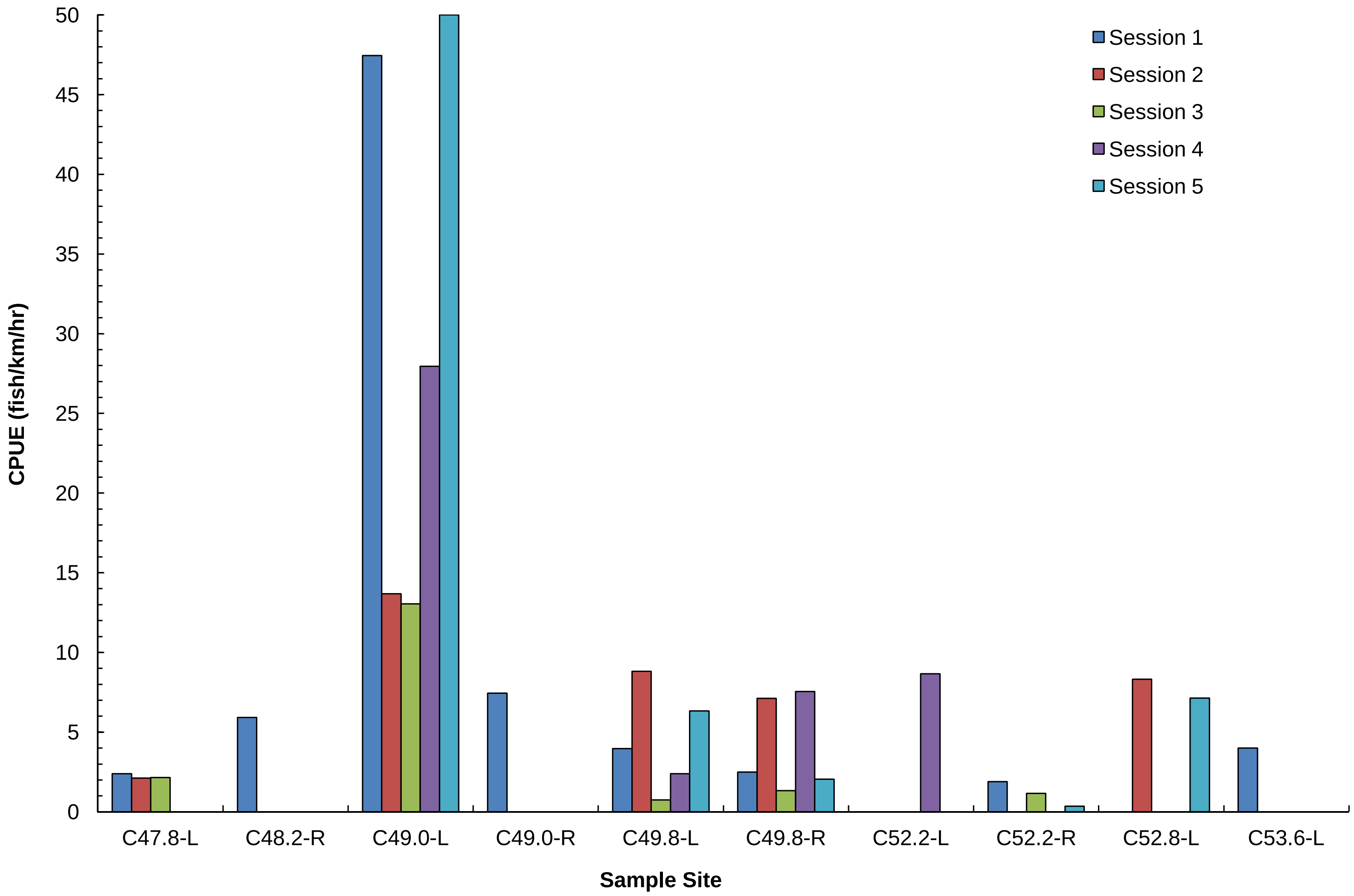

Figure B3: Adult mountain whitefish CPUEs (fish/km/hr) at boat electrofishing sample sites in the lower section of the lower Columbia River, 2011 (Data from Phase 11 LRFIP; Golder 2012).

Table B1: Summary of life history and fecundity data collected from adult Mountain Whitefish, October and November 2011.

Sample Number	Date Captured	LRFIP Section	LRFIP Site	Legnth (mm)	Weight (g)	Sex	Tubercles (Y or N)	Mature (Y or N)	Age (years)	Total Gonad Weight (g)	Weight of 100 eggs (g)	Total Number of Eggs (total count)	Total Number of Eggs (estimated)	Comments
1	30-Oct-2011	Kootenay	K00.6-R	386	658	M	Y	Y	4	-	-	-	-	
2	30-Oct-2011	Kootenay	K00.6-R	356	688	M	Y	Y	4	-	-	-	-	
3	30-Oct-2011	Kootenay	K00.6-R	426	1295	F	Y	Y	5	274.3	1.4	17792	19593	
4	30-Oct-2011	Kootenay	K00.6-R	400	839	M	Y	Y	6	-	-	-	-	
5	30-Oct-2011	Kootenay	K00.6-R	407	937	M	Y	Y	6	-	-	-	-	
6	30-Oct-2011	Kootenay	K00.6-R	355	667	M	Y	Y	5	-	-	-	-	
7	30-Oct-2011	Kootenay	K00.6-R	345	663	F	Y	Y	2	155	1.6	-	9688	
8	30-Oct-2011	Kootenay	K00.6-R	335	608	M	Y	Y	3	-	-	-	-	
9	30-Oct-2011	Kootenay	K00.6-R	414	1088	M	Y	Y	6	-	-	-	-	
10	30-Oct-2011	Kootenay	K01.8-R	317	509	F	Y	Y	2	88	1.3	-	6769	
11	30-Oct-2011	Kootenay	K01.8-R	382	763	M	Y	Y	5	-	-	-	-	large tumor on gonad
12	30-Oct-2011	Kootenay	K00.3-L	371	817	F	Y	Y	6	135.9	1.1	-	12355	
13	30-Oct-2011	Kootenay	K01.8-L	370	747	F	Y	Y	4	117	0.9	-	13000	
14	30-Oct-2011	Kootenay	K01.8-L	315	462	M	Y	Y	5	-	-	-	-	
15	30-Oct-2011	Kootenay	K01.8-R	308	486	M	Y	Y	5	-	-	-	-	
16	30-Oct-2011	Kootenay	K01.8-L	413	1085	F	Y	Y	7	283.1	1.4	-	20221	
17	30-Oct-2011	Kootenay	K00.6-R	381	927	F	Y	Y	7	173.8	1.7	-	10224	
18	30-Oct-2011	Kootenay	K00.6-R	396	919	F	Y	Y	5	178	1.7	-	10471	
19	30-Oct-2011	Kootenay	K01.8-R	305	330	F	N	Y	4	31.9	1.1	-	2900	
20	30-Oct-2011	Kootenay	K00.6-R	374	923	M	Y	Y	6	-	-	-	-	
21	30-Oct-2011	Kootenay	K00.6-R	313	504	M	Y	Y	2	-	-	-	-	
22	30-Oct-2011	Kootenay	K00.6-R	376	918	M	Y	Y	5	-	-	-	-	
23	30-Oct-2011	Kootenay	K01.8-R	305	455	M	Y	Y	2	-	-	-	-	
24	30-Oct-2011	Kootenay	K01.8-L	407	990	M	Y	Y	5	-	-	-	-	
25	30-Oct-2011	Kootenay	K01.8-L	323	537	F	Y	Y	2	80.4	1.5	-	5360	
26	30-Oct-2011	Kootenay	K01.8-R	269	285	M	Y	Y	5	-	-	-	-	
27	30-Oct-2011	Kootenay	K01.8-R	299	354	M	N	N	2	-	-	-	-	immature
28	30-Oct-2011	Kootenay	K01.8-L	422	911	F	N	Y	6	159.4	1.3	-	12262	
29	1-Nov-2011	Lower	Site 11	305	389	F	N	N	2	N/A	N/A	N/A	N/A	immature, no tubercles
30	1-Nov-2011	Lower	Site 15	380	493	M	Y	Y	5	-	-	-	-	entire gut completely full of caddis
31	1-Nov-2011	Lower	Site 07	426	875	F	N	Y	9	150.3	1.3	-	11562	
32	1-Nov-2011	Lower	Site 11	265	295	F	N	N	1	N/A	N/A	N/A	N/A	immature
33	1-Nov-2011	Lower	Site 07	352	556	F	N	Y	3	67.4	1.2	4736	5617	
34	1-Nov-2011	Lower	Site 11	357	473	M	Y	Y	4	-	-	-	-	
35	3-Nov-2011	Middle	Site 03	342	646	F	N	Y	2	87	1.4	-	6214	
36	3-Nov-2011	Middle	Site 03	426	798	F	N	Y	6	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
37	3-Nov-2011	Middle	Site 03	448	719	F	N	Y	7	99.1	1.5	-	6607	
38	2-Nov-2011	Middle	Site 08	357	616	M	N	Y	4	-	-	-	-	
39	2-Nov-2011	Middle	Site 01	415	792	F	N	Y	5	N/A	N/A	N/A	N/A	ovaries completely empty, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
40	2-Nov-2011	Middle	Site 08	365	476	F	N	Y	5	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
41	3-Nov-2011	Middle	Site 03	379	529	F	N	Y	6	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
42	3-Nov-2011	Middle	Site 06	306	411	M	Y	Y	2	-	-	-	-	
43	3-Nov-2011	Middle	Site 06	375	758	M	Y	Y	5	-	-	-	-	pronounced tubercles
44	3-Nov-2011	Middle	Site 06	338	478	F	N	Y	3	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
45	3-Nov-2011	Middle	Site 06	390	655	M	Y	Y	5	-	-	-	-	possible tumor on testes

Table B1: Concluded.

Sample Number	Date Captured	LRFIP Section	LRFIP Site	Legnth (mm)	Weight (g)	Sex	Tubercles (Y or N)	Mature (Y or N)	Age (years)	Total Gonad Weight (g)	Weight of 100 eggs (g)	Total Number of Eggs (total count)	Total Number of Eggs (estimated)	Comments
46	3-Nov-2011	Middle	Site 02	411	1073	F	Y	Y	5	160.8	1.4	-	11486	
47	3-Nov-2011	Middle	Site 02	412	974	M	N	Y	6	-	-	-	-	
48	3-Nov-2011	Middle	Site 02	416	880	F	N	Y	5	162.7	1.3	-	12515	
49	3-Nov-2011	Middle	Site 02	382	850	F	N	Y	5	192.5	1.7	-	11324	
50	3-Nov-2011	Middle	Site 02	403	562	F	N	Y	5	60.2	1.4	3974	4300	
51	4-Nov-2011	Middle	Site 10	370	800	F	Y	Y	5	188.2	1.6	-	11763	
52	3-Nov-2011	Middle	Site 02	467	1000	F	N	Y	6	120.5	1.6	-	7531	
53	3-Nov-2011	Middle	Site 02	415	948	M	Y	Y	6	-	-	-	-	
54	3-Nov-2011	Middle	Site 02	456	936	F	N	Y	6	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity, 2 CC in stomach
55	3-Nov-2011	Middle	Site 02	394	1014	F	N	Y	5	239.1	1.9	-	12584	
56	3-Nov-2011	Middle	Site 02	431	1067	F	N	Y	6	193.6	1.7	-	11388	
57	3-Nov-2011	Middle	Site 02	337	468	F	N	Y	4	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
58	3-Nov-2011	Middle	Site 14	425	1139	F	Y	Y	5	315.9	1.5	-	21060	
59	3-Nov-2011	Middle	Site 14	404	966	F	N	Y	9	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, tumors on liver
60	5-Nov-2011	Upper	Site 16	390	664	F	Y	Y	5	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
61	4-Nov-2011	Upper	Site 05	292	335	M	N	N	2	-	-	-	-	immature
62	4-Nov-2011	Upper	Site 05	414	618	M	Y	Y	6	-	-	-	-	
63	4-Nov-2011	Upper	Site 05	387	736	M	Y	Y	5	-	-	-	-	tumor on gonad
64	4-Nov-2011	Upper	Site 05	370	691	M	Y	Y	4	-	-	-	-	
65	4-Nov-2011	Upper	Site 05	408	793	M	Y	Y	4	-	-	-	-	
66	4-Nov-2011	Upper	Site 05	405	877	M	Y	Y	4	-	-	-	-	
67	4-Nov-2011	Upper	Site 19	267	268	M	N	N	1	-	-	-	-	immature
68	4-Nov-2011	Upper	Site 19	313	370	F	Y	Y	2	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
69	4-Nov-2011	Upper	Site 19	377	828	M	Y	Y	5	-	-	-	-	
70	4-Nov-2011	Upper	Site 19	388	548	M	Y	Y	5	-	-	-	-	
71	4-Nov-2011	Upper	Site 12	400	1002	F	N	Y	6	210.1	2.1	-	10005	
72	4-Nov-2011	Upper	Site 05	398	942	M	Y	Y	4	-	-	-	-	
73	4-Nov-2011	Upper	Site 12	390	993	F	Y	Y	5	202	1.5	-	13467	
74	4-Nov-2011	Upper	Site 05	420	655	F	N	Y	5	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity near vent
75	4-Nov-2011	Upper	Site 12	435	1112	M	Y	Y	7	-	-	-	-	
76	4-Nov-2011	Upper	Site 12	446	1436	F	Y	Y	5	318.4	1.8	-	17689	
77	4-Nov-2011	Upper	Site 12	409	701	F	N	Y	5	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously
78	4-Nov-2011	Upper	Site 12	407	1090	M	N	Y	5	-	-	-	-	
79	4-Nov-2011	Upper	Site 12	407	754	M	Y	Y	4	-	-	-	-	
80	4-Nov-2011	Upper	Site 12	343	442	F	N	Y	3	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity near vent
81	4-Nov-2011	Upper	Site 12	425	818	F	N	Y	5	121.8	1.2	-	10150	
82	4-Nov-2011	Upper	Site 12	457	1233	F	N	Y	7	219.1	1.7	-	12888	
83	4-Nov-2011	Upper	Site 12	334	580	M	Y	Y	3	-	-	-	-	
84	5-Nov-2011	Upper	Site 17	441	839	F	Y	Y	7	N/A	N/A	N/A	N/A	ovaries very small, this fish looks to have spawned previously, and had unabsorbed eggs in body cavity
85	5-Nov-2011	Upper	Site 13	381	612	M	N	Y	5	-	-	-	-	
86	5-Nov-2011	Upper	Site 13	398	539	F	N	Y	5	32.3	1	-	3230	
87	5-Nov-2011	Upper	Site 09	287	379	F	Y	Y	2	44.9	1	-	4490	
88	5-Nov-2011	Upper	Site 17	388	687	M	Y	Y	6	-	-	-	-	
89	5-Nov-2011	Upper	Site 09	380	901	F	Y	Y	5	202.8	1.9	-	10674	
90	5-Nov-2011	Upper	Site 09	359	714	M	Y	Y	3	-	-	-	-	

