Columbia River Project Water Use Plan

Lower Columbia River Fish Management Plan

Implementation Year 5

Reference: CLBMON-48

Lower Columbia River: Whitefish Life History and Egg Mat Monitoring Program: Year 5 Interpretive Report

Study Period: September 2008 to May 2013

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CLBMON-48: LOWER COLUMBIA RIVER

Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program: Year 5 Interpretive Report

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REPORT

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Cover Photo: Mountain Whitefish spawners holding in Norn's Creek, November 2012.

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Executive Summary

Mountain Whitefish (*Prosopium william soni*) 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 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 flow management on Mountain Whitefish reproductive success in the LCR. 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 an in-depth analysis of the results obtained during the five study years.

Based on the current knowledge of Mountain Whitefish spawning in the lower Columbia and Kootenay rivers, factors relating to Mountain Whitefish spawning (such as spawn timing, intensity, distribution and habitat characteristics) vary on an annual basis. There is no evidence that these inter year variations result from flow management. Water temperature appears to be the primary environmental variable that influences spawn timing. Photoperiod is another environmental factor that may influence Mountain Whitefish spawning, although in the present study the onset and peak of spawning occurred at different times between study years, which suggested that photoperiod was not a primary spawning cue. Photoperiod may be a secondary cue that initiates spawning if suitable temperature cues are not experienced by spawners. Neither water temperature nor photoperiod is influenced by flow releases from HLK or Brilliant Dam (BRD).

The component of flow management that likely poses the greatest risk to Mountain Whitefish recruitment success is egg mortality related to stranding following flow reduction events during the extended egg incubation period. Even in years when flows are maintained at or above levels present during the peak spawning period, the implementation of Rainbow Protection flows in early April typically results in the dewatering of large numbers of incubating Mountain Whitefish eggs, particularly at key spawning areas in the Columbia (CPR Island) and the Kootenay rivers. However, based on the data available from the present study and from the Large River Fish Indexing Program (LRFIP), there is no obvious effect of these annual egg losses on subsequent recruitment success, which suggests that other compensatory mechanisms may be at work. Larval surveys in the present study also identified stranding risk to rearing larvae during flow reductions in the LCR, but these effects were not quantified.

The largest numbers of larval Mountain Whitefish were encountered in the upper section of the LCR in shallow, low velocity depositional habitats with a direct connection to the mainstem. Based on low numbers of observed larvae, the locations of key larval rearing habitats downstream of the key spawning areas are unknown. Similar to larvae, the highest numbers of age-0 Mountain Whitefish (based on nighttime observations) were consistently recorded in the upper section in low relief, gently sloping near shore habitat types with fine substrates. In the summer and fall seasons, the use of nearshore areas by age-0 Mountain Whitefish was inconsistent and apparently limited to nighttime; locations or characteristics of daytime habitats remain unknown. With the low recapture rates, clumped distributions, limitations of the capture methods, and current telemetry technology, it is not possible to develop a program to reliably index young-of-the-year whitefish abundance in the LCR at this time.

The present study focused on monitoring the migrations of whitefish adults during the pre-spawning period, which coincides with the LRFIP sample period. Several tagged adults exhibited suspected spawning related movements into known spawning areas as early as late November and mid-December, which coincided with the estimated onset of spawning in the upper, Kootenay and middle sections of the study area. Some spawners travelled large distances during the pre-spawning period and this could influence LRFIP catch rates over the study period as adult whitefish migrate to spawning areas. Additional evidence of this movement is provided by catch rates in the upper Columbia and Kootenay sections that vary over the course of the LRFIP study period. Although the telemetry data cannot be used to quantify the proportions of the adult Mountain Whitefish that undertake pre-spawning migrations within the LCR, the results are sufficiently robust to show that an unknown proportion of the adult Mountain Whitefish that reside in the lower, middle and upper section of the LCR undertake significant migrations to spawning areas in other sections of the river, prior to the peak spawning period. These movements may potentially introduce biases (e.g., violation of the HBM assumption of a closed population) and confound results of the LRFIP although how or to what degree is unclear.

The pre-spawning movements of tagged Mountain Whitefish did not suggest the presence of any new major spawning areas in the mainstem Columbia River within the LCR. However, the observation of large numbers of Mountain Whitefish adults in Norn's Creek in November 2012 led to the documentation of relatively high densities of Mountain Whitefish eggs in the creek, which were comparable to egg densities recorded in the Kinnaird Rapids secondary spawning area.

Several data at night and gaps remain. The relationship between flow changes and egg re-suspension in the drift is still poorly understood and the habitats used by juvenile Mountain Whitefish in the day time are unknown. The current state of knowledge, relating the effects of flow management on the various life history stages of Mountain Whitefish is summarized in tabular format below (Table EI).

Table EI: CLBMON-48 Year 5: STATUS of OBJECTIVES, MANAGEMENT QUESTIONS and HYPOTHESES.

Management Question	Management Hypotheses	Year 5 (2013) Status
MQ1: 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?	$H_0$1: The distribution of spawning habitat used by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.	In all years examined, the upper Columbia River section provided the most extensively utilized Mountain Whitefish spawning habitat. Within this section, CPR Island and Kootenay River were identified as key spawning areas with consistently high rates of egg deposition. Tin Cup and Kinnaird Rapids were identified as secondary spawning areas where spawning occurs annually, but at a lower intensity than in the key spawning areas. Norn's Creek was confirmed as a new secondary spawning area. Other, less extensively used sites were located in the middle or lower sections. Therefore, hypothesis $H_0$1 cannot be rejected but should be rephrased as follows: "*The distribution of key and secondary spawning areas used by Mountain Whitefish in the LCR does not differ significantly between years*".
MQ2: What are the physical and hydraulic characteristics of whitefish spawning and egg incubation habitats?	$H_0$2: The physical characteristics of spawning habitats of Mountain Whitefish in the lower Columbia and lower Kootenay rivers do not differ significantly between years.	The habitat characteristics documented at the CPR Island and Kootenay River spawning areas in the present study are very similar to those recorded in the 1990s. Spawning in both areas occurred over predominantly cobble-boulder substrate. The range of depths at which egg deposition occurs at CPR Island was between approximately 1.0 m and 9.0 m depth in all study years examined. All egg deposition in the Kootenay River occurred between 0.5 m and 11.6 m depth. Mountain Whitefish spawning occurred between mean column water velocities of 0 m/s and 3.5 m/s in both key spawning areas. Secondary and low-use spawning sites in the middle and lower sections of the study area were only sampled during one spawning season; consequently, inter-year comparisons of physical and hydraulic characteristics in these areas could not be made. Therefore, based on the current dataset, hypothesis $H_0$2 cannot be rejected.
MQ3: 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?	$H_0$3: The seasonal timing of spawning by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.	Similar to what was documented in the 1990's, present study results showed that Mountain Whitefish spawning at CPR Island consistently began between early and mid-November, peaked between early to mid-January, and was essentially completed by mid-February in all three spawning seasons surveyed. In the Kootenay River, Mountain Whitefish exhibited a consistent bimodal spawning pattern in all years. The initial peak occurred between mid-December and early January, while the subsequent peak occurred in mid-January. The onset and peak spawning periods in the key areas occurred over varying discharge patterns, which indicates that discharge was not the primary cue to initiate spawning or determine peak spawning. Therefore, based on the results of the present study, hypothesis $H_0$3 cannot be rejected
MQ4: 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?	$H_0$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.	Based on River 2D modelling as part of the CLBMON-47 program, the highest probability of egg deposition was between depths of 1.0 m to 4.5 m at CPR Island and between 3.0 m to 4.5 m.in the Kootenay River. Flow management affects water depth, water velocity patterns, and substrate type availability, which are all important determinants of spawning site selection by Mountain Whitefish. As water elevation and depth change within the key spawning area as a result of flow management, the locations of areas with preferred characteristics may shift as well. This could lead to spawners selecting differing areas to deposit eggs, resulting in differences in vertical distribution. However, given the highly localized and patchy egg distribution patterns observed at both key spawning sites and the relatively low inter-annual variability in flow during the spawning season, particularly in the Kootenay River, associations between egg deposition patterns and flow management could not be identified with the data available. Therefore, based on the current dataset, hypothesis $H_0$4 cannot be rejected.
MQ5: What are the pre-spawning and post-spawning seasonal movement patterns of Mountain Whitefish? How do sub-adult and adult migrations affect the interpretation of annual index monitoring programs?	$H_0$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 population abundance/characteristics.	The LRFIP indexing program only monitors abundance in the early fall period and has not identified trends that would suggest that sub-adults undergo significant migrations during that time. The present study focused on monitoring the migrations of adults during the pre-spawning period. An unknown proportion of adult Mountain Whitefish that reside in the lower, middle and upper section of the LCR undertake significant migrations to spawning areas in other sections of the river, prior to the peak spawning period. These movements may potentially introduce biases (e.g., violation of the HBM assumption of a closed population) and confound results of the LRFIP although how or to what degree is unclear. Therefore, $H_0$5 is accepted.
MQ6: 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?	$H_0$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 largest numbers of larval and young-of-the-year (YOY) Mountain Whitefish were encountered in the upper section of the LCR in shallow, low velocity depositional habitats with fine substrates and a direct connection to the mainstem. YOY used these areas during the night but not during the day. Day time habitat use by YOY fish remains unknown. With low recapture rates, clumped distributions, and limitations of the capture methods and current telemetry technology, it is not possible to develop a reliable program to index YOY abundance in the LCR at this time. Therefore, hypothesis $H_0$6 is rejected.

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1.0 INTRODUCTION

1.1 Background

Mountain Whitefish (*Prosopium william soni*) 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 use of nearshore habitats, characterised by low gradient and water velocity, and utilised as rearing habitat by larval and young-of-the-year (YOY) Mountain Whitefish (R.L.&L. 2001).

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, 1998, 1998a, 1999, 2000, 2001a). Relevant information obtained from these studies (hereafter called the 1990s studies) is incorporated into subsequent sections of this report where appropriate.

Since 2001, Mountain Whitefish have been one of three index species examined annually during BC Hydro's Large River Fish Indexing Program (LRFIP). The LRFIP was designed to provide a long-term database to track population metrics and where possible, relate changes in these metrics to biotic (e.g., changes in predator population abundance) or abiotic factors (e.g., changes in river regulation patterns; Golder 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009a, 2010a, 2011a). This program 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 five year program called 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, with a focus on two key spawning areas. These areas include the Columbia River near Castlegar, BC (hereafter called CPR Island) and in the lower Kootenay River downstream from BRD (the Kootenay River), areas that were identified during studies conducted in the 1990s. This information is needed to inform management actions related to the effects of flow regulation on Mountain Whitefish recruitment success. The results of previous study programs on Mountain Whitefish distribution, movements, spawning behaviour and habitat selection, and early life stage biology in the LCR, plus relevant information from the primary literature reviewed during the course of those studies formed the basis for the design and approach used for CLBMON-48. Additionally, over the course of the five year CLBMON-48 program, an adaptive study approach was used, where the results of the previous year's studies were used to develop the next year's study program. In this way, different approaches to obtaining the information required to address the management questions were explored. This process is described in detail during each of the annual CLBMON-48 reports prepared from 2008 to 2011 (Golder 2009, 2010, 2011, 2012).

This report presents the results of the final year (Year 5: 2012 – 2013) of field studies, provides an in-depth analysis of the data collected over the course of the entire CLBMON-48 study program, and incorporates results from past studies of Mountain Whitefish in the LCR and from the literature.

1.2 Management Questions, Hypotheses, and Study Objectives

As stated in the CLBMON-48 Terms of Reference (BC Hydro 2007), the 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 (MQ) associated with the CLBMON-48 monitoring program are:

MQ1: 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?

MQ2: What are the physical and hydraulic characteristics of spawning and egg incubation habitats?

MQ3: 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?

MQ4: 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?

MQ5: What are the pre-spawning and post-spawning seasonal movement patterns of whitefish? How do sub-adult and adult migrations affect the interpretation of annual index monitoring programs?

MQ6: 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 Loss Model (Golder 2003a). These null hypotheses are:

$H_0$1: The distribution of spawning habitat used by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.

$H_0$2: The physical characteristics of spawning habitats of Mountain Whitefish in the lower Columbia and lower Kootenay rivers do not differ significantly between years.

$H_0$3: The seasonal timing of spawning by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years.

$H_0$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:

$H_0$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 population abundance/characteristics.

$H_0$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 5 field program was intended to assess egg drift after deposition, spawning activity in Norn's Creek, and the locations and characteristics of post-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 5 were:

1. *Document the spatial extent and physical characteristics of whitefish spawning areas in at the Kootenay River key spawning area. (MQ 1 and MQ 2).*
2. *Quantify the periodicity (timing), intensity and distribution of Mountain Whitefish spawning at the Kootenay River key spawning area during the December, January, and February spawning period. (MQ 3).*
3. *Document the vertical distribution (depth) of Mountain Whitefish eggs at the Kootenay River key spawning area. (MQ 4).*
4. *Document egg drift at the Kootenay River key spawning are a after disposition during flow increases from BRD (MQ 4).*
5. *Document egg stranding in the Kootenay River during flow reductions from HLK or BRD (MQ 4).*
6. *Assess Mountain Whitefish spawning in Norn's Creek (MQ 1).*
7. *Identify and characterize the rearing habitats utilized by larval Mountain Whitefish, and determine if operations during the protracted emergence/rearing period displace larvae to different rearing habitats. (MQ 6).*

The scope of CLBMON-48 Year 5 included:

1. *Conduct a modified egg collection mat sampling program in the Kootenay River key spawning area. This will characterize egg deposition prior to the deployment of D-ring samplers and will also supplement spawning-related data collected in Years 2 to 4.*
2. *Conduct intensive D-ring sampling program in the Kootenay River spawning area during a planned flow increase from BRD. This program was designed to provide information on the effects of flow increases on egg displacement and drift.*

3. *During flow reductions from HLK and/or BRD, conduct post peak spawning egg stranding surveys at the Kootenay River key spawning area. This would allow for comparisons of stranding rates between spawning areas and study years.*

4. *Conduct a kick netting program in Norn's Creek. This program was designed to verify anecdotal evidence of Mountain Whitefish spawning in the creek, identify potential spawning areas within the creek, and provide qualitative data on spawning intensity and timing.*

5. *Conduct systematic larval stranding surveys during the spring period to obtain additional information on larval Mountain Whitefish biology and habitat use.*

2.0 METHODS

The following provides a brief summary of the primary methodology that was used during Years 1 to 5 of the CLBMON-48 study program. For a more detailed description of methods used in Years 1 to 4, the reader is referred to the annual reports that are referenced in the introductory paragraphs of each of the major methods descriptions.

2.1 Study Area

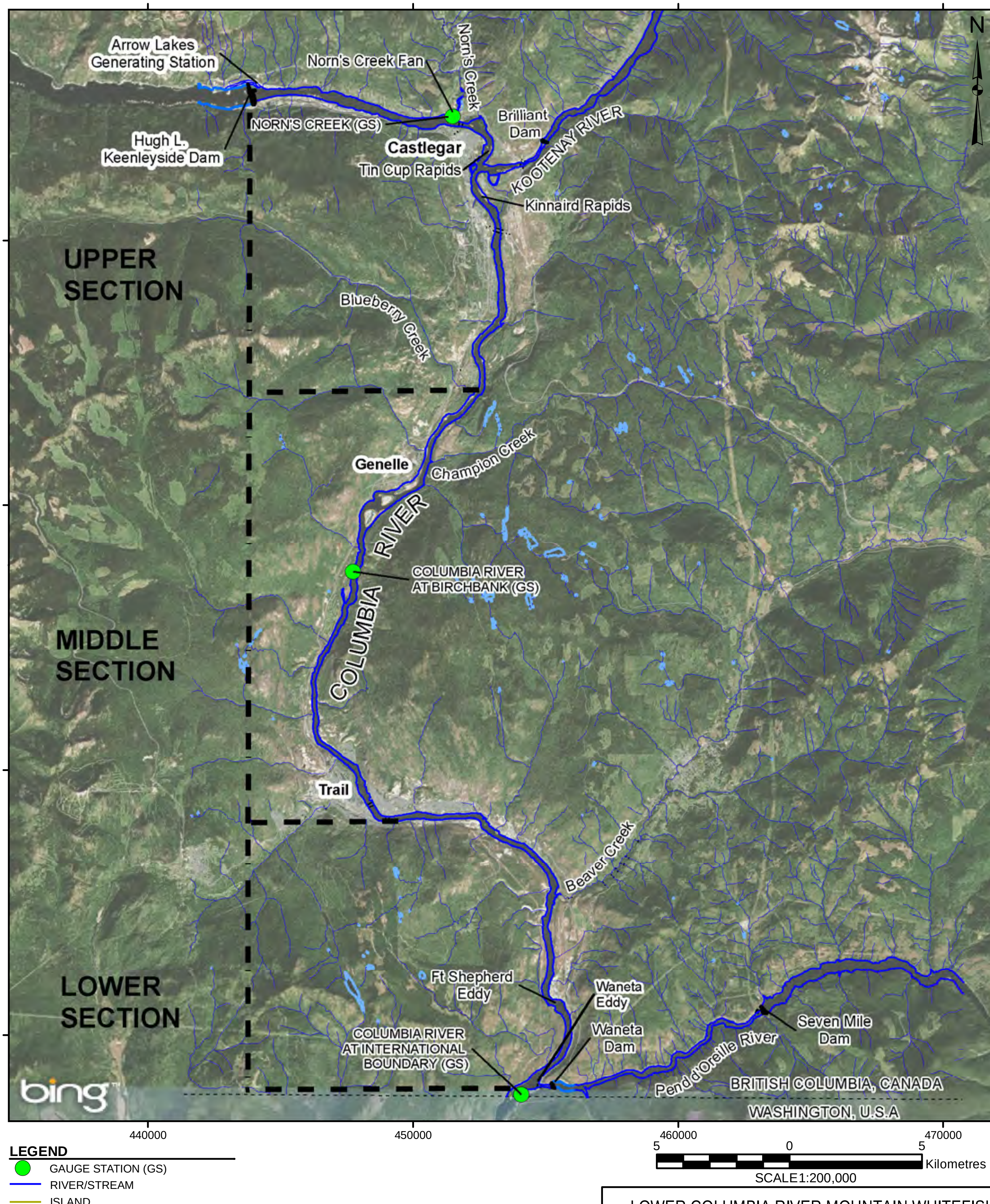
The geographic scope of the CLBMON-48 study was the approximately 56 km section of mainstem LCR from HLK to the Canada-US border (Figure 1). This included the 2.8 km length of the lower Kootenay River from BRD to the confluence with the Columbia River. Sampling in all study years was primarily focussed on the upper section of the study area from River Kilometre (RKm) 0.0 to RKm 23.0, and included the lower Kootenay River (Figure 1). A lesser degree of sample effort was expended in the middle (RKm 23.1 to RKm 40.0; Figure 1) and lower (RKm 40.1 to the Canada-US border at RKm 56.5; Figure 1) Columbia River sections of the study area.

2.2 Sampling Chronology

The chronology for all sampling activities conducted during CLBMON-48 program is provided in Table 1. Over the course of the study, adult and juvenile Mountain Whitefish sampling typically occurred in the fall, while egg and larval sampling occurred in the winter and spring. An in-depth summary of the timing of all sampling is provided in Appendix A, Tables A1 to A5.

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

	Adult Sampling				Egg/Larval Sampling			Juvenile Sampling			
Study Year	**Capture and tagging**	**Boat-based tracking**	**Land-based tracking**	**Sex ratio, fecundity, age-at-maturity**	**Spawn survey**	**Egg strand survey**	**Larval survey**	**Snorkel survey**	**Boat electro-shocking**	**Tagging survival**	**Habitat survey**
2008 – 2009 (Year 1)	Yes	Yes	Yes					Yes	Yes		Yes
2009 – 2010 (Year 2)					Yes	Yes	Yes		Yes	Yes	Yes
2010 – 2011 (Year 3)					Yes	Yes			Yes	Yes	
2011 – 2012 (Year 4)				Yes	Yes	Yes	Yes				
2012 – 2013 (Year 5)					Yes	Yes	Yes				



LEGEND

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

REFERENCE

1. SERVICE LAYER CREDITS: © HARRIS CORP, EARTHSTAR GEOGRAPHICS LLC STATE OF MICHIGAN
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

OVERVIEW OF STUDY AREA

Golder Associates

PROJECT NO. 10-1492-0111			SCALE AS SHOWN	REV. 0
DESIGN	BH	19 Sep. 2012	FIGURE: 1	
GIS	JG	19 Sep. 2012		
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

2.3 Physical Parameters – All Study Years

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 in the Columbia River at the BC Hydro monitoring station adjacent to Norn's Creek Fan and the Water Survey of Canada gauging station at Birchbank (Figure 1). Water temperatures for the lower portion of the LCR were obtained from a BC Hydro temperature monitoring station at RKm 54.5. Water temperatures in the Kootenay River were collected using paired Vemco™ Minilog12 temperature data loggers (accurate to ± 0.5°C) that were deployed on a cobble island downstream of BRD (RKm 1.0, Appendix A, Figure A4). BC Hydro also provided temperature data for the Kootenay River.

In Year 4, paired Vemco™ Minilog12 temperature data loggers (accurate to ± 0.5°C) were also deployed on each side of the river at RKm 8.6 (Appendix A, Figure A4) to determine if cooler water from Norn's Creek influenced water temperatures in the key Mountain Whitefish spawning area at CPR Island.

Spot measurements of water temperature were obtained at the time of sampling using either a calibrated hull-mounted Airmar® digital thermometer (accurate to ± 0.2ºC) or a hand-held thermometer (accurate to ± 0.1ºC).

2.3.2 Discharge

All discharge data for the LCR during the study period 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 (Figure 1). Kootenay River discharge during the study was provided by the operators of BRD (Fortis BC) in the form of hourly spill and generation plant discharges from BRD.

2.4 Evaluation of Suitable Methodology

Since 1990, a wide variety of fish capture/observation techniques have been deployed on the Columbia River within the LCR study area to capture and document life history and habitat use patterns of Mountain Whitefish. The main sample methods used were boat electrofishing (night and day), backpack electrofishing (night and day), stationary gill nets, beach seines (night and day), Gee traps, baited set lines, underwater video (towed and ROV systems), and angling (Table 2). Results from previous studies that employed these methods (R.L.&L.1995, 1995a, 2001, Golder 2002) were reviewed in Year 1 of the present study to determine their relative effectiveness at capturing and/or documenting juvenile and adult Mountain Whitefish abundance and habitat use in the LCR as a means to address MQ5 and test H_05. The following provides a summary of that review:

- Boat electrofishing (night and day): High effectiveness for capturing juveniles and adults; YOY do not attain a sufficient size to effectively recruit to this gear until the fall. High water clarity in the Columbia system reduces the effectiveness of this technique during the day and requires that sampling be conducted at night.

- Backpack electrofishing (night and day): Low effectiveness for adults and moderate effectiveness for juveniles. High water clarity in the Columbia system reduces the effectiveness of this technique during the day; slightly more effective at night, but safety considerations limit areas that can be sampled.
- Stationary gill nets: Moderately effective at capturing adults and older juvenile Mountain Whitefish, however suitable locations for gillnetting are limited in the study area; tends to be a very lethal capture method.
- Beach seines (night and day): Low effectiveness for adults and moderate effectiveness for larval stages. Ineffective at capturing larger YOY and age-1 juveniles due to limited areas suitable for sampling by this method and high water clarity. Despite the ability to capture larval life stages by this method, sampling for this life stage was not considered as a viable index of recruitment success to the age-1+ population due to the very high mortality rates associated with the larval life stage.

Table 2: Summary of Mountain Whitefish caught by the main sample methods used on the Columbia River from 1990 to 2007.

Sample Method	Effort Expended	Juvenile Mountain Whitefish Captured[a]	CPUE (fish/m^2)	Reference
Beach Seine	65,134 m^2	136	*<0.01*	R.L.&L. 1995
	6,570 m^2	14	*<0.01*	R.L.&L. 1995a
	32,556 m^2	2925 [b]	*0.09*	R.L.&L. 2001
Backpack Electrofishing	95,615 m^2	22	*<0.01*	R.L.&L. 1995a
	56,690 m^2	6	*<0.01*	R.L.&L. 1995b
	15,329 m^2	165 [c]	*0.01*	R.L.&L. 2001
Gill Net	61.3 net-units [d]	61 [e]	*N/A*	R.L.&L. 1995a
Boat electroshocking	1,659 km	7240	*N/A*	Golder 2002-2008

[a] Juvenile defined as an individual <250 mm FL
[b] Of these, 2923 were larval whitefish; only two were young-of-the-year
[c] Of these, 134 were larval whitefish; only one was a young-of-the-year
[d] 1 net unit = 100 m^2 of gill net set for the equivalent of 24 h
[e] Includes adult Mountain Whitefish.

Other methods employed at various levels of effort were baited set lines, Gee minnow traps, underwater video systems, angling, boat set seines, hoop traps (baited and unbaited), diver surveys (night and day), and snorkel surveys (night and day). Of these, baited set lines, Gee traps, and hoop traps were considered unsuitable as these methods failed to capture Mountain Whitefish in the LCR. The suitability of the remaining methods is summarized below:

- Underwater video (towed and ROV systems): Low suitability for all life stages. Flow velocities in areas preferred by Mountain Whitefish are generally too fast for effective use of this method; also possible active avoidance of camera during the day. More effective at night, where concentrations can be identified in selected habitats with suitable depths and velocities.
- Angling: Low suitability; only captures larger juveniles and adults and requires a substantial degree of effort.

- Boat set seines: Low suitability for adults and unsuitable for juveniles; very limited areas where this method can safely or effectively be used due to high flow velocities, uneven bottom type, and the frequency of bottom snags and obstructions.
- Diver surveys (night and day): Low suitability for all life stages; occasional individuals (mainly adults) have been observed during dive surveys; inability to capture fish and problems with fish ID in turbulent fast flows further reduces suitability of this method.
- Snorkel surveys (night and day): Low suitability for adults and moderate suitability for juveniles; effective technique to enumerate and identify habitats used by YOY and older juveniles in locations where flow velocities and current patterns allow controlled and coordinated movements of the snorkel team. In the Columbia River, locations that exhibit sufficiently shallow depths and suitable conditions for snorkeling are very limited and, in most cases, are restricted to the immediate nearshore areas. At any distance off shore, velocities and turbulence rapidly increase to a point where accurate identification and enumeration of fish become highly questionable. Other limitations are: 1) Mountain Whitefish are not highly cover oriented and tend to actively avoid divers and swimmers in clear water systems; and, 2) the method relies on subjective visual assessments of species and fish size.

The most effective methods for capturing or observing Mountain Whitefish were boat electrofishing (juveniles and adults; Table 3), snorkel surveys (juveniles) and visual surveys (larval). For this reason, these techniques were selected as the primary methods used to sample Mountain Whitefish in the LCR and address the management questions described in Section 1.2 for CLBMON-48.

2.5 Adult Mountain Whitefish Sampling – Years 1 and 4

Adult Mountain Whitefish were collected during Year 1 (Golder 2009) to obtain individuals for a telemetry study and again in Year 4 (Golder 2012) to assess sex ratio, age-at-maturity, and fecundity. Sections 2.5.1 and 2.5.2 provide a general discussion of methods used in those study years; for specific details, the reader is referred to the respective reports cited above. In-depth descriptions of LRFIP sampling, fish handling/processing, and fish aging procedures are described in the CLBMON-45 2011 annual report (Ford and Thorley 2012).

2.5.1 Adult Telemetry Program – Year 1

In Year 1, 50 adult Mountain Whitefish from the study area were implanted with both radio and acoustic transmitters (dual-tagged; Appendix B, Plate 1) to obtain information on the pre- and post-spawning related movements (Golder 2009). The fish were captured as part of the LRFIP boat electroshocking surveys conducted in the LCR in October. These data were needed to address *MQ5* and test H_05 (adult whitefish undertake significant migrations during pre-spawning and spawning periods, which affect stock assessments). To provide information on spawning movements of whitefish from different areas of the LCR, candidate adult Mountain Whitefish were tagged and released in each of four established sample sections (see Section 2.5.1.1). The number of tags deployed in each section within the study area was roughly based on the adult Mountain Whitefish CPUEs (fish/km/hr) recorded during the 2007 LRFIP (i.e., more fish were tagged and released in sections with higher CPUEs; Table 3). The target ratio of female to male Mountain Whitefish tagging was set at approximately 3:1, as females were considered more likely to return to specific spawning areas, while males could potentially move between several spawning areas and spawn more than once.

Prior to the purchase of the 50 radio tags for implantation into candidate adult Mountain Whitefish, ambient noise and radio frequency (RF) interference at eight of the known Mountain Whitefish spawning locations in the LCR was determined following procedures outlined in Sisak and Nass (2007). The assessment identified a preferred set of candidate low-noise frequencies common to all monitoring locations; 25 of the radio tags purchased were programmed with the frequency 148.460 kHz and 25 tags were programmed with the frequency 148.780 kHz.

Table 3: Adult Mountain Whitefish CPUEs by river section (data from 2007 LRFIP study) and the target number of tags and sex distribution of the tags to be deployed in each section, 2008.

Section	CPUE (fish/km/hr)	Percent	Tags per section - Session 1	Females	Males	Tags per section - Session 2	Females	Males
Lower Kootenay	97.57	53.5	8	6	2	8	6	2
Upper Columbia	54.47	29.9	7	5	2	7	5	2
Middle Columbia	20.82	11.4	5	4	1	5	4	1
Lower Columbia	9.49	5.2	5	4	1	5	4	1

2.5.1.1 Surgical Tag Implantation and Fish Handling

Captured adult Mountain Whitefish that met the sex and health criteria (described below) were tagged with both an internal radio tag and an internal acoustic tag, hereafter referred to as a “dual-tag”. Fish were tagged and released in proximity to their capture location. The radio tag component of the dual-tag allowed fish to be detected in shallow depths and in turbulent riverine habitat. During mobile tracking surveys, the radio transmitter also allowed detection and triangulation of position by boat-based mobile tracking crews. The acoustic tag component allowed detection of the fish at depths greater than 8 m, which is similar to the typical maximum detection depth of most radio transmitters. The main benefit of the acoustic tags was detection of tagged Mountain Whitefish by the existing VR2W acoustic monitoring stations deployed throughout the LCR as part of the Juvenile White Sturgeon Indexing Program (Section 2.5.1.2; Golder 2009b).

The dual-tag consisted of a Lotek Nanotag NTC-4-2L coded radio tag and a Vemco V92H coded high output (147 dB) acoustic tag (Table 4). In total, 50 tags of each type were implanted into fish. A list of all implanted radio and acoustic tag codes and frequencies is provided in Appendix C (Table C1). The dual-tag combination had a total combined weight of 6.8 g. Minimum weight acceptable for tag implantation was 272 g, which is equivalent to a tag/body weight ratio of 2.5%. Life expectancy of both tags was sufficient to allow the tags to remain active from October 2008 throughout the entire spawning period starting in late November and ending in late February 2009.

Prior to surgery and sedation of the fish, the radio and acoustic tags were activated and tested to verify tag function. Once the activation was confirmed, the tags and all surgical instruments were disinfected and then transferred to a rinse tray filled with distilled water. Surgeons used latex surgical gloves rinsed with isopropyl alcohol. To maintain the integrity of the fishes’ mucous coat, handling of the fish was done using latex gloves and a “fish-friendly” soft-mesh transfer net.

Table 4: Specifications of radio and acoustic tags implanted in adult Mountain Whitefish, 2008.

Tag Characteristics	Radio Tag Component	Acoustic Tag Component
Tag Type:	Lotek NTC-4-2L	Vemco V92H
Weight in Air:	2.1 g	4.7 g
Tag Length:	18.3 mm	29 mm
Burst Interval:	5 sec	120 sec
Expected Tag Life:	163 days (extended life option).	185 days

Two adult tagging sessions occurred during the Year 1 study (Appendix A, Table A1). During both tagging sessions, the surgery crew set up at the following locations in each LRFIP section:

- lower Kootenay section: Left Upstream Bank at Kootenay Eddy (RKm 0.3);
- upper Columbia section: Right Upstream Bank at Balfour Bay (RKm 2.7);
- middle Columbia section: Left Upstream Bank at Birchbank (RKm 28.7); and,
- lower Columbia section: Right Upstream Bank at Beaver Creek Launch (RKm 47.4).

Candidate fish were transferred directly to a shore-based surgery crew at locations accessible by road. A plastic stock trough (300 litre capacity) was filled with water and divided in half to provide pre-surgery holding and post-surgery recovery tanks. Water circulation and compressed oxygen were provided to maintain oxygen levels for fish awaiting surgery and promote rapid recovery of fish after surgery and tag implantation.

Only fish in good condition following capture were selected for tag implantation. Fish selected were processed and tagged under anaesthesia using a clove oil bath to sedate the fish following the sedation and surgical protocols developed by Carleton University during CLBMON-18: Middle Columbia River Adult Fish Habitat Use Program (Taylor et al 2011). The area of the incision was disinfected and a surgical drape with a small aperture was used to cover the fish so that only the incision site was exposed. An incision approximately 1 to 1.5 cm in length was made through the abdominal wall, starting at approximately 6 cm anterior of the cloacal vent and slightly off the midline, posterior to the liver. The radio tag was implanted first, followed by the acoustic tag (Appendix B, Plate 2). The incision was then closed with two to three interrupted stitches using Ethicon® monofilament 2-0 sutures swedged on a cutting needle.

After the surgery, the fish were placed in the recovery portion of the trough until fully recovered from the anaesthetic. Once the fish appeared to be healthy and vigorous, they were immediately released into a slack water area near the surgery location. After release, the movement of the fish was monitored to ensure that they actively swam to depth and did not remain in shallow water or at rest on the river bottom at the release site. A surgical record and tag deployment datasheet was used to document the tagging and release process.

Data collected included fork length (FL; to the nearest millimetre), weight (to the nearest gram), and sex and maturity where determined by external examination, or release of gametal products. Ageing structures (scales) were collected from all individuals captured in accordance with the methods outlined in Mackay et al. (1990). All fish were marked with a Plastic Infusion Process (PIP) Passive Integrated Transponder (PIT) tag (tag model ENSID Fusion 11 mm FDX-B), inserted into the dorsal musculature on the left side below the dorsal fin and between the pterygiophores. After insertion, PIP-PIT tags were checked to ensure they were inserted securely and the tag number was recorded.

2.5.1.2 Telemetry Tracking and Spawning Habitat Assessments

Acoustic tracking was accomplished using an existing VR2W array in the LCR that consisted of 22 remote telemetry receivers (VR2s and VR2Ws manufactured by Vemco Ltd.). This array was initially established to monitor movements of acoustic tagged White Sturgeon in the LCR (Golder 2009b).

The downloading of the VR2W acoustic monitoring stations was conducted in conjunction with BC Hydro’s Juvenile White Sturgeon Indexing Program. The VR2W stations were downloaded once in October and November 2008 and twice per month between December 2008 and February 2009. Acoustic telemetry data associated with Mountain Whitefish movement was extracted from the White Sturgeon database structure and incorporated into the database designed for analyzing Mountain Whitefish movement data. Upon return to the office, data were uploaded to a Vemco VUE database. Data were then exported into Microsoft Excel and Access for analysis.

During the VR2W array download sessions, the field crew used a Lotek SRX_400A radio receiver and a portable four element Yagi antenna mounted on a 3 m PVC mast to opportunistically track radio tagged Mountain Whitefish as they moved between VR2W stations. The general location and river kilometre of fish detected during the radio tracking were recorded on data sheets and on aerial photos. Due to limited time available for this opportunistic radio tracking, the field crew did not triangulate the position of detected fish and did not collect associated habitat data.

Mobile land-based radio tracking of the Columbia and Kootenay rivers was conducted at monthly intervals over the study period. Field crews accessed selected radio tracking sites along the Columbia and Kootenay rivers by truck. Once at a tracking site, the field crew set up the Lotek receiver and antenna and scanned for both radio frequencies in an upstream, perpendicular to the shoreline, and downstream directions. Once a tag was detected, the nearest river kilometre was recorded and the approximate location marked on an aerial photograph. Other parameters recorded were date, time, weather conditions, and any obvious habitat association. All mobile tracking results were recorded on standardized datasheets and in the project field book.

Boat-based telemetry tracking sessions were conducted during the peak Mountain Whitefish spawning period between December 2008 and January 2009 to determine the location of tagged fish (Appendix A, Table A1; Appendix B, Plate 3). Tracking was conducted over a two day period, with the crew tracking from HLK to Genelle on day 1, and from Genelle to the Canada-US Border on day 2 (Figure 1). Once a fish was detected, the field crew attempted to verify the location of the fish by lowering the gain of the receiver and finding the location with the highest signal strength. For each triangulated location the crew recorded the fish radio tag code, UTM coordinates, water depth, mean column water velocity, distance in metres to near river bank, date, and time. A weighted anchor of known size (24 cm in length by 18.5 cm wide) was lowered to the river bottom for reference and a view tube was used to estimate substrate size. A description of habitat and shoreline features at the triangulated location was also recorded.

2.5.2 Sex Ratio, Fecundity and Age-at-Maturity Sampling – Year 4

To update information collected in the mid-1990s on Mountain Whitefish sex ratios, fecundity, and age-at-maturity (R.L.&L. 2001), 90 adult Mountain Whitefish were sacrificed from randomly selected sites within the four sections of the LRFIP study area (see Section 2.1) in Year 4. Although these data were not required to address a specific management question or test a specific hypothesis, the data were considered necessary to identify if potential changes to these reproductive spawning metrics had occurred since the 1990s and what effect these changes would have on spawning intensity, egg capture rates, and potential egg deposition (PED) estimates. The fish were collected from the last sample session of the LRFIP, during October 2011. 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 day, 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).

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);
- weight of 100 eggs (g);
- abnormalities of internal organs (Appendix B, Plate 4); 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 total number of eggs from three ovaries (selected at random) was 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 (Ford and Thorley 2012).

2.6 Mountain Whitefish Spawn Monitoring – Years 2 to 5

A primary objective of the CLBMON-48 study was to monitor key Mountain Whitefish spawning areas identified during the 1990s and increase our knowledge on the location, timing, and depth distribution of Mountain Whitefish spawning in the LCR. This information was necessary to address *MQ1*, *MQ2*, *MQ3*, and *MQ4* and to test H_01, H_02, H_03, and H_04. The methods used to identify and monitor spawning activity are similar to those developed in the 1990s studies and are detailed in each of the Years 2 to 5 reports (Golder 2009, 2010, 2011, 2012, and present study). A general description of the spawn monitoring program along with specific methods employed in Year 5 (if these differed from previous studies) are provided in Sections 2.6.1 to 2.6.3.

2.6.1 Egg Collection Mats – Years 2 to 5

The main advantage of egg collection mats over other spawn monitoring methods is that the mats are passive samplers that can be deployed over long periods with little or no maintenance. The processing time of retrieved egg mats is generally shorter than other spawn monitoring equipment (e.g., D-rings or air lift samplers). This allows for a cost effective program for sampling spawning over its entire period.

In Years 2 to 5, egg collection mats were used to characterize Mountain Whitefish spawning at the previously established key Mountain Whitefish spawning areas at CPR Island and the Kootenay River (Appendix A, Figures A4 and A5). In Years 2 and 4, mats were also used in the middle and lower sections of the LCR study area at synoptic sites (Blueberry Creek, Genelle, between Trail and Waneta Eddy; Appendix A, Figures A6 and A7) to assess the level of spawning and to identify potential additional key spawning areas. In Year 5, a modified egg collection mat program was conducted in the Kootenay River in order to characterize egg deposition prior to a proposed D-ring program to study egg drift.

At the key spawning areas, typically three cross-sectional transects were established using three sets of paired egg collection mats at each transect, for a total of 18 collection mats. In Year 3, the number of transects and paired mat sets in the key spawning areas was increased to provide data to the CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topography Survey program to assist in updating the current Whitefish Egg Loss Model (Golder 2012a). At synoptic sites, mats were deployed in areas with similar habitat characteristics to the key spawning areas, where sampling was feasible. Paired egg mat sets were deployed along the left and right upstream banks, as well as mid-channel to increase the sampling coverage. All 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 each program. 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 rope or cable stringer. When deployed, the mats rested on the river bottom (Appendix B, Plate 5) and trapped eggs that drifted downstream. The egg collection mats were retrieved either by hand or by an electric winch mounted on the bow of a jet drive river boat. Once on-board, the mats were inspected and all collected whitefish eggs were counted and removed using forceps. A random subsample of up to 30 eggs per mat was preserved in Stockard's solution 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. During the mat retrieval and examination 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.

2.6.2 Egg Developmental Staging - Years 2 to 5

All preserved eggs were staged in a laboratory using a dissecting microscope and classified according to egg developmental stages. 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, where one thermal unit equals 1^{o}C above 0^{o}C for a 24 hour period; (Table 5) to reach each stage. All subsequent references to egg developmental stages in this report are based on the stage classification system described by Rajagopal (1979; Table 5).

To estimate the spawn timing of collected eggs (herein referred to as spawning events), the water temperatures recorded at the spawning sites or at temperature stations located upstream (see Section 2.3.1), 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.

Table 5: 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

2.6.3 Kick Netting – Year 5

In Year 5, Golder staff observed an aggregation of adult Mountain Whitefish in Norn's Creek (Figure 1; cover photo). To verify spawning activity in this system and the extent of spawning, kick net surveys within Norn's Creek were conducted in February 2013 (Appendix A, Table A5). These surveys occurred in the approximate 2.3 km creek length between the creek mouth and the impassable Norn's Creek falls. A crew member waded into the stream and placed the net end of a long handled, fine mesh dip net on a randomly selected area of the stream bottom. The crew member then disturbed an approximate 1 m^2 area of substrate immediately upstream of the net with their feet (Appendix B, Plate 6). Eggs deposited within the disturbed substrate became dislodged and drifted into the net. Captured eggs in each kick net location were inspected for viability, enumerated, and then returned to the creek.

2.7 Egg Stranding Surveys – Years 2 to 5

An additional objective of the CLBMON-48 study was to assess the effects of flow reductions on incubating Mountain Whitefish eggs. This information was necessary to address *MQ4*, to test $H_0 2$ and $H_0 4$, and improve annual estimates of egg mortality due to flow reductions in the LCR. The methods used to conduct stranding surveys are similar to those developed in the 1990s studies and are detailed in each of the Years 2 to 5 reports (Golder 2010, 2011, 2012, and present study). A general description of the stranding surveys along with specific methods employed in Year 5, where these differed from previous studies, are provided below.

Immediately after notification from BC Hydro of flow reductions from HLK and BRD, crews were dispatched to examine dewatered shoreline areas for Mountain Whitefish eggs (Appendix A, Tables A2 to A5). Egg stranding surveys in Years 2 to 5 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. Surveys were also conducted along selected transects from the BC Hydro HEC RAS model to provide data that could be incorporated into the update of the Mountain Whitefish Egg Loss Model (Golder 2003a).