APPENDIX C

Egg Collection and Developmental Staging Summaries

Table C1: Summary of Mountain Whitefish (MW) eggs collected by egg collection mats deployed in the CLBMON-48 study area, December 6, 2011 to February 9, 2012.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5 L	6-Dec-11 09:34	12-Dec-11 11:43	146.2	4.8	4.5	2.6	1.2	c/g	1	0	1	292.3	*0.08*
8.6L	6-Dec-11 09:45	12-Dec-11 12:03	146.3	4.8	4.5	2.9	dnr[d]	c/g	3	0	3	292.6	*0.25*
8.7L	6-Dec-11 09:54	12-Dec-11 12:26	146.5	4.8	4.5	2.2	dnr[d]	c/g	7	34	41	293.1	*3.36*
8.5R	6-Dec-11 09:10	12-Dec-11 10:06	144.9	4.7	4.5	3.6	dnr[d]	c/g	8	7	15	289.9	*1.24*
8.6R	6-Dec-11 09:17	12-Dec-11 10:33	145.3	4.7	4.5	3.1	dnr[d]	c/g	10	3	13	290.5	*1.07*
8.7R	6-Dec-11 09:25	12-Dec-11 11:02	145.6	4.7	4.5	2.2	dnr[d]	b/g	1	1	2	291.2	*0.16*
8.5M	6-Dec-11 11:47	12-Dec-11 08:47	141.0	4.8	4.5	8.8	dnr[d]	too deep	3	4	7	282.0	*0.60*
8.6M	6-Dec-11 11:52	12-Dec-11 08:39	140.8	4.8	4.5	7.3	dnr[d]	too deep	1	2	3	281.6	*0.26*
8.7M	6-Dec-11 11:57	12-Dec-11 08:32	140.6	4.9	4.5	6.7	dnr[d]	too deep	0	0	0	281.2	*0.00*
46.5R	8-Dec-11 08:46	13-Dec-11 13:38	124.9	3.6	4.1	3.5	1.8	b/c	0	0	0	249.7	*0.00*
46.5L	8-Dec-11 08:57	13-Dec-11 13:17	124.3	4.2	4.1	4.5	1.6	g/c	0	0	0	248.7	*0.00*
46.4L	8-Dec-11 09:12	13-Dec-11 12:55	123.7	4.4	4.1	1.7	1.0	g/b	0	3	3	247.4	*0.29*
44.25R	8-Dec-11 09:26	13-Dec-11 12:31	123.1	4.4	4.1	3.7	1.6	b/c	2	0	2	246.2	*0.19*
44.0R	8-Dec-11 09:39	13-Dec-11 11:38	122.0	4.4	4.1	1.8	0.9	c/b	0	0	0	244.0	*0.00*
43.75L	8-Dec-11 09:56	13-Dec-11 11:14	121.3	4.4	4.1	2.9	1.2	c/sand	0	1	1	242.6	*0.10*
43.0L	8-Dec-11 10:16	13-Dec-11 10:20	120.1	4.4	4.2	2.9	2.4	b/c	0	0	0	240.1	*0.00*
42.8L	8-Dec-11 10:29	13-Dec-11 09:54	119.4	4.4	4.2	5.5	0.9	c/g	0	0	0	238.8	*0.00*
40.5L	8-Dec-11 10:45	13-Dec-11 08:47	118.0	4.4	4.1	1.4	1.8	b/c	0	0	0	236.1	*0.00*
40.5R	8-Dec-11 10:56	13-Dec-11 09:17	118.4	4.4	4.1	3.4	2.5	c/b	0	1	1	236.7	*0.10*
47.0R	8-Dec-11 12:18	14-Dec-11 08:39	140.4	4.4	3.6	1.3	1.4	b/c	3	1	4	280.7	*0.34*
47.25R	8-Dec-11 12:30	14-Dec-11 09:23	140.9	4.4	4.2	2.7	1.6	b/c	0	0	0	281.8	*0.00*
47.25L	8-Dec-11 12:39	14-Dec-11 09:38	141.0	4.5	4.2	3.8	1.7	g/b	0	0	0	282.0	*0.00*
47.4L	8-Dec-11 12:48	14-Dec-11 09:58	141.2	4.4	4.2	3.7	1.8	c/b	0	0	0	282.3	*0.00*
48.0R	8-Dec-11 13:06	14-Dec-11 10:30	141.4	4.4	4.2	3.5	2.1	b/c	17	7	24	282.8	*2.04*
50.5L	8-Dec-11 13:20	14-Dec-11 11:15	141.9	4.4	4.3	1.8	1.3	b/c	0	1	1	283.8	*0.08*
50.6R	8-Dec-11 13:29	14-Dec-11 11:33	142.1	4.4	4.2	3.1	1.8	b/c	0	0	0	284.1	*0.00*
51.0R	8-Dec-11 13:40	14-Dec-11 12:07	142.5	4.4	4.2	1.7	2.2	b/c	0	0	0	284.9	*0.00*
52.0R	8-Dec-11 13:51	14-Dec-11 12:46	142.9	4.4	4.2	2.4	1.7	c/b	0	0	0	285.8	*0.00*
52.0L	8-Dec-11 14:06	14-Dec-11 12:28	142.4	4.4	4.2	0.8	2.4	c/b	0	0	0	284.7	*0.00*
47.0MR	9-Dec-11 09:40	14-Dec-11 08:59	119.3	4.3	4.2	4.6	2.7	b/c	0	4	4	238.6	*0.40*
43.75MR	9-Dec-11 10:18	13-Dec-11 10:47	96.5	4.3	4.1	3.2	1.5	c/g	0	0	0	193.0	*0.00*
44.25MR	9-Dec-11 10:48	13-Dec-11 12:11	97.4	4.3	4.1	2.3	0.6	g/c	0	0	0	194.8	*0.00*
40.5ML	9-Dec-11 11:30	13-Dec-11 09:04	93.6	4.3	4.1	2.6	2.3	b/c	0	0	0	187.1	*0.00*
49.3MR	9-Dec-11 13:36	14-Dec-11 10:57	117.4	4.3	4.2	3.5	1.7	b/c	2	11	15	234.7	*1.53*
54.0MR	9-Dec-11 14:05	14-Dec-11 13:07	119.0	4.4	4.2	1.0	2.9	b/c	0	1	1	238.1	*0.10*
54.1MR	9-Dec-11 14:30	14-Dec-11 13:28	119.0	4.2	4.0	4.7	1.8	c/g	1	2	4	237.9	*0.40*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not record due to equipment failure.

Table C1: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	12-Dec-11 09:51	19-Dec-11 08:37	166.8	4.5	4.3	8.7	1.6	too deep	0	1	1	333.5	*0.07*
8.6M	12-Dec-11 09:54	19-Dec-11 08:32	166.6	4.5	4.3	7.6	2.1	too deep	3	2	5	333.3	*0.36*
8.7M	12-Dec-11 09:57	19-Dec-11 08:26	166.5	4.5	4.3	5.8	2.4	too deep	2	5	7	333.0	*0.50*
8.5R	12-Dec-11 10:30	19-Dec-11 10:06	167.6	4.4	4.3	4.0	1.4	g/c	24	6	30	335.2	*2.15*
8.6R	12-Dec-11 10:58	19-Dec-11 10:44	167.8	4.5	4.3	2.9	1.5	g/c	0	3	3	335.5	*0.21*
8.7R	12-Dec-11 11:22	19-Dec-11 11:04	167.7	4.5	4.3	2.6	2.4	b/c	1	2	3	335.4	*0.21*
8.5L	12-Dec-11 11:58	19-Dec-11 11:29	167.5	4.5	4.3	2.1	1.2	c/g	2	0	2	335.0	*0.14*
8.6L	12-Dec-11 12:20	19-Dec-11 11:56	167.6	4.5	4.3	2.7	1.7	c/b	5	8	13	335.2	*0.93*
8.7L	12-Dec-11 12:54	19-Dec-11 12:20	167.4	4.4	4.3	2.2	2.4	b/c	20	3	23	334.9	*1.65*
40.5L	13-Dec-11 08:57	20-Dec-11 09:21	168.4	4.1	3.8	2.0	0.6	c/b	0	0	0	336.8	*0.00*
40.5ML	13-Dec-11 09:05	20-Dec-11 09:40	168.6	4.1	4.0	3.7	2.7	b/c	0	0	0	337.2	*0.00*
40.5R	13-Dec-11 09:37	20-Dec-11 09:57	168.3	4.1	4.0	2.7	1.7	g/c	0	0	0	336.7	*0.00*
42.8L	13-Dec-11 10:11	20-Dec-11 10:31	168.3	4.1	4.0	5.0	1.1	g/c	0	0	0	336.7	*0.00*
43.0L	13-Dec-11 10:35	20-Dec-11 10:47	168.2	4.1	4.0	2.7	2.6	c/b	0	0	0	336.4	*0.00*
43.75MR	13-Dec-11 10:48	20-Dec-11 11:07	168.3	4.1	4.1	3.8	0.7	c/g	0	0	0	336.6	*0.00*
43.75L	13-Dec-11 11:32	20-Dec-11 11:28	167.9	4.1	4.1	2.9	0.9	c/sand	0	1	1	335.9	*0.07*
44.25MR	13-Dec-11 12:11	20-Dec-11 11:57	167.8	4.1	4.0	7.0	2.6	too deep	1	0	1	335.5	*0.07*
44.25R	13-Dec-11 12:44	20-Dec-11 12:26	167.7	4.1	4.0	3.5	1.3	b/c	0	0	0	335.4	*0.00*
46.4L	13-Dec-11 13:09	20-Dec-11 12:49	167.7	4.1	4.0	2.6	0.8	g/sand	0	0	0	335.3	*0.00*
46.5L	13-Dec-11 13:31	20-Dec-11 13:11	167.7	4.1	4.1	1.1	1.0	b/c	0	0	0	335.3	*0.00*
46.5R	13-Dec-11 13:47	20-Dec-11 13:36	167.8	4.1	4.1	3.6	1.6	c/b	0	0	0	335.6	*0.00*
47.0R	14-Dec-11 08:53	21-Dec-11 09:06	168.2	4.0	4.0	1.7	1.9	b/c	4	0	4	336.4	*0.29*
47.0MR	14-Dec-11 09:01	21-Dec-11 09:20	168.3	4.2	4.0	6.0	2.6	too deep	0	0	0	336.6	*0.00*
47.25R	14-Dec-11 09:35	21-Dec-11 09:40	168.1	4.2	4.0	3.0	0.9	b/g	0	0	0	336.2	*0.00*
47.25L	14-Dec-11 09:54	21-Dec-11 09:58	168.1	4.2	4.0	4.5	1.9	c/b	0	0	0	336.1	*0.00*
47.4L	14-Dec-11 10:12	21-Dec-11 10:30	168.3	4.2	4.0	3.1	0.8	c/b	0	0	0	336.6	*0.00*
48.0R	14-Dec-11 10:50	21-Dec-11 10:52	168.0	4.2	4.0	4.5	2.0	too deep	20	8	28	336.1	*2.00*
49.3MR	14-Dec-11 10:59	21-Dec-11 11:24	168.4	4.2	4.0	4.2	2.2	c/b	0	2	2	336.8	*0.14*
50.5L	14-Dec-11 11:28	21-Dec-11 11:45	168.3	4.2	4.0	2.2	1.6	c/b	0	0	0	336.6	*0.00*
50.6R	14-Dec-11 12:01	21-Dec-11 12:01	168.0	4.2	4.0	3.5	2.1	b/c	0	0	0	336.0	*0.00*
51.0R	14-Dec-11 12:22	21-Dec-11 12:16	167.9	4.2	4.0	2.1	2.4	b/c	0	0	0	335.8	*0.00*
52.0R	14-Dec-11 12:58	21-Dec-11 13:01	168.0	4.2	4.0	2.9	2.2	c/b	0	0	0	336.1	*0.00*
52.0L	14-Dec-11 12:41	21-Dec-11 12:38	168.0	4.2	4.1	3.0	1.9	c/g	0	1	1	335.9	*0.07*
54.0MR	14-Dec-11 13:09	21-Dec-11 13:27	168.3	4.2	4.1	1.7	2.3	b/g	0	0	0	336.6	*0.00*
54.1MR	14-Dec-11 13:29	21-Dec-11 13:46	168.3	4.0	4.1	5.4	2.1	too deep	1	0	1	336.6	*0.07*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

Table C1: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	19-Dec-11 09:58	28-Dec-11 09:00	215.0	4.3	3.8	8.9	1.9	too deep	1	1	2	430.1	*0.11*
8.6M	19-Dec-11 10:01	28-Dec-11 08:55	214.9	4.3	3.8	7.8	2.1	too deep	0	1	1	429.8	*0.06*
8.7M	19-Dec-11 10:04	28-Dec-11 08:50	214.8	4.3	3.8	7.3	2.8	too deep	4	0	4	429.5	*0.22*
8.5R	19-Dec-11 10:40	28-Dec-11 10:45	216.1	4.3	3.8	5.5	1.3	c/g	11	6	17	432.2	*0.94*
8.6R	19-Dec-11 10:59	28-Dec-11 11:38	216.7	4.3	4.0	3.3	1.3	c/g	0	2	2	433.3	*0.11*
8.7R	19-Dec-11 11:25	28-Dec-11 12:00	216.6	4.3	4.0	1.0	2.1	b/c	3	9	12	433.2	*0.66*
8.5L	19-Dec-11 11:44	28-Dec-11 12:28	216.7	4.3	4.1	3.2	1.4	c/g	2	1	3	433.5	*0.17*
8.6L	19-Dec-11 12:13	28-Dec-11 12:52	216.7	4.3	4.0	2.5	1.7	c/b	5	5	10	433.3	*0.55*
8.7L	19-Dec-11 12:48	28-Dec-11 13:21	216.6	4.4	4.1	2.1	2.0	c/b	19	4	23	433.1	*1.27*
40.5L	20-Dec-11 09:37	29-Dec-11 08:51	215.2	4.0	3.8	dnr[d]	1.9	c/g	0	0	0	430.5	*0.00*
40.5ML	20-Dec-11 09:42	29-Dec-11 09:07	215.4	4.0	3.8	dnr[d]	2.5	b/c	0	0	0	430.8	*0.00*
40.5R	20-Dec-11 10:12	29-Dec-11 09:27	215.3	4.0	3.8	dnr[d]	1.8	c/g	0	0	0	430.5	*0.00*
42.8L	20-Dec-11 10:43	29-Dec-11 09:52	215.2	4.0	3.8	dnr[d]	1.1	c/g	0	0	0	430.3	*0.00*
43.0L	20-Dec-11 11:01	29-Dec-11 10:11	215.2	4.0	3.9	dnr[d]	2.3	c/g	0	0	0	430.3	*0.00*
43.75MR	20-Dec-11 11:12	29-Dec-11 10:39	215.4	4.0	3.9	dnr[d]	0.7	g/c	0	0	0	430.9	*0.00*
43.75L	20-Dec-11 11:51	29-Dec-11 11:05	215.2	4.1	3.8	dnr[d]	1.1	g/sand	0	1	1	430.5	*0.06*
44.25MR	20-Dec-11 12:00	29-Dec-11 11:28	215.5	4.0	3.9	dnr[d]	2.7	too deep	0	0	0	430.9	*0.00*
44.25R	20-Dec-11 12:39	29-Dec-11 11:48	215.2	4.0	3.9	dnr[d]	1.3	b/c	0	0	0	430.3	*0.00*
46.4L	20-Dec-11 13:03	29-Dec-11 12:31	215.5	4.1	3.9	dnr[d]	0.9	c/sand	0	0	0	430.9	*0.00*
46.5L	20-Dec-11 13:27	29-Dec-11 12:57	215.5	4.1	3.9	dnr[d]	1.3	c/b	0	0	0	431.0	*0.00*
46.5R	20-Dec-11 13:46	29-Dec-11 13:21	215.6	4.1	3.9	dnr[d]	1.2	b/c	0	1	1	431.2	*0.06*
47.0R	21-Dec-11 09:20	30-Dec-11 08:48	215.5	4.0	3.8	dnr[d]	1.9	b/c	2	0	2	430.9	*0.11*
47.0MR	21-Dec-11 09:25	30-Dec-11 09:05	215.7	3.9	3.9	dnr[d]	3.3	too deep	0	1	1	431.3	*0.06*
47.25R	21-Dec-11 09:53	30-Dec-11 09:24	215.5	4.0	3.9	dnr[d]	0.3	b/c	0	0	0	431.0	*0.00*
47.25L	21-Dec-11 10:09	30-Dec-11 09:40	215.5	4.0	4.0	dnr[d]	1.7	c/g	0	0	0	431.0	*0.00*
47.4L	21-Dec-11 10:44	30-Dec-11 10:20	215.6	4.0	3.9	dnr[d]	1.2	c/b	0	1	1	431.2	*0.06*
48.0R	21-Dec-11 11:20	30-Dec-11 10:40	215.3	4.0	3.9	dnr[d]	1.9	b/c	3	11	14	430.7	*0.78*
49.3MR	21-Dec-11 11:27	30-Dec-11 11:03	215.6	4.0	3.9	dnr[d]	2.2	b/c	3	0	3	431.2	*0.17*
50.5L	21-Dec-11 11:55	30-Dec-11 11:23	215.5	4.0	4.0	dnr[d]	1.6	b/c	0	0	0	430.9	*0.00*
50.6R	21-Dec-11 12:09	30-Dec-11 11:35	215.4	4.0	4.0	dnr[d]	1.9	b/c	0	0	0	430.9	*0.00*
51.0R	21-Dec-11 12:31	30-Dec-11 11:54	215.4	4.0	4.0	dnr[d]	2.0	b/c	0	0	0	430.8	*0.00*
52.0L	21-Dec-11 12:54	30-Dec-11 12:38	215.7	4.0	4.0	dnr[d]	2.0	c/b	0	0	0	431.5	*0.00*
52.0R	21-Dec-11 13:19	30-Dec-11 12:55	215.6	4.0	4.0	dnr[d]	2.1	c/g	0	0	0	431.2	*0.00*
54.0MR	21-Dec-11 13:29	30-Dec-11 13:19	215.8	4.1	4.0	dnr[d]	2.4	b/c	0	1	1	431.7	*0.06*
54.1MR	21-Dec-11 14:05	30-Dec-11 13:46	215.7	4.1	4.0	dnr[d]	2.5	too deep	2	1	3	431.4	*0.17*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not record due to equipment failure.

Table C1: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	28-Dec-11 10:30	3-Jan-12 08:21	141.8	3.9	3.8	8.9	1.8	too deep	0	1	1	283.7	*0.08*
8.6M	28-Dec-11 10:34	3-Jan-12 08:27	141.9	3.9	3.8	7.9	2.0	too deep	11	0	11	283.8	*0.93*
8.7M	28-Dec-11 10:38	3-Jan-12 08:32	141.9	3.9	3.8	6.5	2.5	too deep	2	1	3	283.8	*0.25*
8.5R	28-Dec-11 11:21	3-Jan-12 10:31	143.2	4.0	3.8	3.4	1.3	g/c	10	2	12	286.3	*1.01*
8.6R	28-Dec-11 11:54	3-Jan-12 10:58	143.1	4.0	3.7	3.5	1.5	g/c	0	2	2	286.1	*0.17*
8.7R	28-Dec-11 12:23	3-Jan-12 11:22	143.0	4.0	3.8	1.1	2.2	b/c	40	11	51	286.0	*4.28*
8.5L	28-Dec-11 12:48	3-Jan-12 11:57	143.2	4.0	3.8	2.5	1.2	c/b	2	5	7	286.3	*0.59*
8.6L	28-Dec-11 13:14	3-Jan-12 12:22	143.1	4.0	3.8	3.0	1.6	c/b	5	6	11	286.3	*0.92*
8.7L	28-Dec-11 13:48	3-Jan-12 12:47	143.0	4.0	3.8	2.4	2.1	c/b	13	6	19	286.0	*1.59*
40.5L	29-Dec-11 09:04	5-Jan-12 09:06	168.0	3.8	3.5	1.7	2.0	c/g	0	0	0	336.1	*0.00*
40.5ML	29-Dec-11 09:09	5-Jan-12 09:18	168.1	3.8	3.5	3.5	2.7	b/c	0	0	0	336.3	*0.00*
40.5R	29-Dec-11 09:43	5-Jan-12 09:35	167.9	3.8	3.5	2.8	2.3	c/b	0	0	0	335.7	*0.00*
42.8L	29-Dec-11 10:07	5-Jan-12 10:03	167.9	3.8	3.5	5.1	1.0	too deep	0	0	0	335.9	*0.00*
43.0L	29-Dec-11 10:35	5-Jan-12 10:19	167.7	3.8	3.6	2.3	2.3	c/b	0	0	0	335.5	*0.00*
43.75MR	29-Dec-11 10:42	5-Jan-12 11:19	168.6	3.8	3.6	2.6	1.0	g/sand	0	0	0	337.2	*0.00*
43.75L	29-Dec-11 11:25	5-Jan-12 10:57	167.5	3.8	3.6	3.4	1.0	g/sand	1	0	1	335.1	*0.07*
44.25MR	29-Dec-11 11:30	5-Jan-12 11:40	168.2	3.9	3.6	5.0	2.1	too deep	1	0	1	336.3	*0.07*
44.25R	29-Dec-11 12:10	5-Jan-12 12:04	167.9	3.9	3.6	3.6	1.4	c/b	0	0	0	335.8	*0.00*
46.4L	29-Dec-11 12:48	5-Jan-12 12:24	167.6	3.8	3.6	2.4	1.1	sand/g	1	0	1	335.2	*0.07*
46.5L	29-Dec-11 13:17	5-Jan-12 12:48	167.5	3.8	3.6	1.6	1.2	c/g	0	0	0	335.0	*0.00*
46.5R	29-Dec-11 13:36	5-Jan-12 13:14	167.6	3.8	3.6	4.0	1.3	b/c	1	0	1	335.3	*0.07*
47.0R	30-Dec-11 09:02	6-Jan-12 09:02	168.0	3.9	3.4	1.5	2.0	b/c	7	2	9	336.0	*0.64*
47.0MR	30-Dec-11 09:07	6-Jan-12 09:28	168.3	3.9	3.4	5.8	2.5	too deep	0	0	0	336.7	*0.00*
47.25R	30-Dec-11 09:36	6-Jan-12 09:42	168.1	3.9	3.4	2.0	0.7	b/c	0	0	0	336.2	*0.00*
47.25L	30-Dec-11 10:00	6-Jan-12 09:55	167.9	3.8	3.5	4.3	1.5	c/b	0	0	0	335.8	*0.00*
47.4L	30-Dec-11 10:35	6-Jan-12 10:12	167.6	3.9	3.5	4.1	1.6	g/c	0	0	0	335.2	*0.00*
48.0R	30-Dec-11 11:00	6-Jan-12 10:30	167.5	3.9	3.4	2.5	1.7	c/b	2	12	14	335.0	*1.00*
49.3MR	30-Dec-11 11:05	6-Jan-12 11:01	167.9	3.9	3.5	3.9	2.0	b/c	2	3	5	335.9	*0.36*
50.5L	30-Dec-11 11:33	6-Jan-12 11:12	167.7	4.1	3.6	2.3	1.6	c/b	1	0	1	335.3	*0.07*
50.6R	30-Dec-11 11:48	6-Jan-12 11:46	168.0	4.0	3.6	3.7	1.7	b/c	0	0	0	335.9	*0.00*
51.0R	30-Dec-11 12:10	6-Jan-12 12:02	167.9	3.9	3.6	4.1	2.2	b/c	0	0	0	335.7	*0.00*
52.0R	30-Dec-11 12:49	6-Jan-12 12:34	167.7	4.0	3.5	2.2	2.0	c/g	0	0	0	335.5	*0.00*
52.0L	30-Dec-11 13:12	6-Jan-12 12:52	167.7	3.9	3.5	1.9	1.8	g/c	0	1	1	335.3	*0.07*
54.0MR	30-Dec-11 13:21	6-Jan-12 13:10	167.8	4.0	3.5	1.4	2.7	b/c	1	0	1	335.6	*0.07*
54.1MR	30-Dec-11 13:48	6-Jan-12 13:30	167.7	4.0	3.5	5.5	2.1	c/b	0	0	0	335.4	*0.00*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

Table C1: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	3-Jan-12 09:15	9-Jan-12 08:08	142.9	3.8	3.5	9.3	1.7	too deep	0	1	1	285.8	*0.08*
8.6M	3-Jan-12 09:54	9-Jan-12 08:13	142.3	3.8	3.5	7.9	2.1	too deep	4	0	4	284.6	*0.34*
8.7M	3-Jan-12 09:57	9-Jan-12 08:18	142.4	3.8	3.5	7.5	3.2	too deep	1	1	2	284.7	*0.17*
8.5R	3-Jan-12 10:54	9-Jan-12 10:10	143.3	3.8	3.4	3.3	1.3	g/c	18	2	20	286.5	*1.68*
8.6R	3-Jan-12 11:18	9-Jan-12 10:34	143.3	3.8	3.4	1.6	1.3	c/g	0	5	5	286.5	*0.42*
8.7R	3-Jan-12 11:53	9-Jan-12 10:55	143.0	3.8	3.5	1.0	2.1	b/c	24	19	43	286.1	*3.61*
8.5L	3-Jan-12 12:19	9-Jan-12 11:47	143.5	3.8	3.4	1.6	1.1	c/g	0	3	3	286.9	*0.25*
8.6L	3-Jan-12 12:45	9-Jan-12 12:11	143.4	3.8	3.5	2.8	1.8	c/b	3	9	12	286.9	*1.00*
8.7L	3-Jan-12 13:13	9-Jan-12 12:41	143.5	3.8	3.5	1.6	2.0	c/b	12	11	23	286.9	*1.92*
40.5L	5-Jan-12 09:15	10-Jan-12 08:45	119.5	3.5	3.4	1.3	1.8	b/c	0	0	0	239.0	*0.00*
40.5ML	5-Jan-12 09:21	10-Jan-12 09:05	119.7	3.5	3.4	2.5	2.1	b/c	0	0	0	239.5	*0.00*
40.5R	5-Jan-12 09:52	10-Jan-12 09:29	119.6	3.5	3.3	1.7	0.8	b/c	0	0	0	239.2	*0.00*
42.8L	5-Jan-12 10:14	10-Jan-12 09:45	119.5	3.5	3.4	5.2	0.8	g/c	0	0	0	239.0	*0.00*
43.0L	5-Jan-12 10:34	10-Jan-12 09:59	119.4	3.6	3.3	1.7	2.2	b/c	0	0	0	238.8	*0.00*
43.75MR	5-Jan-12 11:22	10-Jan-12 10:16	118.9	3.6	3.4	2.0	0.6	c/b	0	0	0	237.8	*0.00*
43.75L	5-Jan-12 11:16	10-Jan-12 10:49	119.5	3.6	3.3	2.5	1.0	g/sand	0	0	0	239.1	*0.00*
44.25MR	5-Jan-12 11:42	10-Jan-12 11:06	119.4	3.6	3.3	5.8	2.1	c/b	0	0	0	238.8	*0.00*
44.25R	5-Jan-12 12:17	10-Jan-12 11:24	119.1	3.6	3.3	3.3	1.1	b/c	0	0	0	238.2	*0.00*
46.4L	5-Jan-12 12:42	10-Jan-12 11:47	119.1	3.6	3.4	2.1	0.9	g/sand	0	0	0	238.2	*0.00*
46.5L	5-Jan-12 13:11	10-Jan-12 12:19	119.1	3.6	3.3	1.3	1.1	c/b	0	0	0	238.3	*0.00*
46.5R	5-Jan-12 13:28	10-Jan-12 12:37	119.1	3.6	3.3	3.5	1.8	b/c	0	1	1	238.3	*0.10*
47.0R	6-Jan-12 09:17	10-Jan-12 12:59	99.7	3.2	3.3	1.0	1.0	b/c	0	3	3	199.4	*0.36*
47.0MR	6-Jan-12 09:26	11-Jan-12 09:03	119.6	3.5	3.1	5.3	2.7	too deep	0	0	0	239.2	*0.00*
47.25R	6-Jan-12 09:50	11-Jan-12 09:18	119.5	3.4	3.0	1.9	0.5	b/c	0	0	0	238.9	*0.00*
47.25L	6-Jan-12 10:06	11-Jan-12 09:31	119.4	3.4	3.0	4.9	0.7	g/c	0	0	0	238.8	*0.00*
47.4L	6-Jan-12 10:25	11-Jan-12 09:52	119.4	3.4	3.0	3.8	1.1	c/b	0	0	0	238.9	*0.00*
48.0R	6-Jan-12 10:57	11-Jan-12 10:08	119.2	3.5	3.0	2.5	1.5	b/c	2	3	5	238.4	*0.50*
49.3MR	6-Jan-12 11:03	11-Jan-12 10:47	119.7	3.5	3.0	4.1	2.2	c/b	0	0	0	239.5	*0.00*
50.5L	6-Jan-12 11:41	11-Jan-12 11:02	119.3	3.6	3.0	1.7	1.4	b/c	0	0	0	238.7	*0.00*
50.6R	6-Jan-12 11:59	11-Jan-12 11:20	119.3	3.5	3.0	3.1	1.8	b/c	0	0	0	238.7	*0.00*
51.0R	6-Jan-12 12:14	11-Jan-12 11:41	119.4	3.5	3.0	1.5	2.3	b/c	0	0	0	238.9	*0.00*
52.0R	6-Jan-12 12:49	11-Jan-12 12:21	119.5	3.5	3.0	1.4	1.9	c/b	0	0	0	239.1	*0.00*
52.0L	6-Jan-12 13:04	11-Jan-12 12:41	119.6	3.5	3.0	1.6	1.6	c/g	0	0	0	239.2	*0.00*
54.0MR	6-Jan-12 13:15	11-Jan-12 13:00	119.7	3.5	3.1	1.0	2.6	b/c	0	1	1	239.5	*0.10*
54.1MR	6-Jan-12 13:34	11-Jan-12 13:26	119.9	3.4	2.9	5.3	1.5	c/b	0	0	0	239.7	*0.00*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

Table C1: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	9-Jan-12 09:37	16-Jan-12 08:31	166.9	3.5	3.2	9.3	1.6	too deep	0	0	0	333.8	*0.00*
8.6M	9-Jan-12 09:41	16-Jan-12 08:26	166.8	3.5	3.2	8.5	2.1	too deep	4	0	4	333.5	*0.29*
8.7M	9-Jan-12 09:45	16-Jan-12 08:19	166.6	3.5	3.2	7.6	2.3	too deep	2	1	3	333.1	*0.22*
8.5R	9-Jan-12 10:31	16-Jan-12 10:23	167.9	3.4	3.0	3.0	1.4	c/g	6	10	16	335.7	*1.14*
8.6R	9-Jan-12 10:52	16-Jan-12 10:54	168.0	3.4	3.0	3.0	1.5	g/c	0	2	2	336.1	*0.14*
8.7R	9-Jan-12 11:27	16-Jan-12 11:21	167.9	3.4	3.0	2.2	2.1	b/c	5	4	9	335.8	*0.64*
8.5L	9-Jan-12 12:07	16-Jan-12 12:08	168.0	3.5	3.1	2.0	1.5	c/g	0	1	1	336.0	*0.07*
8.6L	9-Jan-12 12:35	16-Jan-12 12:33	168.0	3.5	3.1	2.8	1.9	c/g	3	0	3	335.9	*0.21*
8.7L	9-Jan-12 13:08	16-Jan-12 13:00	167.9	3.5	3.1	2.4	2.0	b/c	8	6	14	335.7	*1.00*
40.5L	10-Jan-12 09:01	17-Jan-12 08:47	167.8	3.3	2.8	1.4	1.6	b/c	0	0	0	335.5	*0.00*
40.5ML	10-Jan-12 09:07	17-Jan-12 09:14	168.1	3.4	2.9	2.5	2.1	b/c	1	0	1	336.2	*0.07*
40.5R	10-Jan-12 09:38	17-Jan-12 09:31	167.9	3.4	2.8	3.5	2.6	c/g	0	0	0	335.8	*0.00*
42.8L	10-Jan-12 09:55	17-Jan-12 10:01	168.1	3.4	2.8	5.3	1.2	g/c	0	0	0	336.2	*0.00*
43.0L	10-Jan-12 10:11	17-Jan-12 10:21	168.2	3.3	2.8	1.6	2.3	b/c	0	0	0	336.3	*0.00*
43.75MR	10-Jan-12 10:18	17-Jan-12 11:13	168.9	3.4	2.9	1.6	0.4	sand/c	0	0	0	337.8	*0.00*
43.75L	10-Jan-12 11:00	17-Jan-12 10:44	167.7	3.3	2.8	2.5	0.9	sand/g	0	0	0	335.5	*0.00*
44.25MR	10-Jan-12 11:08	17-Jan-12 11:37	168.5	3.3	2.9	5.3	2.0	b/c	0	0	0	337.0	*0.00*
44.25R	10-Jan-12 11:37	17-Jan-12 11:54	168.3	3.3	2.9	2.5	1.6	b/c	0	0	0	336.6	*0.00*
46.4L	10-Jan-12 11:59	17-Jan-12 12:15	168.3	3.3	2.9	2.0	0.9	sand/g	0	0	0	336.5	*0.00*
46.5L	10-Jan-12 12:31	17-Jan-12 12:35	168.1	3.3	2.9	1.6	1.5	c/g	0	0	0	336.1	*0.00*
46.5R	10-Jan-12 12:52	17-Jan-12 12:53	168.0	3.4	2.9	3.6	2.0	b/c	0	1	1	336.0	*0.07*
47.0R	10-Jan-12 13:22	19-Jan-12 08:47	211.4	3.4	2.3	1.0	1.1	b/c	0	0	0	422.8	*0.00*
47.0MR	11-Jan-12 09:04	19-Jan-12 09:01	192.0	3.1	2.4	5.5	3.1	too deep	0	0	0	383.9	*0.00*
47.25R	11-Jan-12 09:28	19-Jan-12 09:17	191.8	2.9	2.4	1.8	0.7	b/c	0	0	0	383.6	*0.00*
47.25L	11-Jan-12 09:48	19-Jan-12 09:35	191.8	2.9	2.4	5.1	0.6	c/g	0	0	0	383.6	*0.00*
47.4L	11-Jan-12 10:03	19-Jan-12 09:49	191.8	3.0	2.5	3.7	1.5	b/c	0	0	0	383.5	*0.00*
48.0R	11-Jan-12 10:44	19-Jan-12 10:16	191.5	2.9	2.4	2.9	1.8	b/c	3	1	4	383.1	*0.25*
49.3MR	11-Jan-12 10:50	19-Jan-12 10:34	191.7	3.0	2.4	4.1	2.2	c/b	0	0	0	383.5	*0.00*
50.5L	11-Jan-12 11:17	19-Jan-12 10:52	191.6	3.0	2.4	1.8	1.1	b/c	0	0	0	383.2	*0.00*
50.6R	11-Jan-12 11:36	19-Jan-12 11:11	191.6	3.0	2.4	3.3	1.8	b/c	0	0	0	383.2	*0.00*
51.0R	11-Jan-12 11:56	19-Jan-12 11:48	191.9	3.0	2.4	1.5	2.2	b/c	0	0	0	383.7	*0.00*
52.0R	11-Jan-12 12:37	19-Jan-12 12:09	191.5	3.1	2.4	1.5	1.8	c/b	0	0	0	383.1	*0.00*
52.0L	11-Jan-12 12:54	19-Jan-12 12:29	191.6	3.0	2.4	2.0	1.9	c/b	0	0	0	383.2	*0.00*
54.0MR	11-Jan-12 13:02	19-Jan-12 12:52	191.8	3.1	2.4	0.7	3.0	b/c	0	0	0	383.7	*0.00*
54.1MR	11-Jan-12 13:44	19-Jan-12 13:11	191.4	2.8	2.3	4.6	1.9	c/b	0	0	0	382.9	*0.00*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