Randomly selected transects were established within each area. Each transect was set perpendicular to the shoreline and extended from the water's edge to the top of the dewatered zone. Along each transect, the substrate was removed, and stranded Mountain Whitefish eggs were enumerated (Appendix B, Plate 7). In Year 3, transects were selected using Generalized Random Tessellation Stratified (GRTS) spatially-balanced sampling design (Golder 2012a), and were conducted at CPR Island for inclusion in the update of the Mountain Whitefish Egg Loss Model. 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 each transect were also recorded.

In Year 4, exploratory 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 the 1990s (Appendix A, Table A4). 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.

In Year 5, sampling for stranded eggs was limited to transect surveys in the Kootenay River. In contrast to randomly selecting transects for sampling, Year 5 stranding surveys sampled the dewatered shoreline at each egg collection mat transect.

2.8 Juvenile Mountain Whitefish Assessments – Years 1 to 3

Another objective of the CLBMON-48 study was to determine the location and characteristics of juvenile Mountain Whitefish rearing habitats in the LCR and to assess whether it is possible to develop a reliable indexing program for this early life stage. This information was required to address *MQ6* and test $H_0 6$. The methods used to capture and/or observe juvenile whitefish were similar to those developed in the 1990s studies and were detailed in each of the Years 1 to 3 reports (Golder 2009, 2010, 2011). A general description of the stranding surveys along with specific methods employed in Year 5, where these differed from previous studies, is provided below.

2.8.1 Boat Electroshocking – Years 1 to 3

To assess the feasibility of using boat electroshocking to index juvenile Mountain Whitefish (defined as YOY and age-1 cohorts), preliminary sample locations were selected based on information collected as part of BC Hydro's LRFIP for the LCR. The entire LRFIP database was queried to identify areas with high catch-rates of juvenile Mountain Whitefish. Historically, field crews have recorded comments regarding the locations and habitat preferences of juveniles; these comments also were queried to determine which electroshocking sites typically had high numbers of juveniles. The total number of juvenile Mountain Whitefish (by boat electroshocking site and by bank habitat type) was calculated and divided by the length of shoreline sampled to get an estimate of juveniles per kilometre of shoreline. Boat electroshocking sites (and habitat types within those sites) with the highest juvenile concentrations were selected for subsequent sampling.

Sampling in each study year was divided into two sample sessions approximately one week apart. During each session, sampling was conducted in depositional areas in the upper portion of the study area and in areas known to support high concentrations of juvenile Mountain Whitefish. Sampling was concentrated in the upper portion of the study area. Lesser effort was applied in the middle and lower portions of the study area also known to have higher concentrations of juveniles (i.e., depositional areas downstream of Genelle and upstream of Fort Shepherd Eddy) and in areas that have not been previously sampled but could contain high concentrations based on habitat type.

Boat electroshocking was conducted using a Smith-Root Inc. high-output GPP 5.0 electroshocker operated out of a 5.5 m 120 Hp jet-drive riverboat by a three-member crew. The electroshocking procedure consisted of manoeuvring the boat into shallow-water areas along the shoreline of sample sites. Two crew members positioned on a netting platform at the bow of the boat collected stunned fish, while the third crew member operated the boat. Captured fish were immediately placed into a 175 L onboard live-well. Compressed oxygen was used to maintain dissolved oxygen in the livewell at levels similar to those in the river. Fish that avoided capture, but were positively identified, were enumerated and recorded as “observed”. The time sampled (seconds of electroshocker operation) was recorded for each sample site. If, due to logistical reasons, a site was not fully sampled, the difference in distance between what was sampled and the established site length was estimated and recorded on the site form. The upstream and downstream ends of all sample sites were recorded with a GPS unit.

During all sample sessions in all years, all captured juvenile Mountain Whitefish in good condition following processing were marked by clipping off the adipose fin with surgical scissors. To reduce the likelihood of infection, the scissors were immersed in an antiseptic and rinsed with distilled water prior to each fin clip. In Years 1 and 2, recaptures of marked juveniles at sample sites ESMW4, ESMW5, and ESMW6 (Appendix A, Figure A1) were sufficient to allow for abundance estimates within the upper section that these sites encompass (Golder 2009 and 2010). The estimates were calculated using the modified Schnabel method (Ricker 1975) and the sequential Bayes algorithm (Gazey and Staley 1986).

2.8.2 Juvenile Acoustic Tagging Survivability Testing – Years 2 and 3

This pilot tagging study was implemented in Years 2 and 3 and involved an assessment of the feasibility of equipping juvenile Mountain Whitefish with acoustic transmitters in order to determine seasonal movements and provide information on diurnal shifts in habitat use. A maximum of ten “dummy tags” (inexpensive, non-operational tags of the same size [18 mm long by 7 mm in diameter] and weight [1.4 g] as active Vemco V7 acoustic tags) were implanted into juvenile whitefish (120 mm to 160 mm FL). Two juvenile tagging sessions occurred in Year 2 (Appendix A, Table A2):

- Session 1, October 28, 2009: lower Columbia River section, Right Upstream Bank at Beaver Creek Boat Launch (RKm 47.4; Appendix A, Figure A3); and,
- Session 2, October 30, 2009: upper Columbia River section: Right Upstream Bank near the Robson Boat Launch (RKm 6.0; Appendix A, Figure A1).

Candidate juvenile Mountain Whitefish for acoustic tag implantation were captured in conjunction with BC Hydro's Phase 9 LRFIP (Golder 2009a) and transferred directly to a shore-based surgery crew. A plastic holding tank (300 L capacity) was filled with water and divided in half to provide pre-surgery holding and post-surgery recovery tanks. A battery-powered water circulator and compressed oxygen diffused through an air stone were used to maintain oxygen levels in the holding tank for fish awaiting surgery and to promote rapid recovery of fish after surgery and tag implantation.

Only fish that were swimming vigorously and in apparent good health were selected for tagging. All fish selected for tag implantation were processed under anaesthesia to minimize stress and handling. Data collected during processing included fork length (to the nearest mm) and weight (to the nearest g).

Juveniles that met size and health criteria were tagged with Vemco VL-1L dummy tags. The tag weight of 1.4 g required a target minimum juvenile weight of 56 g (i.e., tag weight of less than 2.5% of body weight). Of all the juveniles collected by the LRFIP field crew, only six were deemed of sufficient size and condition to be suitable candidates and were implanted with dummy tags following the surgical protocols used to tag adult Mountain Whitefish in Year 1 (Golder 2009). The tagged juveniles were held for two to five hours in the recovery portion of the holding tank, and for up to 16 h post-implantation in a holding pen in the river (anchored to the substrate at a water depth of 1.5 m and sheltered from the main current).

In Year 3, Vemco had developed the V5 acoustic tag (11 mm long by 5 mm in diameter, weight = 0.65 g), and it was hypothesized that post-implantation survival rates would be higher for juveniles implanted with the V5 tag than those implanted with V7s. To test this hypothesis, a juvenile tagging session was conducted on September 23 and 24, 2010 at a field surgical station established at Balfour Bay (RKm 6.0; Appendix A, Figure A1 and Table A3). In this tagging study, four different treatments were used to assess different effects of the tagging process and the tag itself:

1) Control fish – no tags applied and held for the same time as other treatments (*n* = 9 fish);

2) V5 dummy tag implantation (*n* = 10 fish);

3) PIT tag implantation (*n* = 10 fish); and,

4) V5 dummy tag and PIT tag implantation (*n* = 10 fish).

All of the V5 dummy tags were implanted following the juvenile surgical protocols used in Year 2 and described in Section 2.8.2.1 below. Although the V5 tag weight of 0.65 g required a target minimum juvenile weight of 26 g (i.e., tag weight of less than 2.5% of body weight), several fish lighter than the target weight were tagged to determine if smaller fish could survive the tagging process. After the surgery, the fish were placed in the recovery portion of the trough for up to four hours. After this period, fish that appeared healthy and vigorous were transferred into the underwater holding tank. The underwater tank was checked at eight hour intervals and after a 24 hour holding period, all control fish in good condition with normal swimming behaviour were released, and their movements monitored to ensure they actively swam to depth and did not remain in shallow water or at rest on the river bottom at the release site. Surviving fish implanted with mimic tags were sacrificed to retrieve the dummy tags. Fish that succumbed during the holding period were brought to the lab for further examination.

2.8.2.1 Surgical Procedures

A standard surgical record and tag deployment datasheet was used to document the handling, tagging and release processes for each of the four treatments.

Tags and all surgical instruments were placed in a 10% disinfectant solution (Super Germiphene™) for 10 minutes and then transferred to a rinse tray filled with distilled water prior to surgery. An anaesthetic bath of 30 L of water with 50 PPM of clove oil was used to sedate the fish. The clove oil was mixed with 70% ethyl alcohol to achieve a 9:1 alcohol: clove oil ratio, which facilitated mixing the clove oil in the water. Only one fish was anaesthetized at a time. The level of sedation was constantly assessed by checking the ability of each fish to remain vertical in the bath water, the frequency of opercular movement, and tail twitch reflex response. Once anaesthetized, each fish was removed from the anaesthetic bath, weighed and measured, and then placed ventral side up in a sponge-lined surgery tray. During the surgical procedure, an electric pump was used to continuously irrigate the gills with an anaesthetic maintenance solution (river-water containing 25 PPM clove oil). Approximately two-thirds of the way through the surgical procedure, the intake of the electric pump was removed from the anaesthetic maintenance solution and placed in a reservoir of fresh river water to irrigate the gills and initiate recovery.

The area of the incision was disinfected with betadine and then cleaned using a gauze pad saturated in Germiphene™ to reduced irritation. The start of the incision location was anterior of the cloacal vent and slightly off the midline, posterior to the liver. Using a hooked scalpel blade and rat-tooth forceps, an incision approximately 1 cm in length was made through the abdominal wall. The dummy tag was then inserted into the incision and pushed to the side away from the incision. The incision was closed with two to three interrupted stitches using Ethicon monofilament 1-0 sutures wedged on a cutting needle (Appendix B, Plate 8).

In the Year 3 tagging experiment, for fish that received both a dummy tag and a PIT tag, the PIT tag was also inserted into the body cavity via the incision. For fish that just received a PIT tag, a tag was implanted into the body cavity through the ventral surface using a sterilized needle. All PIT tags were checked to ensure they were inserted securely and the tag number was recorded.

2.8.3 Snorkel Surveys – Year 1

In Year 1, snorkel surveys were conducted to assess the suitability of this method as a potential means to enumerate juvenile Mountain Whitefish and provide additional information needed to address *MQ*6.

Snorkel surveys were conducted in areas previously sampled by night-time boat electroshocking and known to contain high concentrations of juvenile Mountain Whitefish (Golder 2009). In an attempt to determine diurnal changes in habitat preference, both daytime and night-time (i.e., 0.5 hours after sunset) snorkel surveys were conducted. To assess juvenile use of deep water habitats during daytime hours, both inshore and offshore surveys were conducted during daytime snorkelling (Appendix B, Plate 9).

For safety reasons, all snorkel surveys were conducted using a three person crew (two snorkelers and a safety watcher/recorder). The two snorkelers were equipped with a mask and snorkel, dry suit, personal flotation device, flippers, and hand-held dive lights (for the night-time surveys). Crew members floated in tandem along the previously designated site and attempted to identify specific habitat characteristics used by juvenile Mountain Whitefish (water depth, position in the water column, substrate type, etc.). Surveys also were conducted where snorkelers started at opposite ends of the site and met in the middle of the site. All observed fish were enumerated by species and life stage (adult or juvenile). Data collected during each survey included time and location of survey, snorkelers conducting survey, visual estimation of water depth where each juvenile was encountered, the relative position of the fish in the water column (bottom, middle or surface), type of instream cover associated with the encountered fish, and substrate type (using a modified Wentworth classification system).

2.8.4 Juvenile Habitat Surveys – Years 1 and 2

Habitat surveys were conducted in inshore habitats identified during boat electroshocking and snorkelling surveys as being used by juvenile Mountain Whitefish for rearing. At each site, field crews conducted a series of measurement transects along the areas designated for habitat characterization. Each transect extended perpendicular from the shoreline to approximately 1 m in depth. Depending on the transect length, 4 to 10 transect verticals were established. At each transect vertical, total depth, velocity (at 0.6 of total depth using a Marsh McBirney Flowmate 2000 flow meter), dominant substrate size (using a modified Wentworth classification system), and cover types were recorded (Appendix B, Plate 10).

2.9 Larval Surveys – Years 2, 4, and 5

In Year 2, larval sampling was conducted during flow reductions from HLK to assess the effects of flow reductions on this life stage and provide information to address *MQ6* (Golder 2010; Appendix A, Table A2). A three person crew accessed sites by jet boat and conducted visual surveys in the lower Columbia River. Communication was maintained with the CLBMON-42: Lower Columbia and Kootenay River Fish Stranding Assessment crew that conducted general stranding assessments over the same period, to ensure that any large aggregations of stranded whitefish larvae observed were sampled by the larval whitefish crew.

The following data were collected at sites with observed whitefish larval stranding:

- type of stranding mechanism (interstitial or pool);
- spatial extent of stranding mechanism (m^2);
- slope of area encompassing stranding mechanism (measured in the same direction that fish would have to travel with receding water toward the mainstem river);
- dominant substrate (modified Wentworth scale);
- available cover;
- mainstem and pool water temperatures; and,
- a subsample of stranded larvae at each sampled location was preserved in Prefer™ for future developmental staging.

Areas with large aggregations of larval whitefish in shallows along the mainstem Columbia River were identified and marked with a GPS and characterized with the same methodology used during juvenile Mountain Whitefish habitat surveys (see Section 2.8.4).

The Year 4 larval program had two main goals (Golder 2012):

- Identify and characterize the rearing habitats utilized by larval whitefish prior to the scheduled flow reductions.
- 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.

Initial sampling prior to the flow reductions at HLK failed to identify individuals and/or concentrations of larval whitefish at the three most upstream sites that are known to be used by larval whitefish (i.e., near Zellstoff-Celgar, at Norn's Creek Fan, and Waldies Island). This result led to the cancellation of the remainder of the larval sampling study component.

In Year 5 (present study), based on limited knowledge of larval habitat use in the spring period, weekly sampling over the expected emergence period was conducted during the day between HLK and Genelle from March 28 to May 23, 2013 (Figure 1; Appendix D, Table D13). Sampling consisted of visual observations along the shoreline in areas with low velocities and depositional substrates and where larval concentrations have been documented in past studies (R.L.&L. 2001a). In the later part of the larval sampling program, water levels in the study area had risen substantially due to the onset of freshet, which substantially altered the characteristics of nearshore habitats and resulted in the flooding of terrestrial vegetation. As a result, the field crew used an 8 m × 6 m beach seine (4 mm stretch) during the last sample day to sample areas of submerged vegetation and determine if larval whitefish were using this habitat type. At all locations where aggregations of larval Mountain Whitefish were observed or in areas where they were captured, habitat data was collected using the same methodology as described in the Year 2 report (Golder 2010).

2.10 Data Analyses

All statistical analyses were performed in R v. 2.15.3 (R Development Core Team, 2013). Data were imported from Access databases using the package RODBC (Ripley and Lapsley 2012), and processed for analysis using the packages plyr (Wickham 2011) and reshape2 (Wickham 2007). Plotting was performed using the packages ggplot2 (Wickham 2007), gridExtra (Augie 2012), scales (Wickham 2012), and RColorBrewer (Neuwirth 2011).

2.10.1 Availability of Preferred Spawning Habitat Conditions

Physical habitat conditions of depth and velocity during peak Mountain Whitefish spawning periods (as interpreted using egg CPUEs) at the two key spawning areas were determined using a River2D developed for the CLMBON-47: Whitefish Spawning Ground Topography project. Details of the model development and outputs are provided in CLMBON-47 (Golder 2014). Information from the River2D model was used in conjunction with Mountain Whitefish egg CPUE data to derive preferred habitat conditions for egg deposition.

To estimate preferred spawning habitat, data from two sources were utilised:

1) Egg mat CPUE, GPS locations, and depths of collection mats from 1996-1997 (R.L.&L. 1997, R.L.&L. 1999) and 2009-2012 (Section 2.6.1),

2) River2D predictions of mean water column velocities across the CPR Island and Kootenay River spawning grounds at varying HLK and BRD discharges.

River2D velocity predictions were interpolated to create a continuous description of mean water column velocities throughout the spawning sites as a function of HLK and BRD discharges (Golder 2014). Interpolated River2D velocities were used to predict mean water column velocity at River2D nodes closest to egg collection mat locations under discharges experienced at each egg collection event.

CPUE values, corrected for fresh egg deposition, were used to construct year-specific relationships between cumulative corrected CPUE values and water depth, at a resolution of 0.1 m. Similarly, year-specific relationships were developed between cumulative corrected CPUE values and mean water column velocity, at a resolution of 0.1 m/s. The two cumulative relationships, between CPUE and depth and velocity, were used to estimate egg deposition probability (EDP) by subtraction. The peaks of the EDP curves were assumed to represent preferred spawning habitat in relation to depth and mean column velocity conditions.

The availability of preferred habitat conditions was estimated using River2D output. For CPR Island, habitat was modeled for HLK discharges ranging from 250 to 2500 m^3/s and at discrete BRD discharges of 250, 750, 1250, and 1500 m^3/s. At Kootenay River, habitat was modeled using BRD discharges ranging from 250 to 1500 m^3/s and at discrete HLK discharges of 250, 900, 1550, and 2525 m^3/s. at each combination of discharges, depth and velocity were predicted for each River2D node in the spawning areas. Habitat was classified using three bins: depth (or velocity) below values at peak egg deposition, depth (or velocity) in the range of yearly values at peak deposition, and depth (or velocity) above values at peak egg deposition. The proportion of spawning area found in each of these three bins was calculated and used to describe the availability of preferred spawning habitat conditions.

2.10.2 Life History Characteristics

Weight-length regressions of juvenile Mountain Whitefish captured during boat electrofishing were performed separately for different sampling years in different collection studies. The regressions were performed as log-log regressions:

Equation 1 $$\log(Weight) = \log(a) + b * \log(Length);$$

where ‘Weight’ if fish weight (g), ‘Length’ is fish length (mm), log(a) is regression intercept and *b* is regression slope. To compare regressions among years and programmes, 95% confidence intervals were estimated for both slope and intercept coefficients. Mean coefficient estimates and their 95% confidence intervals were plotted to examine statistical differences in intercept and slope among years and studies.

3.0 CURRENT POPULATION DYNAMICS

In order to estimate the age-at-maturity, sex ratio and fecundity population dynamics of the current Mountain Whitefish population within the study area, 90 adults were examined (Table 6). Differences from the initial proposed sample sizes in each section of the study area 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 3.1, 3.2, and 3.3, respectively) for the current Mountain Whitefish population.

Table 6: 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**

3.1 Age-at-Maturity

Of the 90 Mountain Whitefish examined in Year 4 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 (Table 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 (R.L.&L. 2001). 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, 78% of age-3 fish were mature and by age-5, 95% were mature (R.L.&L. 1995, 2001). Of the 46 mature females examined in Year 4, 14 (30.4%) were spent (Appendix C, Table C2). Of the spent fish, 12 had loose eggs in their body cavity, which was indicative of recent spawning activity.

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

Age	Number of Females Examined	Mature Females (%)	Number of Males Examined	Mature Males (%)
1	1	0	1	0
2	7	87.5	5	60.0
3	3	100	3	100
4	3	100	9	100
5	19	100	15	100
6	8	100	8	100
7	5	100	1	100
8	0	0	0	0
9	2	100	0	0

Results of the LRFIP studies have documented that the uncertainty related to aging Mountain Whitefish was low, especially for the younger age cohorts (Ford and Thorley 2012). Due to the spacing of the annuli on the scales of age-0 to age-3 Mountain Whitefish, annuli are easy to identify. After age-3, annuli spacing decreases and age becomes more difficult to determine.

3.2 Sex Ratio

The sex ratio of the 90 fish examined was 1 male:1.14 female (42 males and 48 females, Appendix C, Table C2). This is within the range of sex ratios reported in previous studies in the LCR (Table 8). With the exception of the 1995-1996 study year (when the sex ratio was equal), females have made up a greater portion of the sample than males.

Table 8: Mountain Whitefish sex ratios from past and present studies on the lower Columbia River.

Study and Year	Males:Females	Sample Size
1980 – 1981 (Ash et al. 1981)	1:1.4	43
1990 – 1991 (Hildebrand and English 1991)	1:1.3	363
1994 – 1995 (R.L.&L. 2001)	1:1.8	246
1995 – 1996 (R.L.&L. 2001)	1:1	240
2011 – 2012 (CLBMON-48 Year 4)	1:1.1	90

3.3 Fecundity

Fecundity (eggs/fish) and relative fecundity (eggs/g of body weight) were estimated using a combination of gravimetric estimates and absolute egg counts (Appendix C, Table C2). Body weight accounted for a large proportion of the variability in gravimetric estimates, although there still was a considerable amount of variation around the regression (r^2 = 0.773; Figure 2). Therefore, similar to Wydoski (2001), the absolute fecundity was determined for three randomly selected individuals in order to correct gravimetric estimates of fecundity. Based on these counts, a correction factor of 12.3% was obtained (Table 9). The corrected mean fecundity estimate was 9,404 eggs/female, within a range of 2,582 to 18,753 eggs/female. The corrected relative fecundity was 10.7 eggs/g, within a range of 5.3 to 16.3 eggs/g. These corrected values were used to calculate Potential Egg Deposition (PED; Section 4.5).

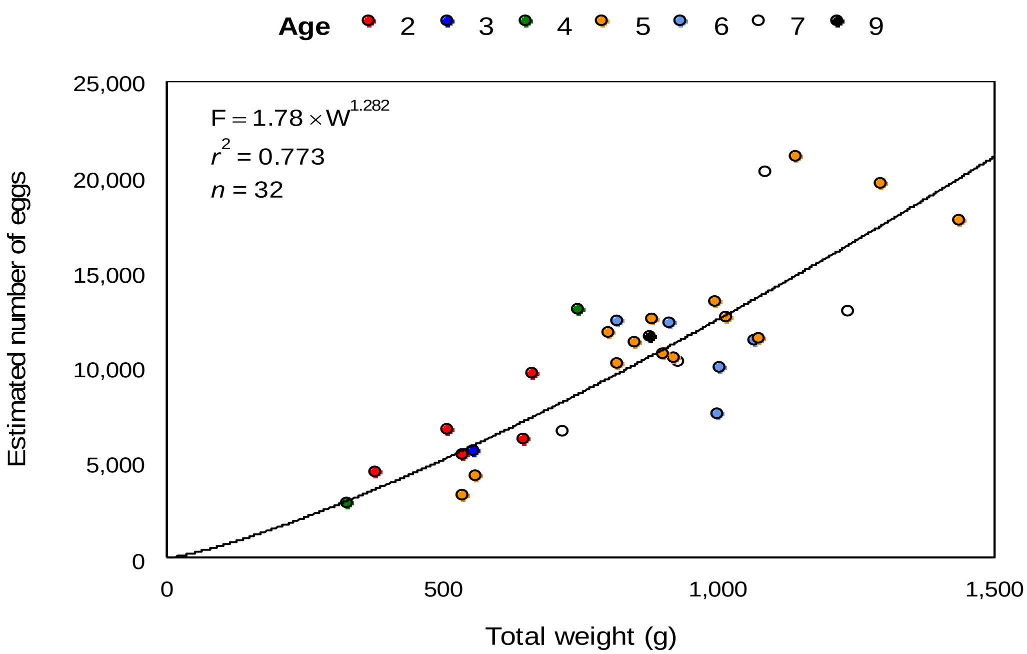


Figure 2: Regression of Mountain Whitefish fecundity (estimated number of eggs) versus total fish weight (g); fish age is designated by colour. The regression equation, R² value, and sample size are provided on the graph.

Table 9: 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 ([weight of ovary/weight of 100 eggs]*100)	Total Count of Eggs	Estimated Number of Eggs Based on Fig 3 Regression	Difference (%)
3	426	1,295	1.4	274.3	19,593	17,792	17,392	10.1
33	352	556	1.2	67.4	5,617	4,736	5,883	18.6
50	403	562	1.4	60.2	4,300	3,974	5,964	8.2
Average Percentage Difference (Estimated Total Egg Count Correction Factor)								**12.3**

In order to determine if these findings show a healthy level of fecundity, the fecundity estimates determined in several other studies were examined for comparison (Table 10). In general, the minimum estimated fecundity was higher than in some of the previous reports (e.g., Wydoski 2001), while maximum estimated fecundity was within the higher previously reported estimates. The relative fecundity observed in this study (10.7 eggs/g fish) was the lowest of all reports examined but this may be an artifact of the low sample size.

Table 10: Comparison of estimated and relative fecundity of Mountain Whitefish from the lower Columbia River with populations in Western Canada and northwestern US.

Study and Year	Minimum Estimated Fecundity (eggs/fish)	Mean Estimated Fecundity (eggs/fish)	Maximum Estimated Fecundity (eggs/fish)	Relative Fecundity (eggs/g of fish)
LCR: CLBMON-48 Year 4 (2011 – 2012)	2,582	9,404	18,753	10.7
LCR: R.L.&L. 2001	4,302	9,061	17,257	13.1
Brown 1952	1,426	4,401	24,143	11.8
Thompson and Davies 1976	1,987	Not reported	10,235	11.6
Wydoski 2001	772	11,844	24,136	15.0
McPhail 2007	1,000	Not reported	15,000	Not reported

3.4 Adult Population Estimates

Abundance and density estimates generated by the LRFIP for adult mountain whitefish exhibited wide credibility limits that confounded interpretation of trends; however, estimates were slightly lower in 2010 and 2011 than in most previous study years (Table 10: Ford and Thorley, 2012).

Table 11: Adult Mountain Whitefish abundance estimates 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)
1994 - 1995	Modified Schnabel	42,600 (33,800 – 57,500)[a]
CLBMON-48 Year 1 (2008 – 2009)	Hierarchical Bayesian	105 200 (65 000 – 192 400)[b]
CLBMON-48 Year 2 (2009 – 2010)	Hierarchical Bayesian	101 200 (61 600 – 177 100)[c]
CLBMON-48 Year 3 (2010 – 2011)	Hierarchical Bayesian	81 400 (49 600 – 146 600)[d]
CLBMON-48 Year 4 (2011 – 2012)	Hierarchical Bayesian	81 800 (50 200 – 149 000)[e]
CLBMON-48 Year 5 (2012 – 2013)	Hierarchical Bayesian	124 506 (83 800 – 200 400)[f]

[a] Based on data from R.L.&L. 2001
[b] Based on 2008 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[c] Based on 2009 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[d] Based on 2010 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[e] Based on 2011 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[f] Based on 2012 LRFIP data (Golder and Poisson 2013); assumes all adults in the abundance estimate will spawn.

3.5 Length Frequency Distribution

The length-frequency distribution of Mountain Whitefish in 2012 was similar to the distributions observed annually since 2008, although the bimodal peaks in 2012 (representing the age-0 and age-1 cohorts ≤250 mm FL) were more apparent in 2012 (Figure 3). The overall distribution pattern in 2012 was very similar to that seen in 1996.

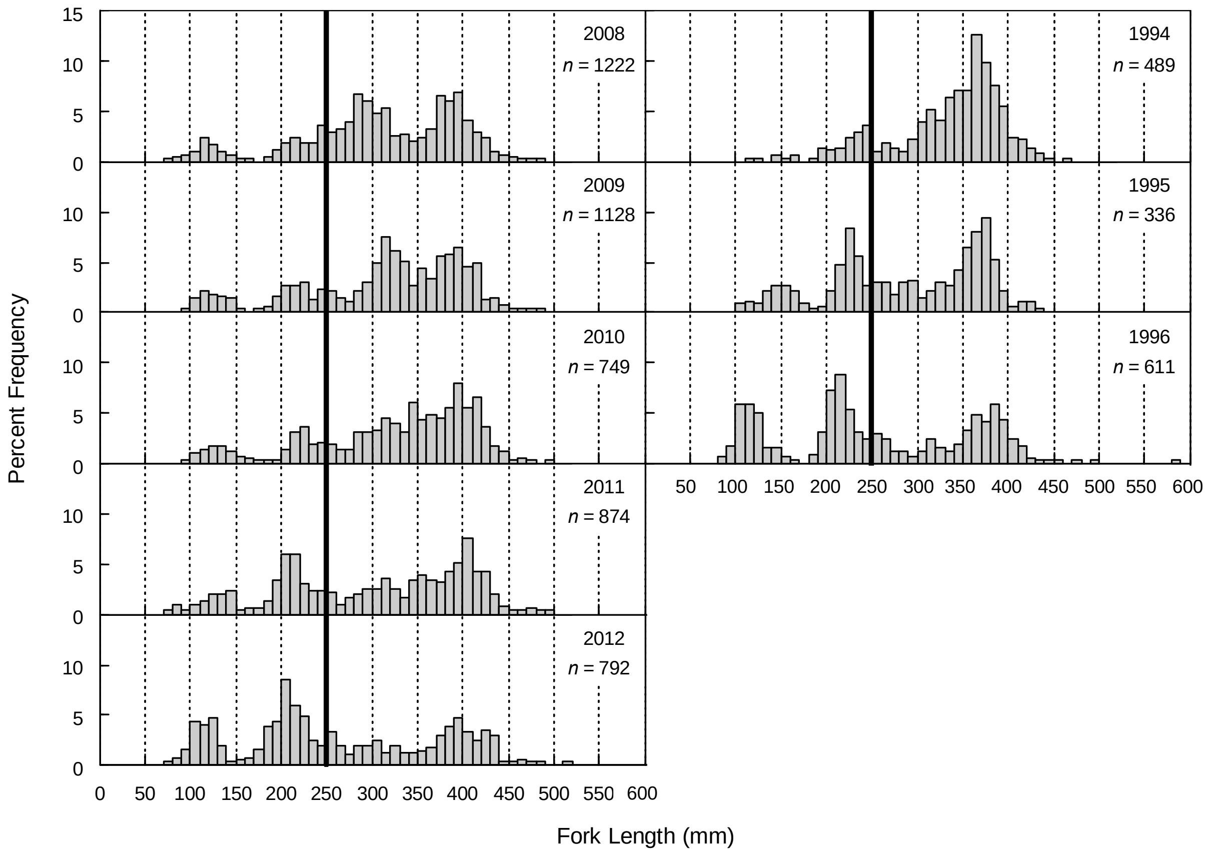


Figure 3: Length frequency distribution of Mountain Whitefish captured during the 1994-1996 studies and the LRFIP 2008-2012 studies, plotted by year; the size-at-maturity cut off (250 mm) is designated by a heavy solid line. The number of fish collected in each sampling year is provided on each panel.

The length-weight regressions recorded in 2012 was very similar to regressions recorded since 2008, but slightly higher than the 1990s estimates (Figure 4). From 2008 to 2012, all exponent values ranged between 3.2 and 3.3, whereas in 1994 to 1996, exponent values ranged between 3.01 and 3.2, suggesting that individuals at a given size are typically heavier in the current population. The r^2 values in all regressions were high, indicating a strong fit for the data points on each regression (Figure 4).

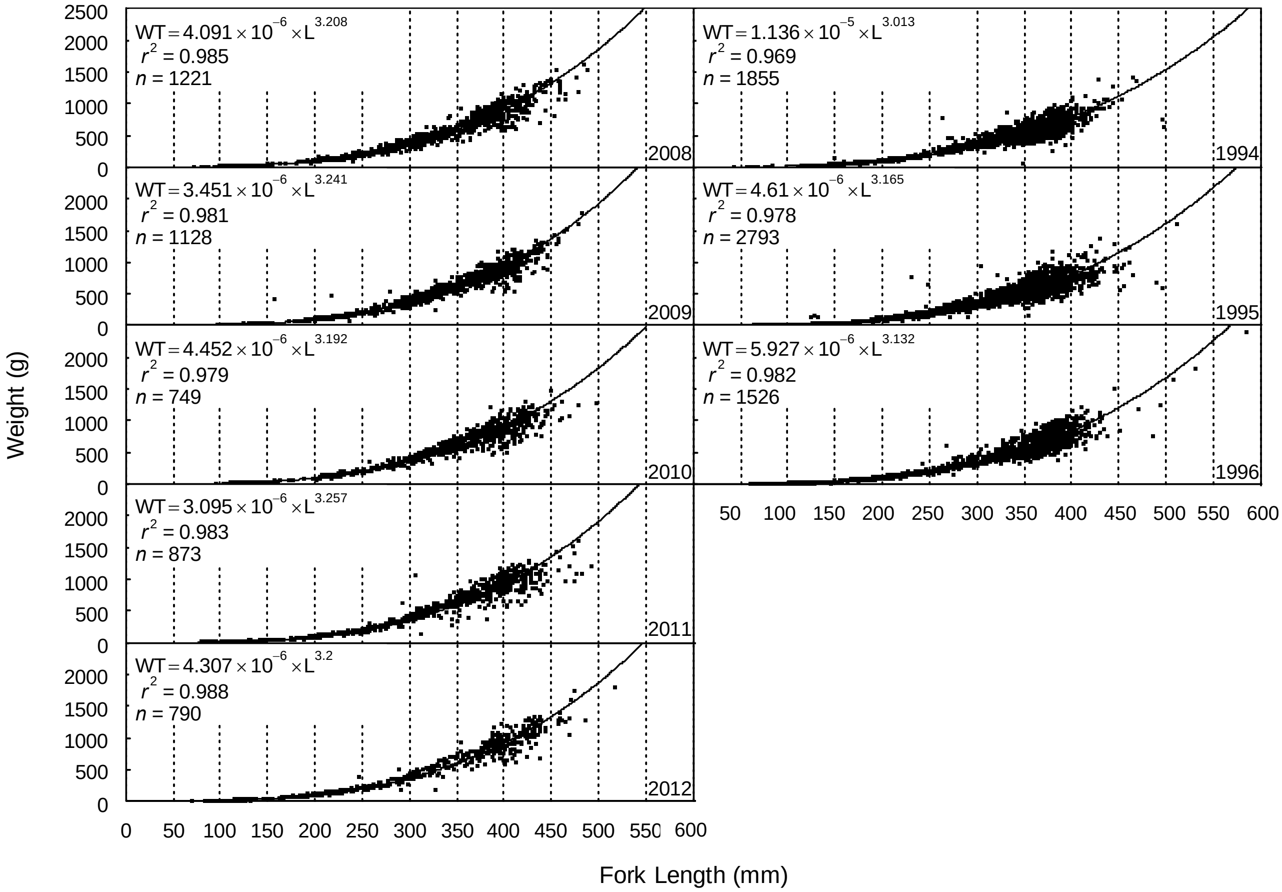


Figure 4: Regressions of weight (g) on fork length (mm) of Mountain Whitefish captured in the Lower Columbia LRFIP electrofishing sessions in 1994-1996 and 2008-2012. The regression equation, r² value and sample size are provided for each year.

4.0 SPAWNING

4.1 Pre- and Post-Spawning Adult Migrations

4.1.1 Telemetry Detections and Movements

In Year 1, 50 adult mountain whitefish (20 males and 30 females) were dual-tagged with sonic and radio tags (Appendix C, Table C1). In total, 48 dual-tagged adult mountain whitefish were detected by radio telemetry and by the VR2W array in the lower Columbia River during the study period (Appendix C, Figures C1 and C2). Of the 48 fish detected after release, 20 were males and 28 were females. Nine fish were excluded from the following spawning related analysis based on insufficient detections to determine the most likely location in which they spawned.

Female dual-tagged mountain whitefish exhibited higher overall total and net movements than males (Table 12). Female movements were slightly greater, but differences in total and net movements between sexes were not statistically significant (*p* values of 0.15 and 0.24, respectively; Golder 2009).

Table 12: Summary of total and net movements of dual-tagged mountain whitefish detected in the study area, October 2008 to March 2009.

Category	*n*	Total Movement (km)a				Net Movement (km)a			
		Mean	Min.	Max.	St. Dev.	Mean	Min.	Max.	St. Dev.
Female	28	48.4	2.4	105.3	30.7	24.2	1.4	55.9	16.8
Male	20	36.0	2.0	91.8	25.1	19.0	1.1	45.3	12.0
All	**48**	**43.2**	**2.0**	**105.3**	**28.9**	**22.0**	**1.1**	**55.9**	**15.1**

[a] Total Movement = sum of all detected movements; Net Movement = difference between furthest upstream and downstream detections.

4.1.2 Suspected Spawning Related Movements in the Study Area

Based on the data collected in Year 1 during the adult telemetry program. The spawning related movements of the 48 fish detected after release at these four locations are illustrated in Appendix C, Figures C1 and C2, and briefly described below.

- Balfour Bay (Upper Section): Both male and female Mountain Whitefish tagged and released at Balfour Bay moved downstream, potentially towards several known spawning areas in the mainstem Columbia River. The majority of fish appeared to spend limited amounts of time in the vicinity of the CPR Island and Kootenay River in the early portions of the spawning period, before continuing with downstream migrations. One male release at Balfour Bay (acoustic tag ID: 52599) moved downstream past CPR Island early in the spawning period in early November, and then moved back upstream to the spawning area during the spawning period. One female (acoustic tag ID: 52606) moved upstream to just below HLK prior to the spawning season, remained there for approximately one month, and then moved downstream to CPR Island where she remained until her tag expired.

- Kootenay Eddy (Upper Section): Of the 17 tagged Mountain Whitefish released in the Kootenay River, the data collected on 3 (1 male [acoustic tag ID: 52566] and 2 females [acoustic tag IDs: 52590 and 52592]) individuals indicated that they likely spawned in that area. Additionally, 2 males (acoustic tag ID: 52570 and 52591) likely spawned in the Columbia River between the Kootenay confluence and Genelle. None of the fish released in the Kootenay River appeared to spawn upstream of the Columbia-Kootenay confluence.

One male released in the Kootenay River (acoustic tag ID: 52568) remained in the same location over its entire detection history, which may indicate that it died after release. One female and one male (acoustic tag IDs: 52569 and 52577, respectively) was only detected prior to the spawning period, and briefly passed CPR Island before returning to the Kootenay River. Another female (acoustic tag ID: 52595) also moved through CPR Island on two separate occasions prior to the spawning period, before moving downstream to spawn near Blueberry Creek.

- Birchbank (Middle Section): None of the Mountain Whitefish released at Birchbank appeared to spawn downstream of their release location. Both sexes tended to disperse upstream and most likely spawned between (and including) the Kootenay River and Genelle. There was no evidence to suggest that any of the fish released at this location spawned at CPR Island.
- Beaver Creek Eddy (Lower Section): Approximately half of the females tagged and released at Beaver Creek appeared to remain in the lower section to spawn. The remainder moved upstream and most likely spawned at Genelle or in the Kootenay River. Of the three males tagged and released at Beaver Creek, two apparently remained in the lower section to spawn. There were insufficient detections to determine the most likely location where the third male may have spawned. There was no evidence to suggest that any of the fish release at this location spawned at CPR Island.

Movements of tagged Mountain Whitefish in late November to mid-December to known spawning areas may suggest that some individuals may have spawned prior to the peak spawning period in January. Two fish (acoustic tag IDs: 52590 [female] and 52611 [male]) exhibited small localized movement upstream in early December prior to the peak spawning period, followed by relatively fast downstream movement (assumed to represent post-spawning movement) in mid-December and early January, respectively (Appendix C, Figures C1 and C2). In contrast, two fish (acoustic tag IDs: 52600 [Female] and 52601 [male]) exhibited slow protracted movements downstream in mid-October and November and then remained at Genelle over the peak spawning period and for the remainder of their detection history. The following five fish exhibited slow protracted movements upstream over long distances prior to peak spawning, and then exhibited fast downstream movements (interpreted as post-spawning) back to near the original location where the upstream movement commenced (Appendix C, Figures C1 and C2):

1) Acoustic Tag ID: 52584 – Female.
2) Acoustic Tag ID: 52585 – Female.
3) Acoustic Tag ID: 52587 – Male.
4) Acoustic Tag ID: 52602 – Female.
5) Acoustic Tag ID: 52613 – Female.

One female (acoustic tag ID: 52603) remained near Blueberry Creek for a long period of time, and then on January 9, exhibited a fast upstream movement to the Kootenay River. This fish remained in this spawning area for five days before it moved rapidly downstream back to Blueberry Creek. The fast upstream movement, suspected spawning activity, and subsequent downstream movement all occurred during the peak spawning period in the Kootenay River.

The LRFIP results indicated that catch rates of adult Mountain Whitefish in the upper section exhibited a general trend of decreasing CPUE over the course of sample period in each study year (Figure 5). Simultaneously, catch rates in the Kootenay River increased with each successive sample session. In the middle section, catch rates in most years were highest in the first sample session and decreased substantially in subsequent sessions, which suggested an emigration of spawners out of this section. Catch rates of adult Mountain Whitefish at LRFIP sample sites in the lower section did not exhibit a discernible pattern. These results indicate a pattern of spawning-related migration out of holding and feeding areas in the upper and middle sections to spawning areas in the Kootenay River that is initiated in the September and early October sessions of the LRFIP (Figure 5). The detected movements of tagged spawners appear to support this observation (Appendix C, Figures C1 and C2). Studies in the Sheep River, AB (Northcote and Ennis 1994, Thompson and Davies 1976) state that spawning related movements in that system initiate as early as late September. These studies also documented small non-migratory populations in the system.

In Session 5 of the 2011 and 2012 LRFIP, sampling shifted to randomly selected sites in order to test specific assumptions of that program. As a result, comparisons with data for that session in those years should be interpreted with caution.