Table C1: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	16-Jan-12 09:55	24-Jan-12 08:58	191.1	3.2	2.8	10.2	1.5	too deep	0	2	2	382.1	*0.13*
8.6M	16-Jan-12 10:01	24-Jan-12 08:52	190.8	3.2	2.8	8.4	2.3	too deep	0	0	0	381.7	*0.00*
8.7M	16-Jan-12 10:06	24-Jan-12 08:47	190.7	3.2	2.8	7.2	2.9	too deep	0	0	0	381.4	*0.00*
8.5R	16-Jan-12 10:48	24-Jan-12 10:41	191.9	2.9	2.8	4.0	1.7	c/g	5	10	15	383.8	*0.94*
8.6R	16-Jan-12 11:16	24-Jan-12 11:07	191.8	3.0	2.8	1.0	1.5	b/c	0	4	4	383.7	*0.25*
8.7R	16-Jan-12 11:43	24-Jan-12 11:27	191.7	3.0	2.8	1.4	2.5	b/c	2	1	3	383.5	*0.19*
8.5L	16-Jan-12 12:27	24-Jan-12 11:49	191.4	3.1	3.1	3.4	1.3	c/g	2	1	3	382.7	*0.19*
8.6L	16-Jan-12 12:56	24-Jan-12 12:25	191.5	3.1	2.8	3.2	1.8	c/b	2	1	3	383.0	*0.19*
8.7L	16-Jan-12 13:29	24-Jan-12 12:48	191.3	3.1	2.8	2.0	1.7	c/b	7	5	12	382.6	*0.75*
40.5L	17-Jan-12 09:12	25-Jan-12 09:13	192.0	2.8	2.5	1.8	2.0	b/c	0	0	0	384.0	*0.00*
40.5ML	17-Jan-12 09:16	25-Jan-12 09:31	192.2	2.8	2.5	3.1	2.5	b/c	0	0	0	384.5	*0.00*
40.5R	17-Jan-12 09:46	25-Jan-12 09:47	192.0	2.8	2.5	2.2	1.4	c/b	0	0	0	384.0	*0.00*
42.8L	17-Jan-12 10:16	25-Jan-12 10:11	191.9	2.8	2.6	6.5	1.2	c/g	0	0	0	383.8	*0.00*
43.0L	17-Jan-12 10:37	25-Jan-12 11:00	192.4	2.8	2.6	1.9	2.4	b/c	0	0	0	384.8	*0.00*
43.75MR	17-Jan-12 11:15	25-Jan-12 11:28	192.2	2.8	2.6	2.0	0.5	sand/g	0	0	0	384.4	*0.00*
43.75L	17-Jan-12 11:10	25-Jan-12 11:53	192.7	2.8	2.6	2.7	1.0	sand/g	0	0	0	385.4	*0.00*
44.25MR	17-Jan-12 11:38	25-Jan-12 12:17	192.7	2.9	2.6	4.3	2.4	b/c	0	0	0	385.3	*0.00*
44.25R	17-Jan-12 12:07	25-Jan-12 12:58	192.8	2.8	2.7	3.5	0.9	b/c	0	0	0	385.7	*0.00*
46.4L	17-Jan-12 12:30	25-Jan-12 13:25	192.9	2.8	2.7	2.3	0.9	g/sand	0	0	0	385.8	*0.00*
46.5L	17-Jan-12 12:49	25-Jan-12 13:43	192.9	2.9	2.7	1.9	1.6	c/g	0	0	0	385.8	*0.00*
46.5R	17-Jan-12 13:07	25-Jan-12 14:07	193.0	2.9	2.7	3.5	1.3	b/c	0	0	0	386.0	*0.00*
47.0R	19-Jan-12 08:56	26-Jan-12 09:42	168.8	2.3	2.7	1.1	0.7	b/c	0	0	0	337.5	*0.00*
47.0MR	19-Jan-12 09:04	26-Jan-12 09:56	168.9	2.4	2.7	5.5	1.4	too deep	0	0	0	337.7	*0.00*
47.25R	19-Jan-12 09:30	26-Jan-12 10:12	168.7	2.4	2.6	1.6	0.2	b/c	0	0	0	337.4	*0.00*
47.25L	19-Jan-12 09:46	26-Jan-12 10:43	168.9	2.4	2.7	4.2	1.1	c/g	0	0	0	337.9	*0.00*
47.4L	19-Jan-12 10:03	26-Jan-12 11:03	169.0	2.5	2.7	3.2	0.3	b/c	0	0	0	338.0	*0.00*
48.0R	19-Jan-12 10:30	26-Jan-12 11:21	168.8	2.4	2.7	3.4	1.0	b/c	2	0	2	337.7	*0.14*
49.3MR	19-Jan-12 10:36	26-Jan-12 11:43	169.1	2.4	2.7	4.2	1.1	b/c	0	0	0	338.2	*0.00*
50.5L	19-Jan-12 11:04	26-Jan-12 12:18	169.2	2.4	2.8	1.1	0.8	b/c	0	0	0	338.5	*0.00*
50.6R	19-Jan-12 11:27	26-Jan-12 12:36	169.2	2.4	2.8	3.4	1.7	b/c	0	0	0	338.3	*0.00*
51.0R	19-Jan-12 12:03	26-Jan-12 13:00	168.9	2.4	2.7	1.8	2.3	c/b	0	0	0	337.9	*0.00*
52.0R	19-Jan-12 12:25	26-Jan-12 13:18	168.9	2.5	2.8	1.9	1.8	c/g	0	0	0	337.8	*0.00*
52.0L	19-Jan-12 12:43	26-Jan-12 13:30	168.8	2.4	2.8	2.8	1.9	c/g	0	0	0	337.6	*0.00*
54.0MR	19-Jan-12 12:55	26-Jan-12 14:00	169.1	2.4	2.8	1.7	2.2	b/c	0	0	0	338.2	*0.00*
54.1MR	19-Jan-12 13:14	26-Jan-12 14:29	169.3	2.3	2.6	6.1	1.9	too deep	0	0	0	338.5	*0.00*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

Table C1: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	24-Jan-12 10:28	1-Feb-12 08:44	190.3	2.8	2.9	8.9	1.7	too deep	4	1	5	380.5	*0.32*
8.6M	24-Jan-12 10:33	1-Feb-12 08:37	190.1	2.8	2.9	7.8	2.2	too deep	1	0	1	380.1	*0.06*
8.7M	24-Jan-12 10:37	1-Feb-12 08:30	189.9	2.8	2.9	7.1	2.6	too deep	0	0	0	379.8	*0.00*
8.5R	24-Jan-12 11:04	1-Feb-12 10:15	191.2	2.8	2.8	4.8	1.6	c/g	39	5	44	382.4	*2.76*
8.6R	24-Jan-12 11:24	1-Feb-12 10:59	191.6	2.8	2.8	2.9	1.5	c/g	7	4	11	383.2	*0.69*
8.7R	24-Jan-12 11:45	1-Feb-12 11:35	191.8	3.0	2.8	1.0	2.6	b/c	3	6	9	383.7	*0.56*
8.5L	24-Jan-12 12:11	1-Feb-12 12:01	191.8	2.8	2.9	1.7	1.1	c/b	4	2	6	383.7	*0.38*
8.6L	24-Jan-12 12:41	1-Feb-12 12:28	191.8	2.8	2.9	3.0	1.9	c/g	3	3	6	383.6	*0.38*
8.7L	24-Jan-12 13:04	1-Feb-12 12:49	191.8	2.8	2.9	1.4	1.9	b/c	6	1	7	383.5	*0.44*
40.5L	25-Jan-12 09:27	2-Feb-12 09:09	191.7	2.5	2.7	1.4	1.3	c/g	0	0	0	383.4	*0.00*
40.5ML	25-Jan-12 09:34	2-Feb-12 09:32	192.0	2.5	2.7	2.4	2.1	b/c	0	0	0	383.9	*0.00*
40.5R	25-Jan-12 09:59	2-Feb-12 09:49	191.8	2.5	2.7	3.1	2.4	c/g	0	0	0	383.7	*0.00*
42.8L	25-Jan-12 10:25	2-Feb-12 10:09	191.7	2.6	2.8	4.3	0.9	g/c	0	0	0	383.5	*0.00*
43.0L	25-Jan-12 11:23	2-Feb-12 10:57	191.6	2.6	2.8	1.5	2.5	b/c	1	0	1	383.1	*0.06*
43.75MR	25-Jan-12 11:30	2-Feb-12 11:51	192.4	2.6	2.8	2.0	0.5	sand/g	0	0	0	384.7	*0.00*
43.75L	25-Jan-12 12:13	2-Feb-12 11:26	191.2	2.6	2.8	2.2	0.5	sand/g	0	0	0	382.4	*0.00*
44.25MR	25-Jan-12 12:19	2-Feb-12 12:11	191.9	2.6	2.8	5.9	1.0	too deep	0	0	0	383.7	*0.00*
44.25R	25-Jan-12 13:11	2-Feb-12 12:32	191.3	2.7	2.8	3.4	0.6	b/c	0	0	0	382.7	*0.00*
46.4L	25-Jan-12 13:38	2-Feb-12 12:53	191.3	2.7	2.8	1.9	0.8	sand/g	0	0	0	382.5	*0.00*
46.5L	25-Jan-12 14:01	2-Feb-12 13:11	191.2	2.7	2.9	2.6	1.5	c/g	0	0	0	382.3	*0.00*
46.5R	25-Jan-12 14:20	2-Feb-12 13:35	191.3	2.7	2.8	3.7	1.7	b/c	0	0	0	382.5	*0.00*
47.0R	26-Jan-12 09:53	3-Feb-12 09:29	191.6	2.7	2.8	0.9	1.0	b/c	0	0	0	383.2	*0.00*
47.0MR	26-Jan-12 09:58	3-Feb-12 10:00	192.0	2.7	2.7	5.1	3.0	too deep	0	0	0	384.1	*0.00*
47.25R	26-Jan-12 10:37	3-Feb-12 10:27	191.8	2.7	2.8	2.4	0.9	b/c	0	0	0	383.7	*0.00*
47.25L	26-Jan-12 10:57	3-Feb-12 10:45	191.8	2.7	2.8	4.2	0.8	c/b	0	0	0	383.6	*0.00*
47.4L	26-Jan-12 11:16	3-Feb-12 10:58	191.7	2.7	2.8	2.9	1.2	b/c	0	0	0	383.4	*0.00*
48.0R	26-Jan-12 11:40	3-Feb-12 11:15	191.6	2.7	2.9	3.1	1.5	b/c	0	0	0	383.2	*0.00*
49.3MR	26-Jan-12 11:45	9-Feb-12 11:07	335.4	2.7	2.7	3.8	1.8	b/c	0	0	0	670.7	*0.00*
50.5L	26-Jan-12 12:32	3-Feb-12 11:40	191.1	2.8	3.0	1.8	1.4	b/c	0	0	0	382.3	*0.00*
50.6R	26-Jan-12 12:54	9-Feb-12 11:59	335.1	2.7	2.7	3.0	2.1	b/c	0	0	0	670.2	*0.00*
51.0R	26-Jan-12 13:13	9-Feb-12 12:14	335.0	2.7	2.7	1.5	2.2	b/c	0	0	0	670.0	*0.00*
52.0R	26-Jan-12 13:31	9-Feb-12 14:19	336.8	2.8	2.7	1.5	1.9	c/b	0	0	0	673.6	*0.00*
52.0L	26-Jan-12 13:54	9-Feb-12 14:02	336.1	2.8	2.7	2.3	1.8	b/c	0	0	0	672.3	*0.00*
54.0MR	26-Jan-12 14:02	9-Feb-12 13:12	335.2	2.8	2.7	1.4	2.4	b/c	0	0	0	670.3	*0.00*
54.1MR	26-Jan-12 14:31	9-Feb-12 13:31	335.0	2.6	2.8	5.7	1.6	too deep	0	0	0	670.0	*0.00*

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

Table C1: Concluded.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5M	1-Feb-12 10:03	7-Feb-12 10:13	144.2	2.9	2.8	8.7	1.8	too deep	1	1	2	288.3	*0.17*
8.6M	1-Feb-12 10:06	7-Feb-12 10:08	144.0	2.9	2.8	6.7	2.3	too deep	1	1	2	288.1	*0.17*
8.7M	1-Feb-12 10:10	7-Feb-12 10:00	143.8	2.9	2.8	5.5	2.4	too deep	0	1	1	287.7	*0.08*
8.5R	1-Feb-12 10:55	7-Feb-12 12:00	145.1	2.9	2.8	2.5	1.4	c/b	2	2	4	290.2	*0.33*
8.6R	1-Feb-12 11:20	7-Feb-12 12:38	145.3	2.9	2.8	2.8	1.6	c/g	1	0	1	290.6	*0.08*
8.7R	1-Feb-12 11:57	7-Feb-12 12:59	145.0	2.9	2.9	1.0	2.6	b/c	1	0	1	290.1	*0.08*
8.5L	1-Feb-12 12:24	7-Feb-12 13:42	145.3	2.9	2.8	1.8	1.3	c/g	1	0	1	290.6	*0.08*
8.6L	1-Feb-12 12:44	7-Feb-12 13:37	144.9	2.9	2.8	1.9	1.6	c/g	0	0	0	289.8	*0.00*
8.7L	1-Feb-12 13:18	7-Feb-12 13:17	144.0	2.9	2.7	1.6	1.9	c/b	0	1	1	288.0	*0.08*
40.5L	2-Feb-12 09:25	8-Feb-12 09:45	144.3	2.7	2.6	0.8	1.0	b/c	0	0	0	288.7	*0.00*
40.5ML	2-Feb-12 09:33	8-Feb-12 09:25	143.9	2.7	2.6	2.1	2.3	b/c	0	0	0	287.7	*0.00*
40.5R	2-Feb-12 10:02	8-Feb-12 09:10	143.1	2.7	2.6	2.5	1.7	c/b	0	0	0	286.3	*0.00*
42.8L	2-Feb-12 10:49	8-Feb-12 10:21	143.5	2.8	2.6	4.1	0.7	c/g	0	0	0	287.1	*0.00*
43.0L	2-Feb-12 11:20	8-Feb-12 10:41	143.4	2.8	2.7	2.3	2.3	b/c	0	0	0	286.7	*0.00*
43.75MR	2-Feb-12 11:51	8-Feb-12 12:26	144.6	2.8	2.7	1.4	0.4	g/sand	0	0	0	289.2	*0.00*
43.75L	2-Feb-12 11:44	8-Feb-12 12:07	144.4	2.8	2.7	2.2	1.0	c/b	0	0	0	288.8	*0.00*
44.25MR	2-Feb-12 12:12	8-Feb-12 11:30	143.3	2.8	2.7	4.7	1.6	c/b	0	0	0	286.6	*0.00*
44.25R	2-Feb-12 12:45	8-Feb-12 11:10	142.4	2.8	2.7	2.3	1.8	b/c	0	0	0	284.8	*0.00*
46.4L	2-Feb-12 13:04	8-Feb-12 12:59	143.9	2.8	2.7	1.5	0.7	c/sand	0	0	0	287.8	*0.00*
46.5L	2-Feb-12 13:27	8-Feb-12 13:19	143.9	2.8	2.6	1.6	1.0	b/c	0	0	0	287.7	*0.00*
46.5R	2-Feb-12 14:04	8-Feb-12 13:39	143.6	2.8	2.6	2.7	1.6	b/c	0	0	0	287.2	*0.00*
47.0R	3-Feb-12 09:41	9-Feb-12 09:16	143.6	2.8	2.6	1.0	dnr[d]	dnr[d]	0	0	0	287.2	*0.00*
47.0MR	3-Feb-12 10:01	9-Feb-12 09:28	143.4	2.7	2.7	4.7	dnr[d]	dnr[d]	0	0	0	286.9	*0.00*
47.25R	3-Feb-12 10:41	9-Feb-12 09:46	143.1	2.8	2.6	1.8	dnr[d]	dnr[d]	0	0	0	286.2	*0.00*
47.25L	3-Feb-12 10:55	9-Feb-12 10:21	143.4	2.8	2.6	3.9	dnr[d]	dnr[d]	0	0	0	286.9	*0.00*
47.4L	3-Feb-12 11:09	9-Feb-12 10:39	143.5	2.8	2.6	2.6	dnr[d]	dnr[d]	0	0	0	287.0	*0.00*
48.0R	3-Feb-12 11:28	9-Feb-12 10:53	143.4	2.8	2.7	2.2	dnr[d]	dnr[d]	0	0	0	286.8	*0.00*
50.5L	3-Feb-12 12:16	9-Feb-12 11:23	143.1	2.9	2.7	1.5	dnr[d]	dnr[d]	0	0	0	286.2	*0.00*
Totals			**52500.8**						**488**	**360**	**851**	**105001.6**	***0.19***

[a] See Figures 2 and 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not record due to equipment failure.