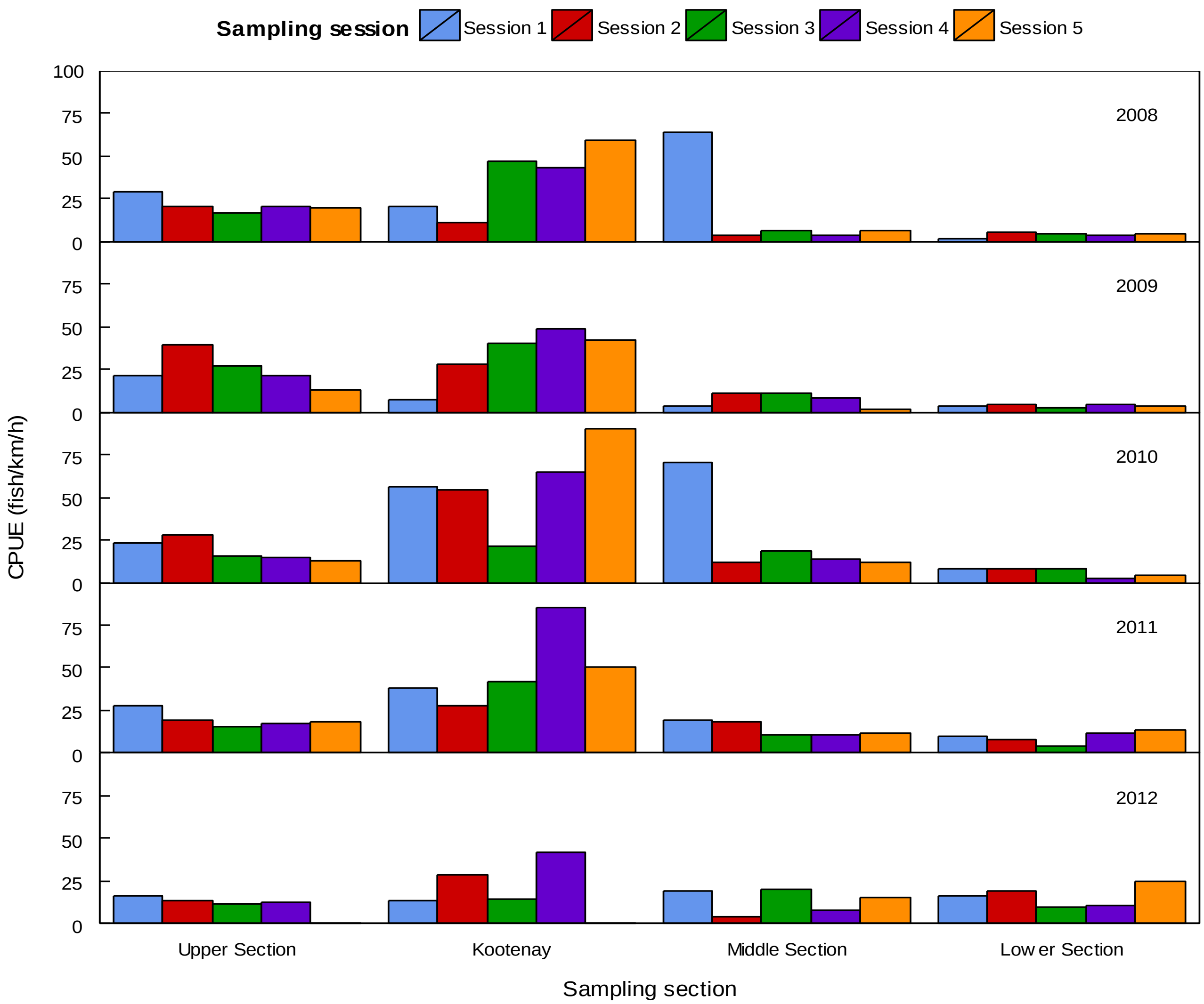


Figure 5: Adult Mountain Whitefish catch per unit effort (CPUE= No. fish/km/h) during LCR Indexing sampling, plotted by sampling year, session, and site.

4.1.3 Mountain Whitefish Movements in the Washington Section of the LCR

Shortly after release, four Mountain Whitefish (one male and three females) moved downstream to or past the Canada-US border into Washington State and did not return to the Canadian portion of the LCR during the study period. Another fish (acoustic tag ID: 52600 [female]) moved downstream past the Canada-US border and returned on two separate occasions in its detection history (Appendix C, Figures C1 and C2). Based on data obtained from VR2W stations in the Washington section of the Columbia River and provided by the Washington Department of Fish and Wildlife (WDFW), the furthest downstream detection of tagged adult mountain whitefish was at North Gorge (RKm 99.0; Table 13).

Table 13: Summary of detections and net downstream movement of dual-tagged Mountain Whitefish detected in Washington State, USA, October 2008 to March 2009.

Sonic Tag ID	Sex	Release Date	Release Location	Release Location RKma	Furthest Downstream Detection Date	Furthest Downstream Detection Location	Furthest Downstream Location RKma	Net Downstream Movement (km)
52571	Female	25-Oct-08	Kootenay Eddy	K0.3	26-Jan-09	Sheep Creek	69.4	59.2b
52574	Female	24-Oct-08	Balfour Bay	2.7	7-Jan-09	US Border	56.0	53.3
52578	Female	23-Oct-08	Beaver Creek	47.7	25-Nov-08	North Gorge	99.0	51.3
52583	Female	24-Oct-08	Balfour Bay	2.7	9-Nov-08	North Gorge	99.0	96.3
52609	Male	9-Oct-08	Birchbank	28.7	20-Oct-08	US Border	56.0	27.3

[a] Columbia River Kilometre, K denotes Kootenay River Kilometre. Hugh L. Keenleyside Dam is RKm 0.0.
[b] The Columbia/Kootenay River Confluence is at RKm 10.5, 0.3 km added for movement out of Kootenay River into Columbia River.

The following Mountain Whitefish exhibited unique movement patterns prior to and/or after movement downstream into Washington State (Appendix C, Figures C1 and C2):

1) Acoustic Tag ID: 52571 – Female: Remained at release location (Kootenay Eddy) for 11 days before exhibiting fast downstream movement past US border.

2) Acoustic Tag ID: 52574 – Female: Exhibited fast movement downstream from release location (Balfour Bay) to the US border and then back upstream to Ft. Shepherd Eddy, where it remained for approximately three months before moving back downstream into the US. Remained in US portion of the lower Columbia River for approximately one month before moving upstream again to Ft. Shepherd Eddy.

3) Acoustic Tag ID: 52578 – Female: Exhibited fast movement downstream from release location (Beaver Creek Eddy) to Fort Shepherd Eddy, and then held at Ft. Shepherd Eddy for four days before moving downstream past the US border.

4) Acoustic Tag ID: 52683 – Female: Moved upstream to HLK Eddy from release location (Balfour Bay), held in HLK Eddy for two days, then fast downstream movement past US border.

5) Acoustic Tag ID: 52609 – Male: Initial fast upstream movement from release location (Birchbank) to Columbia/Kootenay rivers confluence, followed by fast downstream movement to the US border.

4.2 Characterization of Mountain Whitefish Spawning Habitat

4.2.1 Water Temperature

Throughout the present study, water temperature in the Columbia and Kootenay rivers peaked between August and September, typically between 18°C and 17°C, respectively (Figure 6 and Figure 7). Minimum water temperatures were typically between approximately 2°C and 4°C in February and March in the Columbia River (Figure 6 and Figure 8) and between December and February in the Kootenay River (Figure 7). Spawn monitoring in the LCR was performed between December and February, when water temperature in the

Columbia River ranged between 1.9°C and 7.1°C (Figure 6). Water temperature recorded at the Norn's Creek gauging station during the study period throughout the years typically had little variation. Warmer than average values were observed in February 2010, and below-average temperature was recorded in January to February 2012. Kootenay River temperature during the spawn monitoring sample periods ranged between 1.3°C and 7.6°C (Figure 7). Kootenay River temperature was below annual average in December 2008 to February 2009, and above average in January to February 2010. Columbia River temperature at Birchbank gauging station ranged between 2.4°C and 7.2°C during spawn monitoring (Figure 8); recorded water temperatures were close to annual averages in 2008, 2011, and 2012, slightly below average in 2009, and above average in February 2010.

Over the course of the Year 3 spawning period, no difference was observed between water temperature values recorded at the left and right downstream bank temperature stations at CPR Island (Figure 9). This indicates that cooler water from Norn's Creek completely mixes with the Columbia River before it reaches the spawning area and therefore, does not influence water temperatures in the CPR Island spawning area.

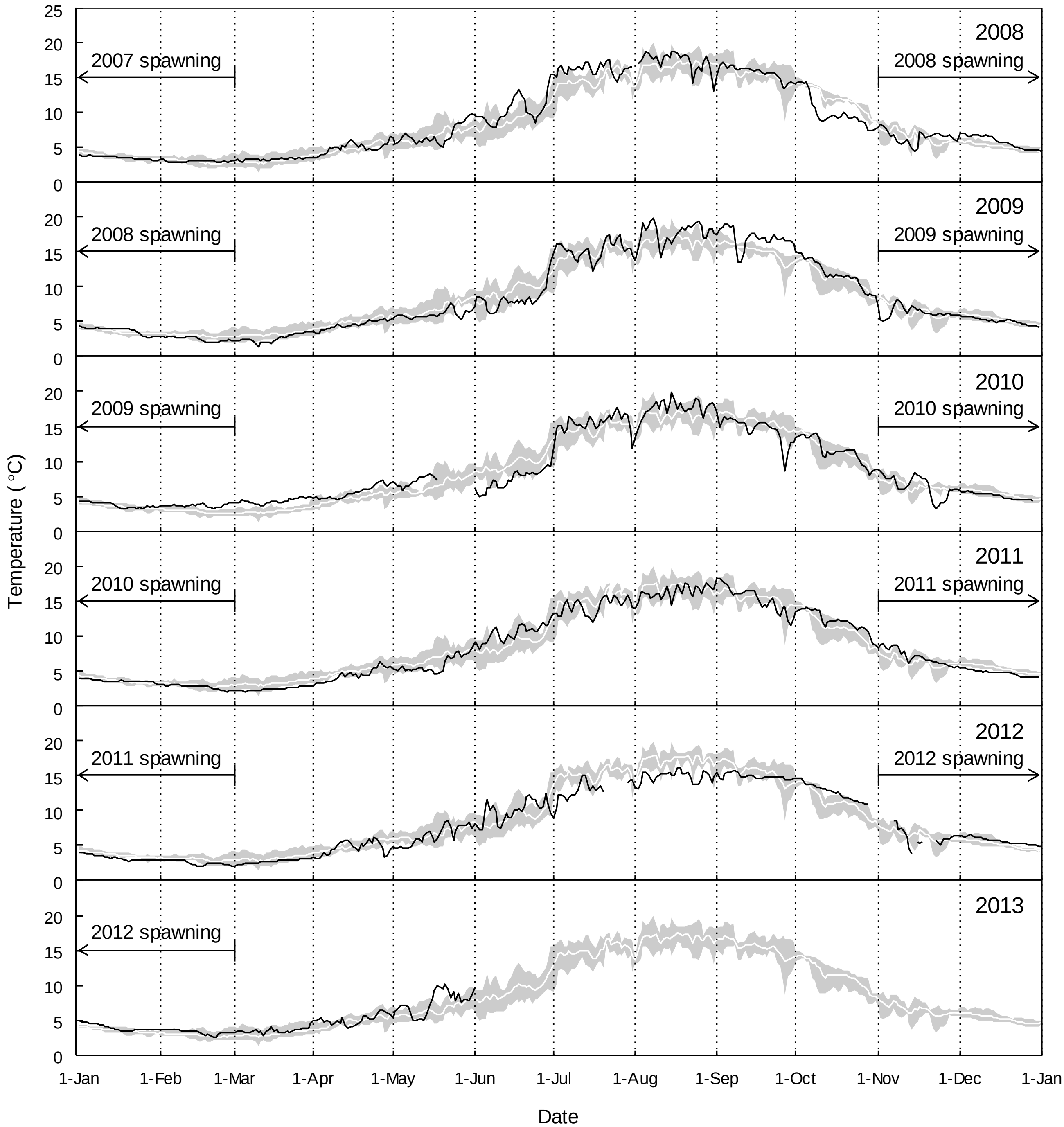


Figure 6: Mean daily water temperature (°C) of the Columbia River at Norn's Creek gauging station (black line), 2008-2013. The shaded area represents minimum and maximum mean daily temperature values recorded at the Norn's Creek gauge during other study years (between 2008 and 2013). The white lines represent average mean daily temperature values over the same time period.

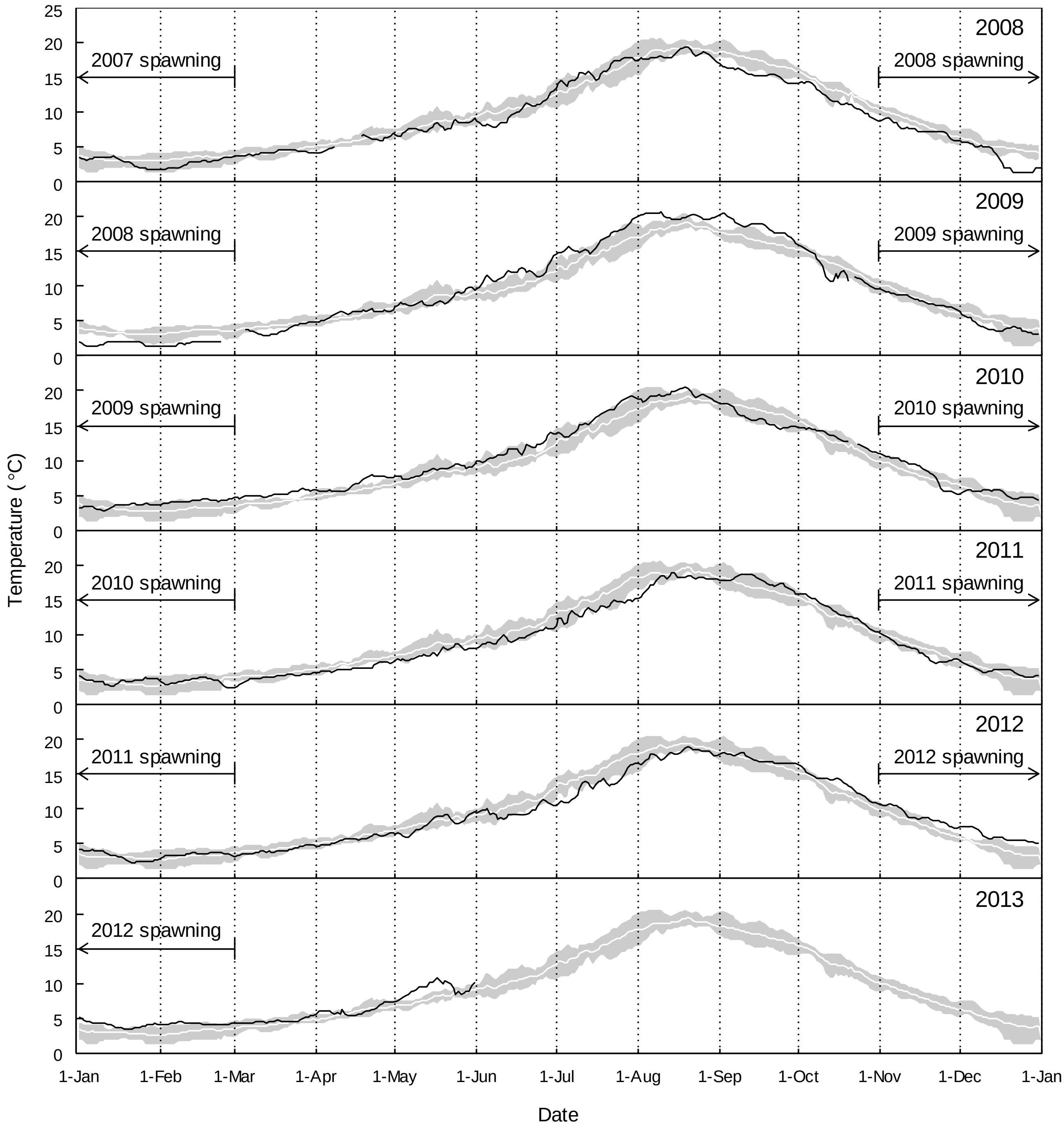


Figure 7: Mean daily water temperature (°C) of the Kootenay River at Brilliant Dam (black line), 2008-2013. The shaded area represents minimum and maximum mean daily temperature values recorded at Brilliant Dam during other study years (between 2008 and 2013).

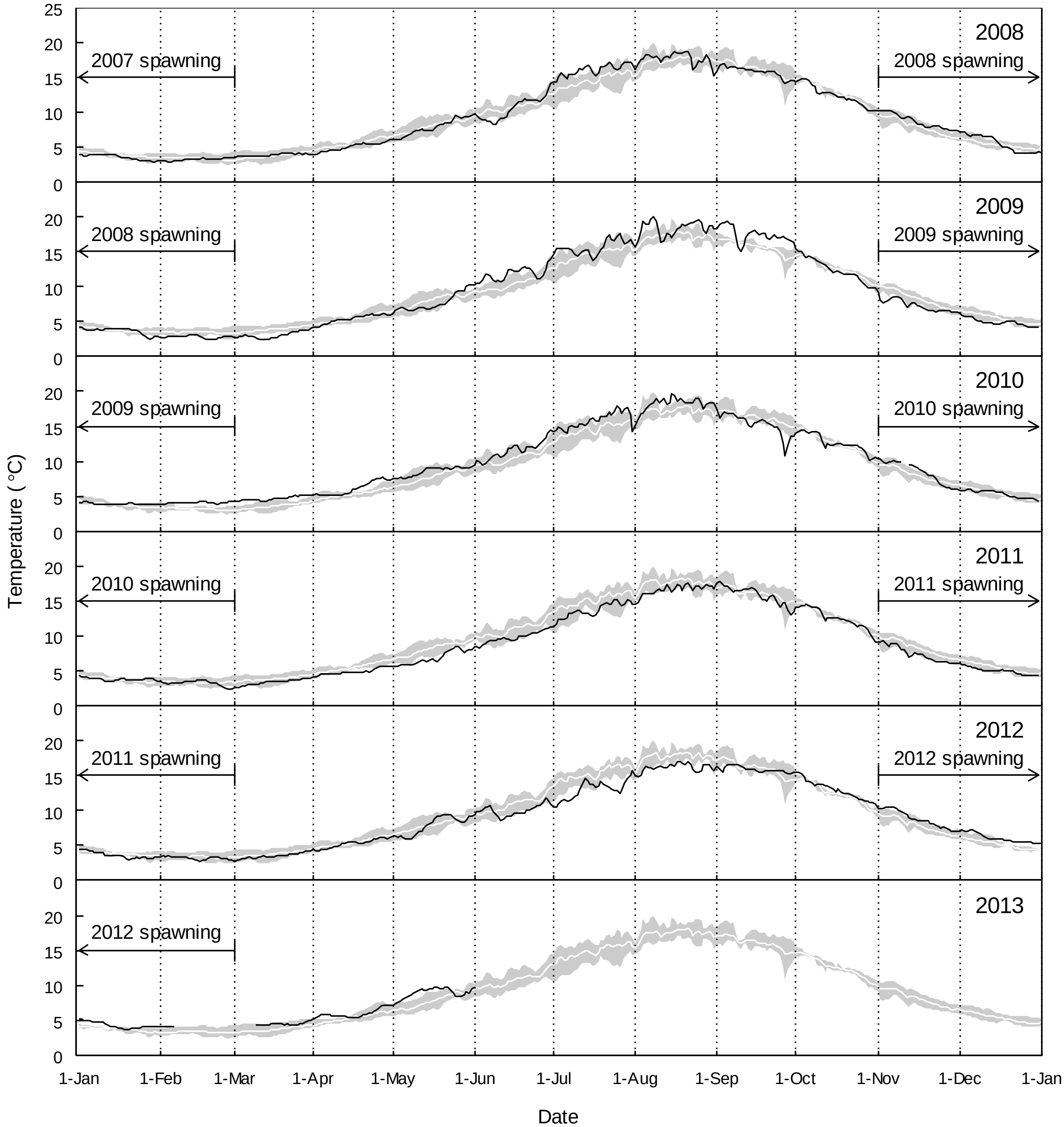


Figure 8: Mean daily water temperature (°C) of the Columbia River at the Birchbank gauging station (black line), 2008-2011. Mean daily values between January 2012 and February 2013 period are from the Fort Shepherd gauging station (data courtesy of Columbia Power Corporation), since the Birchbank temperature logger malfunctioned in mid-2012. The shaded area represents minimum and maximum mean daily temperature values recorded at Birchbank during other study years (between 2008 and 2012). Gaps in the solid line represent missing data.

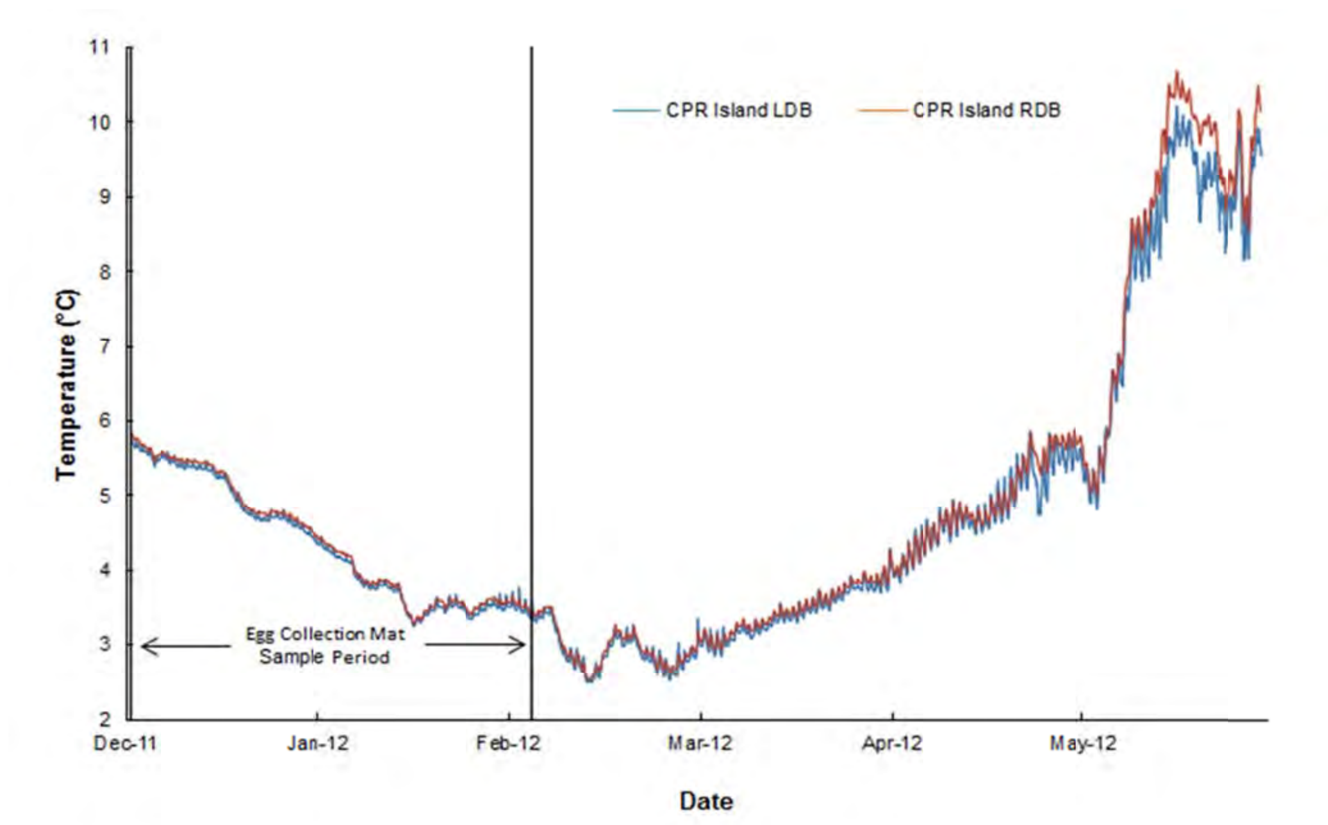


Figure 9: Hourly average water temperatures along the left and right downstream bank at CPR Island a during the Year 4 Mountain Whitefish spawn monitoring program; December 6, 2011 to May 31, 2012.

4.2.2 Discharge

Mean daily discharge of the Columbia River below HLK exhibited a bi-modal pattern with the highest flow between December and March, as well as July and August in most sampling years. In 2012, record flows were observed in the Columbia River (Figure 10). Discharge patterns in the Kootenay River at BRD were unimodal with peak discharge in June to July in all years (Figure 11), similar to peak Columbia River discharge at Birchbank gauging station (Figure 12). During the spawn monitoring sampling periods (December to February), mean daily discharge at HLK ranged from 673 m^3/s to 1865 m^3/s; discharge values were close to the inter-annual average in 2008, 2009, 2011, and 2012, below average in January, February, and December 2010, and above average in January 2013 (Figure 10). Brilliant Dam mean daily discharge ranged from 399 m^3/s to 1,562 m^3/s during the spawn monitoring sampling periods. With the exception of low discharge in December 2008, December 2009, January to February 2010, and December 2011, BRD mean daily discharge in most years was close to the inter-annual average (Figure 11). Mean daily discharge recorded at the Birchbank gauging station ranged from 1,241 m^3/s to 2,929 m^3/s during the spawn monitoring sampling periods, with most years close to the inter-annual average; flows were below average in January-February 2010 and above average in January-February 2013 (Figure 12).

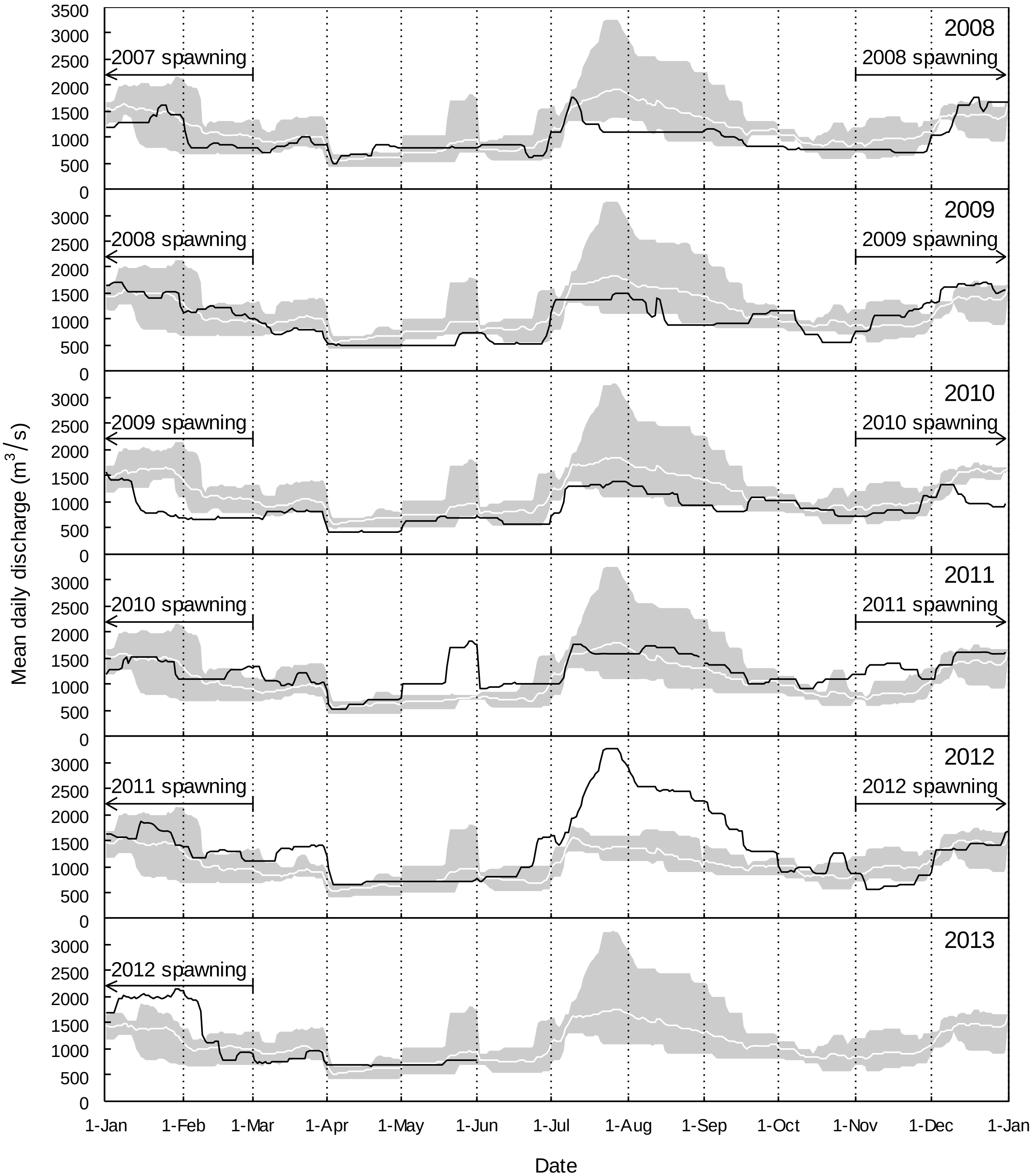


Figure 10: Mean daily discharge (m³/s) for the Columbia River at Hugh L. Keenleyside Dam (black line), 2008-2013. The shaded area represents minimum and maximum mean daily discharge values recorded during other study years (between 2008 and 2013). The white lines represent average mean daily discharge values over the same time period.

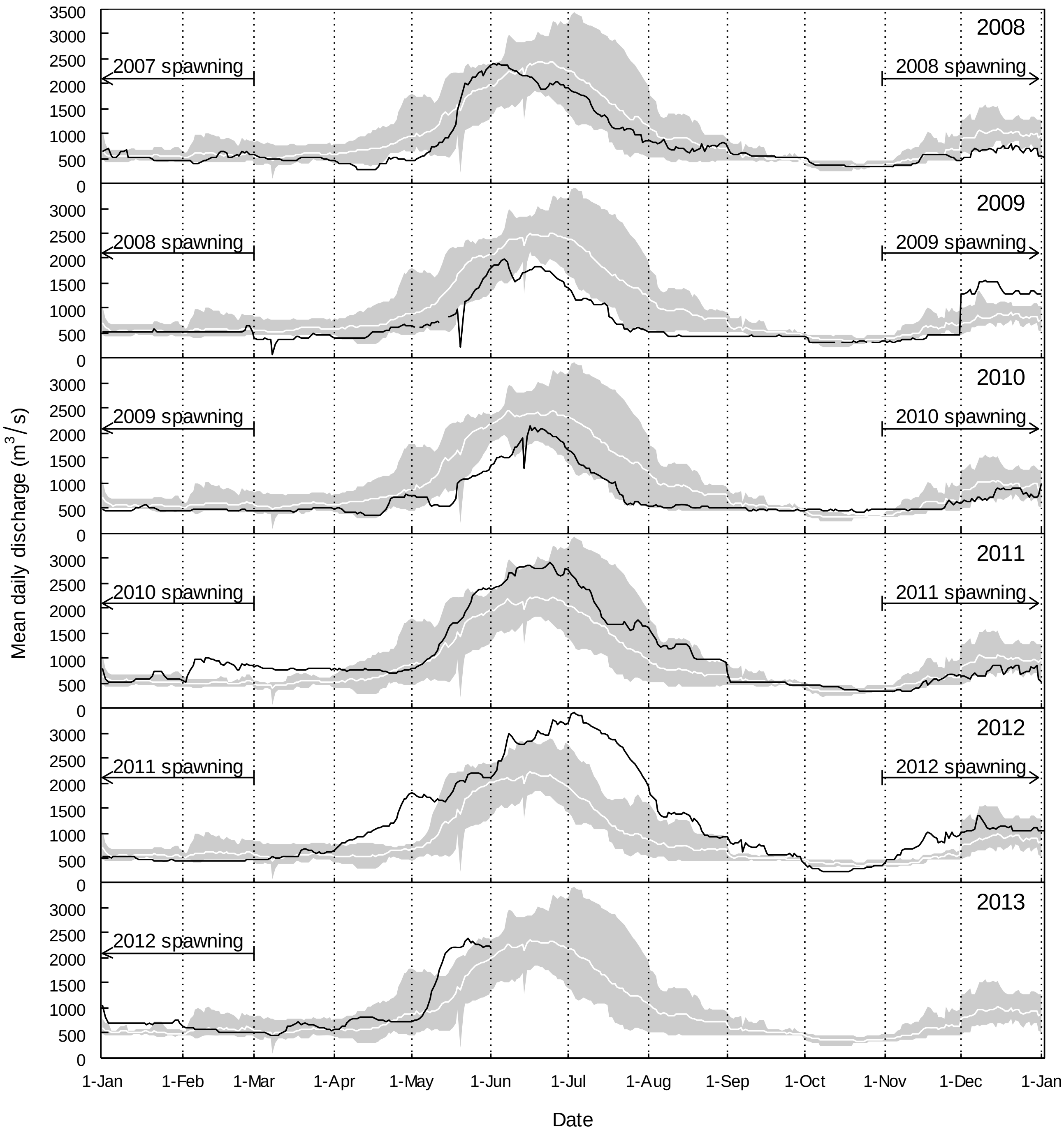


Figure 11: Mean daily discharge (m³/s) for the Kootenay River at Brilliant Dam (black line), 2008-2013. The shaded area represents minimum and maximum mean daily discharge values recorded at Brilliant Dam during other study years (between 2008 and 2013). The white lines represent average mean daily discharge values over the same time period.

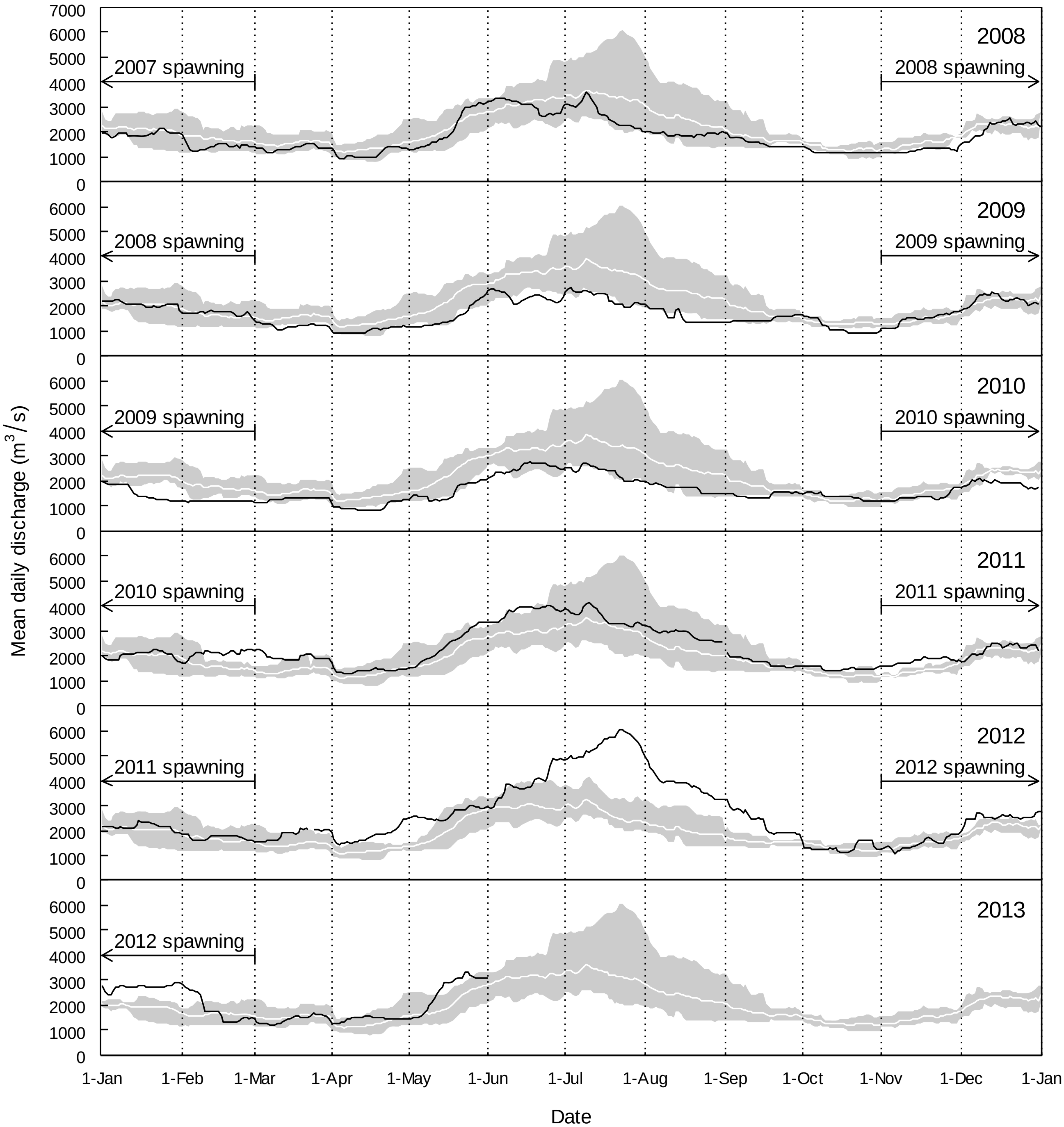


Figure 12: Mean daily discharge (m^3/s) for the Columbia River at the Birchbank water gauging station (black line), 2008-2013. The shaded area represents minimum and maximum mean daily discharge values recorded at Birchbank during other study years (between 2008 and 2013). The white lines represent average mean daily discharge values over the same time period.

4.2.3 Depth, Surface Velocity, and Substrate Type at Egg Mat Deployment Locations

A summary of the habitat variables collected at egg collection mat locations is provided in Appendix D, Tables D1 to D4. Depth at egg collection mat deployment locations varied by year, site, and shore/mid-channel (i.e., subsites). Typically, depth was greatest at mid-channel sites, especially at CPR Island, where mean mid-channel deployment depths were substantially deeper than mean shore set depths (Figure 13). In the Kootenay River, mean mid-channel set depths were typically deeper than shore sets, although both were highly variable (wide ±1 standard deviation intervals).

Mean surface water velocity was slightly higher in mid-channel sites than in shore sites in both CPR Island and Kootenay River locations; however, velocities were highly variable across all sites/years (Figure 13).

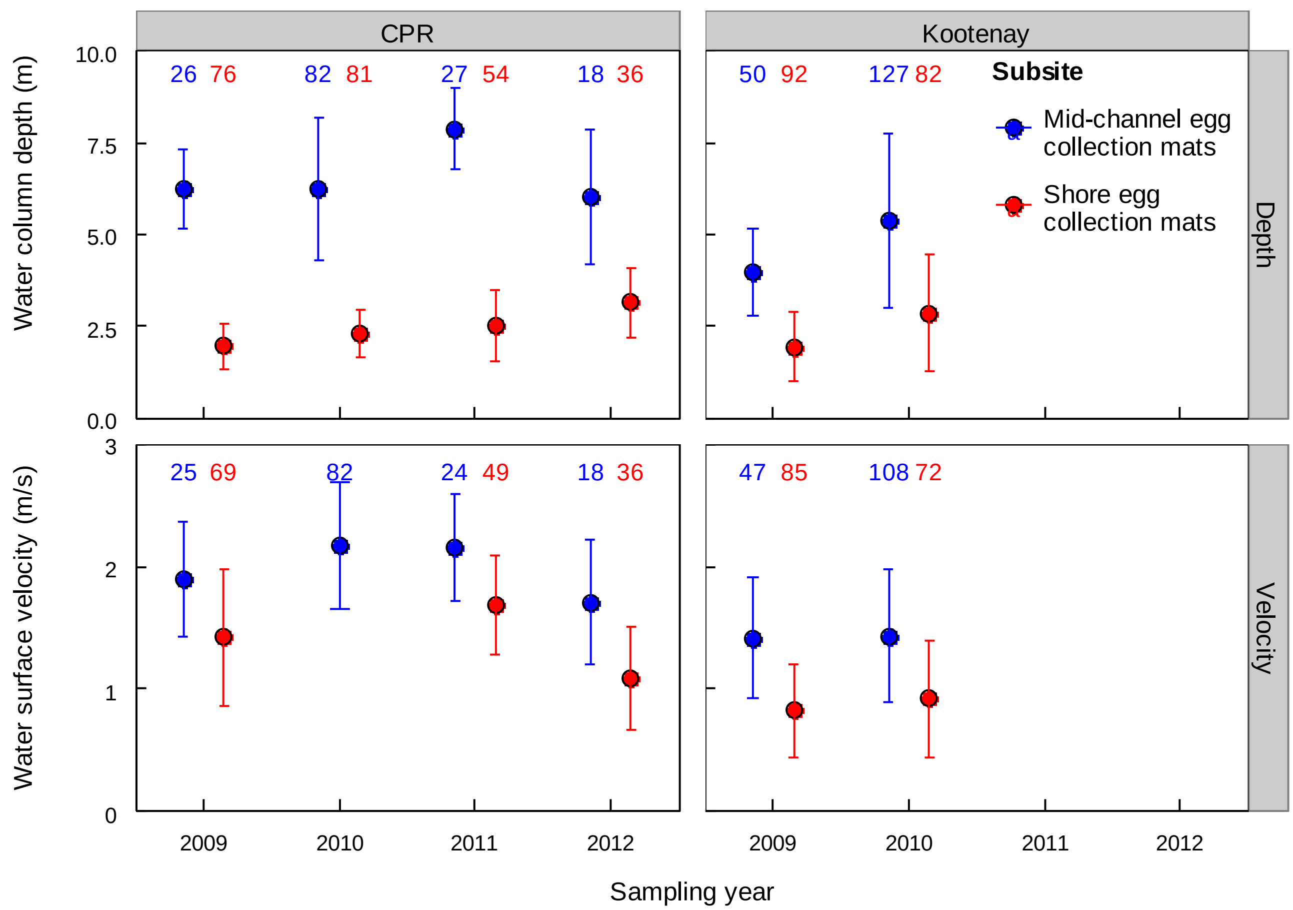


Figure 13: Recorded mean depth (m) and mean surface velocity (m/s) at egg mat deployment locations in key Mountain Whitefish spawning areas , plotted by year (2009-2012), site (CPR Island and Kootenay River), and subsite type (mid-channel and shore). The number of measurements taken for each parameter is shown on top of each panel. Error bars are standard deviations.

In the middle and lower sections of the study area, depth at egg collection mat deployment locations (Blueberry Creek, Genelle, and the area between Trail, and Waneta Eddy) varied by site and shore/mid-channel sub-site. Typically, mid-channel sites had higher depth, especially at Blueberry Creek (Figure 14). Egg collection mats were not deployed at mid-channel locations at Genelle. In the Trail-Waneta area, mid-channel deployment depths were very similar to shore set depths. Overall, depths recorded at Blueberry Creek were comparable to CPR Island, while the Trail-Waneta mid-channel sites had depths similar to the Kootenay River (Figure 14). Mean surface water velocity was slightly higher in mid-channel sites than in shore sites in both Blueberry Creek and the Trail-Waneta area (Figure 14).

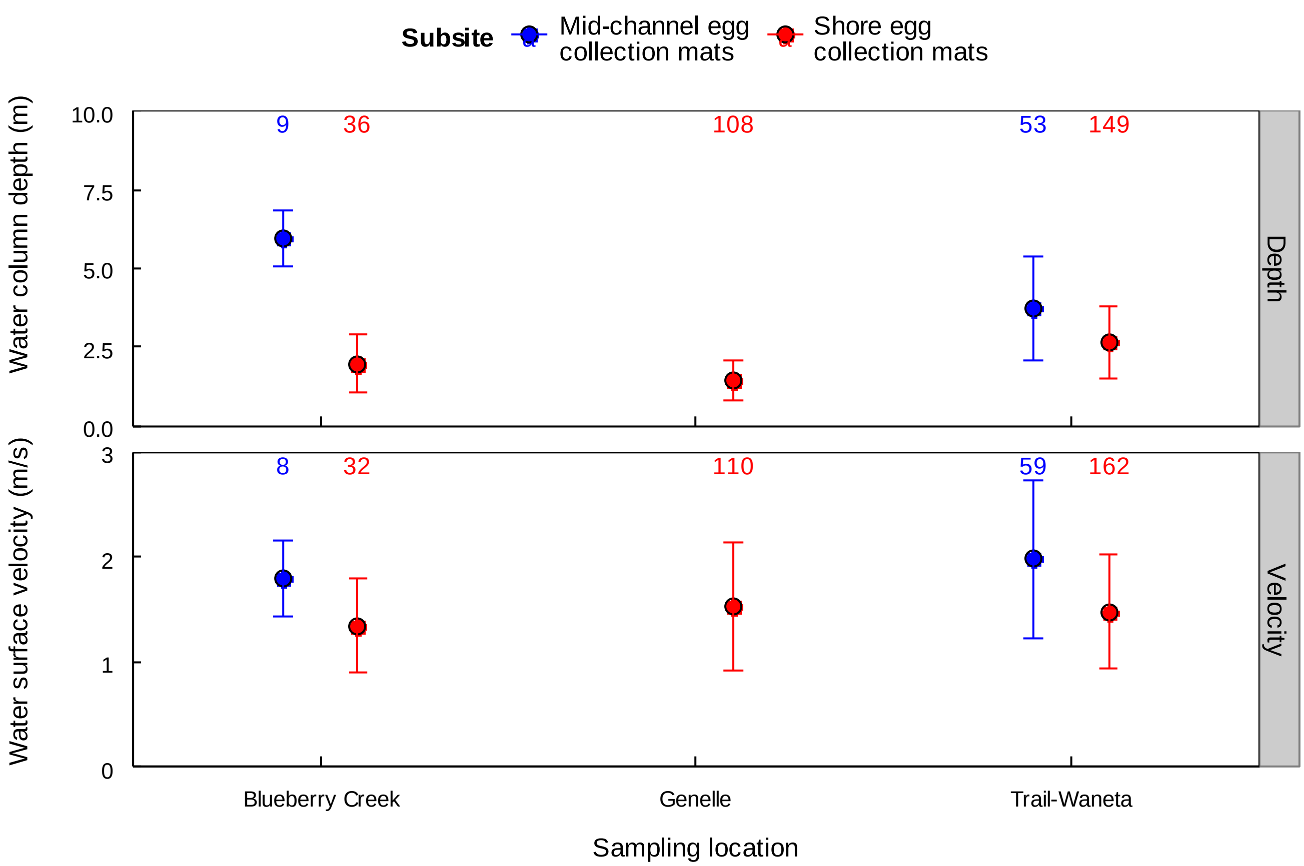


Figure 14: Mean recorded depth (m) and surface velocity (m/s) at egg mat deployment locations in secondary Mountain Whitefish spawning areas , plotted by site (Blueberry Creek, Genelle, and between Trail and Waneta Eddy) and subsite type (mid-channel and shore). The number of samples collected at each sub site of each site is provided on the top of the figure. Error bars are standard deviations. Genelle and Blueberry Creek were sampled in 2009, and the area between Trail and Waneta was sampled in 2011.

The majority of left upstream bank sampling locations at CPR Island were composed of cobble (dominant) and boulder, cobble, or gravel (sub-dominant; Figure 15). The dominant substrate at the right upstream bank site was recorded to be cobble in earlier sampling years and boulders in later sampling years, which indicated a coarsening of the substrate occurred in this area over the study period. Sub-dominant substrate shifted from boulder and gravel (earlier sampling years) to mainly cobble (later sampling years).

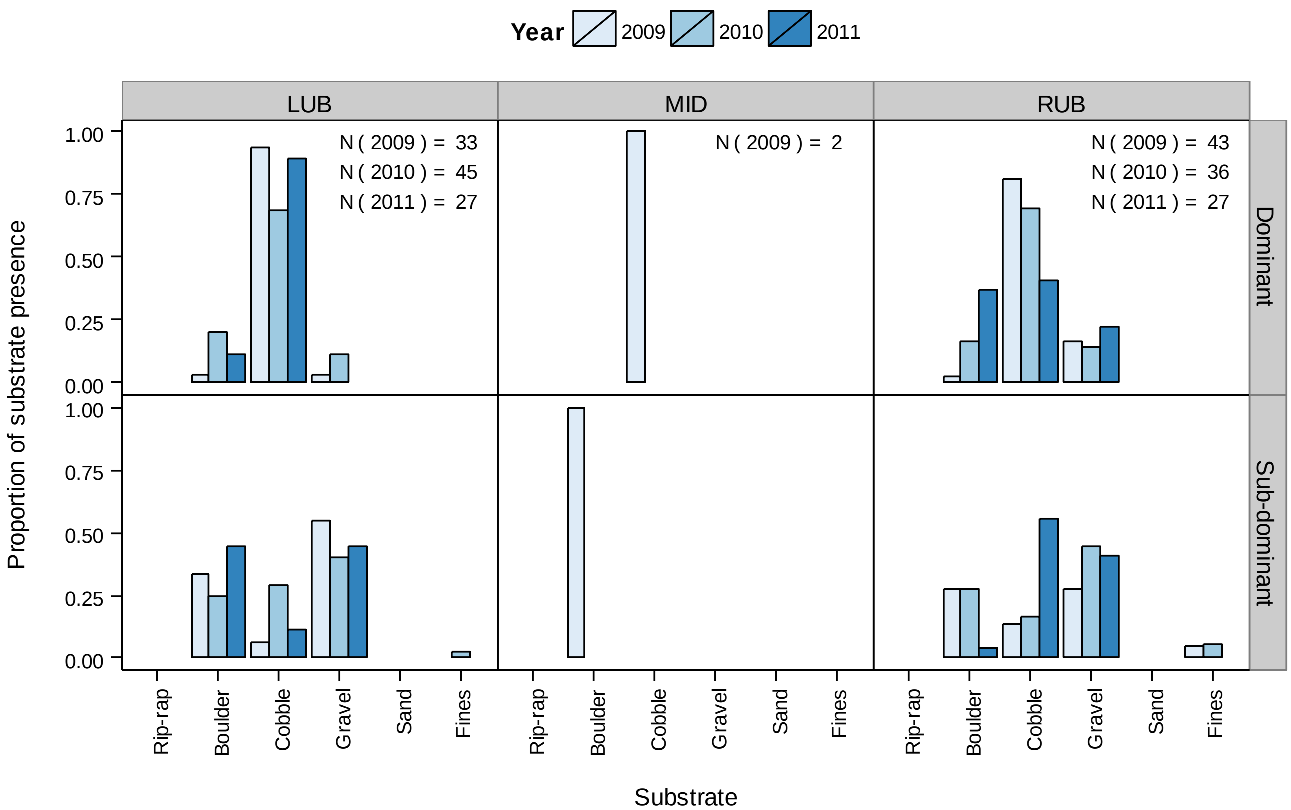


Figure 15: Substrate characterization at egg mat deployment locations in the key Mountain Whitefish spawning area at CPR Island , plotted by year (2009-2011), dominance level (dominant and sub-dominant), and subsite type (mid-channel and shore). The number of measurements taken in each year is shown on top of each panel.

In the Kootenay River spawning area, the dominant substrate across most sub-sites was boulder, cobble, and gravel. At sites along the left upstream bank, rip-rap was the dominant substrate in approximately 20-30% of the cases. The vast majority of sub-dominant substrate was boulder, cobble, and gravel (Figure 16).

In spawning areas in the Middle and Lower Section, the dominant substrate across most sub-sites was boulder, cobble, and gravel. The vast majority of sub-dominant substrate was cobble and gravel (Figure 17).

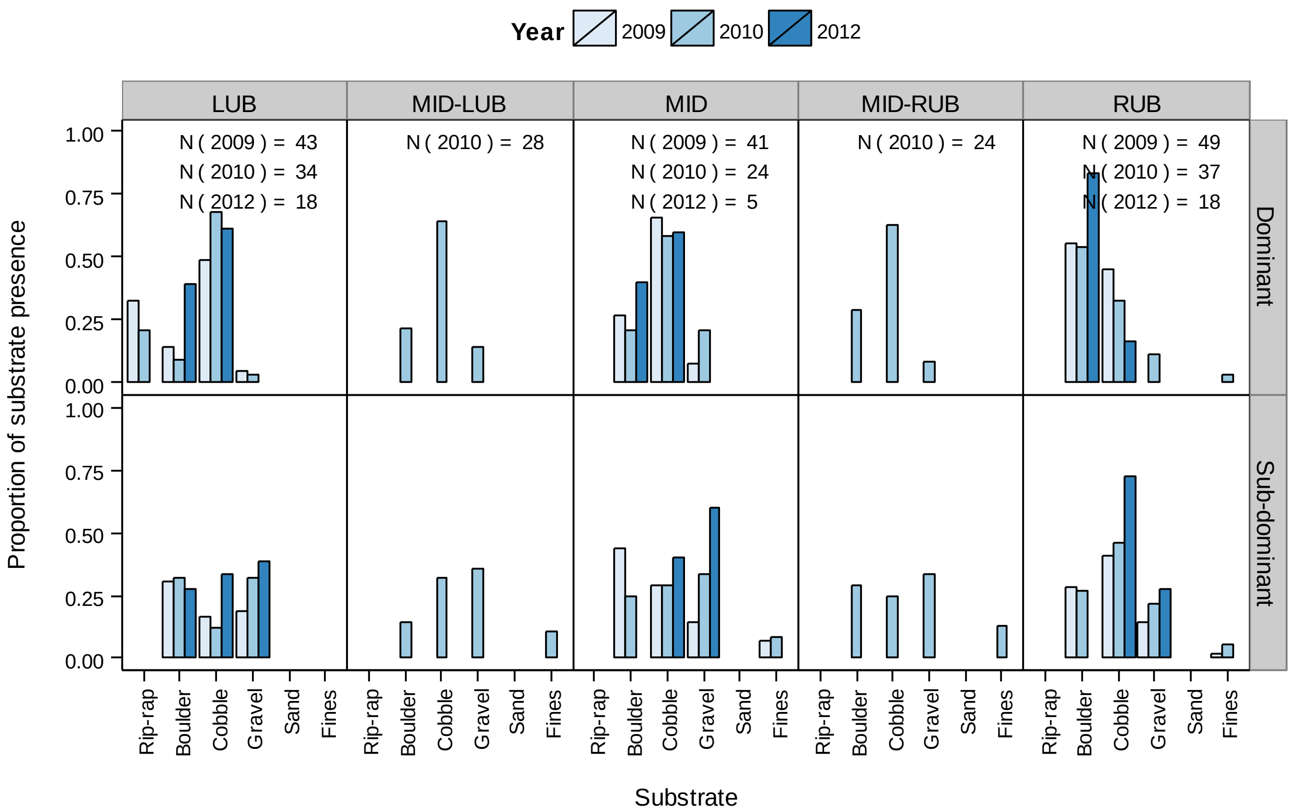


Figure 16: Substrate characterization (dominant and sub-dominant groups) at the egg mat deployment locations in the key Mountain Whitefish spawning area at the Kootenay River, plotted by year (2009-2010), dominance level (dominant and sub-dominant), and sub site type (mid-channel and shore). The number of measurements taken in each year is shown on each panel.

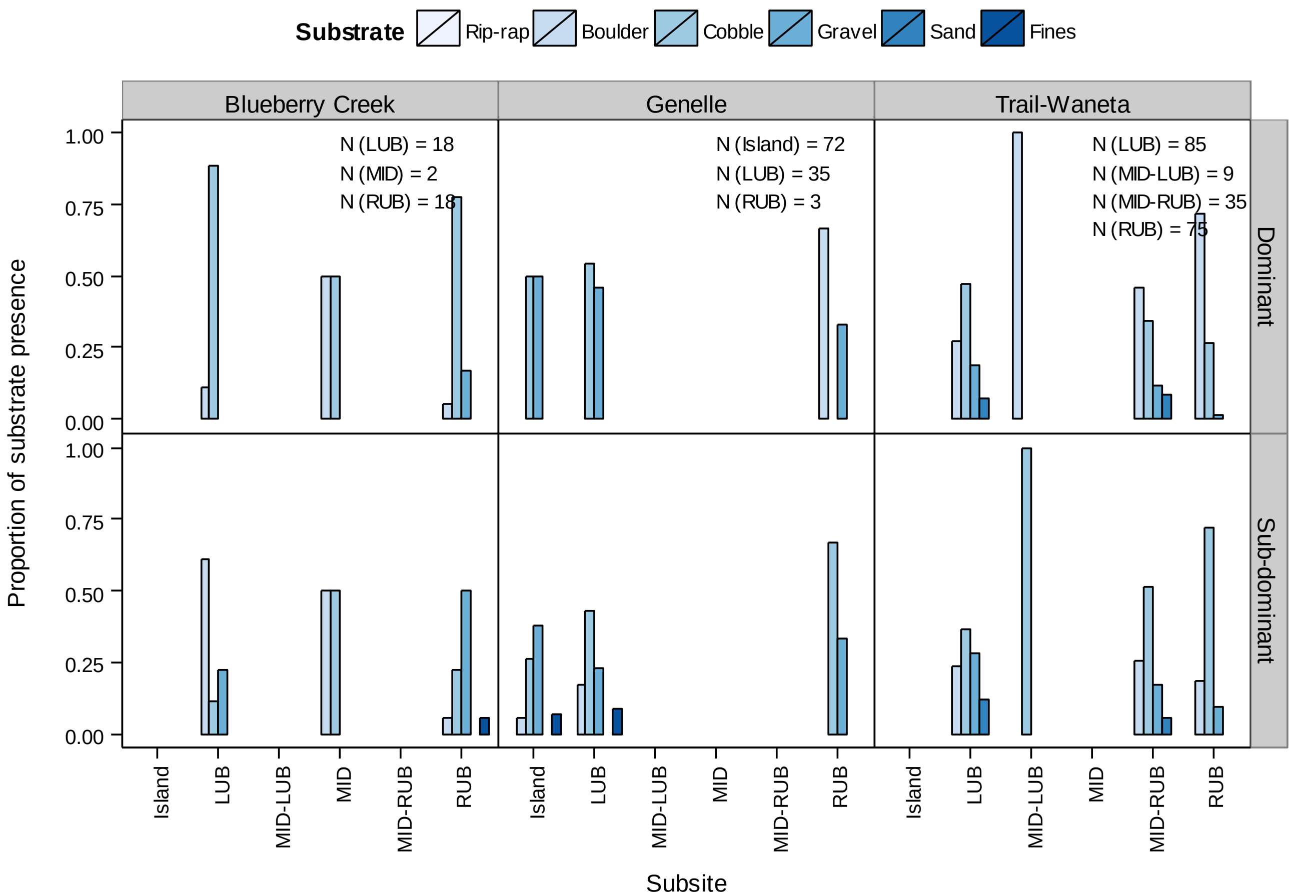


Figure 17: Substrate characterization (dominant and sub-dominant groups) at egg mat deployment sites in secondary Mountain Whitefish spawning areas within the middle (Blueberry Creek and Genelle) and lower (between Trail and Waneta Eddy) sections of the LCR plotted by site, dominance level, and sub site type (mid-channel and shore). Genelle and Blueberry Creek were sampled in 2009, and the area between Trail and Waneta was sampled in 2011.The number of measurements taken in each year is shown on each panel.

4.2.4 Availability of Preferred Spawning Habitat Conditions

In order to determine the depth at which the majority of Mountain Whitefish egg deposition occurred within the key spawning areas, the egg deposition probability (EDP) was modelled based on data collected during egg mat sampling (Figure 18). At CPR Island, EDP peaked at 1.7-1.8 m depth in 2009 and 2011. In 1997, EDP peaked at 2.6 m over a narrower range of depths than other study years. In 2010, egg deposition occurred over a wide range of depths with a slight peak at 4.0 m. In the Kootenay River, the EDP peaked between 2.7 m and 4.4 m in all study years, with the widest depth ranges in 2010 and 2012 (Figure 18).

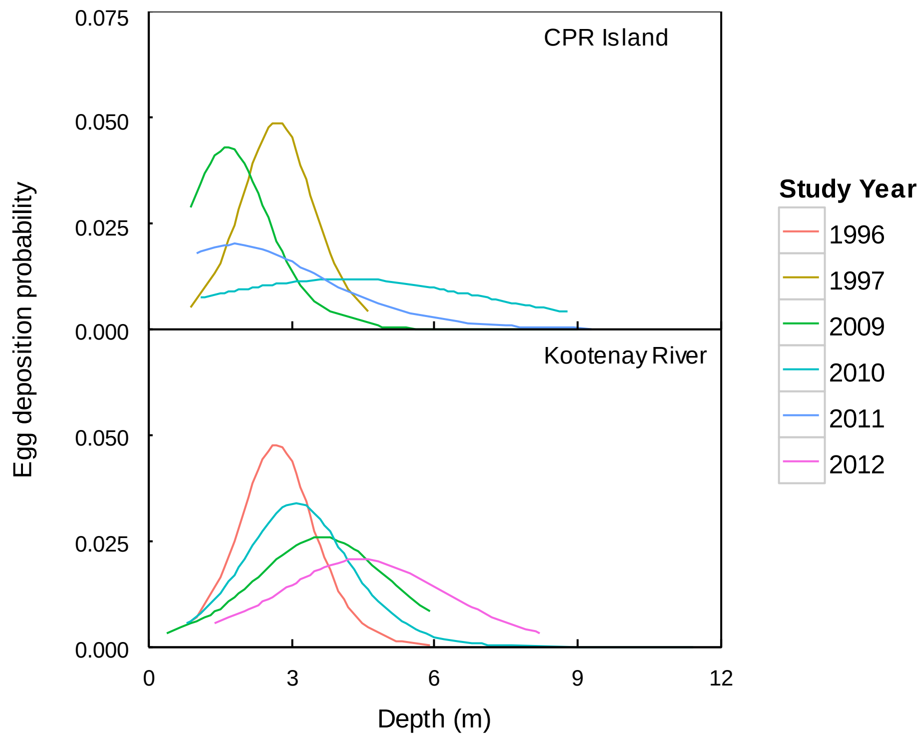


Figure 18: Egg deposition probability at the key spawning areas as a function of depth (m), modeled separately for each year and river.

The EDP was also modelled using the mean column velocities interpolated from the River 2D models created as part of the CLBMON-47 program (Figure 19). At CPR Island in 1997, the peak EDP occurred at a mean column velocity of approximately 0.4 m/s, compared to 0.8 m/s in 2011, and 1.1 m/s in 2009 and 1.3 m/s in 2010. Egg deposition occurred over a wider range of velocities in 2009, 2010, and 2011 compared to 1997. In the Kootenay River, the EDP patterns and ranges were similar for 1996 and 2012 and for 2009 and 2010 (Figure 19). Peak EDP occurred between 0.8 m/s and 1.4 m/s in all years studied although egg deposition occurred over a narrower range of velocities in 1996 and 2012 than in 2009 and 2010.

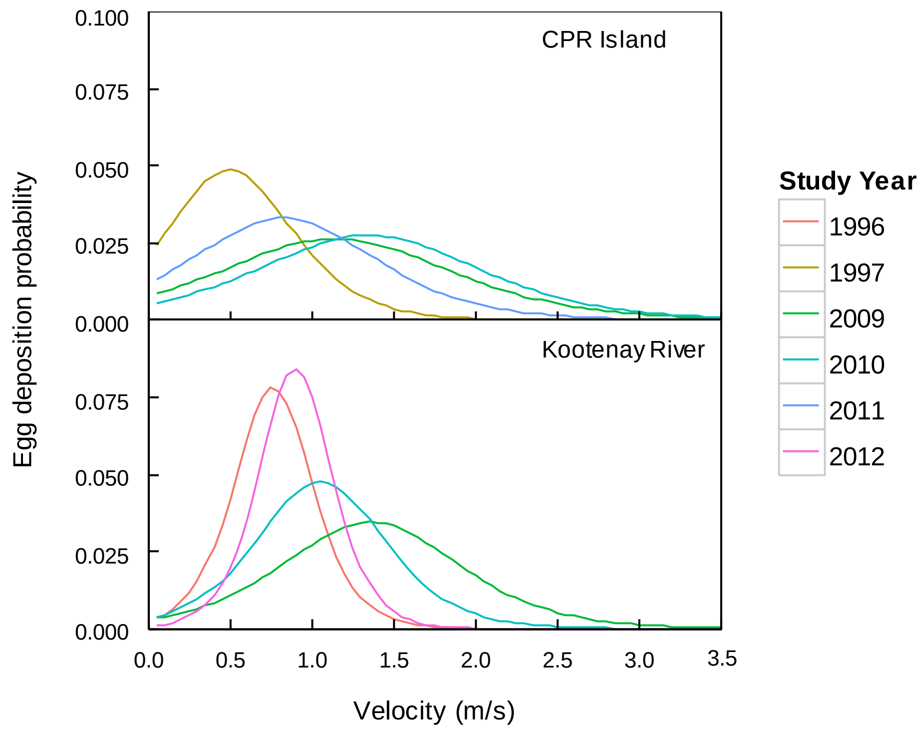


Figure 19: Egg deposition probability at the key spawning areas as a function of mean column velocity (m/s), modeled separately for each year and river. Velocities were derived values interpolated using the CLBMON-47 River2D models.

Based on results of the River 2D model, the amount of area at CPR Island within the preferred depth range of 1.7-4.0 m (i.e., where the highest EDPs occurred (Figure 18) declined slowly as HLK discharge increased (Figure 20). The shallowest depth ranges where EDPs were lowest (0-1.7 m) exhibited steady increases in area as HLK discharge increased, while the amount of area of the deepest habitat (>4 m) steadily declined. BRD discharge had little effect on the preferred depth range at CPR Island (Figure 20).

At CPR Island, HLK discharge had the most effect on the velocity. The amount of available area at CPR Island with preferred mean column velocities (0.4-1.3 m/s; Figure 19) exhibited a trend of decline as HLK discharge increased (Figure 20). While the available habitat with the slowest velocity range (0-0.4m/s) declined as HLK discharge increased, the availability of habitats with fast mean column velocity (>1.3 m/s) steadily increased (Figure 20). Although discharge from BRD had little effect on the amount of spawning area with preferred velocities, these areas were most prevalent at HLK discharges between 500 m^3/s and 1250 m^3/s (Figure 20).

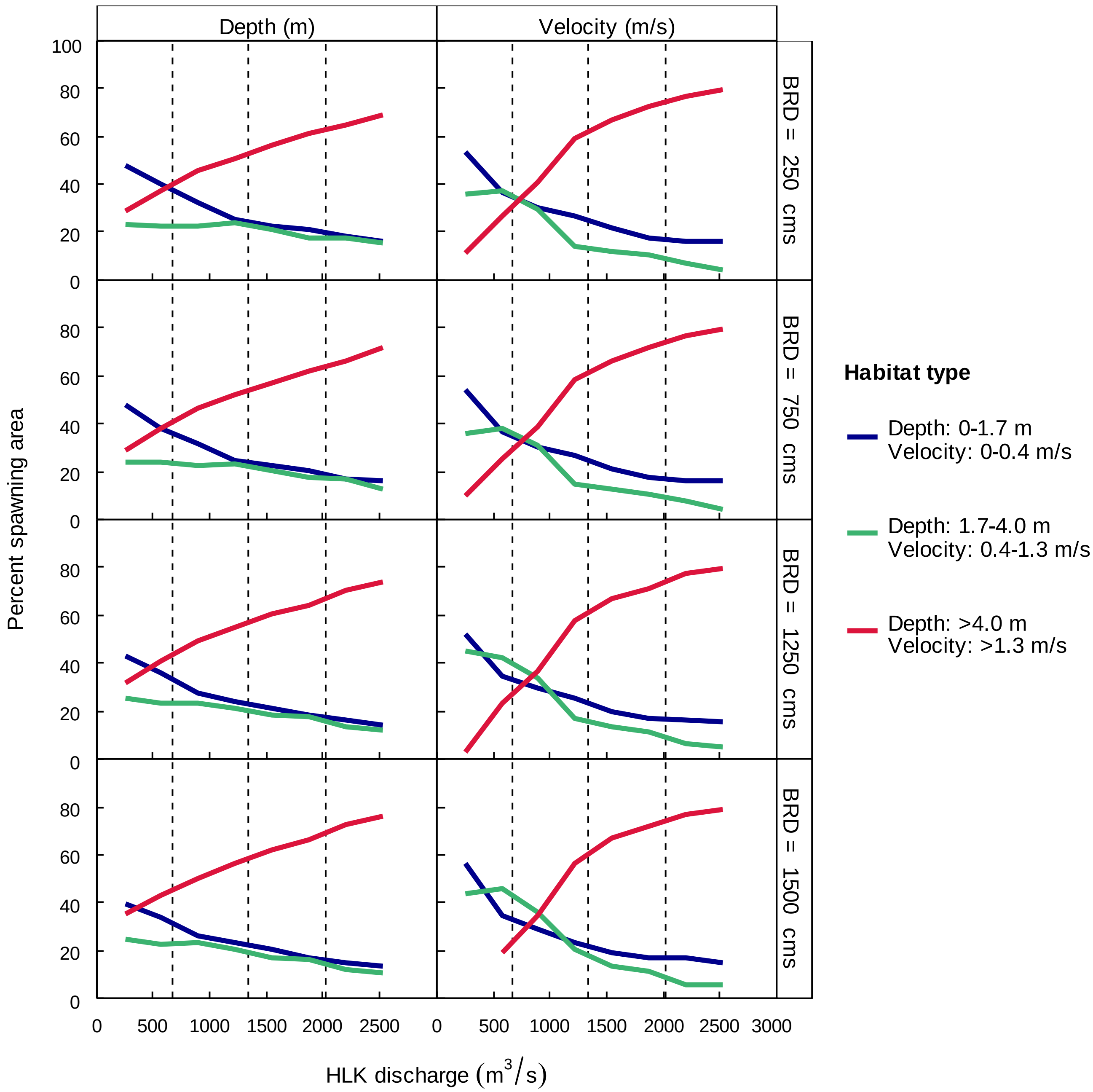


Figure 20: Habitat characterisation at CPR Island in response to HLK and BRD discharges. The percentage of habitat area characterised by each depth or velocity bin are shown in different colours with green representing the preferred habitat range.

When HLK discharge was low (250 to 900 cms) the area in the Kootenay River within the preferred depth range (2.7-4.4 m; Figure 18) slowly increase declined as BRD discharge increased (Figure 21). At high HLK flows (1550 to 2525 cms); the available habitat with preferred depth remains relatively stable. Depth ranges outside of the preferred range (0-2.7 m and >4.4 m) exhibited substantial variation in area as both HLK and BRD discharges increased (Figure 21).

When HLK discharge was low, the amount of available area with preferred velocity (0.8-1.4 m/s; Figure 19) followed a similar pattern as BRD discharge increased (Figure 21). As discharge from both HLK and BRD increased, the available area at all examined velocities became highly variable.

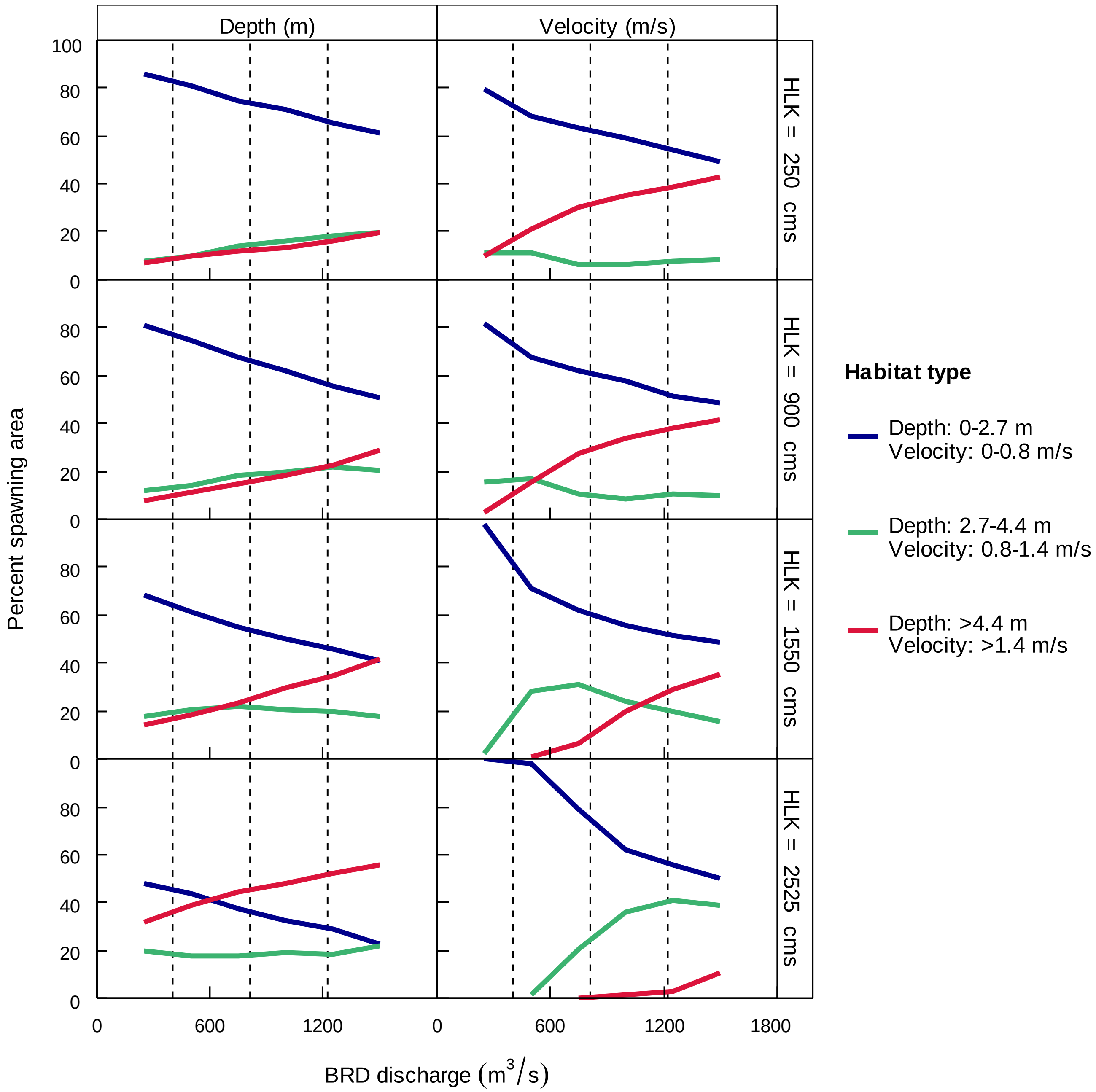


Figure 21: Habitat characterisation of the Kootenay River spawning area in response to BRD and HLK discharges. The percentage of habitat area characterised by each depth or velocity bin are shown in different colours with green representing the preferred habitat range.

The River 2D models were also used to examine the depth and velocity conditions present in the key spawning areas at the time of peak spawning. To accomplish this, flows during peak spawning at the CPR Island and Kootenay River spawning areas during the expanded egg collection mat sampling in Year 3 (2010 – 2011; Appendix A, Table A3 and Figures A4 and A5) were modelled. At CPR Island, the shallowest mean depths over the peak spawning period occurred along the RDB and LDB, as well as the mainstem bank of CPR Island (Figure 22). Mean depths were greatest in the mid-channel areas at the upstream end of the area, and decreased in a downstream direction. Areas with the preferred depth range for spawning occurred at the upstream end of the site along LDB, along the mainstem bank of CPR Island, and along RDB at the downstream end of the site (Figure 22). These areas also contained the egg collection mats with the highest egg CPUE (see Section 4.6 and Figure 28 below). Mean column velocities in near shore habitats at CPR Island followed a similar trend as depth, with modelled velocities lowest in these areas (Figure 22). Mean column velocities were greatest mid-channel, and conversely to depth, increased in a downstream direction. Areas with preferred mean column velocities occurred near shore along both banks, as well as in the mid-channel areas in the upstream portions of the spawning area (Figure 22).

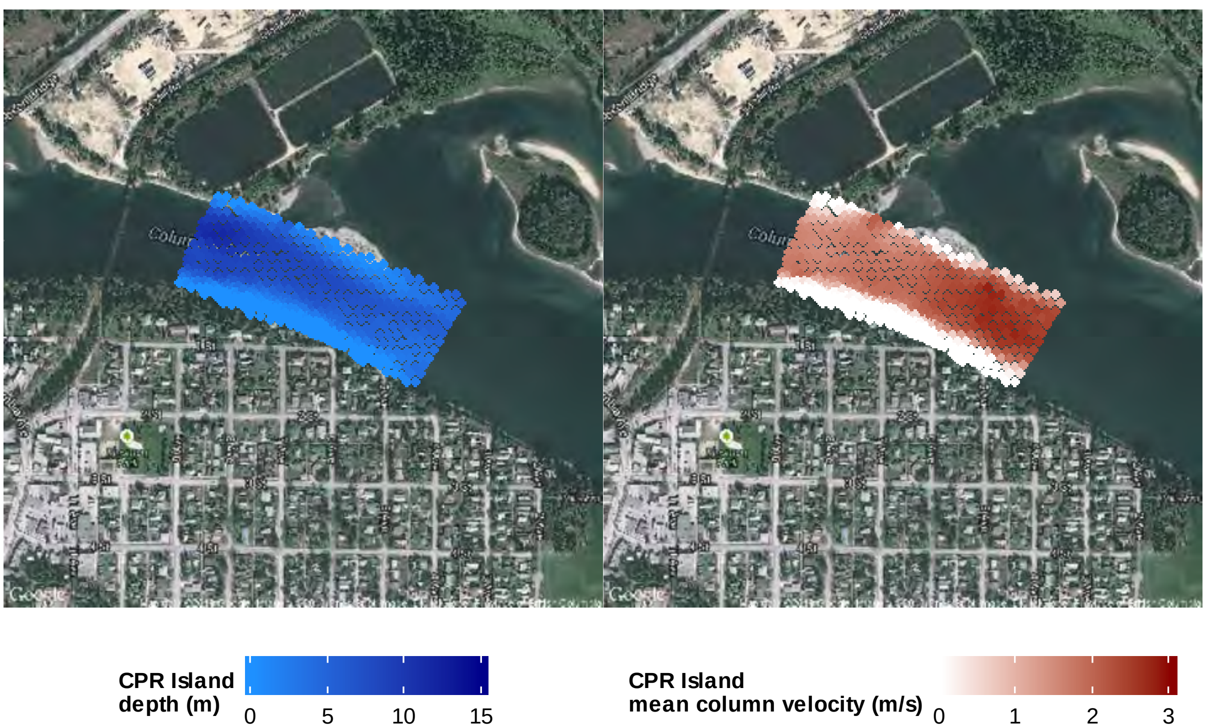


Figure 22: Mean River 2D-derived depths and velocities at CPR Island during peak spawning; values were averaged over the three weeks with the highest CPUEs of newly spawned eggs - January 4, 2011, January 11, 2011, and January 18, 2011.

During the peak spawning period in Year 3 (2010 – 2011), the percent of available habitat at CPR Island within various depth and velocity bins was also modelled (Table 14), During all three documented peaks in spawning, habitats with depths > 5 m were most abundant, followed closely by areas with 0-1 m depth. These two depth categories accounted for over 60% of the available spawning habitat during each documented peak. The percent of available habitat that encompassed the preferred depth accounts for the majority of the remaining habitat at the site during each peak (approximately 25 to 26%; Table 14). Areas at CPR Island with modelled mean column velocity of 0.0-0.5 m/s were the most available, followed by habitats with velocities of 1.5-2.0 m/s. Habitats with velocities of 0.5-1.0 m/s and greater than 2.5 m/s were least abundant during the peak spawning period of Year 3 (Table 14). Areas with preferred mid column velocities encompassed 18 to 26% of the available spawning habitat.

Table 14: Habitat characterisation of the CPR Island area at three dates during 2010-2011 peak spawning using depth and velocity bins. Note: bins encompassing preferred spawning habitat ranges are bolded in the table.

Depth bin (m)	Percent habitat - depth			Velocity bin (m/s)	Percent habitat - velocity		
	4-Jan-2011	11-Jan-2011	18-Jan-2011		4-Jan-2011	11-Jan-2011	18-Jan-2011
0-1	28	25	25	0-0.5	35	30	30
1-2	**6**	**6**	**6**	**0.5-1.0**	**7**	**7**	**7**
2-3	**11**	**10**	**10**	**1.0-1.5**	**19**	**11**	**11**
3-4	**9**	**9**	**9**	1.5-2.0	20	28	29
4-5	9	8	8	2.0-2.5	12	16	16
> 5	37	42	42	> 2.5	7	8	8

At the Kootenay River, the shallowest mean depths (0.0 m to 1.0 m) over the Year 3 peak spawning period occurred along the RDB and LDB (Figure 23) and encompassed approximately 50% of all available habitats (Table 15). Mean depths were greatest in the mid-channel areas at the upstream end of the site, and decreased in a downstream direction. Areas with the preferred depth range for spawning encompassed approximately 29 to 31% of all available spawning area (Table 15) and occurred in the mid-channel habitats (Figure 23). Similar to modelled depths, the mean column velocities were the slowest (0.0 m/s to 0.5 m/s) in near shore habitats (Figure 23). These low velocity areas covered 60 to 66% of all available spawning habitat (Table 15). Mean column velocities were greatest mid-channel in the upstream portion of the spawning area, but only accounted for a small percentage of useable spawning area. Areas with preferred mid column velocities occurred nearshore along both banks, as well as in the mid-channel areas of the Kootenay River (Figure 23). These areas varied in availability over the peak spawning period (15 to 35%; Table 15).

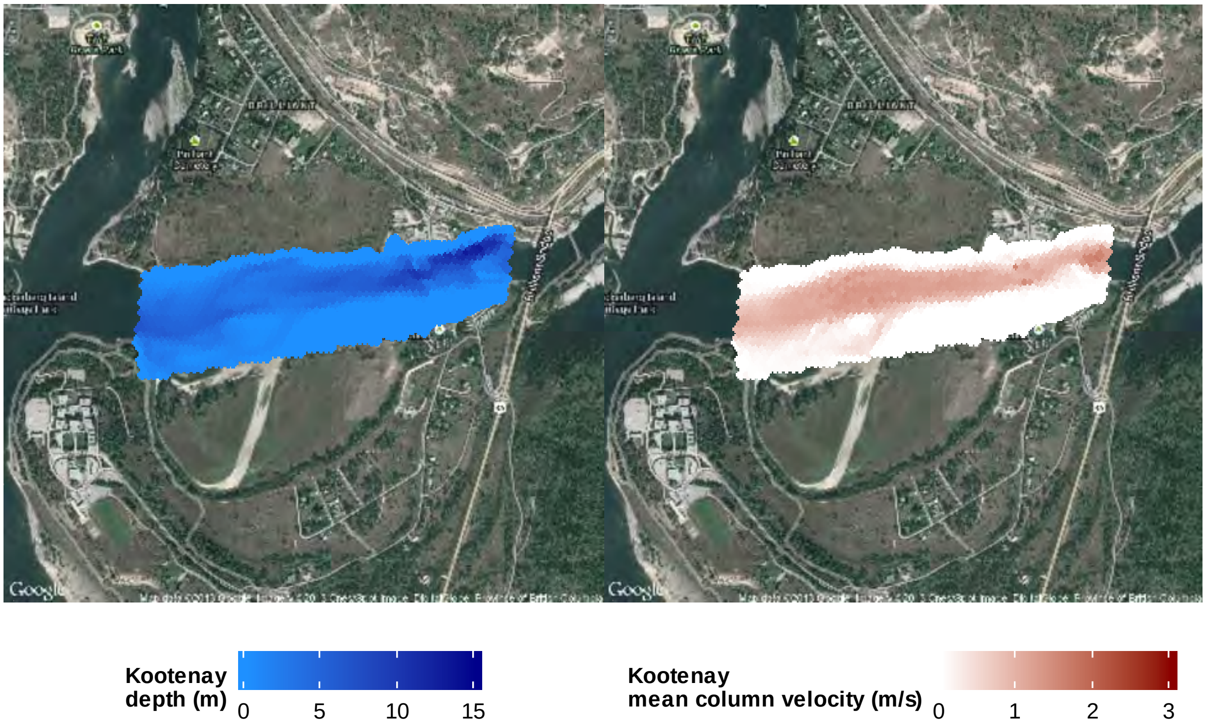


Figure 23: Mean River 2D-derived depths and velocities at the Kootenay River spawning area during peak spawning; values were averaged over the three weeks with the highest CPUEs of newly spawned eggs - December 16, 2010, January 5, 2011, and January 12, 2011.

Table 15: Habitat characterisation of the Kootenay River spawning area at three dates during 2010-2011 peak spawning using depth and velocity bins. Note: bins encompassing preferred spawning habitat ranges are bolded in the table.

Depth bin (m)	Percent habitat - depth			Velocity bin (m/s)	Percent habitat - velocity		
	16-Dec-2010	5-Jan-2011	12-Jan-2011		16-Dec-2010	5-Jan-2011	12-Jan-2011
0-1	50	53	49	0-0.5	60	66	65
1-2	8	9	8	**0.5-1.0**	**7**	**12**	**17**
2-3	**12**	**12**	**12**	**1.0-1.5**	**8**	**20**	**18**
3-4	**10**	**10**	**11**	1.5-2.0	19	2	0
4-5	**7**	**7**	**8**	2.0-2.5	6	0	0
> 5	12	9	12	> 2.5	0	0	0

4.3 Spawning Periodicity, Timing, and Intensity

Based on egg collection and subsequent developmental staging (Appendix D, Tables D1 to D8), the back-calculated estimates indicated that the initiation of Mountain Whitefish spawning at CPR Island occurred in early-mid November in all sampled years (Figure 24). Discharge in the study area increased immediately prior to the onset of spawning in 2009 and 2010 and decreased prior to the onset in 2011. The documented spawning intensity (CPUE expressed as number of eggs/ mat day) was much higher in 2009 (4.4 eggs/mat day) compared to the other study years (1.0 eggs/mat day in 2010 and 1.1 eggs/mat day in 2011; Appendix D, Tables D1 to D4). Peak CPUE was observed in early January in 2009 and 2011, and in mid-January in 2010. Three distinct patterns of hydro operations occurred during the peak spawning periods: in 2009, peak spawning occurred during a period of decreasing discharge, in 2010 discharge was increasing, and in 2011, discharge was relatively stable (Figure 24).

The onset of spawning in 2009 and 2010 occurred during sharp declines in water temperature, while in 2011 temperatures were gradually declining. In all years, the onset of spawning occurred at temperatures between 6°C to 8°C and peak spawning occurred when water temperature gradually decreased from 4°C to 3°C (Figure 24).