Table C2: Summary of Mountain Whitefish (MW) eggs collected by egg collection mats at individual sample stations at CPR Island spawning area, December 6, 2011 to February 7, 2012.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.5L	6-Dec-11 09:34	12-Dec-11 11:43	146.2	4.8	4.5	2.6	1.2	c/g	1	0	1	292.3	*0.08*
8.5L	12-Dec-11 11:58	19-Dec-11 11:29	167.5	4.5	4.3	2.1	1.2	c/g	2	0	2	335.0	*0.14*
8.5L	19-Dec-11 11:44	28-Dec-11 12:28	216.7	4.3	4.1	3.2	1.4	c/g	2	1	3	433.5	*0.17*
8.5L	28-Dec-11 12:48	3-Jan-12 11:57	143.2	4.0	3.8	2.5	1.2	c/b	2	5	7	286.3	*0.59*
8.5L	3-Jan-12 12:19	9-Jan-12 11:47	143.5	3.8	3.4	1.6	1.1	c/g	0	3	3	286.9	*0.25*
8.5L	9-Jan-12 12:07	16-Jan-12 12:08	168.0	3.5	3.1	2.0	1.5	c/g	0	1	1	336.0	*0.07*
8.5L	16-Jan-12 12:27	24-Jan-12 11:49	191.4	3.1	3.1	3.4	1.3	c/g	2	1	3	382.7	*0.19*
8.5L	24-Jan-12 12:11	1-Feb-12 12:01	191.8	2.8	2.9	1.7	1.1	c/b	4	2	6	383.7	*0.38*
8.5L	1-Feb-12 12:24	7-Feb-12 13:42	145.3	2.9	2.8	1.8	1.3	c/g	1	0	1	290.6	*0.08*
8.5L Totals			**1,513.5**						**14**	**13**	**27**	**3,027.1**	***0.21***
8.5M	6-Dec-11 11:47	12-Dec-11 08:47	141.0	4.8	4.5	8.8	dnr[d]	too deep	3	4	7	282.0	*0.60*
8.5M	12-Dec-11 09:51	19-Dec-11 08:37	166.8	4.5	4.3	8.7	1.6	too deep	0	1	1	333.5	*0.07*
8.5M	19-Dec-11 09:58	28-Dec-11 09:00	215.0	4.3	3.8	8.9	1.9	too deep	1	1	2	430.1	*0.11*
8.5M	28-Dec-11 10:30	3-Jan-12 08:21	141.8	3.9	3.8	8.9	1.8	too deep	0	1	1	283.7	*0.08*
8.5M	3-Jan-12 09:15	9-Jan-12 08:08	142.9	3.8	3.5	9.3	1.7	too deep	0	1	1	285.8	*0.08*
8.5M	9-Jan-12 09:37	16-Jan-12 08:31	166.9	3.5	3.2	9.3	1.6	too deep	0	0	0	333.8	*0.00*
8.5M	16-Jan-12 09:55	24-Jan-12 08:58	191.1	3.2	2.8	10.2	1.5	too deep	0	2	2	382.1	*0.13*
8.5M	24-Jan-12 10:28	1-Feb-12 08:44	190.3	2.8	2.9	8.9	1.7	too deep	4	1	5	380.5	*0.32*
8.5M	1-Feb-12 10:03	7-Feb-12 10:13	144.2	2.9	2.8	8.7	1.8	too deep	1	1	2	288.3	*0.17*
8.5M Totals			**1,499.9**						**9**	**12**	**21**	**2,999.8**	***0.17***
8.5R	6-Dec-11 09:10	12-Dec-11 10:06	144.9	4.7	4.5	3.6	dnr[d]	c/g	8	7	15	289.9	*1.24*
8.5R	12-Dec-11 10:30	19-Dec-11 10:06	167.6	4.4	4.3	4.0	1.4	g/c	24	6	30	335.2	*2.15*
8.5R	19-Dec-11 10:40	28-Dec-11 10:45	216.1	4.3	3.8	5.5	1.3	c/g	11	6	17	432.2	*0.94*
8.5R	28-Dec-11 11:21	3-Jan-12 10:31	143.2	4.0	3.8	3.4	1.3	g/c	10	2	12	286.3	*1.01*
8.5R	3-Jan-12 10:54	9-Jan-12 10:10	143.3	3.8	3.4	3.3	1.3	g/c	18	2	20	286.5	*1.68*
8.5R	9-Jan-12 10:31	16-Jan-12 10:23	167.9	3.4	3.0	3.0	1.4	c/g	6	10	16	335.7	*1.14*
8.5R	16-Jan-12 10:48	24-Jan-12 10:41	191.9	2.9	2.8	4.0	1.7	c/g	5	10	15	383.8	*0.94*
8.5R	24-Jan-12 11:04	1-Feb-12 10:15	191.2	2.8	2.8	4.8	1.6	c/g	39	5	44	382.4	*2.76*
8.5R	1-Feb-12 10:55	7-Feb-12 12:00	145.1	2.9	2.8	2.5	1.4	c/b	2	2	4	290.2	*0.33*
8.5R Totals			**1,511.1**						**123**	**50**	**173**	**3,022.1**	***1.37***

[a] See Figure 2 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure.

Table C2: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.6L	6-Dec-11 09:45	12-Dec-11 12:03	146.3	4.8	4.5	2.9	dnr[d]	c/g	3	0	3	292.6	*0.25*
8.6L	12-Dec-11 12:20	19-Dec-11 11:56	167.6	4.5	4.3	2.7	1.7	c/b	5	8	13	335.2	*0.93*
8.6L	19-Dec-11 12:13	28-Dec-11 12:52	216.7	4.3	4.0	2.5	1.7	c/b	5	5	10	433.3	*0.55*
8.6L	28-Dec-11 13:14	3-Jan-12 12:22	143.1	4.0	3.8	3.0	1.6	c/b	5	6	11	286.3	*0.92*
8.6L	3-Jan-12 12:45	9-Jan-12 12:11	143.4	3.8	3.5	2.8	1.8	c/b	3	9	12	286.9	*1.00*
8.6L	9-Jan-12 12:35	16-Jan-12 12:33	168.0	3.5	3.1	2.8	1.9	c/g	3	0	3	335.9	*0.21*
8.6L	16-Jan-12 12:56	24-Jan-12 12:25	191.5	3.1	2.8	3.2	1.8	c/b	2	1	3	383.0	*0.19*
8.6L	24-Jan-12 12:41	1-Feb-12 12:28	191.8	2.8	2.9	3.0	1.9	c/g	3	3	6	383.6	*0.38*
8.6L	1-Feb-12 12:44	7-Feb-12 13:37	144.9	2.9	2.8	1.9	1.6	c/g	0	0	0	289.8	*0.00*
8.6L Totals			**1,513.2**						**29**	**32**	**61**	**3,026.5**	***0.48***
8.6M	6-Dec-11 11:52	12-Dec-11 08:39	140.8	4.8	4.5	7.3	dnr[d]	too deep	1	2	3	281.6	*0.26*
8.6M	12-Dec-11 09:54	19-Dec-11 08:32	166.6	4.5	4.3	7.6	2.1	too deep	3	2	5	333.3	*0.36*
8.6M	19-Dec-11 10:01	28-Dec-11 08:55	214.9	4.3	3.8	7.8	2.1	too deep	0	1	1	429.8	*0.06*
8.6M	28-Dec-11 10:34	3-Jan-12 08:27	141.9	3.9	3.8	7.9	2.0	too deep	11	0	11	283.8	*0.93*
8.6M	3-Jan-12 09:54	9-Jan-12 08:13	142.3	3.8	3.5	7.9	2.1	too deep	4	0	4	284.6	*0.34*
8.6M	9-Jan-12 09:41	16-Jan-12 08:26	166.8	3.5	3.2	8.5	2.1	too deep	4	0	4	333.5	*0.29*
8.6M	16-Jan-12 10:01	24-Jan-12 08:52	190.8	3.2	2.8	8.4	2.3	too deep	0	0	0	381.7	*0.00*
8.6M	24-Jan-12 10:33	1-Feb-12 08:37	190.1	2.8	2.9	7.8	2.2	too deep	1	0	1	380.1	*0.06*
8.6M	1-Feb-12 10:06	7-Feb-12 10:08	144.0	2.9	2.8	6.7	2.3	too deep	1	1	2	288.1	*0.17*
8.6M Totals			**1,498.2**						**25**	**6**	**31**	**2,996.4**	***0.25***
8.6R	6-Dec-11 09:17	12-Dec-11 10:33	145.3	4.7	4.5	3.1	dnr[d]	c/g	10	3	13	290.5	*1.07*
8.6R	12-Dec-11 10:58	19-Dec-11 10:44	167.8	4.5	4.3	2.9	1.5	g/c	0	3	3	335.5	*0.21*
8.6R	19-Dec-11 10:59	28-Dec-11 11:38	216.7	4.3	4.0	3.3	1.3	c/g	0	2	2	433.3	*0.11*
8.6R	28-Dec-11 11:54	3-Jan-12 10:58	143.1	4.0	3.7	3.5	1.5	g/c	0	2	2	286.1	*0.17*
8.6R	3-Jan-12 11:18	9-Jan-12 10:34	143.3	3.8	3.4	1.6	1.3	c/g	0	5	5	286.5	*0.42*
8.6R	9-Jan-12 10:52	16-Jan-12 10:54	168.0	3.4	3.0	3.0	1.5	g/c	0	2	2	336.1	*0.14*
8.6R	16-Jan-12 11:16	24-Jan-12 11:07	191.8	3.0	2.8	1.0	1.5	b/c	0	4	4	383.7	*0.25*
8.6R	24-Jan-12 11:24	1-Feb-12 10:59	191.6	2.8	2.8	2.9	1.5	c/g	7	4	11	383.2	*0.69*
8.6R	1-Feb-12 11:20	7-Feb-12 12:38	145.3	2.9	2.8	2.8	1.6	c/g	1	0	1	290.6	*0.08*
8.6R Totals			**1,512.8**						**18**	**25**	**43**	**3,025.6**	***0.34***

[a] See Figure 2 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure.

Table C2: Concluded.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
8.7L	6-Dec-11 09:54	12-Dec-11 12:26	146.5	4.8	4.5	2.2	dnr[d]	c/g	7	34	41	293.1	*3.36*
8.7L	12-Dec-11 12:54	19-Dec-11 12:20	167.4	4.4	4.3	2.2	2.4	b/c	20	3	23	334.9	*1.65*
8.7L	19-Dec-11 12:48	28-Dec-11 13:21	216.6	4.4	4.1	2.1	2.0	c/b	19	4	23	433.1	*1.27*
8.7L	28-Dec-11 13:48	3-Jan-12 12:47	143.0	4.0	3.8	2.4	2.1	c/b	13	6	19	286.0	*1.59*
8.7L	3-Jan-12 13:13	9-Jan-12 12:41	143.5	3.8	3.5	1.6	2.0	c/b	12	11	23	286.9	*1.92*
8.7L	9-Jan-12 13:08	16-Jan-12 13:00	167.9	3.5	3.1	2.4	2.0	b/c	8	6	14	335.7	*1.00*
8.7L	16-Jan-12 13:29	24-Jan-12 12:48	191.3	3.1	2.8	2.0	1.7	c/b	7	5	12	382.6	*0.75*
8.7L	24-Jan-12 13:04	1-Feb-12 12:49	191.8	2.8	2.9	1.4	1.9	b/c	6	1	7	383.5	*0.44*
8.7L	1-Feb-12 13:18	7-Feb-12 13:17	144.0	2.9	2.7	1.6	1.9	c/b	0	1	1	288.0	*0.08*
8.7L Totals			**1,511.9**						**92**	**71**	**163**	**3,023.8**	***1.29***
8.7M	6-Dec-11 11:57	12-Dec-11 08:32	140.6	4.9	4.5	6.7	dnr[d]	too deep	0	0	0	281.2	*0.00*
8.7M	12-Dec-11 09:57	19-Dec-11 08:26	166.5	4.5	4.3	5.8	2.4	too deep	2	5	7	333.0	*0.50*
8.7M	19-Dec-11 10:04	28-Dec-11 08:50	214.8	4.3	3.8	7.3	2.8	too deep	4	0	4	429.5	*0.22*
8.7M	28-Dec-11 10:38	3-Jan-12 08:32	141.9	3.9	3.8	6.5	2.5	too deep	2	1	3	283.8	*0.25*
8.7M	3-Jan-12 09:57	9-Jan-12 08:18	142.4	3.8	3.5	7.5	3.2	too deep	1	1	2	284.7	*0.17*
8.7M	9-Jan-12 09:45	16-Jan-12 08:19	166.6	3.5	3.2	7.6	2.3	too deep	2	1	3	333.1	*0.22*
8.7M	16-Jan-12 10:06	24-Jan-12 08:47	190.7	3.2	2.8	7.2	2.9	too deep	0	0	0	381.4	*0.00*
8.7M	24-Jan-12 10:37	1-Feb-12 08:30	189.9	2.8	2.9	7.1	2.6	too deep	0	0	0	379.8	*0.00*
8.7M	1-Feb-12 10:10	7-Feb-12 10:00	143.8	2.9	2.8	5.5	2.4	too deep	0	1	1	287.7	*0.08*
8.7M Totals			**1,497.1**						**11**	**9**	**20**	**2,994.1**	***0.16***
8.7R	6-Dec-11 09:25	12-Dec-11 11:02	145.6	4.7	4.5	2.2	dnr[d]	b/g	1	1	2	291.2	*0.16*
8.7R	12-Dec-11 11:22	19-Dec-11 11:04	167.7	4.5	4.3	2.6	2.4	b/c	1	2	3	335.4	*0.21*
8.7R	19-Dec-11 11:25	28-Dec-11 12:00	216.6	4.3	4.0	1.0	2.1	b/c	3	9	12	433.2	*0.66*
8.7R	28-Dec-11 12:23	3-Jan-12 11:22	143.0	4.0	3.8	1.1	2.2	b/c	40	11	51	286.0	*4.28*
8.7R	3-Jan-12 11:53	9-Jan-12 10:55	143.0	3.8	3.5	1.0	2.1	b/c	24	19	43	286.1	*3.61*
8.7R	9-Jan-12 11:27	16-Jan-12 11:21	167.9	3.4	3.0	2.2	2.1	b/c	5	4	9	335.8	*0.64*
8.7R	16-Jan-12 11:43	24-Jan-12 11:27	191.7	3.0	2.8	1.4	2.5	b/c	2	1	3	383.5	*0.19*
8.7R	24-Jan-12 11:45	1-Feb-12 11:35	191.8	3.0	2.8	1.0	2.6	b/c	3	6	9	383.7	*0.56*
8.7R	1-Feb-12 11:57	7-Feb-12 12:59	145.0	2.9	2.9	1.0	2.6	b/c	1	0	1	290.1	*0.08*
8.7R Totals			**1,512.4**						**80**	**53**	**133**	**3,024.8**	***1.06***
Grand Totals			**13570.1**						**401**	**271**	**672**	**27140.2**	***0.59***

[a] See Figure 2 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure.