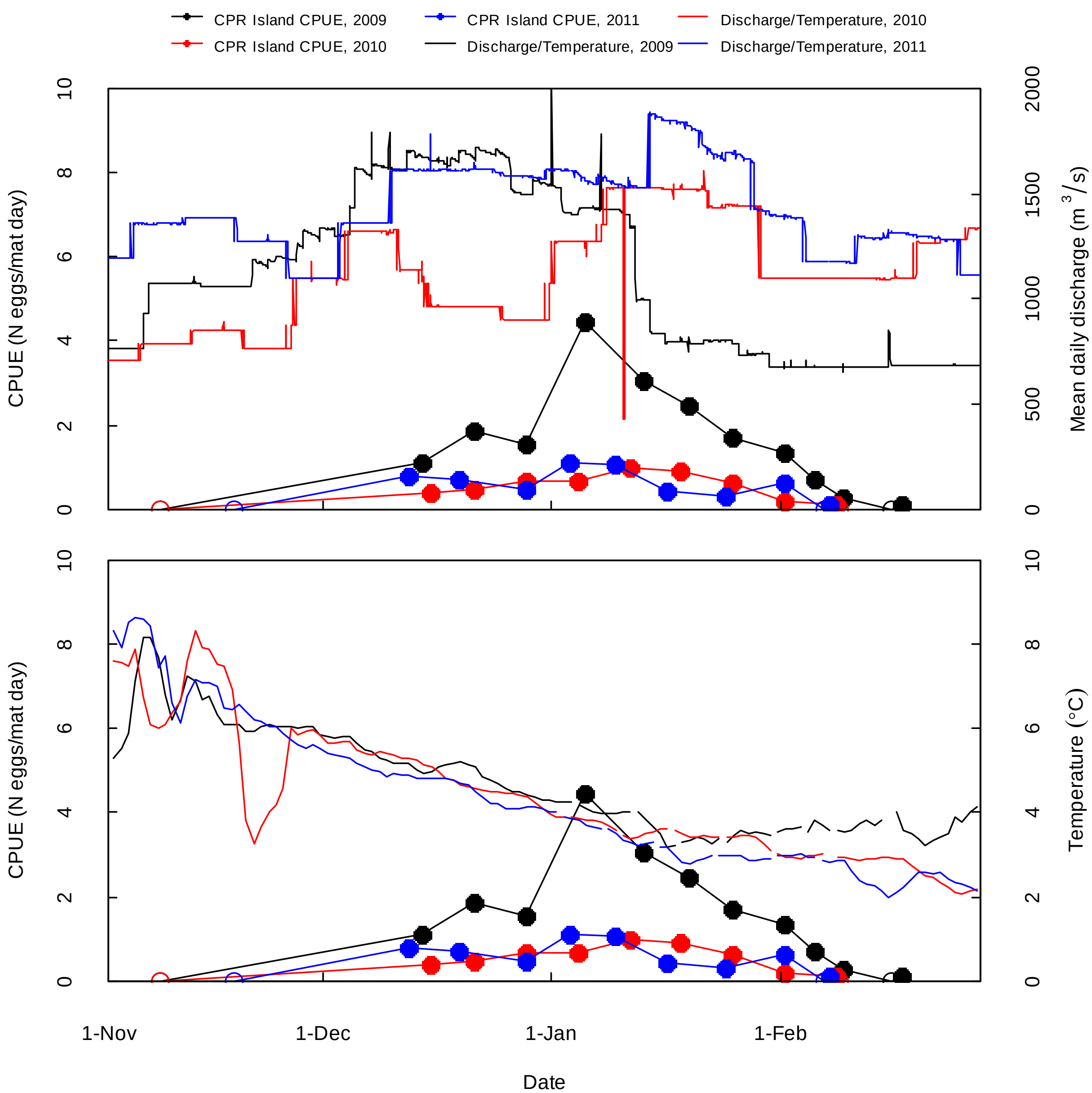


Figure 24: Catch per unit effort (CPUE = No. eggs/mat day) of Mountain Whitefish eggs at CPR Island between 2009 and 2012 (solid dots) and mean hourly discharge (m³/s; top panel) and mean hourly temperature (°C; bottom panel) of the Columbia River at Hugh L. Keenleyside Dam and Norn's Creek gauging station, respectively (2010-2012; solid lines; secondary y-axes). Open points represent the first and last dates of spawning, back-calculated based on ATU values of captured eggs.

In the Kootenay River, catch rates exhibited a bi-modal pattern of peak spawning in all study years (Figure 25). This bi-modal pattern also was recorded during the 1994-1995 and 1995-1996 spawning seasons (R.L.&L. 2001), and strongly indicated the presence of two spawning runs in the Kootenay River.

The back-calculated estimate of first spawning in the Kootenay River was early November in 2010, which was considerably earlier than early December in 2009 and 2012 (Figure 25). Discharge was stable prior to the onset of spawning in 2009 and 2010, but fluctuated frequently (due to daily load shaping operations of BRD) before spawning in 2012. The spawning intensity in the Kootenay River differed between study years; in 2009, maximum CPUE was 5.7 eggs/mat day compared to 8.7 eggs/mat day in 2010 and 13.5 eggs/mat day in 2011. During the first spawning peak in 2009 and 2010, discharge in the Kootenay River fluctuated due to load shaping at BRD. Discharge was relatively stable during the first spawning peak in 2012, as well as during the second peak in all years (Figure 25).

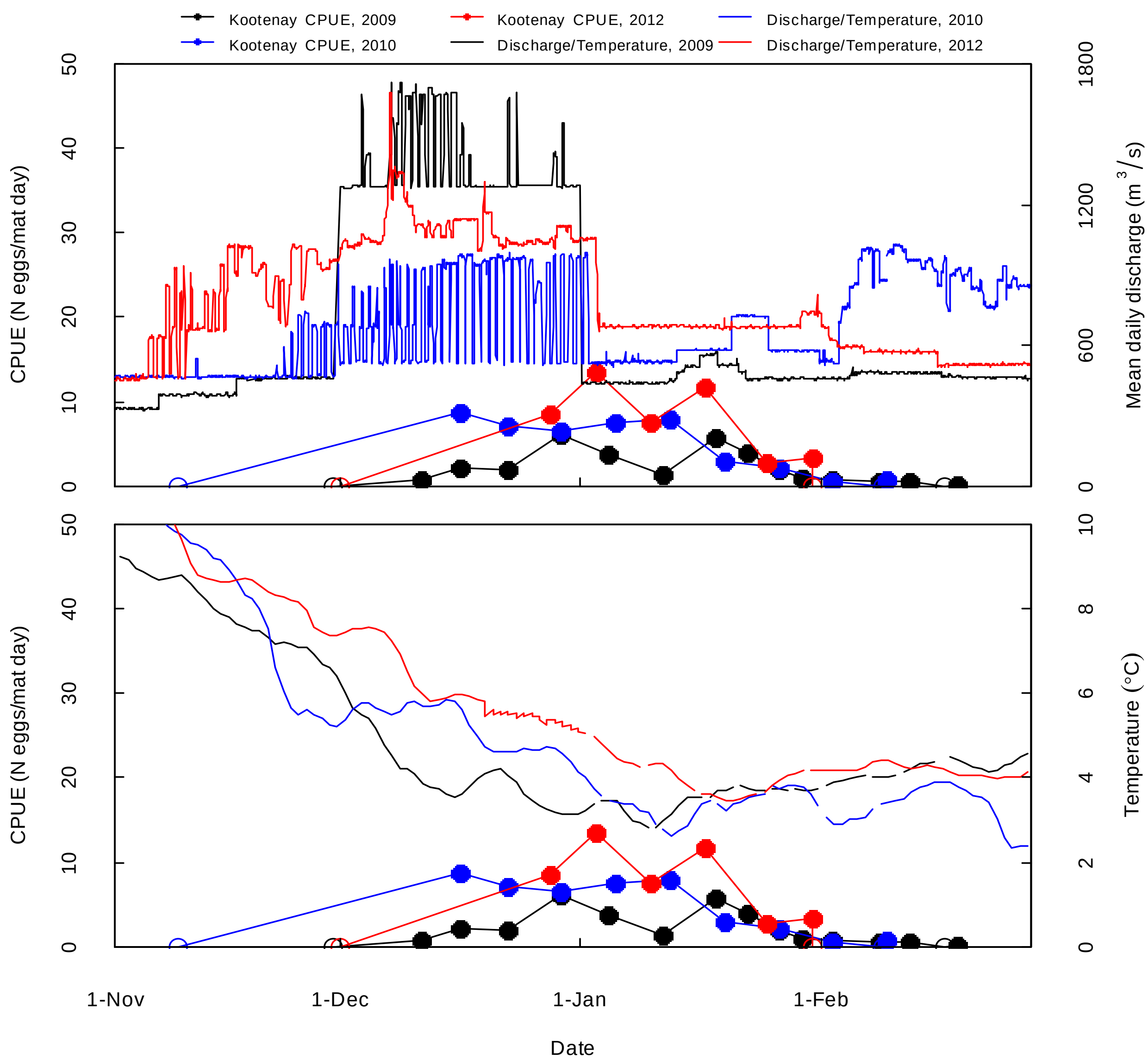


Figure 25: Catch per unit effort (CPUE; N eggs/mat day) of Mountain Whitefish eggs at the Kootenay River in 2009-2010 (points) and mean hourly discharge (m³/s; top panel) and mean hourly temperature (°C; bottom panel) of the Kootenay River at Brilliant Dam (2009-2010; solid lines; secondary y-axis). Open points represent the first and last dates of spawning, back-calculated based on ATU values of captured eggs.

Water temperatures in the Kootenay River steadily declined prior to the onset of spawning in all years (Figure 25). Temperatures differed at the onset of spawning between years, and ranged from approximately 6°C in 2009 to approximately 10°C in 2010. During the three sampling years, water temperature during peak spawning ranged from approximately 3°C in 2009 to approximately 6°C in 2010. The back-calculated day of last recorded spawning usually coincided with the last day of sampling, which indicated that some spawning likely occurred after sampling ended.

The back-calculated estimate of first spawning in the Trail-Waneta area (2011) occurred in early November. In the Blueberry and Genelle areas in 2009, the onset of spawning was estimated to have occurred in late November (Figure 26). Discharge in the middle and lower sections was stable prior to the onset of spawning in all years. The intensity of spawning differed between the sampled sites. In Genelle, CPUE values peaked at 0.8 eggs/mat day, while in Blueberry and Trail-Waneta, maximum CPUE was 0.4 eggs/mat day and 0.2 eggs/mat day, respectively. Spawning intensity exhibited a bimodal pattern at the Genelle and Trail-Waneta areas, with the first peak in mid-late December, and a second, smaller peak, in early January. During the first spawning peak at all sites, discharge fluctuated frequently due to load factoring at BRD. During the subsequent peaks at all sites, discharge was relatively stable or declining (Figure 26).

In 2009, water temperatures were gradually decreasing (from 6-7°C) in the middle section of the study area at the onset of spawning (Figure 26). A sharper decline in temperatures (from 6-8°C) was documented at the onset of spawning in the lower section in 2011. Peak spawning at all sites in the middle and lower sections was observed when water temperature at Birchbank was 4-6°C. In Blueberry, the back-calculated day of last recorded spawning was January 10, 2010, which suggested spawning was completed prior to the end of the sample program. Similarly, in the Trail-Waneta area, the back-calculated date of last spawning occurred on January 19, 2012. Conversely, at the Genelle area, the back-calculated last spawning was on February 12, 2010, which suggested that some spawning was likely to continue after sampling ended.

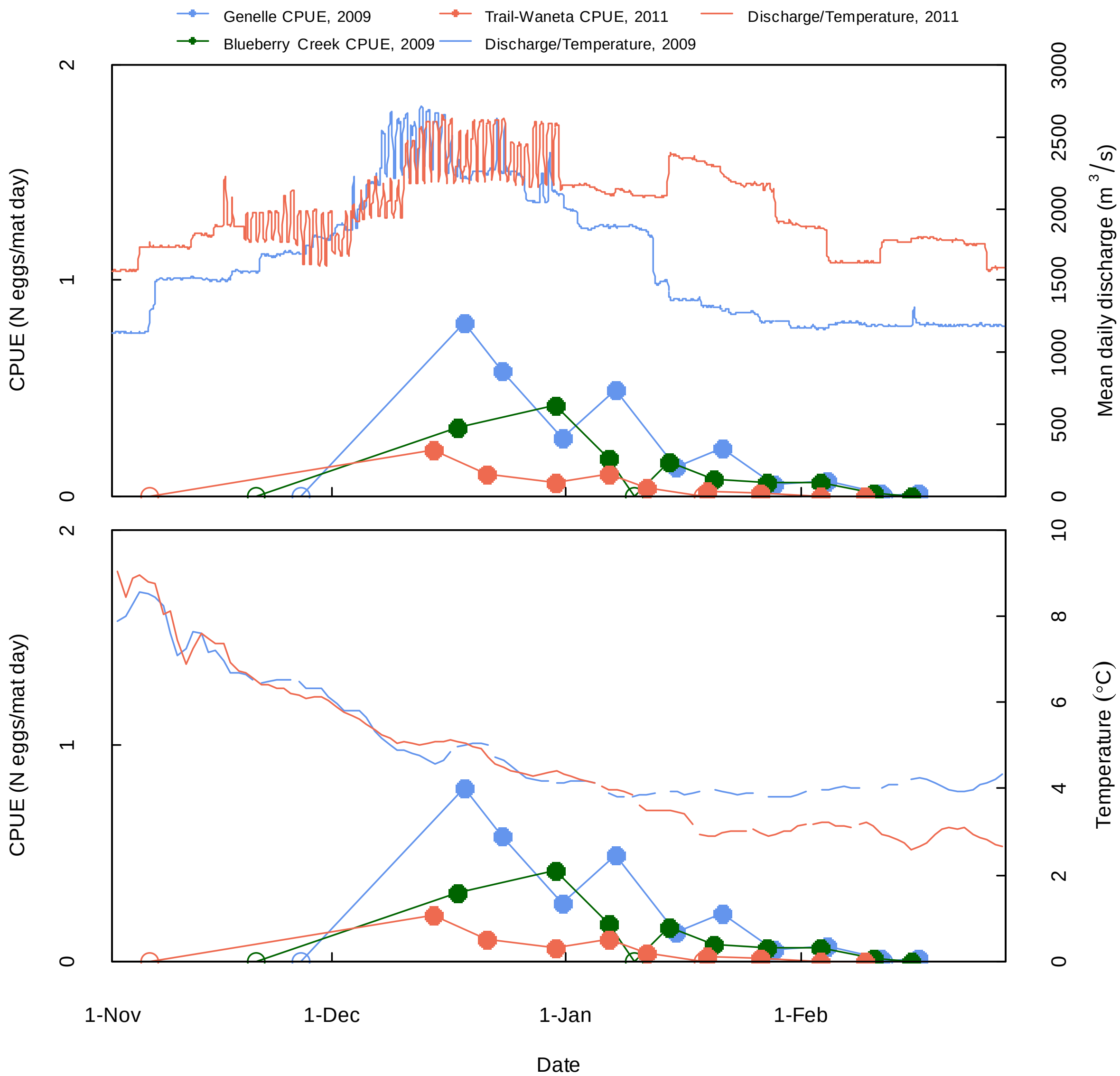


Figure 26: Catch per unit effort (CPUE = No. eggs/mat day) of Mountain Whitefish eggs at the Middle (Genelle and Blueberry Creek in 2009) and Lower Section (between Trail and Waneta Eddy in 2011) sampling sites (solid dots) and mean hourly discharge (m^3/s; top panel) and mean hourly temperature (°C; bottom panel) of the Columbia River at Birchbank gauging station (2009-2010; solid lines; secondary y-axis).Open points represent the first and last dates of spawning, back-calculated based on ATU values of captured eggs.

4.4 Spawner Abundance and Distribution

The abundance of adult (age-2 and older) Mountain Whitefish was estimated for the first four years of the CLBMON-48 program using the data collected as part of the 2011 LRFIP, (Ford and Thorley, 2012). Estimates for Year 5 of the present study are presently unavailable but should be available for inclusion into the final report.

All of the Year 1 to Year 4 estimates of adult Mountain Whitefish abundance were much higher than the 1994-1995 estimate of 42 600 adult fish (95% CI = 33 800 to 57 500; (Table 16; Golder 2010a and 2011a). Although this could be interpreted as an increase in the adult population between these study periods, the 1994-1995 Mountain Whitefish population estimate was derived using a different estimation procedure (see Table 16) and, therefore, caution in the interpretation and comparison of population abundances between studies is advised. In the present study, total Mountain Whitefish spawner abundance estimates were highest in Year 1, and decreased in Years 2 and 3. Estimates in Year 4 were very similar to Year 3. However, the high, overlapping confidence intervals of these estimates prevent any definitive conclusions regarding spawner abundance trends.

The sex ratio calculated in Year 4 (1 male:1.14 females) was applied to the 2008 to 2011 adult Mountain Whitefish abundance estimates from the LRFIP to calculate numbers of male and female spawners (Table 16). We assumed that all fish in the adult abundance estimate were mature. Although not all age-2 fish were actually mature (86% of females and 60% of males), this assumption was required because the proportion of age-2 fish in the adult population was unknown. Consequently, the total spawner estimates presented in Table 16 (Years 1 to 4) slightly overestimate actual spawner abundance. This bias is relatively small considering the potential range of spawner abundance in any given year.

Table 16: 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)
2008 – 2009 (Year 1)	Hierarchical Bayesian	105 200 (65 000 – 192 400)[b]	60 000 (37 100 – 109 700)	55 200 (27 900 – 82 700)	105 200 (65 000 – 192 400)
2009 – 2010 (Year 2)	Hierarchical Bayesian	101 200 (61 600 – 177 100)[c]	57 700 (35 100 – 100 900)	43 526 (26 500 – 76 200)	101 200 (61 600 – 177 100)
2010 – 2011 (Year 3)	Hierarchical Bayesian	81 400 (49 600 – 146 600)[d]	46 400 (28 300 – 83 500)	35 000 (21 300 – 63 000)	81 400 (49 600 – 146 600)
2011 – 2012 (Year 4)	Hierarchical Bayesian	81 800 (50 200 – 149 000)[e]	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. 2001. Estimate was correlated with percentage of mature fish in each age cohort examined.
[b] Based on 2008 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[c] Based on 2009 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[d] Based on 2010 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.
[e] Based on 2011 LRFIP data (Ford and Thorley 2012); assumes all adults in the abundance estimate will spawn.

In all years since 2008, catch rates of adult Mountain Whitefish during the LRFIP were highest in the Kootenay River and generally increased with each subsequent session (Figure 5). This pattern suggests that adults immigrate into the area prior to the spawning period. The upper section of the study area exhibited relatively high adult CPUE values in all years, but the general pattern in this area in most years was a decline in abundance over the five sample sessions, which may suggest a limited emigration out of the area prior to spawning, likely to the Kootenay River. The middle and lower sections of the study area exhibited consistently lower adult CPUE values in most years and sessions, except for the middle section in the first session in 2008 and 2010, when CPUE values were comparable to the Kootenay River (Figure 5). Subsequent rapid declines in CPUE in

Session 2 in both years and the general trend for decreasing CPUE over the rest of the sample period may suggest a net emigration out of the area, likely upstream into the Kootenay River. Adult CPUEs in the lower section were consistently low and did not exhibit any consistent annual trends across sessions, which may indicated a more stable pre-spawning population. However, if the increase in CPUE that occurs in the Kootenay River over the spawning period reflects an increased abundance of spawners, then this increase could be explained by adults that migrate into the area from many other sections of the approximate 80 km length of the Columbia River between HLK and Lake Roosevelt. Even small numbers of emigrating adults spread out over this length of river would have a substantial effect on spawner abundance in the Kootenay River (as measured by CPUE) but the effects of this type of movement would likely be undetectable in the sections of river from which these adults originated.

Spawner abundance in relation to egg CPUE was examined to determine if abundance was correlated with egg deposition rates within Years 1-4 of the present study. However, a relationship between spawner abundance in the LCR and egg deposition rates at either the CPR Island or Kootenay River spawning areas was not apparent (Figure 27). Median abundance estimates provided by the LRFIP were similar between years; however they were highly uncertain (Figure 27). With such uncertainty in abundance estimates, variability in egg deposition cannot be attributed to either abundance or other factors (i.e., flow or sampling biases).

Large numbers of spawners may be utilizing tributaries of the Columbia River as well. Anecdotal evidence from early in the 2011-2012 spawning season numbered spawners within Norn's Creek in the hundreds. Large numbers of Mountain Whitefish spawners were also documented in the fall of 2000 in Norn's Creek during snorkel floats conducted as part of a study on Bull Trout (R.L.&L. 2000a). Mountain whitefish were not encountered during snorkel floats conducted in Norn's Creek in late summer 2002 during a Kokanee study (R.L.&L. 2002), which would indicate that spawners move into the creek in the fall to spawn.

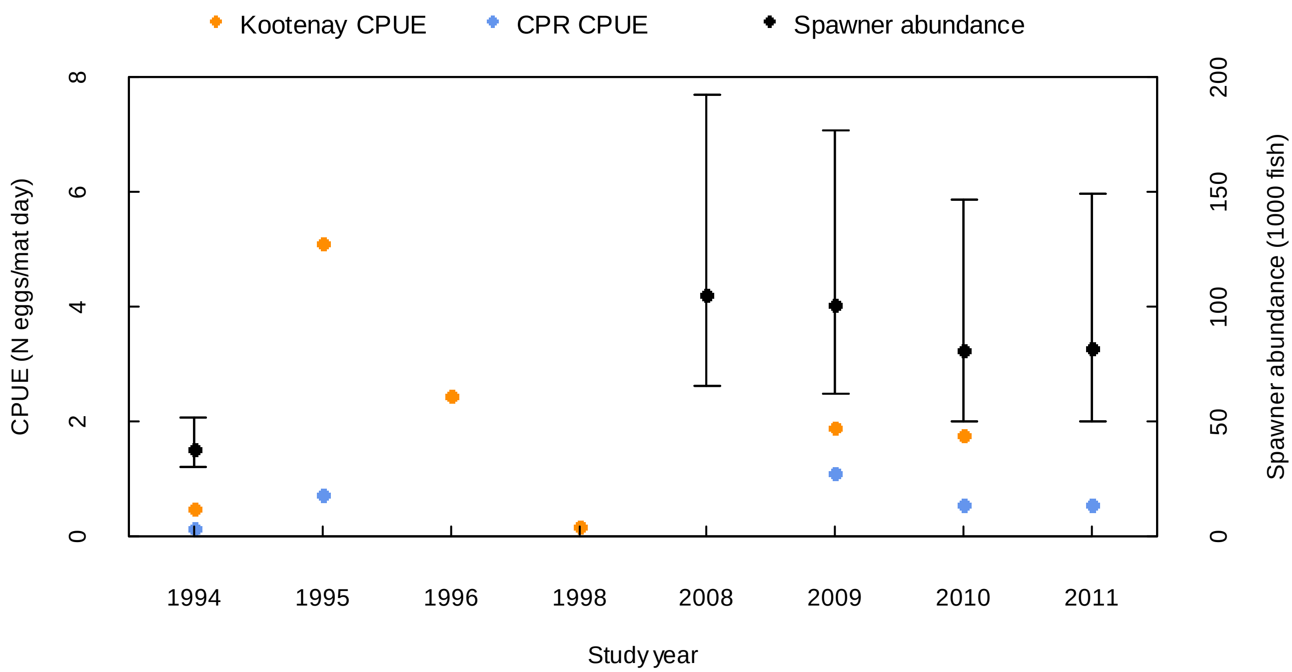


Figure 27: Estimated annual Mountain Whitefish egg CPUE at nine index egg mat sites in both key spawning areas sampled in all study years (primary y-axis) and spawner abundance in the Lower Columbia River (median ± 95% confidence intervals, secondary y-axis; based on modified Schnabel [1994] and HBM analyses [1994-2011]) during the 1994-1998 and 2008-2011 sampling periods. Note that the x-axis is not continuous.

4.5 Potential Egg Deposition (PED)

Over the course of this study, the PED within Years 1 to 4 spawning seasons was calculated based on the assumptions described in Section 4.4. PED ranged between approximately 73 100 000 eggs in Year 3 and 2 057 200 000 eggs in Year 1 (Table 17). Study Years 1 and 2 had similar PED estimates, as did Years 3 and 4. In 2012, the LRFIP analysis methodology changed from an abundance-based model to a density estimation (fish/km) model, which precluded a comparable PED estimate for Year 5 (Golder and Poisson 2013). Due to the high uncertainty related to the LRFIP abundance estimates for adult Mountain Whitefish, the PED is presented for heuristic value only.

PED estimates determined for the 1994-1995 study were substantially lower than estimates from the present study. Although as discussed in Section 4.4, a different method was used to calculate abundance in the 1990s study, given the increases in adult growth rates and greater abundance of larger adults in the present population, PED would be expected to have increased.

Table 17: 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 in millions (95% CI)[a]	PED at mean fecundity in million (95% CI)[b]	PED at maximum fecundity in millions (95% CI)[c]
1994 – 1995	42 600 (33 800 – 57 500)	23 700 (18 800 – 32 000)	190.3 (150.9 – 256.9)	225.5 (178.9 – 304.4)	260.7 (206.8 – 352.0)
2008 – 2009 (CLBMON-48 Year 1)	105 200 (65 000 – 192 400)	60 000 (37 100 – 109 700)	154.9 (95.8 – 283.2)	564.2 (348.9 – 1031.6)	1125.2 (695.7 – 2057.2)
2009 – 2010 (CLBMON-48 Year 2)	101 200 (61 600 – 177 100)	57 700 (35 100 – 101 000)	149.0 (90.6 – 260.8)	542.6 (330.1 – 949.8)	1082.0 (658.2 – 1894.1)
2010 – 2011 (CLBMON-48 Year 3)	81 400 (49 600 – 146 600)	46 400 (28 300 – 83 500)	119.8 (73.1 – 215.6)	436.3 (266.1 – 785.2)	870.1 (530.7 – 1565.9)
2011 – 2012 (CLBMON-48 Year 4)	81 800 (50 200 – 149 000)	46 600 (28 600 – 85 000)	120.3 (73.8 – 219.5)	438.2 (269.0 – 799.3)	873.9 (536.3 – 1594.0)

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

4.6 Egg Deposition Patterns

To provide a visual representation of egg deposition patterns in the key spawning areas, the cumulative newly spawned egg count for each mat set in all years with consistent sampling methodology was plotted (Figure 28 and Figure 29). These plots assumed 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).

At CPR Island, egg deposition patterns were highly variable (Figure 28). In general, egg mat sites along the mainstem bank of CPR Island (RUB) had the highest rates of egg deposition in most years. CPUEs at the mid-channel and LUB mat sites were similar to each other but highly variable within and among years. Contrary to most years, relatively high egg deposition rates were documented at the LUB sites in the 1995-1996 and 2011-2012 spawning periods (Figure 28). There was no apparent upstream to downstream pattern of new egg deposition as might be expected if most spawning occurred in the upper and middle portions of the spawning area and eggs drifted downstream before settling into the substrate. Examination of the CPUE distribution patterns presented in Figure 28 and discharge patterns during the spawning season in the years sampled (Figure 10 and Appendix D, Figure D1) did not suggest any relationship between flow and the distribution of Mountain Whitefish eggs at CPR Island.

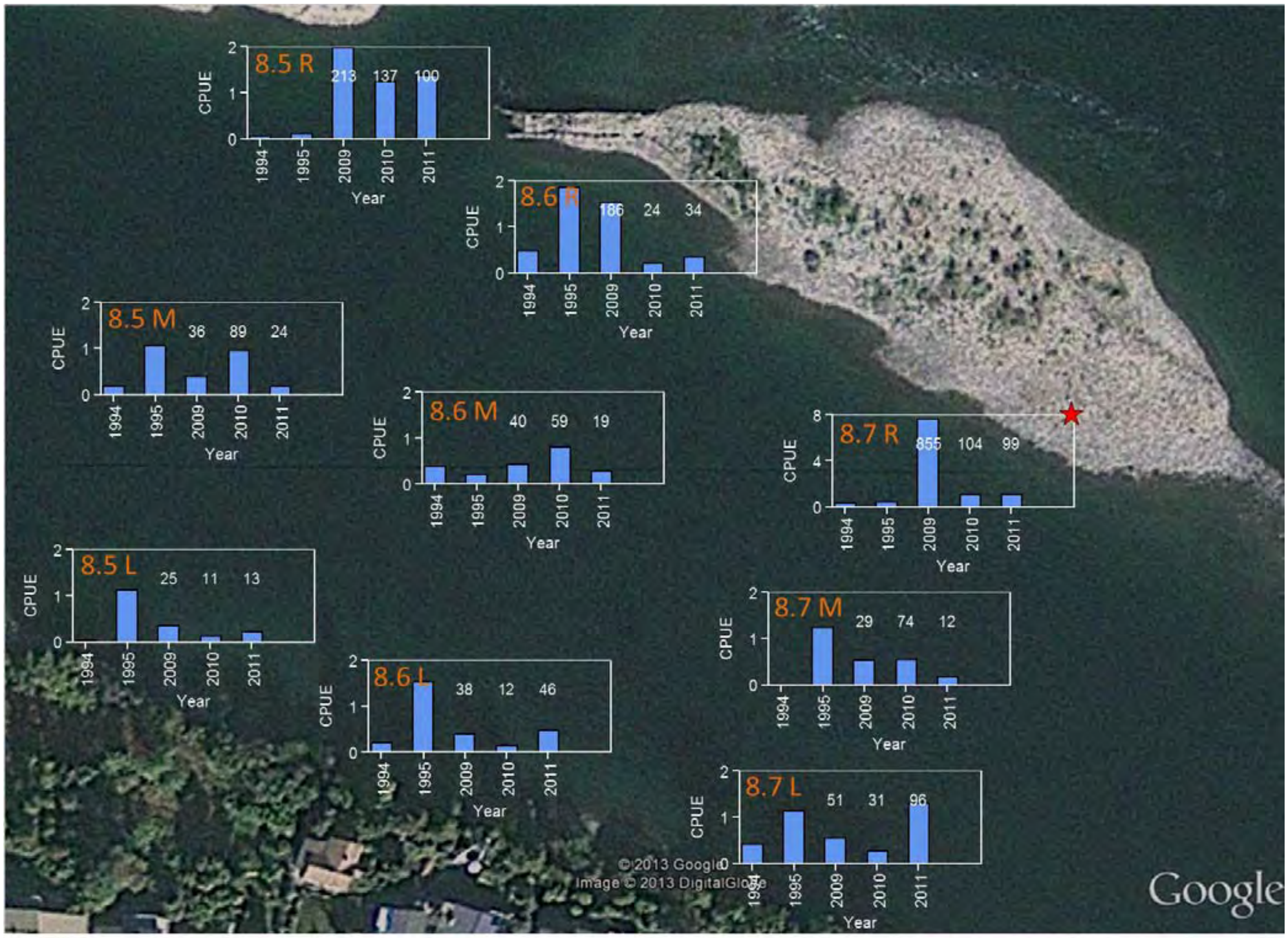


Figure 28: Egg deposition patterns at CPR Island throughout 1994-2011, described using CPUE values (new eggs/mat day). The estimated number of newly deposited eggs collected at the site at each year (2009-2012 only) is shown above each bar. Site name, shown for each panel, depicts the locations of the egg mat deployment sites. Note the different y-axis scale on the starred panel.

Egg CPUE values in the Kootenay River also exhibited high variability between years, with highest rates of egg deposition typically recorded in mid-channel and RUB stations (Figure 29). Similarly to the CPR Island, the highly variable egg deposition patterns in the Kootenay River did not show any relationship to the flow patterns that occurred during their respective spawning periods (Figure 11; Appendix D, Figure D2). As was the case at CPR Island, egg deposition patterns in the Kootenay River also lacked a distinct pattern of increased new egg deposition from the upstream to downstream portions of the study area (Figure 29).

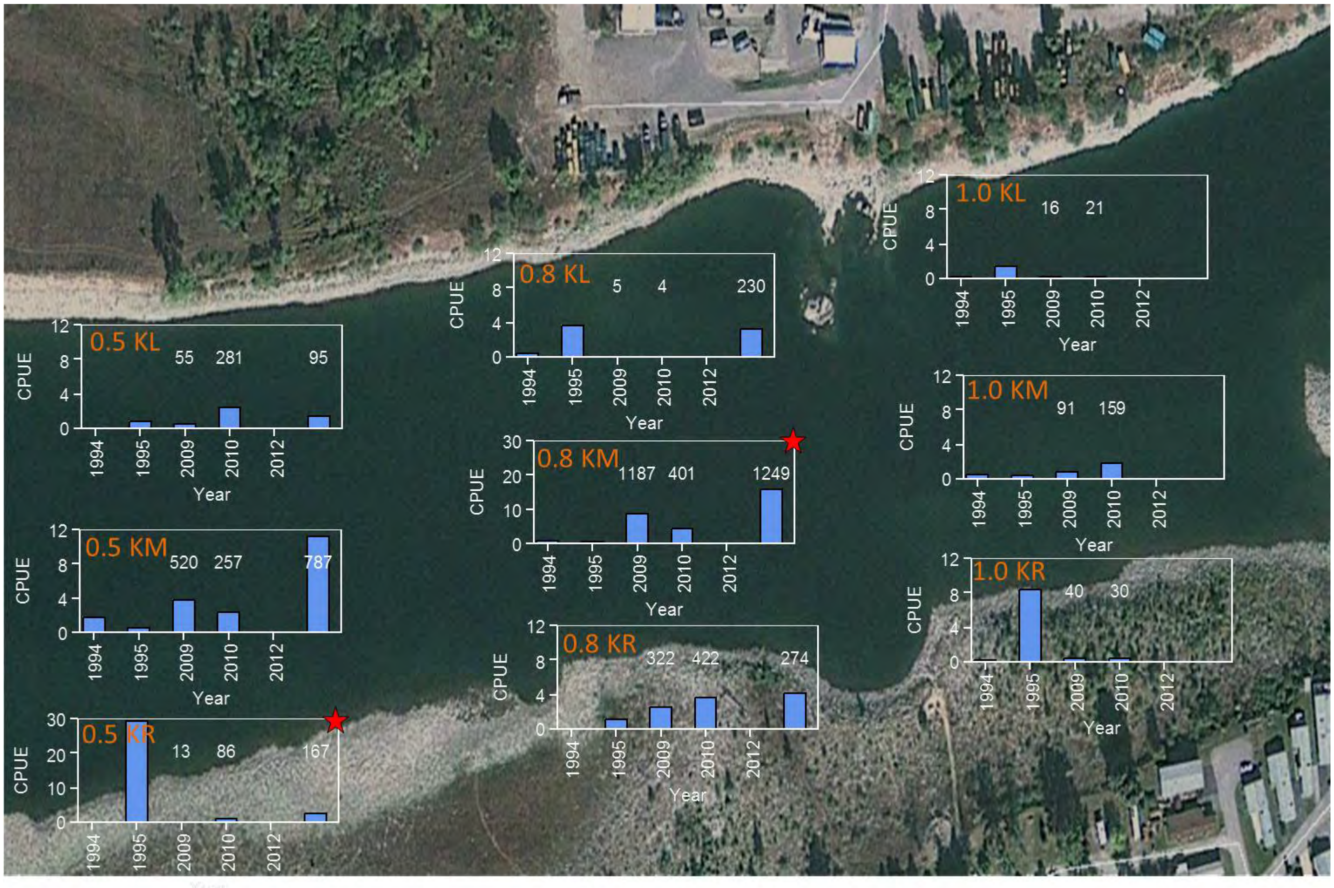


Figure 29: Mountain Whitefish egg deposition patterns at the Kootenay River throughout 1994-2012, described using CPUE values (new eggs/mat day). The number of newly deposited eggs collected at the site at each year is shown above each bar. Site name, shown for each panel, depicts the locations of egg mat deployment sites. Note: the y-axis of the map was stretched horizontally to allow better placement of inset graphs; y-axis scale is different on the starred panels.

Based on low numbers of newly spawned eggs collected and CPUEs in the secondary spawning sites in the middle (Blueberry Creek and Genelle) and lower (Trail-Waneta) sections of the study area, and the absence of mid-channel mat sets at Genelle, in-depth analysis of egg deposition patterns in these areas was not conducted (Appendix D, Table D1 and D3). In the middle section, approximately 50% of the eggs collected at Blueberry Creek were deposited along RUB, while LUB and the cobble island had the highest rates of egg deposition at Genelle. Based on these 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.

In Year 5, Mountain Whitefish spawning assessments were conducted for the first time in Norn's Creek. Relatively high egg densities in Norn's Creek were documented during kick net sampling (Appendix D, Table D9). The high overall egg catch (n = 2593) and CPUE (14.82 eggs/m^2) indicated that spawning intensity in Norn's Creek may occur at a level comparable to the Kinnaird Rapids secondary location (Appendix D, Tables D10 and D11). Operations of HLK affect water levels in the shallow braided delta area at the creek mouth. Low Columbia River levels during periods when adults migrate into the creek to spawn have the potential to affect spawning intensity in the creek. Operations may also limit the availability of suitable rearing habitat at the creek mouth and Norn's Fan for out-migrating larvae.

4.7 Egg Drift

Typically, most of the eggs captured by egg mats are recently spawned eggs that have been broadcast in close upstream proximity to the egg mats. Developmental staging of Mountain Whitefish eggs collected during the egg collection mat program indicated that many of the viable eggs collected were in later stages of development (Appendix D, Tables D5 to D8). This indicated that these eggs had been spawned prior to the mat deployment but for some reason, had been dislodged from upstream interstitial incubation habitats, entered the drift, and were then captured by the egg mats. The causal mechanisms that result in older eggs being dislodged from interstitial spaces and re-enter the water column are poorly understood. Potential reasons may include flow increases, disturbance of the substrate during deployment and retrieval of the egg mats, or disturbance by egg predators (e.g., suckers spp.) that dislodge incubating eggs during foraging. To assess the potential effects of flow on egg drift, a component of the present study program was the implementation of a pilot D-ring drift net sampling program downstream of a known spawning and egg incubation areas prior to and immediately following a large (>142 m^3/s) flow increase. This program was proposed in Years 1, 3, 4, and 5, but the flow regimes in these years during the Mountain Whitefish egg incubation period did not provide a sufficient flow increase to warrant implementation. Therefore, we looked at the distribution and proportions of older Mountain Whitefish eggs in developmental stages 4 or greater to determine the incidence of egg drift, as the time required for eggs to reach stage 4 was longer than the time between egg mat redeployments. Over the course of the study, older eggs contributed 12.1-16.4% of the total egg catch (Table 18).

Table 18: Percentage of late stage Mountain Whitefish eggs collected during egg collection mat sampling, 2009-2013.

CLBMON-48 Study Year	Total Viable Eggs Examined for Developmental Staging (*n*)	Total Late Stage Eggs[1] (*n*)	Egg Catch Contributed to Drift (%)
Year 2 (2009 – 2010)	2990	418	14.0
Year 3 (2010 – 2011)	4470	542	12.1
Year 4 (2011 – 2012)	762	125	16.4
Year 5 (2012 – 2013)	1167	152	13.0

[1] Stage 4 or greater.

Egg drift at CPR Island and Kootenay River occurred at similar proportions between years (Figure 30). Sharp increases in egg drift were documented in late December 2011 at CPR Island and in early January 2010 in the Kootenay River. However, both of these "spikes" occurred over periods of stable discharge (Figure 30). In all years at both key spawning areas, large increases in egg drift were documented between late January and early February near the end of the monitoring programs. With the exception of 2010 in the Kootenay River (when a large increase in discharge occurred), these increases occurred during periods of stable flows.

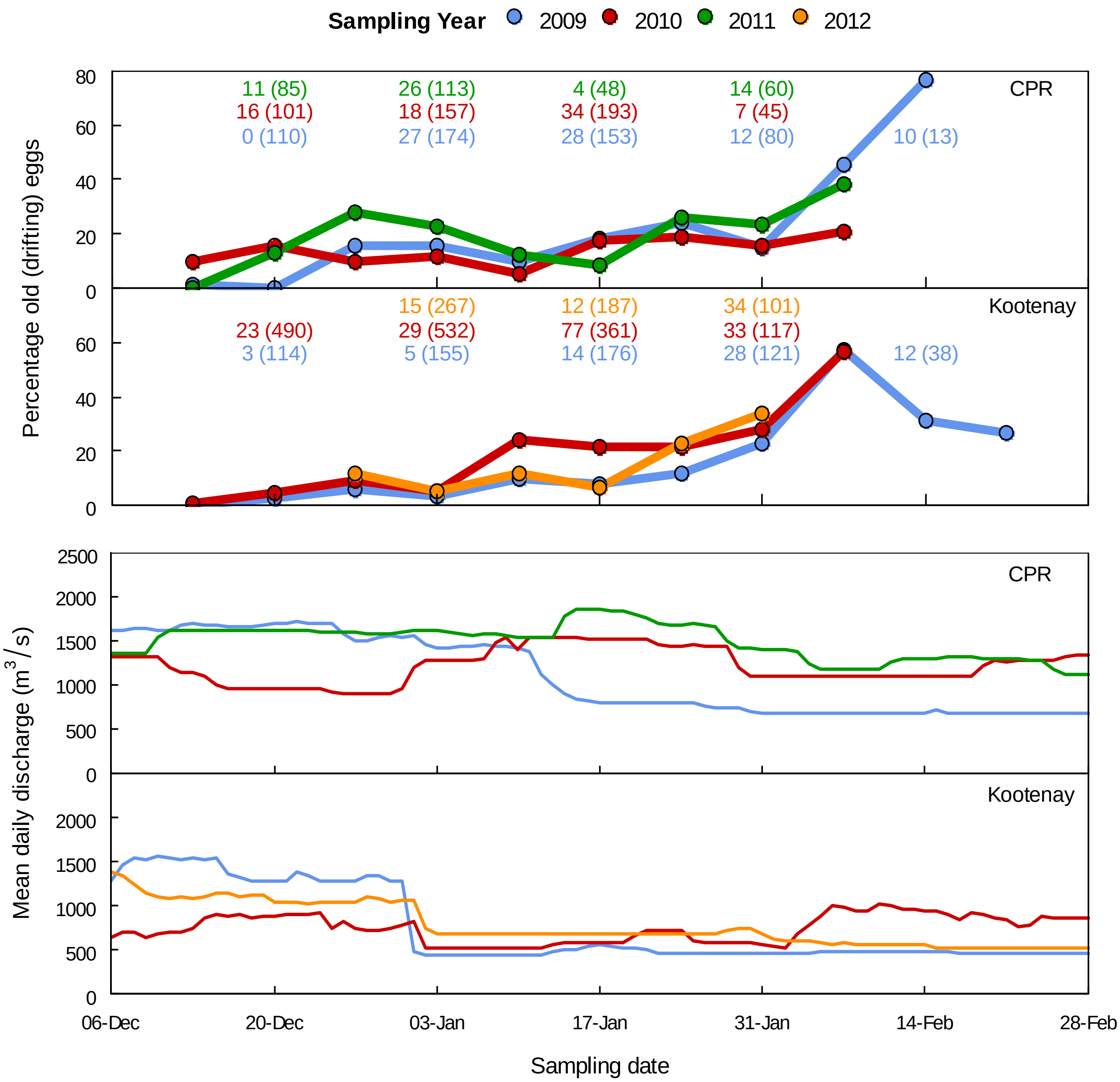


Figure 30: Mountain Whitefish egg drift over time (percent of older eggs in samples) at CPR Island and Kootenay River between 2009 and 2012 (top two panels) and mean daily discharge values (m^3/s) at HLK and BRD (bottom two panels). The numbers on top of each panel represent the counts of older eggs with the total count of captured eggs in parentheses. Counts are provided only every two weeks to reduce graph clutter.

At spawning areas in the middle and lower sections, egg drift was stable in the early portions of the egg collection program and then increased substantially in early January (Figure 31). As was the case in the key spawning areas, however, the increase in egg drift in the middle section occurred over a period of stable flows.

Drift in the middle section then decreased sharply in early February. In the lower section, the increase in drift was associated with declining discharge (Figure 31).

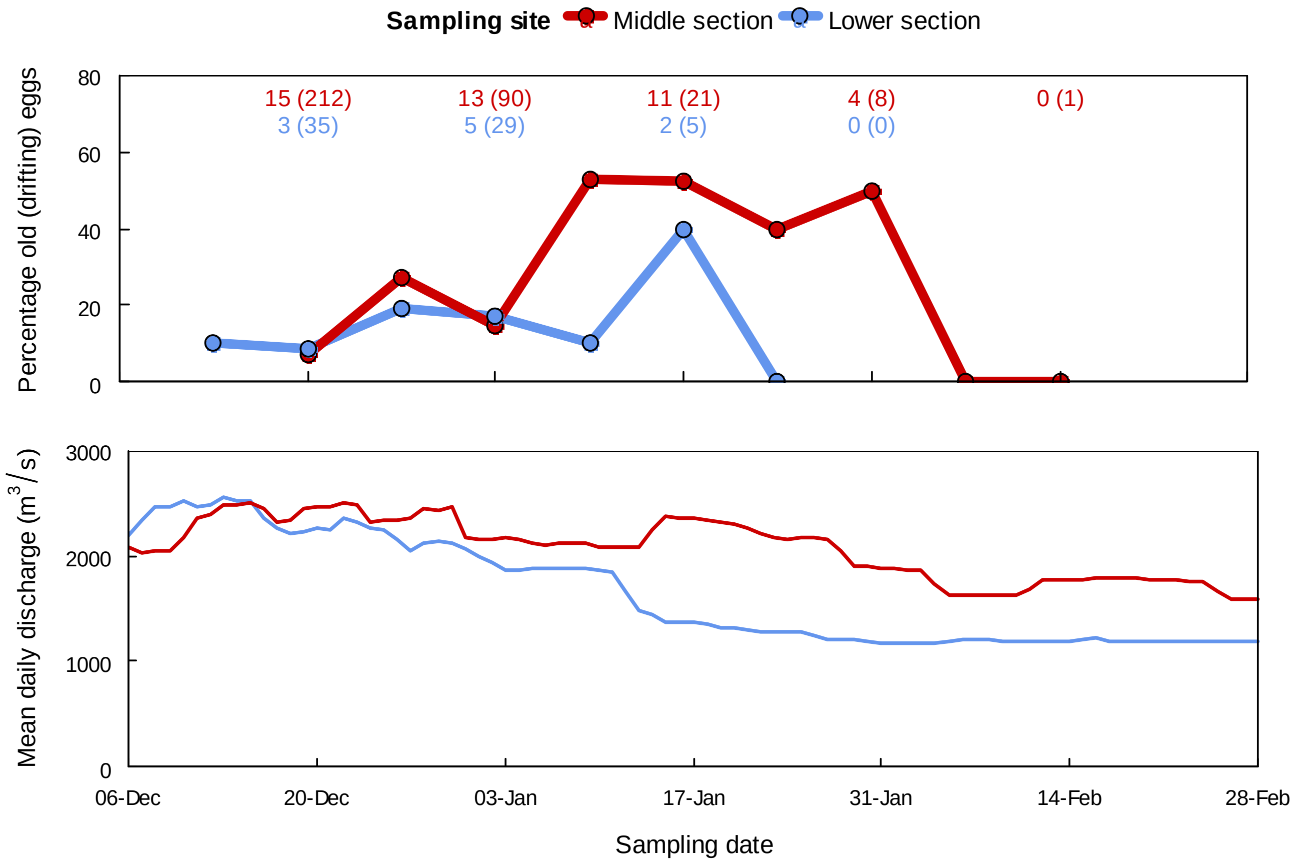


Figure 31: Egg drift over time (percent older eggs in samples) in the Middle (Genelle and Blueberry Creek in 2009) and Lower (between Trail and Waneta Eddy in 2011) sampling sites (top panel) and mean daily discharge values (m³/s) of the Columbia River at Birchbank in 2009 and 2011 (bottom pane). The numbers on top of each panel represent the counts of older eggs and the total count of captured eggs in parentheses. Counts are provided only every two weeks to reduce graph clutter.

4.8 Egg Stranding

Egg stranding surveys were conducted in Years 2 to 4. Transects in the upper portion of CPR Island (RKm 8.6) exhibited substantial variation in densities of stranded eggs, which would suggest patchy and intermittent spawning use in this area (Appendix D, Table D10). This is supported by catches from egg collection mat data (Figure 28; Appendix D, Tables D1 to D3). Consistently high densities of stranded eggs were documented at downstream areas of CPR Island in Years 3 and 4 (RKm 8.7; Appendix D, Table D10). As only 124 and 100 new eggs were captured at the nearest egg mat station in Years 3 and 4, respectively (8.7R; Appendix D, Table D2 and D3), the high density of eggs documented during stranding surveys versus the low numbers recorded at the mats in this area suggest that the mat catch data may under-represent egg deposition at the downstream portions of CPR Island.

Densities of stranded eggs found during surveys along RUB in the Kootenay River exhibited substantial annual variations (Appendix D, Table D10). In January 2010, high densities (722 eggs/m^2) of stranded eggs were documented following a flow reduction from HLK that occurred as egg deposition rates in this spawning area were rising to the second peak (Figure 24 and Figure 25). In April 2012, after the initiation of rainbow protection flows, lower densities of stranded eggs (26.67 eggs/m^2) were found in the same area. The lower stranding rates in April 2012 reflected higher than normal water levels in the Kootenay River at the time of the survey, which reduced the extent of dewatered shoreline area. The LUB of the Kootenay River consists of steep gradient shoreline, which limits the amount of shoreline area that is dewatered during flow reductions. As a result, the risk of egg stranding along this bank is low, as indicated by the low stranded egg densities in Year 5 (Appendix D, Table D10).

In Year 2, egg stranding surveys also were conducted at known secondary spawning sites at Tin Cup Rapids and Kinnaird Rapids. Low densities of stranded eggs were documented at both sites (Appendix D, Table D10). Exploratory egg grids conducted at these sites during the stranding surveys in early February 2012 (Year 4) confirmed that Mountain Whitefish stranding rates at these sites was similar to that documented in Year 2 (Appendix D, Table D11).

5.0 LARVAL EMERGENCE AND REARING

5.1 Accumulated Thermal Units (ATUs)

Results of an egg incubation study conducted in the 1995-1996 spawning season documented a requirement of 327 ATUs for Mountain Whitefish eggs to attain hatch (R.L.&L.2001). This value was at the lower end of the 321 to 540 ATU range reported for various Mountain Whitefish populations in the reviewed literature (Stalnaker and Gresswell 1974; Rajagopal 1979; Ford et al. 1995). The 327 ATU value was used to estimate the timing of hatch of Mountain Whitefish eggs spawned in the LCR key spawning areas in all years when egg collection sampling was conducted.

5.2 Emergence Period

As the timing of onset and peak of Mountain Whitefish spawning activity in the key spawning areas is similar among years, the main factor influencing the subsequent development of deposited eggs and emergence timing of larval Mountain Whitefish is water temperature. Based on 1) the developmental staging of eggs collected in Years 2-5, 2) the documented water tempertures within the key spawning areas, and 3) the 327 ATU requirement described above in Section 5.1, the time required for deposited eggs to reach the hatch stage was estimated within each of the key spawning areas (Figure 32).

Eggs depostited early in the spawning season could reach hatch stage by late December (Golder 2009, 2010, and 2011). Although there was variation in relation to the time at which eggs started to reach maturity, the emergence period at the key spawning areas was protracted and concluded by late April to mid May in all years (Figure 32). This is similar to the emergence period (late January to early July) predicted from data collected during the 1995-1996 spawning season (R.L.&L. 2001).

This emergence timing is supported by the results of larval surveys conducted over the course of this study. During the larval Mountain Whitefish stranding and rearing surveys in Year 2, approximately 6,650 whitefish larvae were recorded during the implementation of Rainbow Protection flows (Appendix D, Table D12). Alternately, during Year 4, larvae were not observed in shallow nearshore areas of the Columbia River upstream of its confluence with the Kootenay River immediately prior to the implementation of Rainbow Trout protection flows (Golder 2012). 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 2011. During systematic sampling in Year 5, larvae were collected between late March and late May, with abundance peaking in early April (Appendix D, Table D13).

At CPR Island in all years, based on ATUs, the majority of deposited eggs at both shore and mid channel locations would not have developed to hatch at the initiation of Rainbow Protection flows (Figure 32). In particular, the onset of Rainbow Protection flows in 2010 and 2011 had a high potential to strand large numbers of incubating eggs. In contrast, the majority of incubating eggs in the Kootenay River, especially at shore subsites, would have developed to the hatch stage when the Rainbow Protection flows were initiated (Figure 32). To determine if there was a detectable relationship between stranding related egg mortality and subsequent age-1 Mountain Whitefish abundance, the LRFIP age-1 abundance estimates were examined (Table 19). The high uncertainty of the abundance estimates precluded the identification of any correlation.

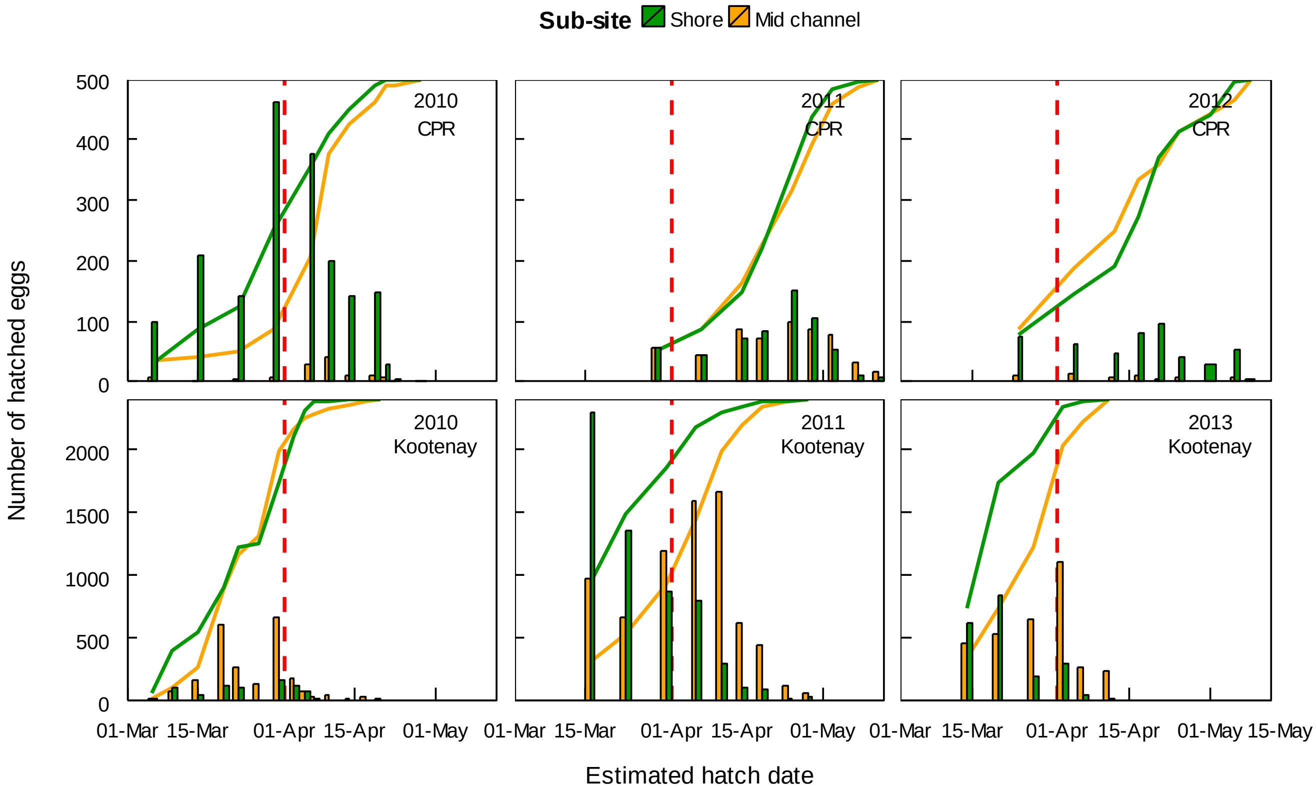


Figure 32: Timing of estimated larval emergence from Mountain Whitefish eggs deposited during or after peak spawning, plotted by key spawning location (CPR Island and Kootenay River), year (2010, 2011, 2013), and subsite (shore and mid-channel). The onset of Rainbow Trout protection flows is depicted as the dashed red line. The cumulative proportion of hatched eggs ranges from 0 to 1 and is shown as a continuous line for each subsite. The units of the cumulative proportion are not shown to reduce graph clutter.

Table 19: Abundance estimates for age-1 Mountain Whitefish in the Lower Columbia River, 2008 to 2011 (data from Ford and Thorley 2012).

LRFIP Study Year	Age-1 Mountain Whitefish Minimum Abundance Estimate	Age-1 Mountain Whitefish Mean Abundance Estimate	Age-1 Mountain Whitefish Maximum Abundance Estimate
2008	11 722	24 403	56 645
2009	10 398	21 117	51 526
2010	8 486	18 058	44 731
2011	11 172	22 784	46 091

5.3 Rearing Habitats

In Year 2, large aggregations of larval Mountain Whitefish were found at the Norn's Creek Fan area (Figure 1) in habitats with shallow depths, very low velocities, and dominant substrates of medium gravels (Golder 2010; Appendix D, Table D14). In Year 5, large aggregations were observed in similar habitats in this area but also at the mouth of Norn's Creek in shallow, low velocity habitats with silt and sand substrates (Appendix D; Table D14). Available cover in the form of substrate interstices, aquatic vegetation, woody and other organic debris were present in these habitats. In Year 5, smaller concentrations of larvae were also observed in numerous other areas in the upper and middle sections of the LCR in shallow, low velocity depositional habitats, although in-depth surveys of habitat parameters were not conducted in these areas (Appendix D, Tables D12 and D13).

Studies conducted on the Columbia River in the spring of 1995 and 1996 determined that larval Mountain Whitefish concentrated in calm, shallow, depositional habitats (R.L.&L. 2001). In the Sheep River, larvae were documented in low velocity areas with substrates consisting of gravel, sand, and mud (Thompson 1974). Northcote and Ennis (1994) reported that the survival of larval Mountain Whitefish is critically dependent on the availability of suitable, low velocity, protected marginal habitat.

In Year 5, after the May 7 larval sample session, water levels rose substantially in the study area, which resulted in a change in nearshore velocity patterns and an increase in depth at all sample sites (Appendix D, Table D13). After the flow increase, the nearshore shallow, low velocity depositional habitats that were formerly used by large concentrations of larvae were flooded out and replaced by deeper, faster flowing habitats. Areas with low velocity characteristics, preferred by larval Mountain Whitefish, were found mainly in areas of flooded terrestrial vegetation. Although visual observations and beach seine sampling were conducted in these flooded vegetation areas, the frequency of larvae encounters decreased substantially. It is unknown whether this resulted from decreased observation effectiveness or sampling efficiency in the flooded vegetation, or indicated that the larvae had been displaced to other habitats.

6.0 YOUNG-OF-THE-YEAR AND JUVENILE REARING

6.1 Distribution and Abundance

In Year 1, snorkel surveys were evaluated as a potential method to enumerate juvenile Mountain Whitefish and identify their habitat associations (Golder 2009). Very few individuals were observed during day time sampling (n = 1 in ESMW4 and n = 2 in ESMW5; Appendix A, Figure A1), which precluded any assessment of habitat selection. Although more juveniles were observed at night (n = 16 in ESMW5 and n = 12 in ESMW23; Appendix A, Figure A1), they actively avoided the lights used by the snorkelers; therefore, most observations were of fish actively moving, which precluded the identification of their original habitat selection.

Boat electroshocking was employed in Years 1 to 3 as an alternate method for indexing juvenile Mountain Whitefish (Appendix A, Figures A1 to A3). In total, 5218 juvenile Mountain Whitefish were encountered (captured and observed) by this method in all sample years combined (Golder 2009, 2010 and 2011; Appendix E, Tables E1 to E3). The majority (n = 4238 [81.2%]) of juveniles were encountered in the upper section of the LCR, followed by the middle (n = 673 [12.9%]) and lower sections (n = 307 [5.9%]), respectively.

Juvenile Mountain Whitefish encounters by study year were 2290, 2330, and 601 in Years 1 to 3, respectively (Table 20; Appendix E, Tables E1 to E3). CPUE was similar in all years, although sample effort and total length of shoreline sampled was lower in Year 3. Recaptures remained very low in all sample years (Table 20). Several aggregations of juvenile Mountain Whitefish (from 5 to over 50 individuals) were observed during boat electroshocking surveys in all years (Appendix A, Figures A1 to A3; Appendix E, Table E4). Aggregations of similar size were also observed during sampling conducted in 1994-1996 (R.L.&L. 2001).

Table 20: Comparison of results from Years 1, 2 and 3 juvenile Mountain Whitefish boat electroshocking surveys in the lower Columbia River, September 2008, 2009, and 2010.

Parameter	Year 1	Year 2	Year 3
Number of fish captured	650	761	320
Number of fish observed	1640	1569	281
Number of fish marked and released healthy (percent of total captured)	635 (97.7)	751 (98.7)	306 (95.6)
Number of fish recaptured (percent of total marked)	22 (3.4)	20 (2.7)	4 (1.3)
Number of mortalities (percent of total captured)	15 (2.3)	10 (1.3)	14 (4.4)
Total sample effort (hrs)	13.05	11.33	7.09
Total shoreline sampled (km)	37.44	37.78	16.10
Overall CPUE (fish/km/hr)	*4.69 5.44*		*5.25*

The highest number of juvenile Mountain Whitefish encountered was during Session 2 in Year 1 (Figure 33). CPUEs at individual sample sites ranged between 0 fish/km/hr at three sites (one site in the upper section and two sites in the lower section) in Year 1 and 4898.9 fish/km/hr at ESMW11 in the middle section, also in Year 1 (Appendix E, Tables E1 to E3). This very high value likely overestimates actual abundance of juveniles in ESMW11; decreased water depths between sample sessions in Year 1 prevented sampling of the entire site and the CPUE reflects the capture of a small concentration (15 juveniles) in a limited area (100 m bank length) for a brief sample duration (0.03 hrs). In Year 3, both juvenile Mountain Whitefish encounters and CPUEs were substantially lower in both sessions than in Years 1 and 2 (Figure 33; Appendix E, Tables E1 to E3).

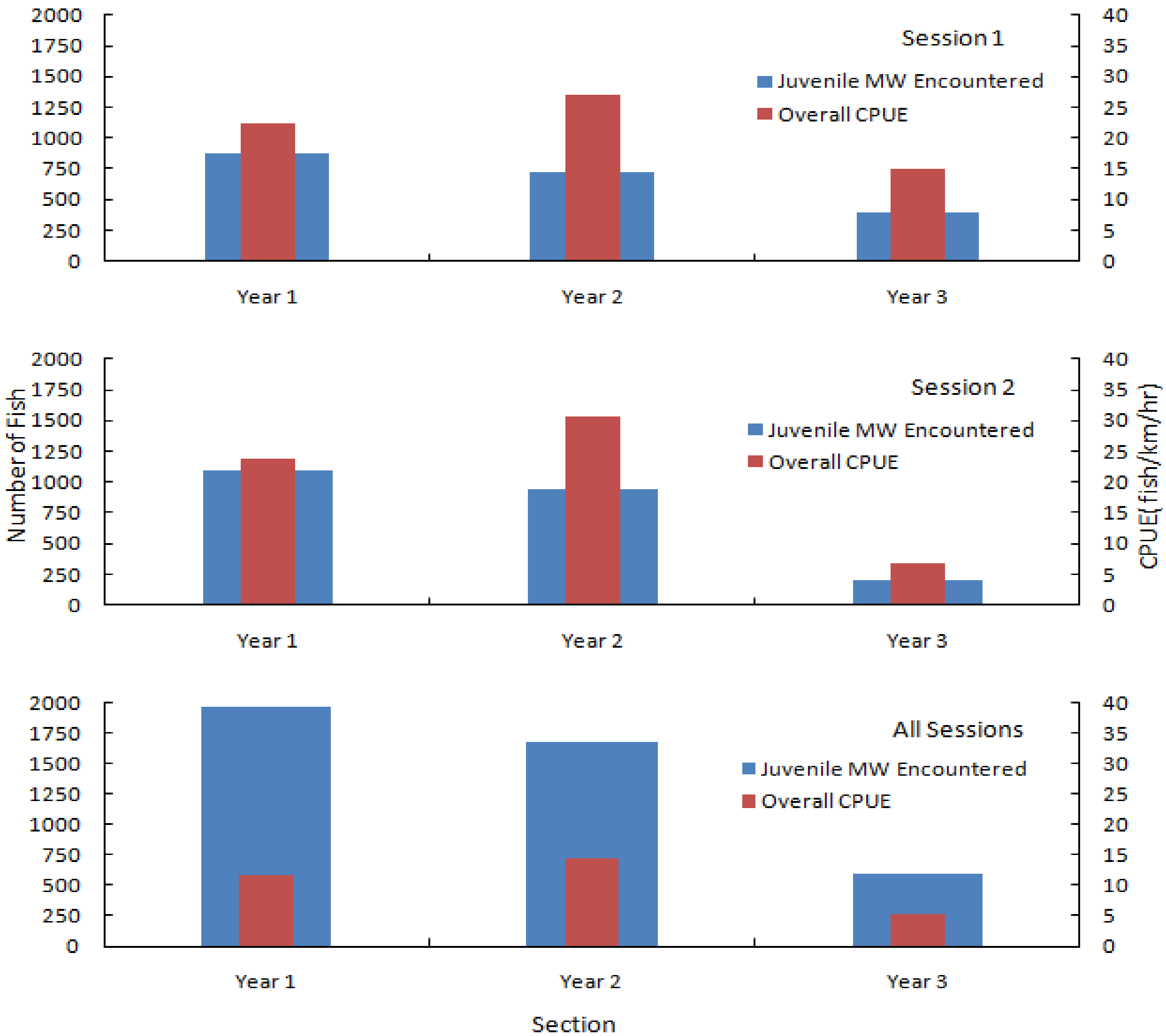


Figure 33: Total number of juvenile Mountain Whitefish encountered (captured and observed) and CPUE (fish/km/hr) in the upper section of the Lower Columbia River during boat electroshocking in Session 1: (mid-September) and Session 2 (late September) of 2008, 2009, and 2010.

In Years 1 and 2, sufficient numbers of marked juvenile Mountain Whitefish were recaptured at sites ESMW4, ESMW5, and ESMW6 in the upper section (Table 21; Appendix A, Figure A1) to allow the calculation of abundance estimates for these specific sites only (Golder 2009b and 2010a). In Year 3, low recapture rates at all sites prevented the calculation of useable abundance estimates (Table 20; Appendix E, Tables E5 to E7).

Table 21: Population estimates for juvenile mountain whitefish the upper section of the lower Columbia River (sites ESMW4, ESMW5, and ESMW6 combined), September 2008 and 2009.

Sample Year	Modified Schnabel Method			Sequential Bayes Algorithm Method		
	Mean	Confidence Intervals		Mean	Confidence Intervals	
		Lower (2.5%)	Upper (97.5%)		Lower (2.5%)	Upper (97.5%)
Year 1 (2008)	2359	1571	3542	2458	1778	4072
Year 2 (2009)	2824	1738	4592	3012	2063	5791

6.2 Life History Characteristics

In total, 1 726 juvenile Mountain Whitefish were captured by boat electroshocking (from all sessions in Years 1 to 3 combined; Table 20) and measured. Fork lengths ranged from 64 to 248 mm (median = 110.5 mm FL). The size distribution of the catch was similar among sample sessions and in all sample years of the present study (Figure 34). The largest proportion of the measured catch was within the 101 to 110 mm FL size interval in most years. The distribution of length frequencies had two modes; one in the 70 to 140 mm FL size-range and another in the 160 to 250 mm FL size-range. These two modes represented the age-0 and age-1 cohorts respectively, and were evident in catches from all sections.

The length-frequency distribution patterns recorded during the CLBMON-48 juvenile sample program differed from the LRFIP and the 1990's results (Figure 34; R.L.&L. 2001, Golder 2011). Both data sets show two distinct size modes of the juveniles captured, however the modes from the present study contain smaller fish and range from 70 to 140 mm FL and 150 to 250 mm FL. Both the 1990s and the LRFIP data sets also recorded a substantially higher frequency of age-1 individuals in comparison to the present study. These differences likely result from differences in sampling methods. In the 1990s and in the LRFIP, sampling was conducted later in the year than the present study, which would explain the greater occurrence of larger individuals in the catch. Also, sampling in the 1990s and the LRFIP was conducted in deeper water, in order to capture older Mountain Whitefish as well as other species. Sampling in the present study was focused in shallower nearshore areas to increase captures of age-0 fish.

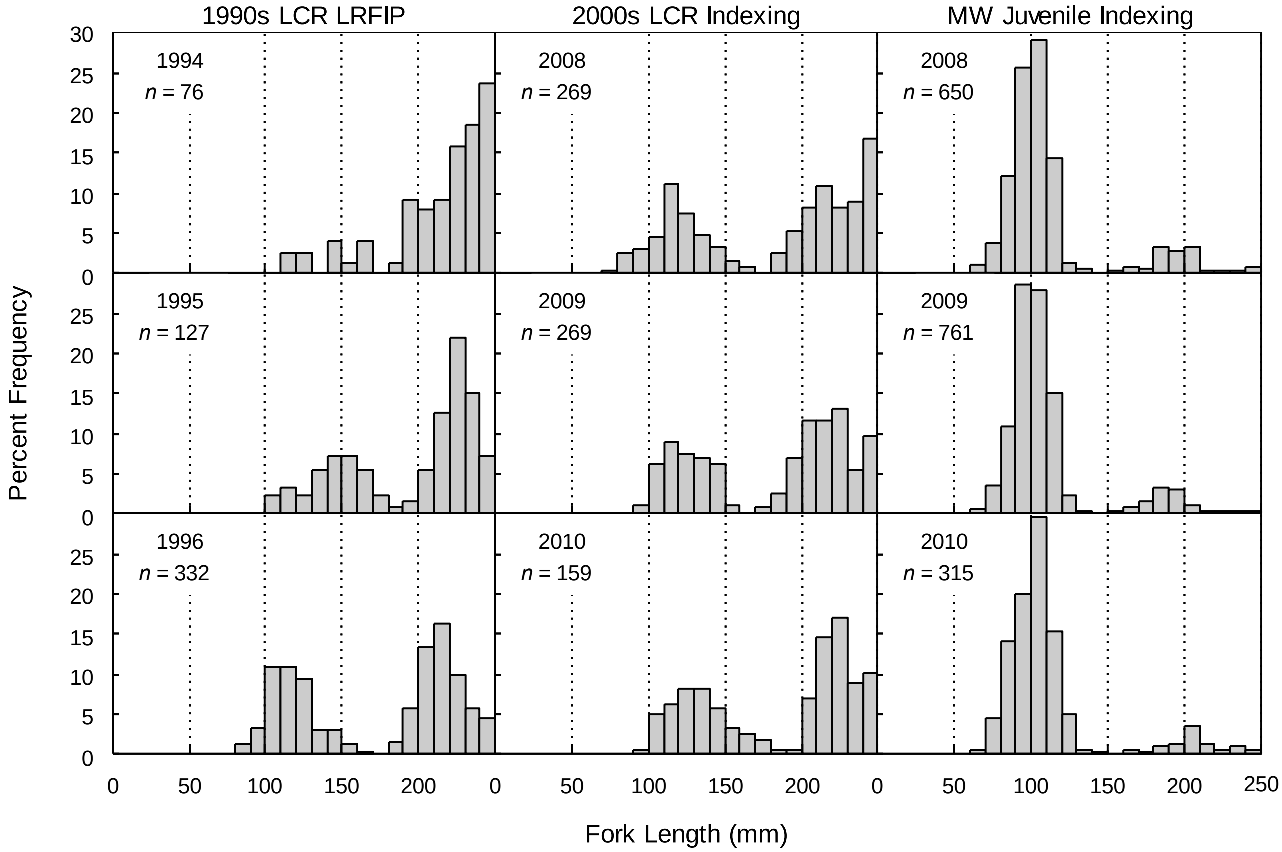


Figure 34: Length-frequency distributions for juvenile Mountain Whitefish captured by boat electroshocking in the lower Columbia River. The number of juveniles captured in each year (excluding intra-year recaptures) is shown on each panel.

Two distinct age cohorts (age-0 and age-1) are visible in the data set from the present study, with fewer individuals at the high end of the length and weight ranges than in the 1990s or the LRFIP data (Figure 35). The isolated cluster of individuals in the upper right of the regression lines from the present study was unique among the three data sets and may either represent an age-2 cohort or may be large outliers from the age-1 cohort. The regression coefficients between the 1990s, the LRFIP, and the present study were very similar, which indicated juvenile Mountain Whitefish growth was similar in all studies. Although there was variability in flows between years (Figure 12), there was no detectable effect of flow on growth. The r^2 values for all years and programs were high, supporting good fit of regression curves to the data (Figure 35).

Length and weight were highly variable among age-0 and age-1 fish (Figure 35). The regression data from the LRFIP and the 1990s studies showed even more variability in length and weight for these age cohorts. As discussed above, sampling for those studies was conducted later in the fall, which allowed for more growth before capture.

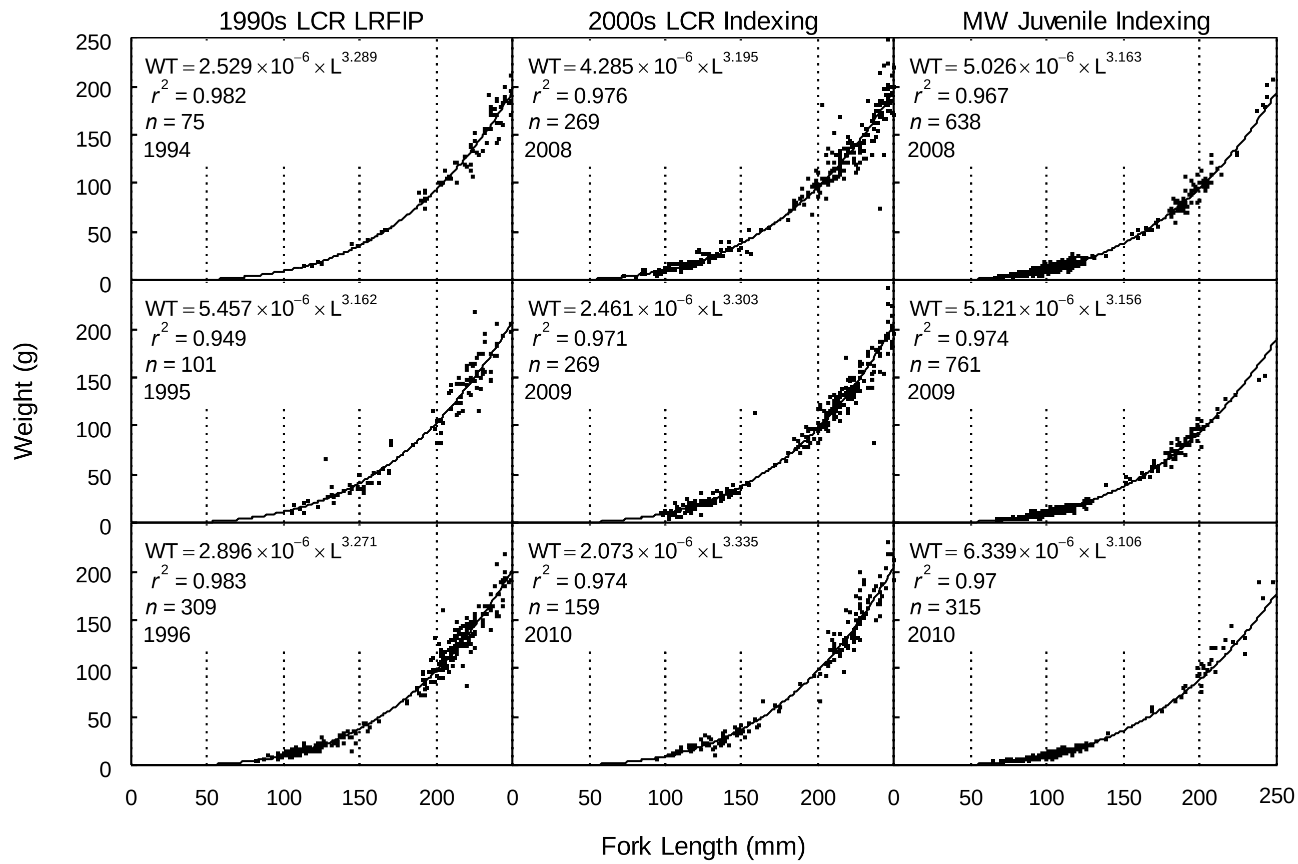


Figure 35: Weight-length regressions for juvenile Mountain Whitefish captured by boat electroshocking in the lower Columbia River.

A comparison of the weight-length regression curves was conducted to determine if there were significant differences between the lines (Figure 36. All regression curves were very similar for age 0+ fish, but began to diverge for age 1+ individuals. The weight-length regression curves from all studies were also compared by analysis of covariance (ANCOVA). Although there were substantial differences between several of the intercepts and slopes for each study and year, overlapping confidence intervals indicated the curves were not significantly different (Figure 37 and Figure 38).

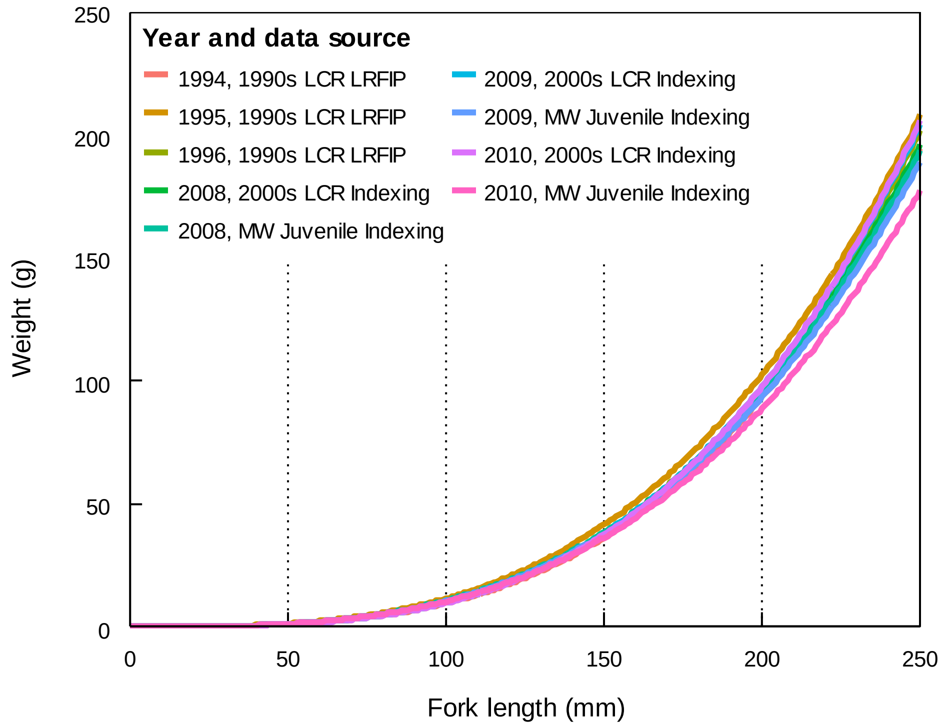


Figure 36: Comparison of juvenile Mountain Whitefish weight-length regression curves developed for each year and project; see individual curves in Figure 35.

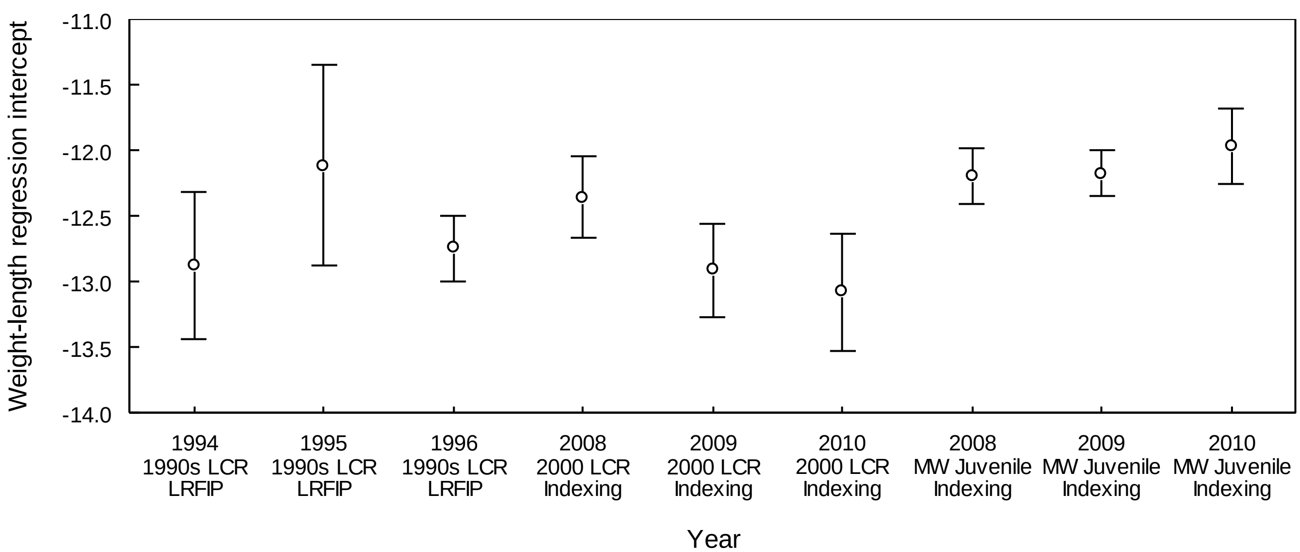


Figure 37: Comparison of intercept values of log-log juvenile Mountain Whitefish weight-length regressions (see individual curves in Figure 35). Error bars are 95% confidence intervals.

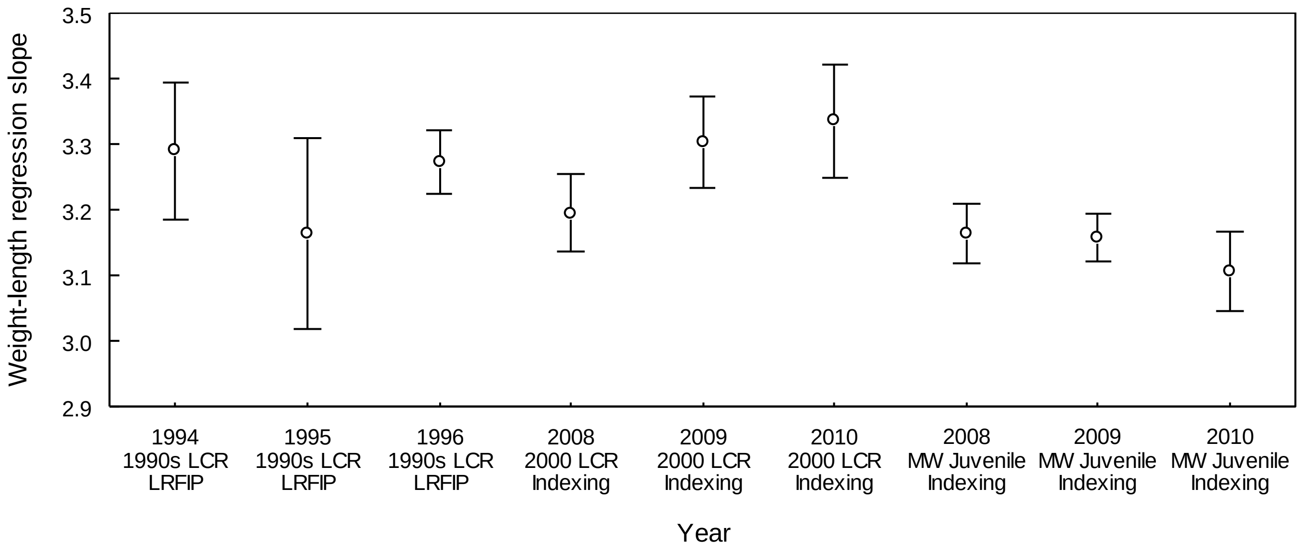


Figure 38: Comparison of slope values of log-log juvenile Mountain Whitefish weight-length regressions (see individual curves in Figure 35). Error bars are 95% confidence intervals.

6.3 Juvenile Rearing Habitats

Currently, little is known about juvenile habitat use in the daytime. In all study years, the highest numbers of juveniles at night were consistently recorded in in the upper section in D1 bank habitat types (low relief, gently sloping, and with fine substrates), which were often found in combination with D2 or A1 bank types (Table 22; see Appendix E, Table E8 for in-depth bank habitat classifications). The highest CPUEs were also documented in D1 habitat. Low encounters in the middle and lower sections of the study area precluded an in-depth look at habitat utilization in those areas.

Table 22: Bank habitat types in the upper section of the lower Columbia River and associated juvenile Mountain Whitefish abundance (captured and observed) recorded during boat electroshocking, September 2008, 2009, and 2010.

Study Year	Section	Bank Habitat Types Present[a]	Total Length of Habitat Type Sampled (km)	Total Juvenile Mountain Whitefish Recorded	CPUE (fish/km)
1 (2008)	Upper	D1 (low relief, fines)	7.92	1219	*153.91*
		D1+D2 (low relief, fines and coarse materials)	3.78	390	*103.17*
		D2 (low relief, coarse materials)	0.43	30	*69.77*
		D1+D2/EDDY[b] (low relief, fines and coarse materials/areas with counter current)	1.20	62	*51.67*
		D1/A1[c] (low relief, fines/uniform bank with cobble and small boulders)	4.86	251	*51.65*
		D2/BW/A2+A3[d] (low relief, coarse materials/eddy or reduced flows/irregular shoreline, armoured cobble, boulder and bedrock outcrops)	1.40	10	*7.14*
		A1/D1[c] (uniform bank with cobble and small boulders/ low relief, fines)	1.10	4	*3.64*
		A2 (irregular shoreline, armoured cobble, boulder outcrops)	0.28	0	*0.00*
	Year 1 Subtotals		**20.97**	**1966**	***93.75***
2 (2009)	Upper	D1/A1[c] (low relief, fines/uniform bank with cobble and small boulders)	3.82	499	*130.55*
		D1 (low relief, fines)	7.84	713	*90.96*
		D1+D2 (low relief, fines + coarse materials)	4.74	399	*84.23*
		D2 (low relief, coarse materials)	0.87	39	*45.07*
		D1+D2/EDDY[b] (low relief, fines and coarse materials/areas with counter current)	1.19	23	*19.31*
	Year 2 Subtotals		**18.46**	**1673**	***90.65***
3 (2010)	Upper	D1 (low relief, fines)	7.22	369	*51.11*
		D1+D2 (low relief, fines + coarse materials)	5.04	149	*29.56*
		D1/A1[c] (low relief, fines/uniform bank with cobble and small boulders)	3.84	82	*21.35*
	Year 3 Subtotals		**16.10**	**600**	***37.27***

[a] See Appendix E, Table E8 for Habitat Type Descriptions.
[b] Majority of juvenile Mountain Whitefish associated with D1+D2 habitat type.
[c] Majority of juvenile Mountain Whitefish associated with D1 habitat type.
[d] Majority of juvenile Mountain Whitefish associated with D2 habitat type.