Table C3: Summary of Mountain Whitefish (MW) eggs collected by egg collection mats at individual sample stations in the lower section of the study area, December 8, 2011 to February 9, 2012.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
40.5L	8-Dec-11 10:45	13-Dec-11 08:47	118.0	4.4	4.1	1.4	1.8	b/c	0	0	0	236.1	*0.00*
40.5L	13-Dec-11 08:57	20-Dec-11 09:21	168.4	4.1	3.8	2.0	0.6	c/b	0	0	0	336.8	*0.00*
40.5L	20-Dec-11 09:37	29-Dec-11 08:51	215.2	4.0	3.8	dnr[d]	1.9	c/g	0	0	0	430.5	*0.00*
40.5L	29-Dec-11 09:04	5-Jan-12 09:06	168.0	3.8	3.5	1.7	2.0	c/g	0	0	0	336.1	*0.00*
40.5L	5-Jan-12 09:15	10-Jan-12 08:45	119.5	3.5	3.4	1.3	1.8	b/c	0	0	0	239.0	*0.00*
40.5L	10-Jan-12 09:01	17-Jan-12 08:47	167.8	3.3	2.8	1.4	1.6	b/c	0	0	0	335.5	*0.00*
40.5L	17-Jan-12 09:12	25-Jan-12 09:13	192.0	2.8	2.5	1.8	2.0	b/c	0	0	0	384.0	*0.00*
40.5L	25-Jan-12 09:27	2-Feb-12 09:09	191.7	2.5	2.7	1.4	1.3	c/g	0	0	0	383.4	*0.00*
40.5L	2-Feb-12 09:25	8-Feb-12 09:45	144.3	2.7	2.6	0.8	1.0	b/c	0	0	0	288.7	*0.00*
40.5L Totals			**1485.0**						**0**	**0**	**0**	**2970.0**	***0.00***
40.5ML	9-Dec-11 11:30	13-Dec-11 09:04	93.6	4.3	4.1	2.6	2.3	b/c	0	0	0	187.1	*0.00*
40.5ML	13-Dec-11 09:05	20-Dec-11 09:40	168.6	4.1	4.0	3.7	2.7	b/c	0	0	0	337.2	*0.00*
40.5ML	20-Dec-11 09:42	29-Dec-11 09:07	215.4	4.0	3.8	dnr[d]	2.5	b/c	0	0	0	430.8	*0.00*
40.5ML	29-Dec-11 09:09	5-Jan-12 09:18	168.1	3.8	3.5	3.5	2.7	b/c	0	0	0	336.3	*0.00*
40.5ML	5-Jan-12 09:21	10-Jan-12 09:05	119.7	3.5	3.4	2.5	2.1	b/c	0	0	0	239.5	*0.00*
40.5ML	10-Jan-12 09:07	17-Jan-12 09:14	168.1	3.4	2.9	2.5	2.1	b/c	1	0	1	336.2	*0.07*
40.5ML	17-Jan-12 09:16	25-Jan-12 09:31	192.2	2.8	2.5	3.1	2.5	b/c	0	0	0	384.5	*0.00*
40.5ML	25-Jan-12 09:34	2-Feb-12 09:32	192.0	2.5	2.7	2.4	2.1	b/c	0	0	0	383.9	*0.00*
40.5ML	2-Feb-12 09:33	8-Feb-12 09:25	143.9	2.7	2.6	2.1	2.3	b/c	0	0	0	287.7	*0.00*
40.5ML Totals			**1461.7**						**1**	**0**	**1**	**2923.3**	***0.01***
40.5R	8-Dec-11 10:56	13-Dec-11 09:17	118.4	4.4	4.1	3.4	2.5	c/b	0	1	1	236.7	*0.10*
40.5R	13-Dec-11 09:37	20-Dec-11 09:57	168.3	4.1	4.0	2.7	1.7	g/c	0	0	0	336.7	*0.00*
40.5R	20-Dec-11 10:12	29-Dec-11 09:27	215.3	4.0	3.8	dnr[d]	1.8	c/g	0	0	0	430.5	*0.00*
40.5R	29-Dec-11 09:43	5-Jan-12 09:35	167.9	3.8	3.5	2.8	2.3	c/b	0	0	0	335.7	*0.00*
40.5R	5-Jan-12 09:52	10-Jan-12 09:29	119.6	3.5	3.3	1.7	0.8	b/c	0	0	0	239.2	*0.00*
40.5R	10-Jan-12 09:38	17-Jan-12 09:31	167.9	3.4	2.8	3.5	2.6	c/g	0	0	0	335.8	*0.00*
40.5R	17-Jan-12 09:46	25-Jan-12 09:47	192.0	2.8	2.5	2.2	1.4	c/b	0	0	0	384.0	*0.00*
40.5R	25-Jan-12 09:59	2-Feb-12 09:49	191.8	2.5	2.7	3.1	2.4	c/g	0	0	0	383.7	*0.00*
40.5R	2-Feb-12 10:02	8-Feb-12 09:10	143.1	2.7	2.6	2.5	1.7	c/b	0	0	0	286.3	*0.00*
40.5R Totals			**1484.3**						**0**	**1**	**1**	**2968.6**	***0.01***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
42.8L	8-Dec-11 10:29	13-Dec-11 09:54	119.4	4.4	4.2	5.5	0.9	c/g	0	0	0	238.8	*0.00*
42.8L	13-Dec-11 10:11	20-Dec-11 10:31	168.3	4.1	4.0	5.0	1.1	g/c	0	0	0	336.7	*0.00*
42.8L	20-Dec-11 10:43	29-Dec-11 09:52	215.2	4.0	3.8	dnr[d]	1.1	c/g	0	0	0	430.3	*0.00*
42.8L	29-Dec-11 10:07	5-Jan-12 10:03	167.9	3.8	3.5	5.1	1.0	dnr[d]	0	0	0	335.9	*0.00*
42.8L	5-Jan-12 10:14	10-Jan-12 09:45	119.5	3.5	3.4	5.2	0.8	g/c	0	0	0	239.0	*0.00*
42.8L	10-Jan-12 09:55	17-Jan-12 10:01	168.1	3.4	2.8	5.3	1.2	g/c	0	0	0	336.2	*0.00*
42.8L	17-Jan-12 10:16	25-Jan-12 10:11	191.9	2.8	2.6	6.5	1.2	c/g	0	0	0	383.8	*0.00*
42.8L	25-Jan-12 10:25	2-Feb-12 10:09	191.7	2.6	2.8	4.3	0.9	g/c	0	0	0	383.5	*0.00*
42.8L	2-Feb-12 10:49	8-Feb-12 10:21	143.5	2.8	2.6	4.1	0.7	c/g	0	0	0	287.1	*0.00*
42.8L Totals			**1485.6**						**0**	**0**	**0**	**2971.3**	***0.00***
43.0L	8-Dec-11 10:16	13-Dec-11 10:20	120.1	4.4	4.2	2.9	2.4	b/c	0	0	0	240.1	*0.00*
43.0L	13-Dec-11 10:35	20-Dec-11 10:47	168.2	4.1	4.0	2.7	2.6	c/b	0	0	0	336.4	*0.00*
43.0L	20-Dec-11 11:01	29-Dec-11 10:11	215.2	4.0	3.9	dnr[d]	2.3	c/g	0	0	0	430.3	*0.00*
43.0L	29-Dec-11 10:35	5-Jan-12 10:19	167.7	3.8	3.6	2.3	2.3	c/b	0	0	0	335.5	*0.00*
43.0L	5-Jan-12 10:34	10-Jan-12 09:59	119.4	3.6	3.3	1.7	2.2	b/c	0	0	0	238.8	*0.00*
43.0L	10-Jan-12 10:11	17-Jan-12 10:21	168.2	3.3	2.8	1.6	2.3	b/c	0	0	0	336.3	*0.00*
43.0L	17-Jan-12 10:37	25-Jan-12 11:00	192.4	2.8	2.6	1.9	2.4	b/c	0	0	0	384.8	*0.00*
43.0L	25-Jan-12 11:23	2-Feb-12 10:57	191.6	2.6	2.8	1.5	2.5	b/c	1	0	1	383.1	*0.06*
43.0L	2-Feb-12 11:20	8-Feb-12 10:41	143.4	2.8	2.7	2.3	2.3	b/c	0	0	0	286.7	*0.00*
43.0L Totals			**1486.1**						**1**	**0**	**1**	**2972.1**	***0.01***
43.75L	8-Dec-11 09:56	13-Dec-11 11:14	121.3	4.4	4.1	2.9	1.2	c/sand	0	1	1	242.6	*0.10*
43.75L	13-Dec-11 11:32	20-Dec-11 11:28	167.9	4.1	4.1	2.9	0.9	c/sand	0	1	1	335.9	*0.07*
43.75L	20-Dec-11 11:51	29-Dec-11 11:05	215.2	4.1	3.8	dnr[d]	1.1	g/sand	0	1	1	430.5	*0.06*
43.75L	29-Dec-11 11:25	5-Jan-12 10:57	167.5	3.8	3.6	3.4	1.0	g/sand	1	0	1	335.1	*0.07*
43.75L	5-Jan-12 11:16	10-Jan-12 10:49	119.5	3.6	3.3	2.5	1.0	g/sand	0	0	0	239.1	*0.00*
43.75L	10-Jan-12 11:00	17-Jan-12 10:44	167.7	3.3	2.8	2.5	0.9	sand/g	0	0	0	335.5	*0.00*
43.75L	17-Jan-12 11:10	25-Jan-12 11:53	192.7	2.8	2.6	2.7	1.0	sand/g	0	0	0	385.4	*0.00*
43.75L	25-Jan-12 12:13	2-Feb-12 11:26	191.2	2.6	2.8	2.2	0.5	sand/g	0	0	0	382.4	*0.00*
43.75L	2-Feb-12 11:44	8-Feb-12 12:07	144.4	2.8	2.7	2.2	1.0	c/b	0	0	0	288.8	*0.00*
43.75L Totals			**1487.6**						**1**	**3**	**4**	**2975.2**	***0.03***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
43.75MR	9-Dec-11 10:18	13-Dec-11 10:47	96.5	4.3	4.1	3.2	1.5	c/g	0	0	0	193.0	*0.00*
43.75MR	13-Dec-11 10:48	20-Dec-11 11:07	168.3	4.1	4.1	3.8	0.7	c/g	0	0	0	336.6	*0.00*
43.75MR	20-Dec-11 11:12	29-Dec-11 10:39	215.4	4.0	3.9	dnr[d]	0.7	g/c	0	0	0	430.9	*0.00*
43.75MR	29-Dec-11 10:42	5-Jan-12 11:19	168.6	3.8	3.6	2.6	1.0	g/sand	0	0	0	337.2	*0.00*
43.75MR	5-Jan-12 11:22	10-Jan-12 10:16	118.9	3.6	3.4	2.0	0.6	c/b	0	0	0	237.8	*0.00*
43.75MR	10-Jan-12 10:18	17-Jan-12 11:13	168.9	3.4	2.9	1.6	0.4	sand/c	0	0	0	337.8	*0.00*
43.75MR	17-Jan-12 11:15	25-Jan-12 11:28	192.2	2.8	2.6	2.0	0.5	sand/g	0	0	0	384.4	*0.00*
43.75MR	25-Jan-12 11:30	2-Feb-12 11:51	192.4	2.6	2.8	2.0	0.5	sand/g	0	0	0	384.7	*0.00*
43.75MR	2-Feb-12 11:51	8-Feb-12 12:26	144.6	2.8	2.7	1.4	0.4	g/sand	0	0	0	289.2	*0.00*
43.75MR Totals			**1465.8**						**0**	**0**	**0**	**2931.7**	***0.00***
44.0R	8-Dec-11 09:39	13-Dec-11 11:38	122.0	4.4	4.1	1.8	0.9	c/b	0	0	0	244.0	*0.00*
44.0R Totals			**122.0**						**0**	**0**	**0**	**244.0**	***0.00***
44.25MR	9-Dec-11 10:48	13-Dec-11 12:11	97.4	4.3	4.1	2.3	0.6	g/c	0	0	0	194.8	*0.00*
44.25MR	13-Dec-11 12:11	20-Dec-11 11:57	167.8	4.1	4.0	7.0	2.6	dnr[d]	1	0	1	335.5	*0.07*
44.25MR	20-Dec-11 12:00	29-Dec-11 11:28	215.5	4.0	3.9	dnr[d]	2.7	dnr[d]	0	0	0	430.9	*0.00*
44.25MR	29-Dec-11 11:30	5-Jan-12 11:40	168.2	3.9	3.6	5.0	2.1	dnr[d]	1	0	1	336.3	*0.07*
44.25MR	5-Jan-12 11:42	10-Jan-12 11:06	119.4	3.6	3.3	5.8	2.1	c/b	0	0	0	238.8	*0.00*
44.25MR	10-Jan-12 11:08	17-Jan-12 11:37	168.5	3.3	2.9	5.3	2.0	b/c	0	0	0	337.0	*0.00*
44.25MR	17-Jan-12 11:38	25-Jan-12 12:17	192.7	2.9	2.6	4.3	2.4	b/c	0	0	0	385.3	*0.00*
44.25MR	25-Jan-12 12:19	2-Feb-12 12:11	191.9	2.6	2.8	5.9	1.0	dnr[d]	0	0	0	383.7	*0.00*
44.25MR	2-Feb-12 12:12	8-Feb-12 11:30	143.3	2.8	2.7	4.7	1.6	c/b	0	0	0	286.6	*0.00*
44.25MR Totals			**1708.5**						**2**	**0**	**2**	**3416.9**	***0.01***
44.25R	8-Dec-11 09:26	13-Dec-11 12:31	123.1	4.4	4.1	3.7	1.6	b/c	2	0	2	246.2	*0.19*
44.25R	13-Dec-11 12:44	20-Dec-11 12:26	167.7	4.1	4.0	3.5	1.3	b/c	0	0	0	335.4	*0.00*
44.25R	20-Dec-11 12:39	29-Dec-11 11:48	215.2	4.0	3.9	dnr[d]	1.3	b/c	0	0	0	430.3	*0.00*
44.25R	29-Dec-11 12:10	5-Jan-12 12:04	167.9	3.9	3.6	3.6	1.4	c/b	0	0	0	335.8	*0.00*
44.25R	5-Jan-12 12:17	10-Jan-12 11:24	119.1	3.6	3.3	3.3	1.1	b/c	0	0	0	238.2	*0.00*
44.25R	10-Jan-12 11:37	17-Jan-12 11:54	168.3	3.3	2.9	2.5	1.6	b/c	0	0	0	336.6	*0.00*
44.25R	17-Jan-12 12:07	25-Jan-12 12:58	192.8	2.8	2.7	3.5	0.9	b/c	0	0	0	385.7	*0.00*
44.25R	25-Jan-12 13:11	2-Feb-12 12:32	191.3	2.7	2.8	3.4	0.6	b/c	0	0	0	382.7	*0.00*
44.25R	2-Feb-12 12:45	8-Feb-12 11:10	142.4	2.8	2.7	2.3	1.8	b/c	0	0	0	284.8	*0.00*
44.25R Totals			**1487.9**						**2**	**0**	**2**	**2975.7**	***0.02***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
46.4L	8-Dec-11 09:12	13-Dec-11 12:55	123.7	4.4	4.1	1.7	1.0	g/b	0	3	3	247.4	*0.29*
46.4L	13-Dec-11 13:09	20-Dec-11 12:49	167.7	4.1	4.0	2.6	0.8	g/sand	0	0	0	335.3	*0.00*
46.4L	20-Dec-11 13:03	29-Dec-11 12:31	215.5	4.1	3.9	dnr[d]	0.9	c/sand	0	0	0	430.9	*0.00*
46.4L	29-Dec-11 12:48	5-Jan-12 12:24	167.6	3.8	3.6	2.4	1.1	sand/g	1	0	1	335.2	*0.07*
46.4L	5-Jan-12 12:42	10-Jan-12 11:47	119.1	3.6	3.4	2.1	0.9	g/sand	0	0	0	238.2	*0.00*
46.4L	10-Jan-12 11:59	17-Jan-12 12:15	168.3	3.3	2.9	2.0	0.9	sand/g	0	0	0	336.5	*0.00*
46.4L	17-Jan-12 12:30	25-Jan-12 13:25	192.9	2.8	2.7	2.3	0.9	g/sand	0	0	0	385.8	*0.00*
46.4L	25-Jan-12 13:38	2-Feb-12 12:53	191.3	2.7	2.8	1.9	0.8	sand/g	0	0	0	382.5	*0.00*
46.4L	2-Feb-12 13:04	8-Feb-12 12:59	143.9	2.8	2.7	1.5	0.7	c/sand	0	0	0	287.8	*0.00*
46.4L Totals			**1489.9**						**1**	**3**	**4**	**2979.8**	***0.03***
46.5L	8-Dec-11 08:57	13-Dec-11 13:17	124.3	4.2	4.1	4.5	1.6	g/c	0	0	0	248.7	*0.00*
46.5L	13-Dec-11 13:31	20-Dec-11 13:11	167.7	4.1	4.1	1.1	1.0	b/c	0	0	0	335.3	*0.00*
46.5L	20-Dec-11 13:27	29-Dec-11 12:57	215.5	4.1	3.9	dnr[d]	1.3	c/b	0	0	0	431.0	*0.00*
46.5L	29-Dec-11 13:17	5-Jan-12 12:48	167.5	3.8	3.6	1.6	1.2	c/g	0	0	0	335.0	*0.00*
46.5L	5-Jan-12 13:11	10-Jan-12 12:19	119.1	3.6	3.3	1.3	1.1	c/b	0	0	0	238.3	*0.00*
46.5L	10-Jan-12 12:31	17-Jan-12 12:35	168.1	3.3	2.9	1.6	1.5	c/g	0	0	0	336.1	*0.00*
46.5L	17-Jan-12 12:49	25-Jan-12 13:43	192.9	2.9	2.7	1.9	1.6	c/g	0	0	0	385.8	*0.00*
46.5L	25-Jan-12 14:01	2-Feb-12 13:11	191.2	2.7	2.9	2.6	1.5	c/g	0	0	0	382.3	*0.00*
46.5L	2-Feb-12 13:27	8-Feb-12 13:19	143.9	2.8	2.6	1.6	1.0	b/c	0	0	0	287.7	*0.00*
46.5L Totals			**1490.1**						**0**	**0**	**0**	**2980.3**	***0.00***
46.5R	8-Dec-11 08:46	13-Dec-11 13:38	124.9	3.6	4.1	3.5	1.8	b/c	0	0	0	249.7	*0.00*
46.5R	13-Dec-11 13:47	20-Dec-11 13:36	167.8	4.1	4.1	3.6	1.6	c/b	0	0	0	335.6	*0.00*
46.5R	20-Dec-11 13:46	29-Dec-11 13:21	215.6	4.1	3.9	dnr[d]	1.2	b/c	0	1	1	431.2	*0.06*
46.5R	29-Dec-11 13:36	5-Jan-12 13:14	167.6	3.8	3.6	4.0	1.3	b/c	1	0	1	335.3	*0.07*
46.5R	5-Jan-12 13:28	10-Jan-12 12:37	119.1	3.6	3.3	3.5	1.8	b/c	0	1	1	238.3	*0.10*
46.5R	10-Jan-12 12:52	17-Jan-12 12:53	168.0	3.4	2.9	3.6	2.0	b/c	0	1	1	336.0	*0.07*
46.5R	17-Jan-12 13:07	25-Jan-12 14:07	193.0	2.9	2.7	3.5	1.3	b/c	0	0	0	386.0	*0.00*
46.5R	25-Jan-12 14:20	2-Feb-12 13:35	191.3	2.7	2.8	3.7	1.7	b/c	0	0	0	382.5	*0.00*
46.5R	2-Feb-12 14:04	8-Feb-12 13:39	143.6	2.8	2.6	2.7	1.6	b/c	0	0	0	287.2	*0.00*
46.5R Totals			**1490.9**						**1**	**3**	**4**	**2981.8**	***0.03***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Continued.

Station[a]	Date and Time: Set	Date and Time: Pull	Set Duration (h)	Water Temp.: Set (°C)	Water Temp.: Pull (°C)	Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch: Mat 1 No. MW Eggs	Catch: Mat 2 No. MW Eggs	Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
47.0MR	9-Dec-11 09:40	14-Dec-11 08:59	119.3	4.3	4.2	4.6	2.7	b/c	0	4	4	238.6	*0.40*
47.0MR	14-Dec-11 09:01	21-Dec-11 09:20	168.3	4.2	4.0	6.0	2.6	dnr[d]	0	0	0	336.6	*0.00*
47.0MR	21-Dec-11 09:25	30-Dec-11 09:05	215.7	3.9	3.9	dnr[d]	3.3	dnr[d]	0	1	1	431.3	*0.06*
47.0MR	30-Dec-11 09:07	6-Jan-12 09:28	168.3	3.9	3.4	5.8	2.5	dnr[d]	0	0	0	336.7	*0.00*
47.0MR	6-Jan-12 09:26	11-Jan-12 09:03	119.6	3.5	3.1	5.3	2.7	dnr[d]	0	0	0	239.2	*0.00*
47.0MR	11-Jan-12 09:04	19-Jan-12 09:01	192.0	3.1	2.4	5.5	3.1	dnr[d]	0	0	0	383.9	*0.00*
47.0MR	19-Jan-12 09:04	26-Jan-12 09:56	168.9	2.4	2.7	5.5	1.4	dnr[d]	0	0	0	337.7	*0.00*
47.0MR	26-Jan-12 09:58	3-Feb-12 10:00	192.0	2.7	2.7	5.1	3.0	dnr[d]	0	0	0	384.1	*0.00*
47.0MR	3-Feb-12 10:01	9-Feb-12 09:28	143.4	2.7	2.7	4.7	dnr[d]	dnr[d]	0	0	0	286.9	*0.00*
47.0MR Totals			**1487.6**						**0**	**5**	**5**	**2975.1**	***0.04***
47.0R	8-Dec-11 12:18	14-Dec-11 08:39	140.4	4.4	3.6	1.3	1.4	b/c	3	1	4	280.7	*0.34*
47.0R	14-Dec-11 08:53	21-Dec-11 09:06	168.2	4.0	4.0	1.7	1.9	b/c	4	0	4	336.4	*0.29*
47.0R	21-Dec-11 09:20	30-Dec-11 08:48	215.5	4.0	3.8	dnr[d]	1.9	b/c	2	0	2	430.9	*0.11*
47.0R	30-Dec-11 09:02	6-Jan-12 09:02	168.0	3.9	3.4	1.5	2.0	b/c	7	2	9	336.0	*0.64*
47.0R	6-Jan-12 09:17	10-Jan-12 12:59	99.7	3.2	3.3	1.0	1.0	b/c	0	3	3	199.4	*0.36*
47.0R	10-Jan-12 13:22	19-Jan-12 08:47	211.4	3.4	2.3	1.0	1.1	b/c	0	0	0	422.8	*0.00*
47.0R	19-Jan-12 08:56	26-Jan-12 09:42	168.8	2.3	2.7	1.1	0.7	b/c	0	0	0	337.5	*0.00*
47.0R	26-Jan-12 09:53	3-Feb-12 09:29	191.6	2.7	2.8	0.9	1.0	b/c	0	0	0	383.2	*0.00*
47.0R	3-Feb-12 09:41	9-Feb-12 09:16	143.6	2.8	2.6	1.0	dnr[d]	dnr[d]	0	0	0	287.2	*0.00*
47.0R Totals			**1507.1**						**16**	**6**	**22**	**3014.2**	***0.18***
47.25L	8-Dec-11 12:39	14-Dec-11 09:38	141.0	4.5	4.2	3.8	1.7	g/b	0	0	0	282.0	*0.00*
47.25L	14-Dec-11 09:54	21-Dec-11 09:58	168.1	4.2	4.0	4.5	1.9	c/b	0	0	0	336.1	*0.00*
47.25L	21-Dec-11 10:09	30-Dec-11 09:40	215.5	4.0	4.0	dnr[d]	1.7	c/g	0	0	0	431.0	*0.00*
47.25L	30-Dec-11 10:00	6-Jan-12 09:55	167.9	3.8	3.5	4.3	1.5	c/b	0	0	0	335.8	*0.00*
47.25L	6-Jan-12 10:06	11-Jan-12 09:31	119.4	3.4	3.0	4.9	0.7	g/c	0	0	0	238.8	*0.00*
47.25L	11-Jan-12 09:48	19-Jan-12 09:35	191.8	2.9	2.4	5.1	0.6	c/g	0	0	0	383.6	*0.00*
47.25L	19-Jan-12 09:46	26-Jan-12 10:43	168.9	2.4	2.7	4.2	1.1	c/g	0	0	0	337.9	*0.00*
47.25L	26-Jan-12 10:57	3-Feb-12 10:45	191.8	2.7	2.8	4.2	0.8	c/b	0	0	0	383.6	*0.00*
47.25L	3-Feb-12 10:55	9-Feb-12 10:21	143.4	2.8	2.6	3.9	dnr[d]	dnr[d]	0	0	0	286.9	*0.00*
47.25L Totals			**1507.9**						**0**	**0**	**0**	**3015.7**	***0.00***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
47.25R	8-Dec-11 12:30	14-Dec-11 09:23	140.9	4.4	4.2	2.7	1.6	b/c	0	0	0	281.8	*0.00*
47.25R	14-Dec-11 09:35	21-Dec-11 09:40	168.1	4.2	4.0	3.0	0.9	b/g	0	0	0	336.2	*0.00*
47.25R	21-Dec-11 09:53	30-Dec-11 09:24	215.5	4.0	3.9	dnr[d]	0.3	b/c	0	0	0	431.0	*0.00*
47.25R	30-Dec-11 09:36	6-Jan-12 09:42	168.1	3.9	3.4	2.0	0.7	b/c	0	0	0	336.2	*0.00*
47.25R	6-Jan-12 09:50	11-Jan-12 09:18	119.5	3.4	3.0	1.9	0.5	b/c	0	0	0	238.9	*0.00*
47.25R	11-Jan-12 09:28	19-Jan-12 09:17	191.8	2.9	2.4	1.8	0.7	b/c	0	0	0	383.6	*0.00*
47.25R	19-Jan-12 09:30	26-Jan-12 10:12	168.7	2.4	2.6	1.6	0.2	b/c	0	0	0	337.4	*0.00*
47.25R	26-Jan-12 10:37	3-Feb-12 10:27	191.8	2.7	2.8	2.4	0.9	b/c	0	0	0	383.7	*0.00*
47.25R	3-Feb-12 10:41	9-Feb-12 09:46	143.1	2.8	2.6	1.8	dnr[d]	dnr[d]	0	0	0	286.2	*0.00*
47.25R Totals			**1507.5**						**0**	**0**	**0**	**3015.0**	***0.00***
47.4L	8-Dec-11 12:48	14-Dec-11 09:58	141.2	4.4	4.2	3.7	1.8	c/b	0	0	0	282.3	*0.00*
47.4L	14-Dec-11 10:12	21-Dec-11 10:30	168.3	4.2	4.0	3.1	0.8	c/b	0	0	0	336.6	*0.00*
47.4L	21-Dec-11 10:44	30-Dec-11 10:20	215.6	4.0	3.9	dnr[d]	1.2	c/b	0	1	1	431.2	*0.06*
47.4L	30-Dec-11 10:35	6-Jan-12 10:12	167.6	3.9	3.5	4.1	1.6	g/c	0	0	0	335.2	*0.00*
47.4L	6-Jan-12 10:25	11-Jan-12 09:52	119.4	3.4	3.0	3.8	1.1	c/b	0	0	0	238.9	*0.00*
47.4L	11-Jan-12 10:03	19-Jan-12 09:49	191.8	3.0	2.5	3.7	1.5	b/c	0	0	0	383.5	*0.00*
47.4L	19-Jan-12 10:03	26-Jan-12 11:03	169.0	2.5	2.7	3.2	0.3	b/c	0	0	0	338.0	*0.00*
47.4L	26-Jan-12 11:16	3-Feb-12 10:58	191.7	2.7	2.8	2.9	1.2	b/c	0	0	0	383.4	*0.00*
47.4L	3-Feb-12 11:09	9-Feb-12 10:39	143.5	2.8	2.6	2.6	dnr[d]	dnr[d]	0	0	0	287.0	*0.00*
47.4L Totals			**1508.1**						**0**	**1**	**1**	**3016.2**	***0.01***
48.0R	8-Dec-11 13:06	14-Dec-11 10:30	141.4	4.4	4.2	3.5	2.1	b/c	17	7	24	282.8	*2.04*
48.0R	14-Dec-11 10:50	21-Dec-11 10:52	168.0	4.2	4.0	4.5	2.0	dnr[d]	20	8	28	336.1	*2.00*
48.0R	21-Dec-11 11:20	30-Dec-11 10:40	215.3	4.0	3.9	dnr[d]	1.9	b/c	3	11	14	430.7	*0.78*
48.0R	30-Dec-11 11:00	6-Jan-12 10:30	167.5	3.9	3.4	2.5	1.7	c/b	2	12	14	335.0	*1.00*
48.0R	6-Jan-12 10:57	11-Jan-12 10:08	119.2	3.5	3.0	2.5	1.5	b/c	2	3	5	238.4	*0.50*
48.0R	11-Jan-12 10:44	19-Jan-12 10:16	191.5	2.9	2.4	2.9	1.8	b/c	3	1	4	383.1	*0.25*
48.0R	19-Jan-12 10:30	26-Jan-12 11:21	168.8	2.4	2.7	3.4	1.0	b/c	2	0	2	337.7	*0.14*
48.0R	26-Jan-12 11:40	3-Feb-12 11:15	191.6	2.7	2.9	3.1	1.5	b/c	0	0	0	383.2	*0.00*
48.0R	3-Feb-12 11:28	9-Feb-12 10:53	143.4	2.8	2.7	2.2	dnr[d]	dnr[d]	0	0	0	286.8	*0.00*
48.0R Totals			**1506.8**						**49**	**42**	**91**	**3013.7**	***0.72***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
49.3MR	9-Dec-11 13:36	14-Dec-11 10:57	117.4	4.3	4.2	3.5	1.7	b/c	2	11	15	234.7	*1.53*
49.3MR	14-Dec-11 10:59	21-Dec-11 11:24	168.4	4.2	4.0	4.2	2.2	c/b	0	2	2	336.8	*0.14*
49.3MR	21-Dec-11 11:27	30-Dec-11 11:03	215.6	4.0	3.9	dnr[d]	2.2	b/c	3	0	3	431.2	*0.17*
49.3MR	30-Dec-11 11:05	6-Jan-12 11:01	167.9	3.9	3.5	3.9	2.0	b/c	2	3	5	335.9	*0.36*
49.3MR	6-Jan-12 11:03	11-Jan-12 10:47	119.7	3.5	3.0	4.1	2.2	c/b	0	0	0	239.5	*0.00*
49.3MR	11-Jan-12 10:50	19-Jan-12 10:34	191.7	3.0	2.4	4.1	2.2	c/b	0	0	0	383.5	*0.00*
49.3MR	19-Jan-12 10:36	26-Jan-12 11:43	169.1	2.4	2.7	4.2	1.1	b/c	0	0	0	338.2	*0.00*
49.3MR	26-Jan-12 11:45	9-Feb-12 11:07	335.4	2.7	2.7	3.8	1.8	b/c	0	0	0	670.7	*0.00*
49.3KR Totals			**1485.2**						**7**	**16**	**25**	**2970.5**	***0.20***
50.5L	8-Dec-11 13:20	14-Dec-11 11:15	141.9	4.4	4.3	1.8	1.3	b/c	0	1	1	283.8	*0.08*
50.5L	14-Dec-11 11:28	21-Dec-11 11:45	168.3	4.2	4.0	2.2	1.6	c/b	0	0	0	336.6	*0.00*
50.5L	21-Dec-11 11:55	30-Dec-11 11:23	215.5	4.0	4.0	dnr[d]	1.6	b/c	0	0	0	430.9	*0.00*
50.5L	30-Dec-11 11:33	6-Jan-12 11:12	167.7	4.1	3.6	2.3	1.6	c/b	1	0	1	335.3	*0.07*
50.5L	6-Jan-12 11:41	11-Jan-12 11:02	119.3	3.6	3.0	1.7	1.4	b/c	0	0	0	238.7	*0.00*
50.5L	11-Jan-12 11:17	19-Jan-12 10:52	191.6	3.0	2.4	1.8	1.1	b/c	0	0	0	383.2	*0.00*
50.5L	19-Jan-12 11:04	26-Jan-12 12:18	169.2	2.4	2.8	1.1	0.8	b/c	0	0	0	338.5	*0.00*
50.5L	26-Jan-12 12:32	3-Feb-12 11:40	191.1	2.8	3.0	1.8	1.4	b/c	0	0	0	382.3	*0.00*
50.5L	3-Feb-12 12:16	9-Feb-12 11:23	143.1	2.9	2.7	1.5	dnr[d]	dnr[d]	0	0	0	286.2	*0.00*
50.5L Totals			**1507.7**						**1**	**1**	**2**	**3015.5**	***0.02***
50.6R	8-Dec-11 13:29	14-Dec-11 11:33	142.1	4.4	4.2	3.1	1.8	b/c	0	0	0	284.1	*0.00*
50.6R	14-Dec-11 12:01	21-Dec-11 12:01	168.0	4.2	4.0	3.5	2.1	b/c	0	0	0	336.0	*0.00*
50.6R	21-Dec-11 12:09	30-Dec-11 11:35	215.4	4.0	4.0	dnr[d]	1.9	b/c	0	0	0	430.9	*0.00*
50.6R	30-Dec-11 11:48	6-Jan-12 11:46	168.0	4.0	3.6	3.7	1.7	b/c	0	0	0	335.9	*0.00*
50.6R	6-Jan-12 11:59	11-Jan-12 11:20	119.3	3.5	3.0	3.1	1.8	b/c	0	0	0	238.7	*0.00*
50.6R	11-Jan-12 11:36	19-Jan-12 11:11	191.6	3.0	2.4	3.3	1.8	b/c	0	0	0	383.2	*0.00*
50.6R	19-Jan-12 11:27	26-Jan-12 12:36	169.2	2.4	2.8	3.4	1.7	b/c	0	0	0	338.3	*0.00*
50.6R	26-Jan-12 12:54	9-Feb-12 11:59	335.1	2.7	2.7	3.0	2.1	b/c	0	0	0	670.2	*0.00*
50.6R Totals			**1508.6**						**0**	**0**	**0**	**3017.3**	***0.00***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Continued.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
51.0R	8-Dec-11 13:40	14-Dec-11 12:07	142.5	4.4	4.2	1.7	2.2	b/c	0	0	0	284.9	*0.00*
51.0R	14-Dec-11 12:22	21-Dec-11 12:16	167.9	4.2	4.0	2.1	2.4	b/c	0	0	0	335.8	*0.00*
51.0R	21-Dec-11 12:31	30-Dec-11 11:54	215.4	4.0	4.0	dnr[d]	2.0	b/c	0	0	0	430.8	*0.00*
51.0R	30-Dec-11 12:10	6-Jan-12 12:02	167.9	3.9	3.6	4.1	2.2	b/c	0	0	0	335.7	*0.00*
51.0R	6-Jan-12 12:14	11-Jan-12 11:41	119.4	3.5	3.0	1.5	2.3	b/c	0	0	0	238.9	*0.00*
51.0R	11-Jan-12 11:56	19-Jan-12 11:48	191.9	3.0	2.4	1.5	2.2	b/c	0	0	0	383.7	*0.00*
51.0R	19-Jan-12 12:03	26-Jan-12 13:00	168.9	2.4	2.7	1.8	2.3	c/b	0	0	0	337.9	*0.00*
51.0R	26-Jan-12 13:13	9-Feb-12 12:14	335.0	2.7	2.7	1.5	2.2	b/c	0	0	0	670.0	*0.00*
51.0R Totals			**1508.9**						**0**	**0**	**0**	**3017.8**	***0.00***
52.0L	8-Dec-11 14:06	14-Dec-11 12:28	142.4	4.4	4.2	0.8	2.4	c/b	0	0	0	284.7	*0.00*
52.0L	14-Dec-11 12:41	21-Dec-11 12:38	168.0	4.2	4.1	3.0	1.9	c/g	0	1	1	335.9	*0.07*
52.0L	21-Dec-11 12:54	30-Dec-11 12:38	215.7	4.0	4.0	dnr[d]	2.0	c/b	0	0	0	431.5	*0.00*
52.0L	30-Dec-11 13:12	6-Jan-12 12:52	167.7	3.9	3.5	1.9	1.8	g/c	0	1	1	335.3	*0.07*
52.0L	6-Jan-12 13:04	11-Jan-12 12:41	119.6	3.5	3.0	1.6	1.6	c/g	0	0	0	239.2	*0.00*
52.0L	11-Jan-12 12:54	19-Jan-12 12:29	191.6	3.0	2.4	2.0	1.9	c/b	0	0	0	383.2	*0.00*
52.0L	19-Jan-12 12:43	26-Jan-12 13:30	168.8	2.4	2.8	2.8	1.9	c/g	0	0	0	337.6	*0.00*
52.0L	26-Jan-12 13:54	9-Feb-12 14:02	336.1	2.8	2.7	2.3	1.8	b/c	0	0	0	672.3	*0.00*
52.0L Totals			**1509.8**						**0**	**2**	**2**	**3019.7**	***0.02***
52.0R	8-Dec-11 13:51	14-Dec-11 12:46	142.9	4.4	4.2	2.4	1.7	c/b	0	0	0	285.8	*0.00*
52.0R	14-Dec-11 12:58	21-Dec-11 13:01	168.0	4.2	4.0	2.9	2.2	c/b	0	0	0	336.1	*0.00*
52.0R	21-Dec-11 13:19	30-Dec-11 12:55	215.6	4.0	4.0	dnr[d]	2.1	c/g	0	0	0	431.2	*0.00*
52.0R	30-Dec-11 12:49	6-Jan-12 12:34	167.7	4.0	3.5	2.2	2.0	c/g	0	0	0	335.5	*0.00*
52.0R	6-Jan-12 12:49	11-Jan-12 12:21	119.5	3.5	3.0	1.4	1.9	c/b	0	0	0	239.1	*0.00*
52.0R	11-Jan-12 12:37	19-Jan-12 12:09	191.5	3.1	2.4	1.5	1.8	c/b	0	0	0	383.1	*0.00*
52.0R	19-Jan-12 12:25	26-Jan-12 13:18	168.9	2.5	2.8	1.9	1.8	c/g	0	0	0	337.8	*0.00*
52.0R	26-Jan-12 13:31	9-Feb-12 14:19	336.8	2.8	2.7	1.5	1.9	c/b	0	0	0	673.6	*0.00*
52.0R Totals			**1511.1**						**0**	**0**	**0**	**3022.1**	***0.00***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C3: Concluded.