In the middle and lower sections, erosional zones with larger substrates dominated the available habitat. In the middle section in Year 1, the highest captures of juvenile mountain whitefish were recorded in small areas of nearshore depositional habitat types and therefore, sampling in Year 2 focussed on these bank types (Table 23).

In both study years, the highest densities of juveniles in the middle section were consistently recorded in D2 bank habitat types, which were often found in combination with D1 or A1 bank types, although some variability in recorded densities by bank habitat type was noted (Table 23).

Table 23: Bank habitat types in the middle section of the lower Columbia River and associated juvenile Mountain Whitefish abundance (captured and observed) recorded during boat electroshocking, September 2008 and 2009.

Study Year	Section	Bank Habitat Types Present[a]	Total Length of Habitat Type Sampled (km)	Total Juvenile Mountain Whitefish Recorded	CPUE (fish/km)
1 (2008)	Middle	D2 (low relief, coarse materials)	2.69	190	*70.63*
		D1+D2/A1[b] (low relief, fines + coarse materials/uniform bank with cobble and small boulders)	0.33	14	*42.42*
		BW (eddy or reduced flow)	0.25	4	*16.00*
		D1+D2 (low relief, fines + coarse materials)	1.84	29	*15.76*
		A2 (irregular shoreline, armoured cobble, boulder outcrops)	1.15	12	*10.43*
		A1/A5 (uniform bank with cobble and small boulders/steep bedrock banks)	0.79	7	*8.86*
		A2+A3/D2/A5[c] (irregular shoreline, armoured cobble, boulder and bedrock outcrops/low relief, coarse materials/steep bedrock banks)	0.62	1	*1.61*
	Year 1 Subtotals		**7.67**	**257**	***33.51***
2 (2009)	Middle	D1+D2 (low relief, fines + coarse materials)	1.85	128	*69.21*
		D2 (low relief, coarse materials)	4.96	240	*48.44*
		D1+D2/A1[b] (low relief, fines + coarse materials/uniform bank with cobble and small boulders)	0.65	30	*46.05*
		BW (eddy or reduced flow)	0.50	18	*35.96*
	Year 2 Subtotals		**7.96**	**416**	***52.28***

[a] See Appendix E, Table E8 for Habitat Type Descriptions.
[b] Majority of juvenile Mountain Whitefish associated with D1+D2 habitat type.
[c] Majority of juvenile Mountain Whitefish associated with D2 habitat type.

Similar to the upper and middle sections, juvenile mountain whitefish in the lower section were most abundant in depositional habitats during sampling (Table 24). Low numbers of juveniles were encountered in habitats with armoured bank types. Overall, juveniles were observed in lower abundance in all habitat types sampled within the lower section than in either the middle or upper sections.

The general decrease in juvenile abundance from the upper to lower sections coincides with a reduction in the availability of depositional habitats types with increased downstream distance.

Table 24: Bank habitat types in the lower section of the lower Columbia River and associated juvenile Mountain Whitefish abundance (captured and observed) recorded during boat electroshocking, September 2008 and 2009.

Study Year	Section	Bank Habitat Types Present[a]	Total Length of Habitat Type Sampled (km)	Total Juvenile Mountain Whitefish	CPUE (fish/km)
1 (2008)	Lower	D1+D2 (low relief, fines + coarse materials)	1.38	34	*24.64*
		D1+D2/A2[b] (low relief, fines + coarse materials/irregular shoreline, armoured cobble, boulder outcrops)	0.34	7	*20.59*
		A1/D2 (uniform bank with cobble and small boulders/low relief, coarse materials)	0.96	12	*12.50*
		D1+D2/BW[b] (low relief, fines + coarse materials/eddy or reduced flow)	1.12	5	*4.64*
		D1/A1+A2[c] (low relief, fines/uniform bank with cobble and small boulder + irregular shoreline, armoured cobble, boulder outcrops)	0.70	3	*4.29*
		A2 (irregular shoreline, armoured cobble, boulder outcrops)	1.17	3	*2.56*
		D2/BW (low relief, coarse materials/eddy or reduced flow)	0.88	2	*2.27*
		EDDY/A1 (areas with counter current/ uniform bank with cobble and small boulders)	0.56	1	*1.79*
		BW/A6 (eddy or reduced flow/man made banks, boulders, rip-rap)	0.68	0	*0.00*
		EDDY (areas with counter current)	0.32	0	*0.00*
	Year 1 Subtotals		**8.11**	**67**	***8.26***
2 (2009)	Lower	D1+D2 (low relief, fines + coarse materials)	1.37	71	*51.73*
		D1+D2/BW[b] (low relief, fines + coarse materials/eddy or reduced flow)	2.25	79	*35.13*
		D1+D2/A2[b] (low relief, fines + coarse materials/irregular shoreline, armoured cobble, boulder outcrops)	0.69	17	*24.76*
		A1/D2[d] (uniform bank with cobble and small boulders/low relief, coarse materials)	1.92	31	*16.13*
		D2/BW[d] (low relief, course materials/eddy or reduced flow)	0.84	8	*9.58*
		A2 (irregular shoreline, armoured cobble, boulder outcrops)	2.35	22	*9.38*
		D1/A1+A2[c] (low relief, fines/uniform bank with cobble and small boulder + irregular shoreline, armoured cobble, boulder outcrops)	1.40	10	*7.15*
		EDDY/A1 (areas with counter current/ uniform bank with cobble and small boulders)	0.56	3	*5.38*
	Year 2 Subtotals		**11.37**	**241**	***21.20***

[a] See Appendix E, Table E8 for Habitat Type Descriptions.
[b] Majority of juvenile Mountain Whitefish associated with D1+D2 habitat type.
[c] Majority of juvenile Mountain Whitefish associated with D1 habitat type.
[d] Majority of juvenile Mountain Whitefish associated with D2 habitat type.

During habitat surveys in Year 1, areas in the upper section that contained high concentrations of juvenile Mountain Whitefish exhibited mean depths of 0.5 m or less, low velocities, and fine gravel to medium gravel substrates (Table 25; Appendix E, Tables E9 and E10). Interstices were the predominant cover type at each site, followed by aquatic vegetation.

Habitats used by juveniles in the lower section exhibited slightly higher velocities than the upper section in both survey years (Table 25). Mean velocity in the middle section in 2009 was substantially higher than in the upper or lower sections in that year.

In Year 2, juvenile habitats in the upper and lower sections exhibited similar dominant substrate (i.e., fine to medium gravels) and cover type characteristics (interstitial spaces and aquatic vegetation) as the upper section in Year 1, although small woody debris were more prevalent in Year 2 (Table 25; Golder 2010 and 2011). The dominant substrate in the middle section in Year 2 consisted mainly of large gravels. All areas in both years were in shallow, nearshore habitats with mean depths of 0.51 m or less.

Table 25: Habitat parameters from habitats frequented by juvenile mountain whitefish in the upper, middle, and lower sections of the Columbia River. September 2008 and 2009.

Date	Section and Sample Year	Number of Transects	Depth (cm)		Velocity (m/s)		Dominant Substrate[a]		Cover Types[b]
			Mean	SD	Mean	SD	Mean	SD	
Sep 28-08	Upper (Year 1)	22	42	31.71	0.01	0.06	3.56	1.79	INT, AV
Sep 23-09	Upper (Year 2)	40	49	28.72	0.04	0.08	3.51	1.53	INT, AV, SWD
Sep 26-09	Middle (Year 2)	30	48	27.44	0.48	0.48	5.05	1.92	INT, AV, LWD
Sep 29-09	Lower (Year 2)	25	51	25.54	0.11	0.14	3.18	1.94	INT, SWD

[a] Dominant substrate based on Modified Wentworth values: 3 = fine gravel (2-8mm), 4 = medium gravel (8-17mm), 5 = large gravel (18-32mm).

[b] Cover Type: INT = interstices, AV = aquatic vegetation, SWD = small woody debris, LWD = large woody debris.

6.4 Tagging Survivability Testing

In Year 2, six juvenile mountain whitefish (five in the lower section and one in the upper section) were tagged with V7 dummy tags as part of the juvenile acoustic tagging survivability testing study component (Appendix E, Table E9). The juveniles ranged in length from 132 to 158 mm and in weight from 21.6 to 41.3 g. Five untagged juveniles (captured in the same manner and held in the same holding tank for the same duration as the tagged fish) were also placed into the underwater holding tank as a control to assess potential mortality associated with the holding pen. Following the 24 hour holding period, two of the six tagged fish and all five untagged fish were still alive and active. The fish that survived were the largest individuals, and although inspection of the mortalities in the laboratory could not positively identify the direct cause of death, the likely cause was insufficient space within the body cavity to accommodate the V7 dummy tags without inducing excessive pressure on the various surrounding soft tissues and organs.

In Year 3, 39 juvenile Mountain Whitefish were selected for the tag survivability experiment (Table 26: Appendix E, Table E10). The juveniles ranged from 70 to 230 mm FL and from 3.5 to 145.0g in weight. Three different treatments were applied to the juveniles to test survivability after specific tagging and handling procedures (Section 2.8.2). Untagged fish (n = 9) were also added to the holding pen to act as a control for the experiment.

Table 26: Summary of results from the juvenile Mountain Whitefish tagging experiment, Lower Columbia River, September 2010.

Date	Experimental Treatment[a]	Total Number of Fish	Fork Length Range (mm)	Average Fork Length (mm)	Median Fork Length (mm)	Weight Range (g)	Average Weight (g)	After 24 h Holding	
								Alive	Mortality
Sep 23 & 24, 2010	Control	9	70 – 220	167	199	3.5 – 145.0	72.2	7	2[b]
	V5	10	105 – 230	125	110	11.5 – 131.5	26.4	5	5
	PIT	10	58 – 201	109	100	6.0 – 81.5	17.2	0	10[b]
	V5 & PIT	10	101 – 205	133	121	10.5 – 99.5	30.5	1	9[b]

[a] Control = no tags applied, V5 = only V5 dummy tag applied, PIT = only PIT tag applied, V5 & PIT = both V5 and PIT tag applied.

[b] Includes one fish killed by a heron while in the holding cage.

Control fish had the highest survival rate, followed by fish tagged with the V5 mimic tags. The control fish were, on average, substantially longer and heavier than the other groups and the two control fish that died were the smallest individuals of that group (Appendix E, Table E10). Examination of the sizes of the V5 group indicated that the fish that lived after 24 h were larger (mean = 137.6 mm FL and 38.7 g) than fish that died (mean = 111.8 mm FL and 14.1 g). Fish from treatments that involved insertion of PIT tags exhibited very low survival rates. The PIT tagged group was, on average, the smallest of all the groups, with 60% ≤ 100 mm FL.

During a check of the holding pen, the crew observed a great blue heron perched beside the pen. Upon inspection, several holes were noted on the sides of the pen and three of the dead juveniles in the pen had large wounds on their bodies. The heron was directly responsible for the deaths of these three fish in the holding cage (one each of the V5 & PIT, the PIT, and control fish). With the exception of the fish directly injured and killed by the heron, the direct cause of death of the other fish that succumbed during the tagging process could not be positively identified, although stress from heron predation may have contributed to the death of some fish.

The low (0%) survival rate of the PIT tagged fish in the present study was surprising, considering that a similar experiment conducted during Phase 10 of the LRFIP resulted in 100% survival of similar sized (n = 4; mean and median = 143 mm FL) PIT tagged juvenile Mountain Whitefish (Dustin Ford, Golder, pers. comm). The main differences between the two experiments were that the fish in the LRFIP experiment were held for 24 h in a larger net pen (with black mesh) covered with a dark tarp to reduce light, river rocks were placed inside the pen to provide some cover, and the pen was situated in deeper water.

7.0 DISCUSSION

A considerable amount of information on the biology, life history, and population characteristics of Mountain Whitefish has been obtained during the present five year CLBMOB-48 study program and previous studies on Mountain Whitefish in the LCR. This information has been provided in the annual series of data reports prepared for each study year of the CLBMON-48 program (Golder 2009, 2010, 2011 and 2012) and in the main summary report prepared for the 1990s studies (R.L.&L. 2001). The following sections summarize and discuss the available information collected by the previous and present study programs as they relate to addressing the specific management questions and hypotheses identified in Section 1.2. As the management questions pertain in general to questions regarding adult movements, adult spawning activity, and juvenile abundance and habitat use, the following sections have been organized around these categories.

7.1 Adult Mountain Whitefish

Management Question 5: *"What a re the pre-spa wning an d po st-spawning sea sonal m ovement patte rns of whitefish? How do sub-adult and adult migrations affect the interpretation of annual index monitoring programs?"*

The LRFIP only indexes adult Mountain Whitefish in the early fall period. Therefore, post-spawning movement patterns of spawners should not affect the interpretation of the results of that program. Furthermore, the LRFIP documented that age-1 Mountain Whitefish exhibit higher site fidelity than mature adults and has not identified trends that would suggest that sub-adults undergo significant migrations during the LRFIP sample period (Dustin Ford, Golder, pers. comm). Hence, to identify potential effects of Mountain Whitefish movements on the LRFIP, the present study focused on monitoring the migrations of adults during the pre-spawning period, which coincides with the LRFIP sample period. Therefore, in-depth analysis of post spawning related movement was not conducted.

Pre-spawning movement patterns. Results of the telemetry program in the present study indicated that the average total movement (sum of all detected movements over the detection histories) and net movement (difference between furthest upstream and downstream detections) was relatively high (43.2 km and 22.0 km, respectively). Females tended to move slightly longer distances than males, but differences between sexes were not statistically significant. However, the large variation in these values indicated that not all adults undergo substantial pre-spawning movements. This finding is supported by the results of past studies that indicated the presence of non-migratory sub-populations of Mountain Whitefish in the LCR (R.L.&L. 2001). Similarly, Davies and Thompson (1976) documented both migratory and non-migratory sub-populations of Mountain Whitefish in the Sheep River, Alberta.

In the present study, CPR Island, Tin Cup Rapids, Kootenay River, Kinnaird Rapids, Blueberry Creek, Genelle, Rock Island, and Fort Shepherd were the main areas frequented by dual-tagged Mountain Whitefish during the spawning period. Their presence in these areas of previously documented whitefish spawning use was considered as indicative of spawning related activity. This pattern is also supported by the findings of previous studies in the area. Studies in the 1990's indicated that movement patterns of Mountain Whitefish in the lower Columbia River were complex and were a function of season, resident location, and fish size (R.L.&L. 2001). Preliminary findings suggested that the largest and, therefore, most fecund individuals of the Columbia River Mountain Whitefish population may prefer to spawn in the upper section of the LCR.

The pre-spawning movements of dual-tagged Mountain Whitefish did not suggest the presence of any new key spawning areas in the mainstem Columbia River within the LCR. However, large numbers of Mountain Whitefish adults were reported in Norn's Creek in the fall of 2000 during snorkel floats conducted as part of a Bull Trout study (R.L.&L. 2000a). Mountain Whitefish were not encountered during snorkel floats conducted in Norn's Creek in late summer 2002 during a Kokanee study (R.L.&L. 2002), which would indicate the adults moved into the creek in the fall. Opportunistic observations by study team members in the fall of 2011 and 2012 reported several hundred adult Mountain Whitefish in Norn's Creek. Subsequent examination of the creek in November 2012 documented the occurrence of relatively high densities of Mountain Whitefish egg similar to those found in the Kinnaird Rapids secondary spawning area.

Of the adult dual-tagged Mountain Whitefish detected during this study period, several exhibited suspected spawning-related movements into known spawning areas as early as late November and mid-December, which coincided with the estimated onset of spawning in the upper, Kootenay, and middle sections of the study area. The finding that some spawners travelled large distances during the pre-spawning period could have a potential influence on LRFIP results, such as changing catch rates over the study period as adult whitefish migrate to spawning areas. This is evident in the upper and Kootenay sections, where catch rates tend to decrease and increase over the course of the LRFIP study period, respectively. As the LRFIP indexes the pre-spawning period, any spawning-related movement after the onset of spawning would not be documented by the program. An example of such movement would be migration related to the second spawning run in the Kootenay River. With the current state of knowledge, it is unknown if the individuals comprising the second spawning run migrate to the spawning area at the same time as individuals spawning in the first run, or if they migrate into the area after the first spawners have emigrated out.

Due to the relatively short period of time the tags were active and the relatively small sample size, especially in the lower section where few tags were deployed, the telemetry data cannot be used to quantify the proportions of the adult Mountain Whitefish that undertake pre-spawning migrations within the LCR. However the results are sufficiently robust to show that an unknown proportion of the adult Mountain Whitefish that reside in the lower, middle, and upper section of the LCR undertake significant migrations to spawning areas in other sections of the river, prior to the peak spawning period. These types of pre-spawning movement also have been documented in other populations of Mountain Whitefish (Thompson and Davies 1976).

Post-spawning movement patterns. Based on the telemetry program, 12 individuals (8 females and 4 males) exhibited suspected post spawning related movements out of identified spawning areas (Appendix C, Figures C1 and C2). These movements occurred between mid-December to mid-January, and were all in a downstream direction. This exclusive downstream post spawning migration pattern was also documented in the Sheep River in Alberta (Thompson 1974). In the present study, the exodus out of the spawning areas was rapid in most cases and the distance travelled ranged from 3 km to 38 km. As it is not possible to determine actual spawn timing based on the telemetry data, the length of time individuals remained in identified spawning areas after spawning was completed could not be determined.

Based on these data, study hypothesis H_05: "*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 population abundance/characteristics*" cannot be rejected. These movements may potentially introduce biases (e.g., violation of the HBM assumption of a closed population) and confound results of the LRFIP, although how or to what degree is unclear.

7.2 Mountain Whitefish Spawning

Management Question 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?"*

Spawning distribution. Although the present study was primarily focussed on documenting spawning activities in previously identified key spawning areas, a secondary objective was the identification of new spawning areas, This was achieved through the combined results of a telemetry program, egg mat sampling in other known or suspected spawning areas, and egg stranding surveys. However, it is highly likely that there are other undocumented low-use spawning areas in the LCR. Dual tagged Mountain Whitefish that were detected outside of key spawning area during the spawning period were assumed to have occupied these areas for non-spawning related reasons, but could have been spawning in undocumented low-use areas. Suitable Mountain Whitefish spawning habitat is abundantly available in the LCR and the reasons why spawning occurs more intensively in some areas than in others is still unknown.

In all years examined, the upper Columbia River section provided the most extensively utilized Mountain Whitefish spawning habitat. Within this section, CPR Island and the Kootenay River were identified as key spawning areas with the consistently highest rates of egg deposition. Tin Cup and Kinnaird Rapids were identified as secondary spawning areas, where spawning occurs annually, but at a lower intensity than in the key spawning areas. Norn's Creek proper was confirmed as a new secondary spawning area. Other, less extensively used sites (i.e., Genelle, Beaver Creek, Fort Shepherd Eddy, and Waneta Eddy areas) were located in the middle or lower sections (R.L.&L. 2001).

Inter-annual variation. Differences in CPUE and cumulative new egg counts within the key spawning areas indicated a high degree of inter-annual variation in egg deposition rates. Different patterns of egg deposition rates at individual mat stations between years also suggests inter-annual variation of habitats used for spawning within given spawning areas. The variability in egg density during stranding surveys within the secondary spawning sites in the upper section (Tin Cup and Kinnaird Rapids) also suggests inter-annual variation at these locations.

Based on low numbers of newly spawned eggs collected and low overall egg CPUEs at spawning sites in the middle (Blueberry and Genelle) and lower sections of the LCR, these areas continue to be less extensively used. As multiyear sample programs were not conducted in these areas, inter-annual variation in spawning habitat use could not be assessed.

Site fidelity may reduce inter-annual variation in spawning habitat use. The results from a telemetry study conducted from 1995 to 1997 implied a remarkable year-to-year site fidelity of adult Mountain Whitefish in several tributaries of the Fraser River (McPhail and Troffe 1998). However, similar levels of site fidelity have not been verified in the LCR (R.L.&L. 2001 and present study).

Overall, based on the current dataset, the null hypothesis H_01: "*The distribution of spawning habitat used by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years"* cannot be rejected.

Furthermore, we suggest that the hypothesis be rephrased to: "*The distribution of key and secondary spawning areas used by Mountain Whitefish in the LCR does not differ significantly between years"*

Management Question 2: *"What are the physical and hydraulic characteristics of spawning and egg incubation habitats?"*

Operations at HLK and ALH have the potential to alter downstream water temperatures during periods of thermal stratification in Arrow Lakes Reservoir that typically occur in the late spring and summer seasons (Golder 2002a). During the Mountain Whitefish spawning and egg incubation periods (late fall and winter), thermal stratification does not occur and operations from HLK and ALH do not affect downstream temperatures. Brilliant Reservoir is a run-of-the-river type reservoir and is essentially isothermal all year; consequently, BRD operations do not influence water temperatures in downstream spawning and incubation habitats.

Hydraulic characteristics, spawning habitat. The habitat characteristics documented at the key Mountain Whitefish spawning areas in the present study are very similar to those recorded in the 1990s (R.L.&L. 2001). Spawning in both areas occurred over predominantly cobble-boulder substrate (greater than 65 mm diameter). In previous studies, documented egg deposition areas were located in 0.5 to 9.0 m water depth with surface velocities from 0.1 to 3.4 m/s and upstream from riffles or rapids (R.L.& L. 1997, 1999, 2000, 2001). In the Sheep River, Thompson and Davies (1976) also documented similar substrate in spawning areas, although spawning was documented at much shallower depths. Secondary and low-use spawning sites in the middle and lower sections of the study area were only sampled during one spawning season; consequently, inter-year comparisons of physical and hydraulic characteristics in these areas could not be made.

At CPR Island, mean mid-channel egg collection mat deployment depths were considerably deeper than mean shore set depths. In the Kootenay River, although mean mid-channel set depths also were substantially greater than shore sets, but measurements at both subsites were highly variable. Mean surface water velocity was slightly higher in mid-channel sites than in shore sites in both CPR Island and Kootenay River locations, however measurements were quite variable (1 SD of approximately 0.5 m/s). The majority of shore sampling locations at CPR Island were dominated by larger substrates (cobble and boulder). In the Kootenay River, the dominant substrate at most sites was boulder, cobble, and gravel. Sub-dominant substrate consisted mainly of boulder, cobble, and gravel as well. Although depth, velocity and substrate at egg collection mat deployment locations in key spawning areas varied by year, site, and shore/mid-channel sub-site, there were no major differences in these habitat variables between years.

Mountain Whitefish spawning was documented between mean column water velocities of 0.0 m/s and 3.5 m/s in both key spawning areas. At CPR Island, the highest probability of egg deposition occurred between mean column velocities between 0.5 m/s and 1.25 m/s. In the Kootenay River, the mean column velocity with the highest probability of egg deposition was slightly higher, between 0.7 m/s and 1.5 m/s. These mean column ranges were similar to those documented during Mountain Whitefish spawning in the Sheep River (Thompson and Davies 1976).

River 2D modelling of depth and mean column velocity at the CPR Island key spawning areas showed that the amount of available area with preferred habitat remained relatively stable over most HLK discharges. Discharge changes from BRD had little effect on preferred habitat availability in this area, In the Kootenay River, modeling indicated the area of preferred depth remained relatively stable over the range of HLK and BRD discharges examined. However, as HLK and BRD discharges increased, the amount of available area within the preferred velocity range became highly variable.

The results of the River 2D modelling provided strong evidence to indicate that changes in discharge from HLK have the greatest influence on preferred depth and velocity parameters in both of the key Mountain Whitefish spawning areas.

Hydraulic characteristics, egg incubation habitat. Fluctuations in hydraulic characteristics at egg incubation habitats may result in the re-suspension of deposited eggs and subsequent downstream drift, which would increase the risks of predation and mechanical damage. Currently, the relationship between flow increases and the re-suspension of whitefish eggs is poorly understood. Over the course of the study, the contribution of old drifting eggs in the catch was remarkably similar between years (12.1-16.4% annually), considering the variability in flows among years. There was no correlation between egg drift (proportion of older eggs) and discharge. A pilot D-ring drift net sampling program was proposed for one of the key Mountain Whitefish spawning areas to assess egg drift following a flow increase of 142 m^3/s or higher, but could not be conducted as the late-winter flow regimes did not provide the necessary flows increase required to warrant implementation.

Based on the current dataset, the null hypothesis H_02: "*The physical characteristics of spawning habitats of Mountain Whitefish in the lower Columbia and lower Kootenay rivers do not differ significantly between years"* cannot be rejected.

Management Question 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?"*

Seasonal timing, LCR. Present study results showed that Mountain Whitefish spawning at CPR Island consistently began between early and mid-November, peaked between early to mid-January, and was essentially completed by mid-February in all three spawning seasons surveyed. In the 1990s studies, spawning at CPR Island was initially detected in early December, peaked in late December-early January with a second peak in mid-January, and was essentially completed by mid-February in the 1994 to 1996 study years. (R.L.&L. 2001). This bimodal pattern was not evident in the 1998 to 1999 spawning season (R.L.&L. 2000). The reasons for the change in pattern from bimodal in the mid-1990s to unimodal in the present study are unknown, but do not appear to be related to changes in flow patterns resulting from dam operations.

Seasonal timing, Kootenay River. In the Kootenay River, peak egg catch-rates were recorded in early January. Due to the variation in flow levels during the onset and peak of spawning in these studies, patterns that would indicate that spawning was dependent on discharge were not evident (Appendix D, Figures D1 and D2).

In the Kootenay River, Mountain Whitefish exhibited a consistent bimodal spawning pattern in all years. The initial peak occurred between mid-December and early January, while the subsequent peak occurred in mid-January. The onset and peak spawning periods in the key areas occurred over varying discharge patterns, which indicates that discharge was not the primary cue to initiate spawning or determine peak spawning. Greater variation in the onset of spawning was documented in the Kootenay River than at CPR Island. Based on estimates from the developmental staging of captured eggs, spawning in 2010 was initiated almost a month earlier compared to other study years. Although there was greater variability related to the onset of spawning, the timing of peak spawning occurred over a more consistent period.

Similar to the Kootenay River spawning pattern, egg CPUE at the middle (2009) and lower (2011) sections exhibited a bimodal pattern, with the first peak occurring in mid-late December, and the second peak in early-mid

January in both years. Discharge in both sections was stable prior to the onset of spawning in both study years. During the first peak in spawning at all sites, discharge fluctuated frequently, as a result of load factoring at BRD. During the subsequent peak in these sections, discharge was relatively stable or declining. As spawning at these locations was only monitored in one study year, annual variations in the flow regime in relation to spawning in these sections could not be examined.

Mountain Whitefish spawn timing also directly correlates to larval emergence. Based on the developmental stages of Mountain Whitefish eggs collected and temperature data, eggs that are deposited early in the spawning season could potentially reach hatch stage by late December (Golder 2009, 2010 and 2011). Although there was variation in relation to the time at which eggs started to reach maturity, the emergence period at the key spawning areas was protracted and concluded by late April to mid May in all years. This documented emergence range is similar to the emergence period predicted from data collected during the 1995-1996 spawning season (late January to early July; R.L.&L. 2001). This protracted emergence timing is supported by the results of the larval surveys conducted over the course of this study. The earliest that larval Mountain Whitefish have been recorded in the LCR was in late March (Appendix D, Table D12 and D13). This suggests that upon reaching later stages of egg development (pre-hatch stage), eggs remain in stasis until suitable cues for hatching are provided (R.L.& L. 2001). Support for this phenomenon is provided by research conducted in the Lagen River in Norway that showed that although temperature affected the rate of embryonic development, increased water flow and the action of hatching enzymes induced hatch (Naesje et al. 1995).

Spawning intensity. In order to determine spawning intensity in the LCR, various Mountain Whitefish population metrics that directly relate to spawning intensity (age-at-maturity, sex ratio, fecundity, abundance and size distribution) were examined. The majority of age-2 fish were mature, with a higher proportion of mature females than males; all age-3 and older fish examined were mature. This is similar to findings of the 1990's studies (R.L.&L. 2001). Mountain Whitefish typically become sexually mature at age-3 and age-4 (Scott and Crossman 1973; Thompson and Davies 1976). Most individuals in the Upper Columbia and Fraser systems are sexually mature by age-6 (McPhail 2007). All individuals were mature by age-4 in the Blacks Fork River in Utah (Wydoski 2001) and by age-3 in the Snake River basin (Meyer et al. 2009). All of those studies indicated that males typically mature earlier than females. The results from this present study indicate that both male and female Mountain Whitefish mature earlier in the LCR than in other parts of their range. This earlier age-at-maturity in the study area is likely related to faster growth rates in the LCR.

The slight differences in Mountain Whitefish sex ratios between study years in the LCR likely reflect variations in spatial and temporal distributions of each sex during the sample period and habitat preferences of individuals present at the time of sampling (R.L.&L. 2001). The sex ratio in the LCR was similar to ratios reported from the Sheep River in Alberta (1 male:1 female; Thompson 1974) and the Snake River in Idaho (1.04 male:1 female; Wydoski 2001) but different than in the Blacks Fork River, where males outnumbered females (1.6 males: 1 female; Meyer et al. 2009).

Spawning intensity at the key spawning areas (as measured by eggs/mat day) differed between years. At CPR Island, spawning intensity was substantially higher in the 2009-2010 spawning season when compared to the 2010-2011 and 2011-2012 seasons. Alternatively, documented spawning intensity in the Kootenay River was at its lowest during the 2009 to 2010 season. It is unknown whether this pattern is a result of sample bias or suggests that a portion of spawners that typically use the Kootenay River relocated to CPR Island to spawn.

Fecundity estimates. The fecundity estimates for female Mountain Whitefish in the LCR obtained in the present study are within the higher end of the ranges reported elsewhere in western Canada and the Northwestern US. The decrease in relative fecundity from the 1990s studies (R.L.&L. 2001) to the present study likely reflects an overall increase in fish size, as indicated by the greater proportion of fish larger than 400 mm FL in the catch from the present study.

Abundance and density estimates. Estimates generated by the LRFIP for adult Mountain Whitefish had wide credibility limits that confound interpretation of trends; however, abundance estimates were slightly lower in 2010 and 2011 than in most previous study years (Ford and Thorley 2012). Adult Mountain Whitefish site-level density estimates also had high levels of uncertainty. Generally, median density was higher in sites known to contain suitable spawning habitat for this species. These included: Norn's Creek Fan (RKm 7.4), the Kootenay River, between the Kootenay River confluence (RKm 10.6) and Kinnaird Bridge (RKm 13.4), the Genelle area (RKm 27.0), and upstream of Fort Shepherd Eddy (RKm 49.0).

Adult length distribution. Although adult length varied among years, there was a distinctive peak at 375 to 400 mm FL across all study years. A secondary peak at 300 to 325 mm FL was observed in some years (1996, 2008 to 2011). The size range of adults from 2008 to 2012 was similar, ranging from 250 to 500 mm FL. In 2012, a small number of individuals measured over 500 mm FL. In 1994 to 1996, the size range of adults was slightly more variable. The largest adults were captured in 1996, with several individuals measuring over 550 mm FL. In comparison to data collected in the 1990s, length-weight regressions indicated that individuals at a given size are typically heavier in the current population.

Flow management. Although both discharge patterns and spawning intensity in the key spawning areas varied in all three years of sampling, correlations between these two parameters could not be identified. Spawning intensity is likely correlated with population metrics such as fecundity and adult abundance, as well as other environmental factors such as temperature.

Based on the current state of Mountain Whitefish spawning in the lower Columbia and Kootenay rivers, factors relating to Mountain Whitefish spawning (such as spawn timing, intensity, distribution, and habitat characteristics) vary on an annual basis. There is no evidence to neither indicate that these inter-annual variations are biologically significant nor result from flow management. Water temperature appears to be the primary environmental variable that influences timing of spawning. In the present study, the temperature range during peak spawning in all sections was similar to the range documented at the peak of the 1994-1996 spawning seasons (3-5°C, R.L.&L. 2001; Appendix D, Figures D1 and D2). Wydoski (2001) also documented a similar decline in temperatures (7.2 to 4.4°C) during the spawning period in rivers in Utah, US, while Thompson and Davies (1976) documented a temperature range of 8 to 0°C during the spawning period in the Sheep River, Alberta. Photoperiod is another environmental factor that may influence Mountain Whitefish spawning, although in the present study the onset and peak of spawning occurred at different times between study years, which suggested that photoperiod was not a primary spawning cue. Photoperiod may be a secondary cue that initiates spawning if suitable temperature cues are not experienced by spawners.

Therefore, based on the results from the present study, the null hypothesis H_03: "*The seasonal timing of spawning by Mountain Whitefish in the lower Columbia and lower Kootenay rivers does not differ significantly between years*" cannot be rejected.

Management Question 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?"*

Egg dispersal. At CPR Island, egg deposition patterns were highly variable, especially at mid-channel stations. In most years (past and present programs), egg mat sites along the mainstem bank of CPR Island (RUB) had the highest egg CPUE values. A notable exception was in 1995-1996, when highest CPUE was recorded at the stations along LUB (R.L.&L. 2001). Discharge during the 1995-1996 spawning season was substantially less variable in comparison to other years, which may have resulted in an extended period of time when the physical characteristics of habitat along LUB were suitable for spawning. In most years, egg CPUE at CPR Island did not exhibit a pattern of increased new egg deposition from the upstream to downstream portions of the site. This would suggest that the vast majority of newly spawned eggs in the upstream portions of the study settled into the substrate before drifting to the downstream egg mat stations.

Documented egg deposition rates in the Kootenay River during previous years and during the present study also exhibited high variability between years, with highest egg CPUE typically recorded at mid-channel and RUB stations (R.L.&L. 2001). Similar to CPR Island, the Kootenay River stations also lacked a distinct pattern of increased new egg deposition from the upstream to downstream portions of the study area, which further supports that most newly spawned eggs settle into substrate interstices and do not drift for appreciable distances downstream.

Due to the low numbers of newly spawned eggs collected and low CPUE in the secondary spawning sites in the middle section of the study area (Blueberry and Genelle), as well as the absence of mid-channel mat sets at Genelle, in-depth analysis of egg deposition patterns in these areas was not possible. Spawning in the lower section was apparently localized between RKm 47.0 and 49.3.

Vertical Distribution of Eggs. Based on the River 2D modelling conducted as part of the CLBMON-47 program, the range of depths at which egg deposition occurred was between approximately 1.0 m and 9.0 m depth at CPR Island and between 0.5 m and 8.0 m depth in the Kootenay River in all study years examined. The highest probability of egg deposition (preferred depth range) was between 1.7 m to 4.0 m at CPR Island and 2.7 m to 4.4 m in the Kootenay River.

Flow management. Flow management affects water depth, water velocity patterns, and substrate type availability, which are all important determinants of spawning site selection by Mountain Whitefish. Therefore, it seems reasonable to expect that flow management would have some effect on egg distribution patterns in the LCR. Flow changes within the spawning period have the potential to alter the location of areas with preferred depth and velocity characteristics, which could lead to spawners selecting differing areas to deposit their eggs. This would result in differences in vertical egg distribution patterns. However, given the highly localized and patchy egg distribution patterns observed at both key spawning sites and the relatively low inter-annual variability in flow during the spawning season, particularly in the Kootenay River, associations between egg deposition patterns and flow management could not be identified with the data available.

Therefore, based on the current dataset, the null hypothesis H_04: "*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"* cannot be rejected.

7.3 Juvenile Mountain Whitefish

Management Question 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?"*

Juvenile Mountain Whitefish habitat use. In the upper section of the LCR, larval Mountain Whitefish were most abundant in shallow, low velocity depositional habitats with a direct connection to the mainstem. The largest concentrations were documented at the Norn's Creek Fan area. The larvae in this area likely originated from Norn's Creek, as it is unlikely that they swam upstream from the adjacent CPR Island site, given the high flow velocities in this section of the river. Conversely, low numbers of larvae were observed downstream of the key spawning areas during systematic sampling in Year 5. Currently, the locations of key larval rearing habitats downstream of the key spawning areas are unknown. Although areas with potentially suitable habitat characteristics for larval rearing (low gradient, slow velocity depositional zones) are present below both the CPR Island (Waldies Island area) and the Kootenay River spawning areas (RUB location including the oxbow when inundated), sampling in these areas recorded low and inconsistent larvae encounters. In the middle section, relatively high numbers of larvae were observed at Sandbar Eddy and Genelle, which suggests that these areas may provide important rearing habitats for larval Mountain Whitefish from upstream spawning areas. Larval sampling was not conducted in the lower section of the study area in the present study.

The findings of the present study are consistent with previous studies conducted on the Columbia River. In 1995 and 1996, an intensive survey was conducted in the Columbia River between HLK and Lake Roosevelt in Washington State to identify early life stage rearing habitats for Mountain Whitefish (R.L.& L. 2001). Observations suggested that after hatch, whitefish larvae remained in the interstices of the spawning area until their yolk-sac was consumed and then emerged from the interstices and drifted downstream to suitable rearing areas. A component of this downstream movement involved an active lateral migration from deeper channel areas into suitable nearshore habitats. Mountain Whitefish larvae concentrated in calm, shallow shoreline margins, backwaters, and embayments with mean depths from 11 to 25 cm, mean velocities from 0 to 3 cm/s, substrates dominated by silt and sand, and bank slopes less than 25%. The limited catch data over the extensive area sampled, in conjunction with the confined nature and limited diversity of the Columbia River channel, suggested the availability and suitability of Mountain Whitefish rearing habitats may be limited within the study area (R.L.& L. 2001). In the Sheep River, larvae were documented in low velocity areas with substrates consisting of gravel, sand and mud (Thompson 1974). Northcote and Ennis (1994) reported that the survival of larval Mountain Whitefish is critically dependent on the availability of suitable, low velocity, protected marginal habitat.

Similar to larvae, the highest numbers of age-0 Mountain Whitefish (based on nighttime observations) were consistently recorded in the upper section in low relief, gently sloping habitat types with fine substrates. Low encounters in the middle and lower sections of the study area precluded an in-depth look at habitat utilization. While data have been collected on nighttime habitat use of age-0 and age-1 juvenile Mountain Whitefish, little is known about habitats used by these age-classes in the daytime. Due to the difficulties of capturing juveniles during the day (Golder 2009) and poor survival rates of juveniles during acoustic tag implantation in Years 2 and 3 (Golder 2010 and 2011), 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. The high use of shallow, low velocity habitat by young-of-the-year Mountain Whitefish documented in this study is consistent with the results from the studies conducted on the Lower Columbia River in the 1990s. Between 1994 and 1996, age-0 Mountain Whitefish were typically observed over depositional substrates in shallow sheltered embayments and back water areas (R.L.&L. 2001). McPhail (2007) also states that young of the year and juveniles are associated with shallow, quiet water and fine substrates. The juveniles sampled by Thompson and Davies (1976) were also collected in various backwater areas.

Juvenile Mountain Whitefish were more abundant in the upper section in the 1990s studies (Ash et al. 1981 and R.L.&L. 2001) than in the present study. Results from the 1990s indicated that use of the upper section can fluctuate substantially between years (R.L.&L. 2001), which was also evident in the present study with the reduction in juvenile encounters from Years 2 to 3 (Appendix E, Tables E2 and E3). It is unknown whether these results accurately represent juvenile abundance in the upper section or reflect potential biases due to sampling. Decreased abundance of Mountain Whitefish fry in the summer and fall in rearing areas where they were previously recorded suggested a shift in habitat use, likely to offshore areas, related to fish size (R.L.& L. 2001). In the summer, diel migrations are suspected to occur between nearshore and offshore habitats. Whitefish fry may undergo offshore migrations during the day to feed, and inshore migrations at night to avoid predators. The presence of young-of-the-year (YOY) in the upper section, upstream to spawning grounds and larval rearing areas, suggested that some YOY undergo an upstream migration to rearing and overwintering habitats (R.L.&L. 2001).

Juvenile Mountain Whitefish CPUE values may not be an accurate indication of relative abundance of these age-classes as they maybe be influenced by changes in sampling efficiency and site-specific fluctuations in density between study years. In some cases, portions of sample sites were not sampled due to the presence of public, wildlife, or the encounter of listed species. Juvenile distribution in suitable low velocity depositional habitats within the upper section was aggregated and irregular, which sometimes resulted in longer distances between juvenile encounters. Site length, in combination with lower velocities (which increased sample effort), may have lowered CPUE values within the longer sites of the upper section. Conversely, lower water velocities also increased netter efficiency, which may have somewhat offset the effects of increased sample effort.

In summary, larval Mountain Whitefish were documented consistently in near shore habitats. In the summer and fall seasons, the use of nearshore areas by age-0 Mountain Whitefish was inconsistent and apparently limited to nighttime. With the low recapture rates, clumped distributions, and limitations of the capture methods and current telemetry technology, it is not possible to develop a reliable program to index young-of-the-year abundance in the LCR at this time.

Therefore, study hypothesis $H_0$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."* is rejected.

7.4 Summary

Analysis of the current dataset indicates that the component of flow management that likely poses the greatest quantifiable risk to Mountain Whitefish recruitment success is egg mortality related to stranding. In past studies, grid surveys of dewatered shoreline areas in whitefish spawning areas provided information on the potential susceptibility of eggs to become stranded during flow reduction events (R.L.&L. 1994, 1997, 1999, 2000, and 2001). Large numbers of stranded eggs were present at both CPR Island and the Kootenay River, while low numbers were observed at secondary sites. The information obtained led to the development of an egg stranding model in 2001 with revisions in 2003 (R.L.&L. 2001a; Golder 2003a) and the refinement of this model in 2008. Although highly variable, documented egg stranding rates have shown that flow reductions during the incubation period and the implementation of Rainbow Protection flows have the potential to dewater substantial numbers of eggs. Larval surveys in the present study also identified stranding risk to rearing larvae during flow reductions in the LCR. Alexander et al. (2006) determined through extensive modelling that HLK should theoretically be operated to provide spawning flows of 1699 m^3/s, which would provide a balance between egg mortality due to dewatering at high flows and exclusion of high-quality spawning habitat at low flows. That study also estimated that in order to detect directional recruitment dynamics as a result of flow, 10 to 20 years of study would be required at an estimated cost between $3.35 and $4.55 million. As that study was based on population estimates from the 1990s and did not discuss BRD operations in relation to the ideal HLK discharge, its findings should be interpreted with caution.

An interesting finding of the present study is the relatively high use of Norn's Creek for Mountain Whitefish spawning. Although operations of HLK and BRD have no direct effect on water levels in the creek, access at the creek mouth may be restricted early in the spawning period as adults migrate in to spawn. The availability of rearing habitat at the mouth of the creek and on Norn's Fan for out-migrating larvae after emergence may also be affected by operations.

There is evidence in the literature to suggest that Mountain Whitefish eggs spawned at different times may have varying incubation times so that eggs hatch when conditions for survival are optimal (Rajagopal 1979, R.L.&L. 2001). Naesje et al. (1995) identified spring floods as a primary cue for hatching of river-spawning Coregoninae in Norway, and also described that early spring floods caused by hydroelectric facility operations could induce hatching when conditions for survival are less than optimal. The effectiveness of artificial freshet flows from HLK to provide suitable cues to stimulate early hatching of whitefish eggs has previously been investigated (R.L.&L. 1997, 1999). These studies were also designed to determine if artificial freshets reduced the potential incidence of egg stranding when Rainbow Trout Protection Flows were initiated in the spring. Experimental flow reductions were followed by flow increases, but the results did not indicate that the flow manipulations had a measurable effect on hatching rates. One possible explanation suggested for the apparent failure to induce hatching was that the magnitude of the flow increases was inadequate to provide suitable hatching cues.