Station[a]	Date and Time		Set Duration (h)	Water Temp.		Mat Depth (m)	Surface Velocity at Deployment (m/s)	Substrate at Deployment[b]	Catch		Total Catch	Sampling Effort[c] (mat-hours)	CPUE Per Station (Total catch/ 24 mat-hours)
	Set	Pull		Set (°C)	Pull (°C)				Mat 1 No. MW Eggs	Mat 2 No. MW Eggs			
54.0MR	9-Dec-11 14:05	14-Dec-11 13:07	119.0	4.4	4.2	1.0	2.9	b/c	0	1	1	238.1	*0.10*
54.0MR	14-Dec-11 13:09	21-Dec-11 13:27	168.3	4.2	4.1	1.7	2.3	b/g	0	0	0	336.6	*0.00*
54.0MR	21-Dec-11 13:29	30-Dec-11 13:19	215.8	4.1	4.0	dnr[d]	2.4	b/c	0	1	1	431.7	*0.06*
54.0MR	30-Dec-11 13:21	6-Jan-12 13:10	167.8	4.0	3.5	1.4	2.7	b/c	1	0	1	335.6	*0.07*
54.0MR	6-Jan-12 13:15	11-Jan-12 13:00	119.7	3.5	3.1	1.0	2.6	b/c	0	1	1	239.5	*0.10*
54.0MR	11-Jan-12 13:02	19-Jan-12 12:52	191.8	3.1	2.4	0.7	3.0	b/c	0	0	0	383.7	*0.00*
54.0MR	19-Jan-12 12:55	26-Jan-12 14:00	169.1	2.4	2.8	1.7	2.2	b/c	0	0	0	338.2	*0.00*
54.0MR	26-Jan-12 14:02	9-Feb-12 13:12	335.2	2.8	2.7	1.4	2.4	b/c	0	0	0	670.3	*0.00*
54.0MR Totals			**1486.8**						**1**	**3**	**4**	**2973.6**	***0.03***
54.1MR	9-Dec-11 14:30	14-Dec-11 13:28	119.0	4.2	4.0	4.7	1.8	c/g	1	2	4	237.9	*0.40*
54.1MR	14-Dec-11 13:29	21-Dec-11 13:46	168.3	4.0	4.1	5.4	2.1	dnr[d]	1	0	1	336.6	*0.07*
54.1MR	21-Dec-11 14:05	30-Dec-11 13:46	215.7	4.1	4.0	dnr[d]	2.5	dnr[d]	2	1	3	431.4	*0.17*
54.1MR	30-Dec-11 13:48	6-Jan-12 13:30	167.7	4.0	3.5	5.5	2.1	c/b	0	0	0	335.4	*0.00*
54.1MR	6-Jan-12 13:34	11-Jan-12 13:26	119.9	3.4	2.9	5.3	1.5	c/b	0	0	0	239.7	*0.00*
54.1MR	11-Jan-12 13:44	19-Jan-12 13:11	191.4	2.8	2.3	4.6	1.9	c/b	0	0	0	382.9	*0.00*
54.1MR	19-Jan-12 13:14	26-Jan-12 14:29	169.3	2.3	2.6	6.1	1.9	dnr[d]	0	0	0	338.5	*0.00*
54.1MR	26-Jan-12 14:31	9-Feb-12 13:31	335.0	2.6	2.8	5.7	1.6	dnr[d]	0	0	0	670.0	*0.00*
54.1MR Totals			**1486.2**						**4**	**3**	**8**	**2972.4**	***0.06***
Grand Totals			**39174.6**						**87**	**89**	**179**	**78349.3**	***0.05***

[a] See Figure 3 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: B = boulder, C = cobble, G = gravel.

[c] Calculated by multiplying the number of mats set at each station by the set duration.

[d] dnr = did not recorde due to equipment failure or conditions did not allow for the colletion of this data point.

Table C4: Developmental stages of Mountain Whitefish (MW) eggs collected on substrate mats in the CLBMON-48 study area, 2011/2012, adapted from Vernier (1969).

River	Site	Date	MW Eggs		Unfertilized/Unable to Stage	Number of eggs at Each Developmental Stage																													
			Alive	Dead		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Columbia	8.5L	12-Dec-11	1														1																		
	8.5M	12-Dec-11	7		2		1	1			1			1		1																			
	8.5R	12-Dec-11	14	1		2	1			1			1	2	4	2	1																		
	8.6L	12-Dec-11	1													1																			
	8.6M	12-Dec-11	2					1									1																		
	8.6R	12-Dec-11	12	1		2				1	3	3	2		1																				
	8.7L	12-Dec-11	29	1	1	1	4		1			1	4	10	2	5																			
	8.7R	12-Dec-11		1																															
	40.5R	13-Dec-11	1																												1				
	44.25R	13-Dec-11	3			1										1											1								
	46.4L	13-Dec-11		1																															
	47.0MR	14-Dec-11	2	1																											2				
	47.0R	14-Dec-11	4												3		1																		
	48.0R	14-Dec-11	23		3	2	2						1	3	3	7	2																		
	49.3MR	14-Dec-11	12	1	1								2	1	2	5															1				
	50.5L	14-Dec-11	1							1																									
	54.0MR	14-Dec-11	1								1																								
	54.1MR	14-Dec-11	3		2								1																						
	8.5M	19-Dec-11	1												1																				
	8.5R	19-Dec-11	31		2		3	1			1	3	1	4		5	5	1		2	3														
	8.6L	19-Dec-11	13				1						1	1	2	1	7																		
	8.6M	19-Dec-11	5		2									1	2																				
	8.6R	19-Dec-11	3		1											2																			
	8.7L	19-Dec-11	23		4								2	4	5	1	3	1			3														
	8.7M	19-Dec-11	7			2		1						1	1		1		1																
	8.7R	19-Dec-11	2											1			1																		
	43.75L	20-Dec-11	1												1																				
	44.25MR	20-Dec-11		1																															
	47.0R	21-Dec-11	3		1								1	1																					
	48.0R	21-Dec-11	27			1			2		2			6	6	2	5	2			1														
	49.3MR	21-Dec-11	2		1										1																				
	52.0L	21-Dec-11	1														1																		
	54.1MR	21-Dec-11	1												1																				
	8.5L	28-Dec-11	3		1										1									1											
	8.5M	28-Dec-11	2											1	1																				
	8.5R	28-Dec-11	14			1								1	1	3	2		1		2	1	2												
	8.6L	28-Dec-11	10			1	1						1	1	4		1	1																	
	8.6M	28-Dec-11	1										1																						
	8.6R	28-Dec-11	1													1																			
	8.7L	28-Dec-11	24		1	1		1					1	5	1	1	2	4	1		2	1	1	2											
	8.7M	28-Dec-11	4		1								2	1																					
	8.7R	28-Dec-11	9	1		3					2		3				1																		
	43.75L	29-Dec-11	1																			1													
	46.5R	29-Dec-11	1												1																				
	47.0MR	30-Dec-11	1		1																														
	47.0R	30-Dec-11	2		1		1																												
	47.4L	30-Dec-11	1			1																													
	48.0R	30-Dec-11	14		1	3	1			1			1	1			3				2				1										
	49.3MR	30-Dec-11	3												2	1																			
	54.0MR	30-Dec-11	1			1																													
	54.1MR	30-Dec-11	2														1				1														
	8.5L	3-Jan-12	7								1	1	4	1																					
	8.5M	3-Jan-12	1										1																						
	8.5R	3-Jan-12	12									2		3				1	1		3			1		1									
	8.6L	3-Jan-12	10					1		1				1	2	2					1			2											
	8.6M	3-Jan-12	10										1	1	4							1	1	1							1				
	8.6R	3-Jan-12	2		1																				1										
	8.7L	3-Jan-12	18		1						2		3	4		1		1			2	1			1		2								
	8.7M	3-Jan-12	3				1										1				1														
	8.7R	3-Jan-12	50		2	4	1			2	1		7	10	14	5	1							2			1								

Table C4: Concluded.

River	Site	Date	MW Eggs		Number of eggs at Each Developmental Stage																															
			Alive	Dead	Unfertilized/Unable to Stage	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	43.75L	5-Jan-12	1			1																													
	44.25MR	5-Jan-12	1									1																							
	46.5R	5-Jan-12	1								1																								
	47.0R	6-Jan-12	7									1	1	2	1								1				1								
	48.0R	6-Jan-12	14		2	1	1				1	1	1	1	2	2					1			1											
	49.3MR	6-Jan-12	4			1	1								1	1																			
	50.5L	6-Jan-12		1																															
	54.0MR	6-Jan-12	1																		1														
	8.5L	9-Jan-12	3		1		1									1																			
	8.5M	9-Jan-12	1													1																			
	8.5R	9-Jan-12	20				2				1	1	3	10	1						1			1											
	8.6L	9-Jan-12	12				2							3	4	1						2													
	8.6M	9-Jan-12	4											1	1							1					1								
	8.6R	9-Jan-12	5				1			1			1	1								1													
	8.7L	9-Jan-12	21		6	1			1	2	1		1	2	6									1											
	8.7M	9-Jan-12	2																			1									1				
	8.7R	9-Jan-12	43		3	5	4		1	2	4	3	3	7	5	1	1		1	3															
	46.5R	10-Jan-12	1											1																					
	47.0R	10-Jan-12	3				1				1			1																					
	48.0R	11-Jan-12	5											3	1			1																	
	54.0MR	11-Jan-12	1													1																			
	8.5L	16-Jan-12	1			1																													
	8.5M	16-Jan-12	9		1	3								4						1															
	8.5R	16-Jan-12	16		3	7								3	1	1	1																		
	8.6L	16-Jan-12	3		1										1			1																	
	8.6M	16-Jan-12	3			3																													
	8.6R	16-Jan-12	2										1			1																			
Columbia	8.7L	16-Jan-12	13		2							1	3	2	3							2													
	8.7M	16-Jan-12	1		1																														
	46.5R	17-Jan-12	1										1																						
	40.5ML	17-Jan-12	1			1																													
	48.0R	19-Jan-12	3			1																1	1												
	8.5L	24-Jan-12	3																1	1							1								
	8.5R	24-Jan-12	16		3	1						1		2	4	2			1		2														
	8.6L	24-Jan-12	3				1								1						1														
	8.6R	24-Jan-12	4												1	1	2																		
	8.7L	24-Jan-12	13		1		1			1		1		3	1		1	2			1	1													
	8.7R	24-Jan-12	3		1	1								1																					
	48.0R	26-Jan-12	1		1																														
	8.5L	1-Feb-12	3		3																														
	8.5M	1-Feb-12	5			1							3		1																				
	8.5R	1-Feb-12	25		11	1							2	1	1	1	1	1				1	1	2	1					1					
	8.6L	1-Feb-12	5	1	2									1			2																		
	8.6M	1-Feb-12	1							1																									
	8.6R	1-Feb-12	11						2						1	5					3														
	8.7L	1-Feb-12	1																		1														
	8.7R	1-Feb-12	9		1									2	1	1	1				1	1	1												
	8.5L	7-Feb-12	1														1																		
	8.5M	7-Feb-12	2									1			1																				
	8.5R	7-Feb-12	4												1	1							1									1			
	8.6M	7-Feb-12	2										1									1													
	8.6R	7-Feb-12	1														1																		
	8.7L	7-Feb-12	1																			1													
	8.7M	7-Feb-12	1											1																					
	8.7R	7-Feb-12	1																			1													
Totals			**762**	**11**	**73**	**55**	**32**	**6**	**7**	**14**	**23**	**21**	**62**	**118**	**106**	**68**	**52**	**16**	**7**	**7**	**33**	**19**	**9**	**14**	**4**	**1**	**7**	**0**	**0**	**1**	**6**	**1**	**0**	**0**	**0**

Table C5: Developmental stages of Mountain Whitefish (MW) eggs collected on substrate mats in the CLBMON-48 study area, 2011/2012, adapted from Rajagopal (1969).

River	Site	Date	MW Eggs		Number of eggs at Each Developmental Stage										
			Alive	Dead	Unfertilized	1	2	3	4	5	6	7	8	9	10
Columbia	8.5L	12-Dec-11	1					1							
	8.5M	12-Dec-11	7		2		4	1							
	8.5R	12-Dec-11	14	1		2	5	7							
	8.6L	12-Dec-11	1					1							
	8.6M	12-Dec-11	2				1	1							
	8.6R	12-Dec-11	12	1		2	9	1							
	8.7L	12-Dec-11	29	1	1	1	20	7							
	8.7R	12-Dec-11		1											
	40.5R	13-Dec-11	1										1		
	44.25R	13-Dec-11	3			1		1				1			
	46.4L	13-Dec-11		1											
	47.0MR	14-Dec-11	2	1									2		
	47.0R	14-Dec-11	4					4							
	48.0R	14-Dec-11	23		3	2	6	12							
	49.3MR	14-Dec-11	12	1	1		3	7					1		
	50.5L	14-Dec-11	1				1								
	54.0MR	14-Dec-11	1				1								
	54.1MR	14-Dec-11	3		2		1								
	8.5M	19-Dec-11	1					1							
	8.5R	19-Dec-11	31		2		13	10	6						
	8.6L	19-Dec-11	13				3	10							
	8.6M	19-Dec-11	5		2		1	2							
	8.6R	19-Dec-11	3		1			2							
	8.7L	19-Dec-11	23		4		6	9	4						
	8.7M	19-Dec-11	7			2	2	2	1						
	8.7R	19-Dec-11	2				1	1							
	43.75L	20-Dec-11	1					1							
	44.25MR	20-Dec-11		1											
	47.0R	21-Dec-11	3		1		2								
	48.0R	21-Dec-11	27			1	10	13	3						
	49.3MR	21-Dec-11	2		1			1							
	52.0L	21-Dec-11	1					1							
	54.1MR	21-Dec-11	1					1							
	8.5L	28-Dec-11	3		1			1		1					
	8.5M	28-Dec-11	2				1	1							
	8.5R	28-Dec-11	14			1	1	6	3	3					
	8.6L	28-Dec-11	10			1	3	5	1						
	8.6M	28-Dec-11	1				1								
	8.6R	28-Dec-11	1					1							
	8.7L	28-Dec-11	24		1	1	7	4	7	4					
	8.7M	28-Dec-11	4		1		3								
	8.7R	28-Dec-11	9	1		3	5	1							
	43.75L	29-Dec-11	1							1					
	46.5R	29-Dec-11	1					1							
	47.0MR	30-Dec-11	1		1										
	47.0R	30-Dec-11	2		1		1								
	47.4L	30-Dec-11	1			1									
	48.0R	30-Dec-11	14		1	3	4	3	2	1					
	49.3MR	30-Dec-11	3					3							
	54.0MR	30-Dec-11	1			1									
	54.1MR	30-Dec-11	2					1	1						
	8.5L	3-Jan-12	7				7								
	8.5M	3-Jan-12	1				1								
	8.5R	3-Jan-12	12				5		5	1	1				
	8.6L	3-Jan-12	10				3	4	1	2					
	8.6M	3-Jan-12	10				2	4		3			1		
	8.6R	3-Jan-12	2		1					1					
	8.7L	3-Jan-12	18		1		9	1	3	2		2			
	8.7M	3-Jan-12	3				1	1	1						
	8.7R	3-Jan-12	50		2	4	21	20		2		1			

Table C5: Concluded.

River	Site	Date	MW Eggs		Number of eggs at Each Developmental Stage										
			Alive	Dead	Unfertilized	1	2	3	4	5	6	7	8	9	10
Columbia	43.75L	5-Jan-12	1			1									
	44.25MR	5-Jan-12	1				1								
	46.5R	5-Jan-12	1				1								
	47.0R	6-Jan-12	7				4	1		1		1			
	48.0R	6-Jan-12	14		2	1	5	4	1	1					
	49.3MR	6-Jan-12	4			1	1	2							
	50.5L	6-Jan-12		1											
	54.0MR	6-Jan-12	1						1						
	8.5L	9-Jan-12	3		1		1	1							
	8.5M	9-Jan-12	1					1							
	8.5R	9-Jan-12	20				17	1	1	1					
	8.6L	9-Jan-12	12				5	5		2					
	8.6M	9-Jan-12	4				1	1		1		1			
	8.6R	9-Jan-12	5				4			1					
	8.7L	9-Jan-12	21		6	1	7	6		1					
	8.7M	9-Jan-12	2							1			1		
	8.7R	9-Jan-12	43		3	5	24	7	4						
	46.5R	10-Jan-12	1				1								
	47.0R	10-Jan-12	3				3								
	48.0R	11-Jan-12	5				3	1	1						
	54.0MR	11-Jan-12	1					1							
	8.5L	16-Jan-12	1			1									
	8.5M	16-Jan-12	9		1	3	4		1						
	8.5R	16-Jan-12	16		3	7	3	3							
	8.6L	16-Jan-12	3		1			1	1						
	8.6M	16-Jan-12	3			3									
	8.6R	16-Jan-12	2				1	1							
	8.7L	16-Jan-12	13		2		6	3		2					
	8.7M	16-Jan-12	1		1										
	46.5R	17-Jan-12	1				1								
	40.5ML	17-Jan-12	1			1									
	48.0R	19-Jan-12	3			1				2					
	8.5L	24-Jan-12	3						2			1			
	8.5R	24-Jan-12	16		3	1	3	6	3						
	8.6L	24-Jan-12	3				1	1	1						
	8.6R	24-Jan-12	4					4							
	8.7L	24-Jan-12	13		1		6	2	3	1					
	8.7R	24-Jan-12	3		1	1	1								
	48.0R	26-Jan-12	1		1										
	8.5L	1-Feb-12	3		3										
	8.5M	1-Feb-12	5			1	3	1							
	8.5R	1-Feb-12	25		11	1	3	3	1	5		1			
	8.6L	1-Feb-12	5	1	2		1	2							
	8.6M	1-Feb-12	1				1								
	8.6R	1-Feb-12	11				2	6	3						
	8.7L	1-Feb-12	1						1						
	8.7R	1-Feb-12	9		1		2	3	1	2					
	8.5L	7-Feb-12	1					1							
	8.5M	7-Feb-12	2				1	1							
	8.5R	7-Feb-12	4					2		1				1	
	8.6M	7-Feb-12	2				1			1					
	8.6R	7-Feb-12	1					1							
	8.7L	7-Feb-12	1							1					
	8.7M	7-Feb-12	1				1								
	8.7R	7-Feb-12	1							1					
Totals			**762**	**11**	**73**	**55**	**283**	**226**	**63**	**46**	**1**	**8**	**6**	**1**	**0**

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solutions@golder.com
www.golder.com

Golder Associates Ltd.
201 Columbia Avenue
Castlegar, British Columbia, V1N 1A8
Canada
T: +1 (250) 365 0344