Several studies have been conducted in the past that indirectly relate to this program in which several potential mitigation options were explored. The most feasible option was substrate scarification in spawning areas (R.L.&L. 1999, 2000). At low flows, substrates in known spawning areas were mechanically scarified to break up the surficial armour layer and increase substrate porosity. Although this method resulted in increased substrate porosity, the scarified areas did contain more eggs than non-scarified adjacent controls. Also, the new interstitial spaces filled in with sand and small gravels within one or two years of scarification, and this approach did not prove to be a viable, long-term mitigation option to enhance Mountain Whitefish spawning success.

As this study concludes, some gaps in the data set remain. The relationship between flow changes and egg re-suspension in the drift continues to be relatively unknown (pertains to Management Question 4). 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. Natural systems do not exhibit the large sustained flow increases that typically occur during winter in regulated systems like the LCR. Therefore, some the egg resuspension that does occur could reasonably be expected to result from water management practices.

However, as dam operations did not provide the conditions needed to conduct the experiments needed to assess the relationship between egg re-suspension and flow, this relationship remains poorly understood.

With the current radio and acoustic transmitter technology, mortality rates of tagged juvenile Mountain whitefish were too high to implement an effective telemetry program. In order to address the data gap of juvenile Mountain Whitefish daytime habitat use (pertains to Management Question 6), juvenile tagging survivability should be re-examined as transmitters become smaller and more technologically advanced. If tagging survivability testing is to be conducted in the future, the net pen holding enclosures (Section 6.4) used by the LRFIP (Dustin Ford, Golder, pers. comm) should be employed. This may allow for the development of an effective tagging methodology with suitable survival rates. A successful telemetry program for juvenile Mountain Whitefish would allow for the characterization of rearing habitats in the LCR and the Kootenay River, as well as assessing whether the availability and suitability of these habitats are affected by flow regimes.

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9.0 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

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Fisheries Biologist, Project Manager

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Senior Fisheries Scientist, Project Director

BH/LH/cmc

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APPENDIX A

Sampling Chronology and Study Area

Table A1: Detailed chronology of sampling activities for the Year 1 (2008 – 2009) Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program.

Date(s)	Sections Sampled	Juvenile Mountain Whitefish Sampling Activities
9 – 12 September 2008	All	Sample Session 1 – Boat Electroshocking Surveys
16, 18 – 20 September 2008	All	Sample Session 2 – Boat Electroshocking Surveys
23 & 24 September 2008	Upper	Day-time Snorkel Surveys
26 & 29 September 2008	Upper	Night-time Snorkel Surveys
29 September 2008	Upper	Habitat Assessments

Date(s)	Sections Sampled	Adult Mountain Whitefish Sampling Activities
12, 14 August 2008	All	Radio Frequency Noise Assessments
7, 9 – 11 October 2008	All	Session 1 – Adult Capture and Tagging Component
22 – 25 October 2008	All	Session 2 – Adult Capture and Tagging Component
31 October & 1 December 2008, 4 February & 4 March 2009	All	Download and maintenance of VR2W array
14 November 2008, 6, 15 & 19 January 2009	All	Download, maintenance and range testing of VR2W array under separate contract (CLBMON-28: Lower Columbia River Adult White Sturgeon Program)
18 November, 18 December 2008, 2 & 23	All	Mobile Land-Based Radio Tracking
30 December 2008, 6, 16 & 19 January	All	Boat-Based Radio Tracking

Table A2: Detailed chronology of sampling activities for the Year 2 (2009 - 2010) Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program.

Date(s)	Sections Sampled	Juvenile Mountain Whitefish Sampling Activities
September 10 – 13, 2009	All	Sample Session 1 – Boat Electroshocking Surveys
September 16 – 18, 21 2009	All	Sample Session 2 – Boat Electroshocking Surveys
September 23, 2009	Upper	Habitat Assessments
September 26, 2009	Middle	Habitat Assessments
September 29, 2009	Lower	Habitat Assessments
October 28, 29, 2009	Lower	Tagging Survivability Testing
October 30, 31, 2009	Upper	Tagging Survivability Testing

Date(s)	Sections Sampled	Egg Collection Mat and Egg Stranding Sampling Activities
December 7, 2009	Upper	Deployment in Kootenay River sample site
December 8, 2009	Upper	Deployment at CPR Island sample site
December 9, 2009	Upper	Deployment at Blueberry Creek sample site
December 10, 2009	Middle	Deployment at Genelle sample site
December 11, 16, 22, 29, 2009; January 4, 11, 18, 22, 26, 29, 2010; February 2, 8, 12, 2010	Upper	Retrieval, inspection and redeployment of sample gear at Kootenay River sample site
December 14, 21, 28, 2009; January 5, 13, 19, 25, 2010; February 1, 5, 9, 2010	Upper	Retrieval, inspection and redeployment of sample gear at CPR Island sample site
December 17, 30, 2009; January 6, 14, 20, 27, 2010; February 3, 10, 2010	Upper	Retrieval, inspection and redeployment of sample gear at Blueberry Creek sample site
December 18, 23, 31, 2009; January 6, 7, 15, 21, 27, 28, 2010; February 4, 11, 2010	Middle	Retrieval, inspection and redeployment of sample gear at Genelle sample site
January 12 and 14, 2010	Upper	Egg Stranding surveys
February 15, 2010	Upper	Retrieval, inspection and removal of sample gear from Blueberry Creek sample site
February 16, 2010	Middle	Retrieval, inspection and removal of sample gear from Genelle Sample Site
February 17, 2010	Upper	Retrieval, inspection and removal of sample gear from CPR Island Sample Site
February 18, 2010	Upper	Retrieval, inspection and removal of sample gear from Kootenay River Sample Site

Date(s)	Sections Sampled	Larval Mountain Whitefish Sampling Activities
March 30, 2010	Upper and Middle	Larval mountain whitefish stranding and rearing surveys
March 31, 2010	Upper	Larval mountain whitefish stranding and rearing surveys

Table A3: Detailed chronology of sampling activities for the CLBMON-48 Year 3 (2010 - 2011) Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program.

Date(s)	Sections Sampled	Juvenile Mountain Whitefish Sampling Activities
September 7, 9, 10, 13, 2010	Upper	Sample Session 1 – Boat Electroshocking Surveys
September 17, 23, 2010	Upper	Sample Session 2 – Boat Electroshocking Surveys
September 23, 24, 2010	Upper	Tagging Survivability Testing

Date(s)	Sections Sampled	Egg Collection Mat and Egg Stranding Sampling Activities
December 7, 8, 2010	Upper	Deployment at CPR Island area
December 8, 9, 2010	Upper	Deployment in Kootenay River area
December 15, 21, 28, 2010; January 4, 11, 18, 24, 2011; February 1, 2011	Upper	Retrieval, inspection and redeployment of sample gear at CPR Island area
December 16, 22, 23, 29, 2010; January 5, 6, 12, 13, 19, 26, 2011; February 2, 2011	Upper	Retrieval, inspection and redeployment of sample gear in Kootenay River area
February 8, 2011	Upper	Removal of sample gear from CPR Island area
February 9, 10, 2011	Upper	Removal of sample gear from Kootenay River area

Date(s)	Sections Sampled	Egg Stranding Sampling Activities
April 1, 2011	Upper	Egg Stranding Surveys at CPR Island area

Table A4: Detailed 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 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

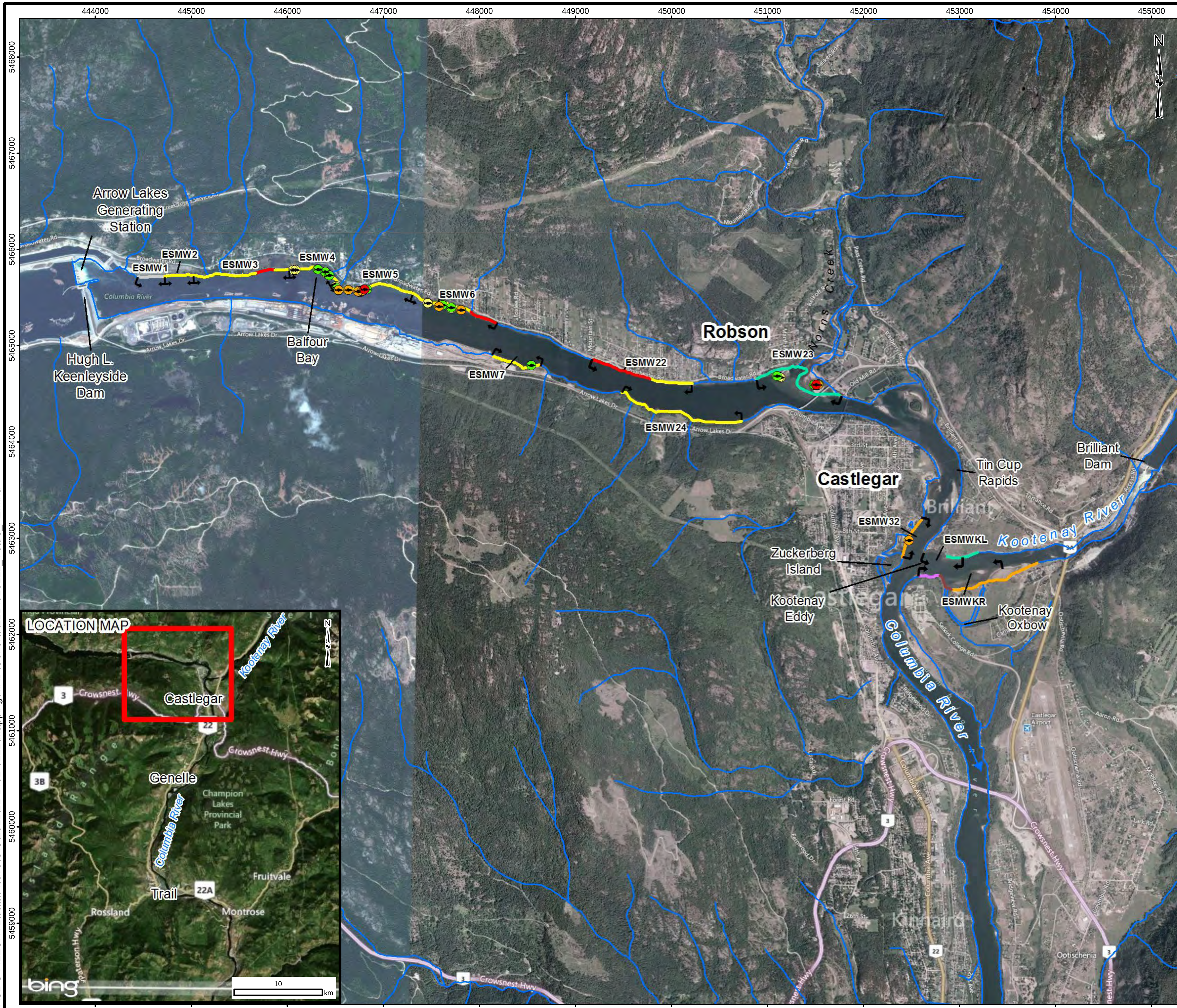
Date(s)	Sections Sampled	Egg Stranding and Larval Sampling Activities
February 4, 2012	Upper	Egg stranding surveys at Tin Cup Rapids and Kinnaird Rapids
March 29, 2012	Upper	Larval sampling
April 2, 2012	Upper	Egg stranding surveys at CPR Island and Kootenay River spawning areas

Table A5: Detailed chronology of sampling activities for the CLBMON-48 Year 5 (2012 - 2013) Lower Columbia River Whitefish Life History and Egg Mat Monitoring Program.

Date(s)	Sections Sampled	Egg Collection Mat and Kick Netting Sampling Activities
December 19, 2012	Upper	Deployment in Kootenay River area
December 27, 2012; January 2, 9, 16, 24, 30, 2013	Upper	Retrieval, inspection and redeployment of sample gear in Kootenay River area
January 30, 2013	Upper	Removal of sample gear from CPR Island area
February 8, 13, 2013	Upper	Kick Net Sampling in Norn's Creek

Date(s)	Sections Sampled	Egg Stranding Sampling Activities
February 16, 2013	Upper	Egg stranding surveys in the Kootenay River area

Date(s)	Sections Sampled	Larval Sampling Activities
March 28, 2013; May 17, 2013	Upper and Middle	Larval sampling – visual assessments
April 4, 9, 12, 16, 23, 30, 2013; May 1, 7, 14, 2013	Upper	Larval sampling – visual assessments
May 23, 2013	Upper	Larval sampling – beach seines



LEGEND

JUVENILE MOUNTAIN WHITEFISH CONCENTRATION

- 5-10
- 10 - 20
- 20 - 50
- >50

BANK HABITAT TYPE

- A1 - ARMOURED COBBLE / GRAVEL
- A1/A2 - ARMOURED COBBLE / GRAVEL / SMALL BOULDER
- A2 - ARMOURED COBBLE / SMALL BOULDER
- A2/A3 - A2 - ARMOURED COBBLE / SMALL / LARGE BOULDER
- A3 - ARMOURED SMALL / 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

ES1 BOAT ELECTROSHOCKING SITE

REFERENCE

BING IMAGERY: © HARRIS CORP, EARTHSTAR GEOGRAPHICS LLC © 2013 MICROSOFT CORPORATION © 2010 NAVTEQ © AND

DATUM: NAD83 PROJECTION: UTM ZONE 11

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PROJECT

CLBMON-48: LOWER COLUMBIA RIVER WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE

UPPER SECTION OF STUDY AREA INCLUDING THE LOWER KOOTENAY RIVER: BOAT ELECTROSHOCKING SAMPLE SITE LOCATIONS

Golder Associates

PROJECT		11-1492-0111	FILE No.	
DESIGN	BH	17 June 2013	SCALE AS SHOWN	REV. 0
GIS	CD	20 June 2013		
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REVIEW	XXX	DD Mmm. 2010		

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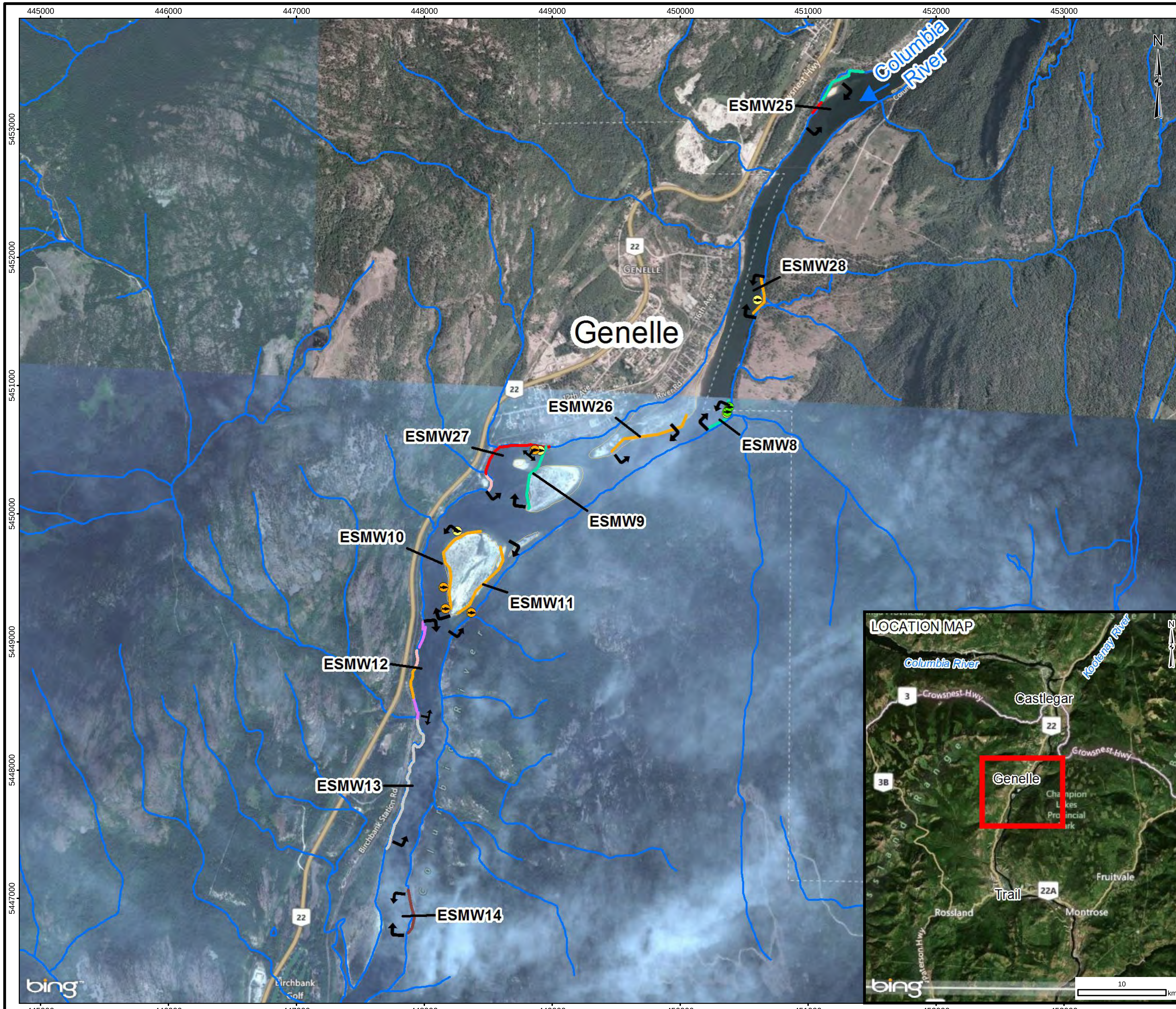

LEGEND

JUVENILE MOUNTAIN WHITEFISH CONCENTRATION

- 5-10
- 10 - 20
- 20 - 50
- >50

BANK HABITAT TYPE

- A1 - Armoured Cobble / Gravel
- A1/A2 - Armoured Cobble / Gravel / Small Boulder
- A2 - Armoured Cobble / Small Boulder
- A2/A3 - A2 - Armoured Cobble / Small / Large Boulder
- A3 - Armoured Small / 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

ES1 BOAT ELECTROSHOCKING SITE

REFERENCE

DATUM: NAD83 PROJECTION: UTM ZONE 11

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SCALE 1:30,000

PROJECT
CLBMON-48: LOWER COLUMBIA RIVER WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE
MIDDLE SECTION OF STUDY AREA: BOAT ELECTROSHOCKING SAMPLE SITE LOCATIONS

PROJECT	11-1492-0111		FILE No.	
DESIGN	BH	17 June 2013	SCALE AS SHOWN	REV. 0
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REVIEW	XXX	DD Mmm. 2010		

Golder Associates

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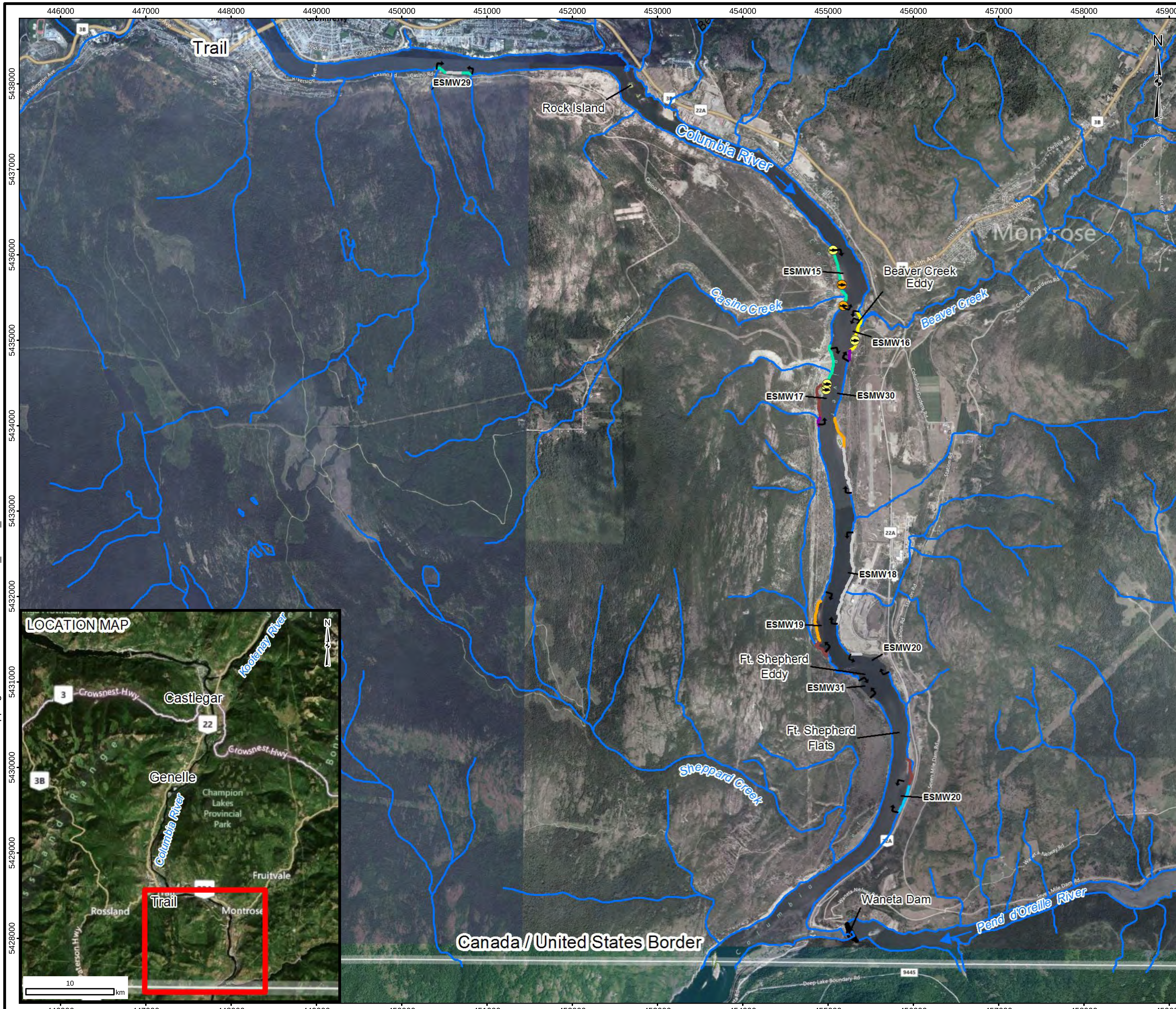

LEGEND

JUVENILE MOUNTAIN WHITEFISH CONCENTRATION

- 5-10
- 10 - 20
- 20 - 50
- >50

BANK HABITAT TYPE

- A1 - ARMOURED COBBLE / GRAVEL
- A1/A2 - ARMOURED COBBLE / GRAVEL / SMALL BOULDER
- A2 - ARMOURED COBBLE / SMALL BOULDER
- A2/A3 - A2 - ARMOURED COBBLE / SMALL / LARGE BOULDER
- A3 - ARMOURED SMALL / 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

ES1 BOAT ELECTROSHOCKING SITE

REFERENCE

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SCALE 1:45,000

PROJECT: CLBMON-48: LOWER COLUMBIA RIVER WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE: **LOWER SECTION OF STUDY AREA: BOAT ELECTROSHOCKING SAMPLE SITE LOCATIONS**

Golder Associates

PROJECT	11-1492-0111	FILE No.	
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LEGEND

EGG COLLECTION MAT LOCATION

- ▲ 8.5L; 8.5M; 8.5ML; 8.5MR; 8.5R
- ■ 8.6L; 8.6M; 8.6ML; 8.6MR; 8.6R
- ● 8.7L; 8.7M; 8.7ML; 8.7MR; 8.7R
- ▼ 8.8L; 8.8MR
- ✚ 8.9L; 8.9MR
- ♦ WALD1

EGG MAT STATIONS

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

REFERENCE

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DATUM: NAD83 PROJECTION: UTM ZONE 11

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PROJECT
CLBMON-48: LOWER COLUMBIA RIVER WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE
CPR ISLAND KEY SPAWNING AREA: EGG MAT SAMPLE LOCATIONS

Golder Associates

PROJECT	11-1492-0111		FILE No.	
DESIGN	BH	17 June 2013	SCALE AS SHOWN	REV. 0
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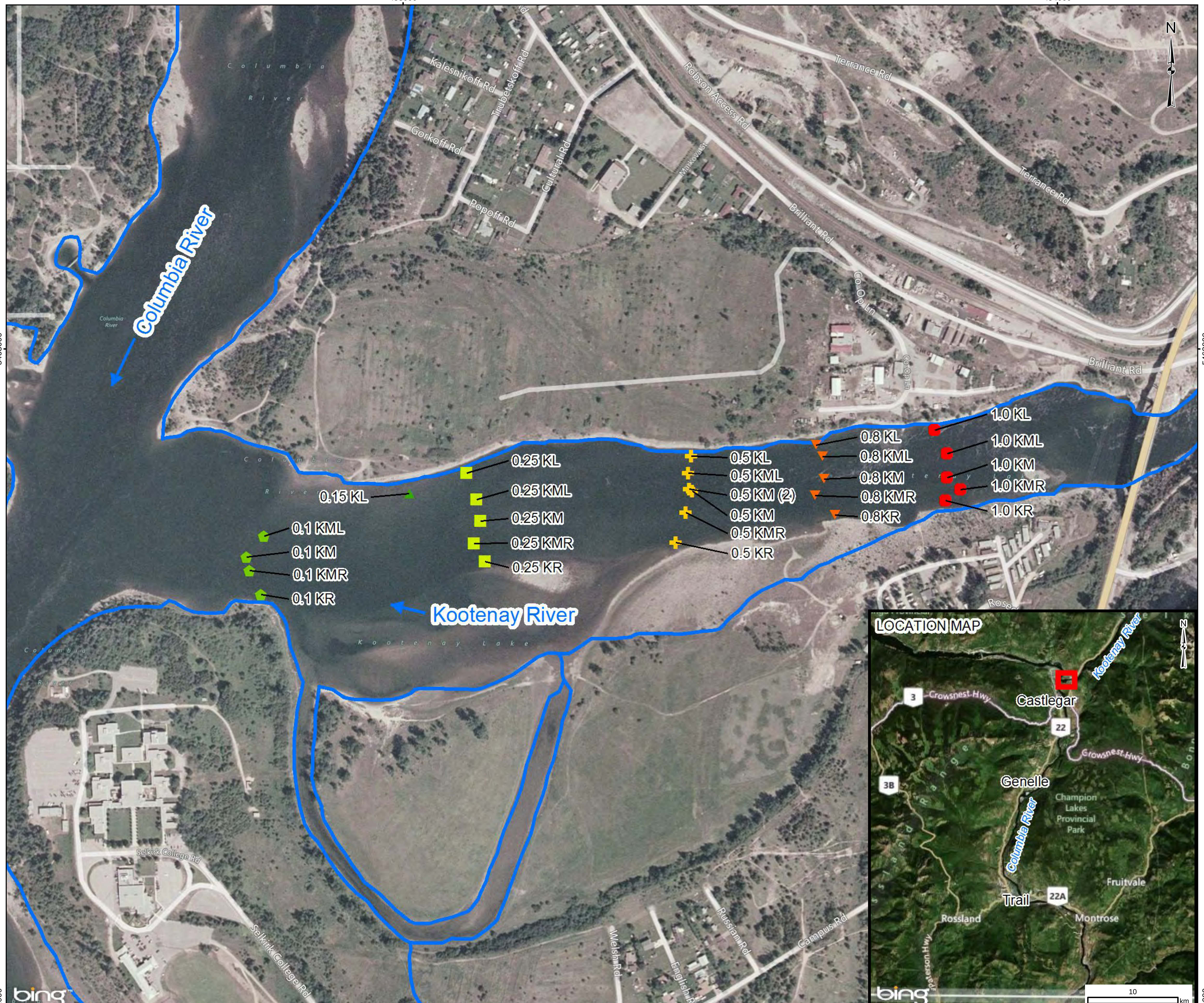

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LEGEND

EGG COLLECTION MAT LOCATION

- 0.15KL
- 0.1KM; 0.1KML; 0.1KMR; 0.1KR
- 0.25KL; 0.25KM; 0.25KML; 0.25KMR; 0.25KR
- 0.5KL; 0.5KM; 0.5KM (2); 0.5KML; 0.5KMR; 0.5KR
- 0.8KL; 0.8KM; 0.8KML; 0.8KMR; 0.8KR
- 1.0KL; 1.0KM; 1.0KML; 1.0KMR; 1.0KR

EGG MAT STATIONS

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

REFERENCE

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DATUM: NAD83 PROJECTION: UTM ZONE 11

200 0 200 m

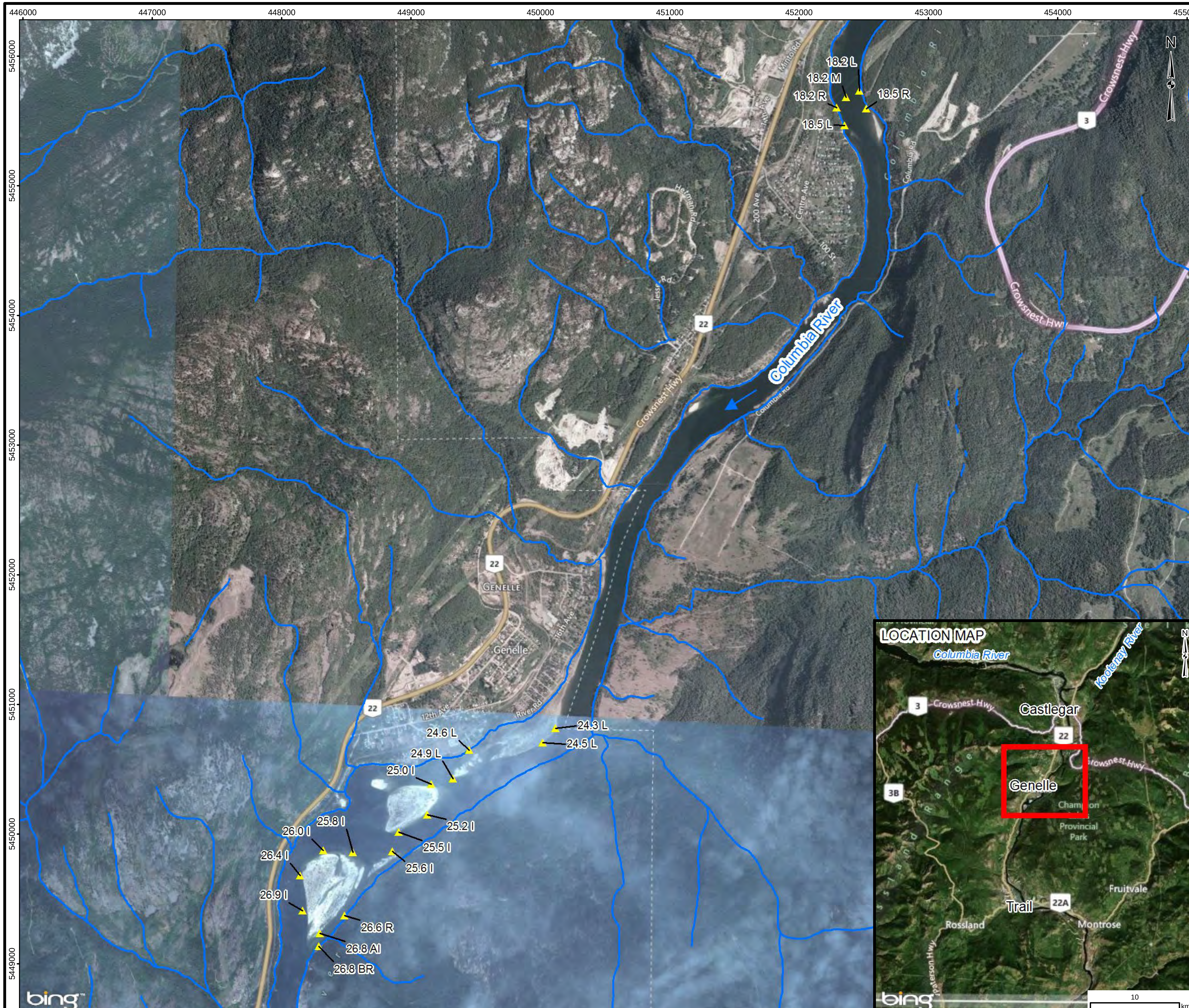
SCALE 1:6,000

PROJECT
CLBMON-48: LOWER COLUMBIA RIVER WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE
LOWER KOOTENAY RIVER KEY SPAWNING AREA: EGG MAT SAMPLE LOCATIONS

Golder Associates

PROJECT	11-1492-0111		FILE No.
DESIGN	BH	17 June 2013	SCALE AS SHOWN / REV. 0
GIS	CD	20 June 2013	
CHECK	XXX	DD Mmm. 2010	**FIGURE: A5**
REVIEW	XXX	DD Mmm. 2010	



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LEGEND

EGG COLLECTION MAT LOCATION

▲ EGG COLLECTION MAT LOCATION

EGG MAT STATIONS

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

REFERENCE

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DATUM: NAD83 PROJECTION: UTM ZONE 11

1 0 1 km

SCALE 1:30,000

PROJECT

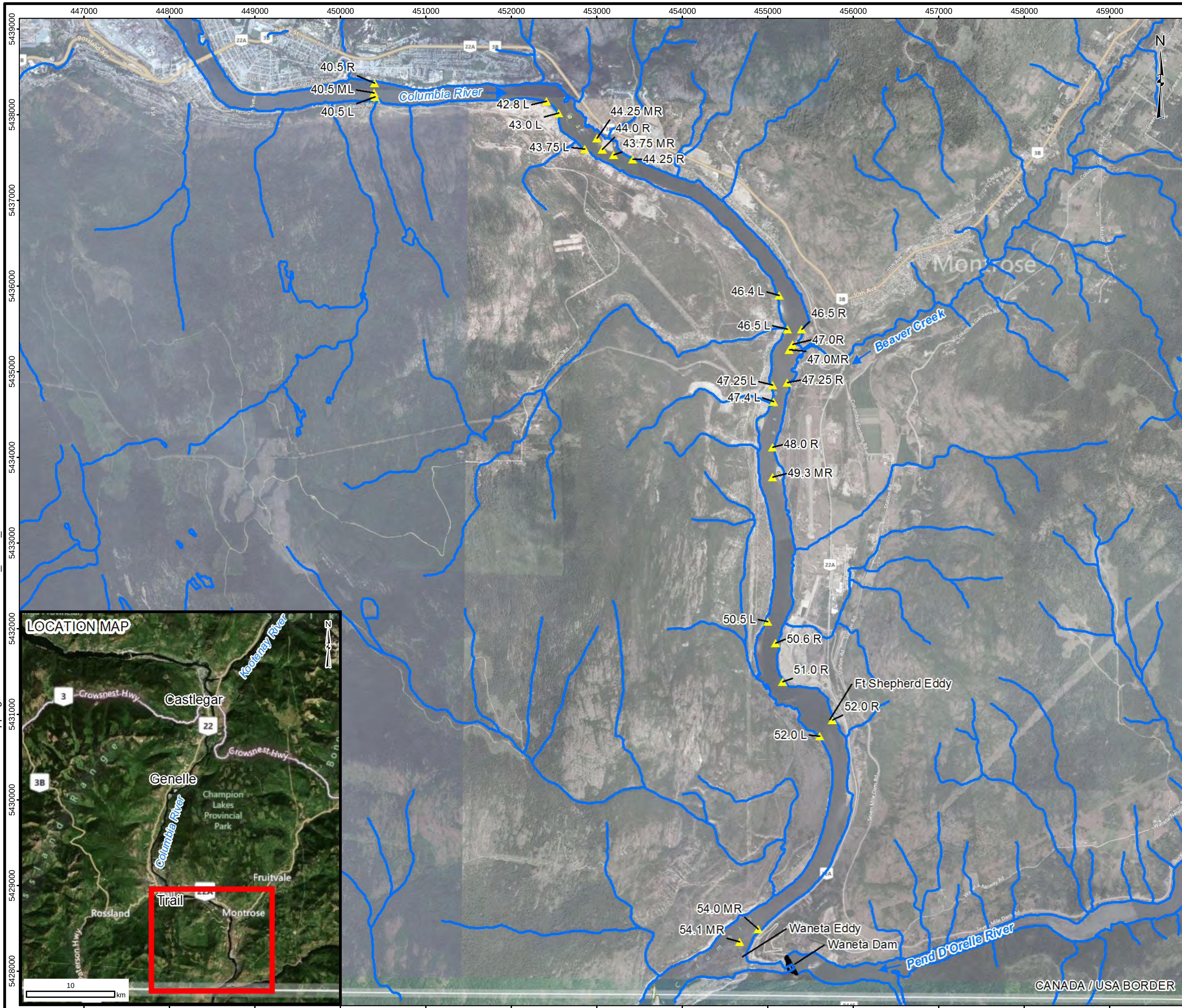
CLBMON-48: LOWER COLUMBIA RIVER WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE

MIDDLE SECTION OF STUDY AREA: EGG MAT SAMPLE LOCATIONS

Golder Associates

PROJECT	11-1492-0111		FILE No.	
DESIGN	BH	17 June 2013	SCALE AS SHOWN	REV. 0
GIS	CD	20 June 2013		
CHECK	XXX	DD Mmm. 2010	**FIGURE: A6**	
REVIEW	XXX	DD Mmm. 2010		



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LEGEND

EGG COLLECTION MAT LOCATION

▲ EGG COLLECTION MAT LOCATION

EGG MAT STATIONS

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

REFERENCE

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DATUM: NAD83 PROJECTION: UTM ZONE 11

1 0 1 km

SCALE 1:45,000

PROJECT

CLBMON-48: LOWER COLUMBIA RIVER WHITEFISH LIFE HISTORY AND EGG MAT MONITORING PROGRAM

TITLE

LOWER SECTION OF STUDY AREA: EGG MAT SAMPLE LOCATIONS

Golder Associates

PROJECT		11-1492-0111	FILE No.	
DESIGN	BH	17 June 2013	SCALE AS SHOWN	REV. 0
GIS	CD	20 June 2013	FIGURE: A7	
CHECK	XXX	DD Mmm. 2010		
REVIEW	XXX	DD Mmm. 2010		

APPENDIX B

Photographic Plates

Plate 1 Radio and acoustic trnasmitters (dual-tag) implanted into candidate adult Mountain Whitefish, October 2008 (Year 1).

Plate 2 Implanting dual-tag into candidate Mountian Whitefish, October 2008 (Year 1).

Plate 3 Boat based mobile tracking and habitat surveys near Fort Shepherd on the Lower Columbia River, January 2009 (Year 1).

Plate 4 Comparison of normal (top) and abnormal (large tumor; bottom) mature male Mountain Whitefish gonads in Year 4. Both fish were captured in the Kootenay River.

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

Plate 6 Kick net sampling in Norn's Creek, February 2013 (Year 5).

Plate 7 Removing substrate to enumerate stranded Mountain Whitefish eggs within a transect at the CPR Island spawning area, April 2012 (Year 4).

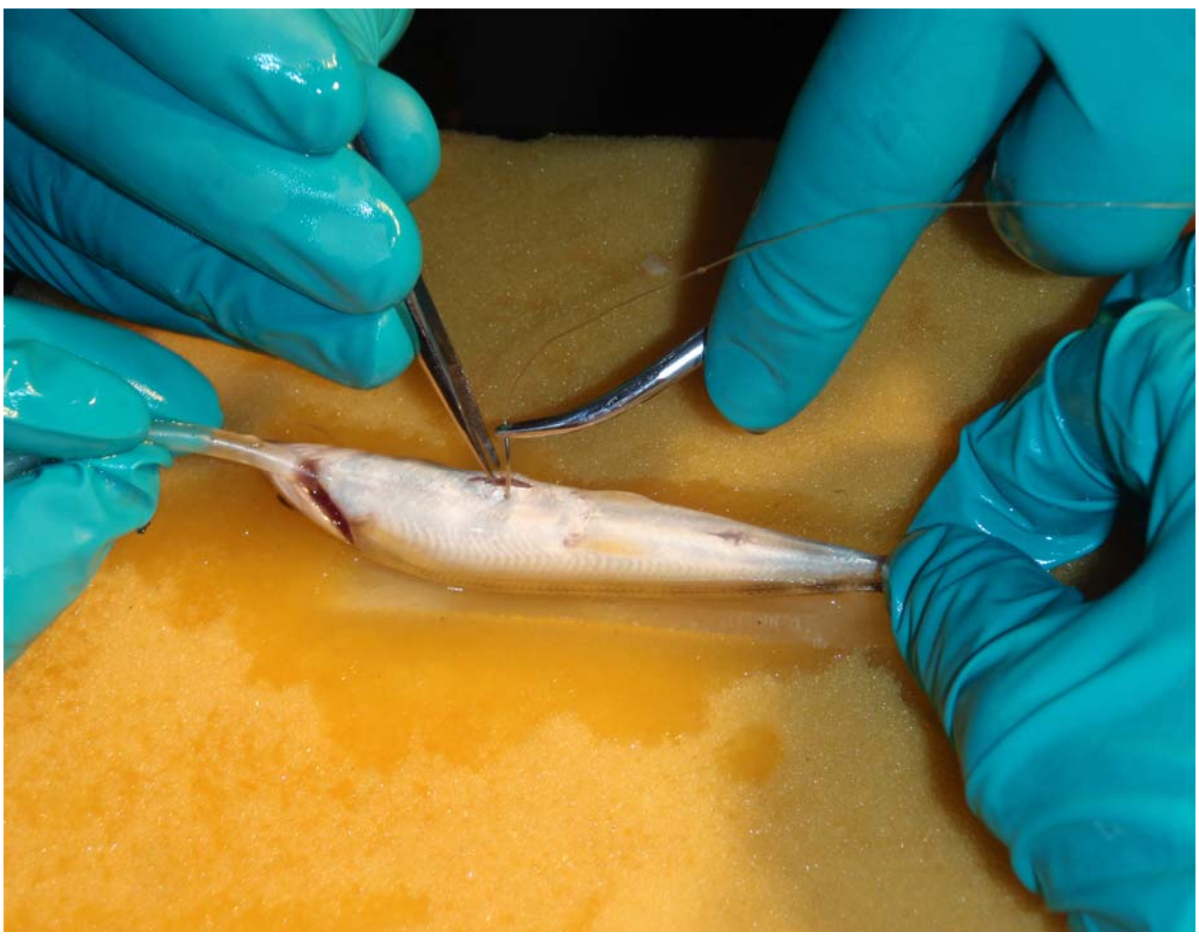


Plate 8 Closing incision on juvenile Mountain Whitefish with sutures after Vemco V5 tag implantaion, September 2010 (Year 3).

Plate 9 Day-time snorkel survey conducted in the upper section of the study area, September 2008 (Year 1).

Plate 10 Recording habitat characteristics at a measurement transect in the upper section of the Lower Columbia River, September 2009 (Year 2).

APPENDIX C

Adult Mountain Whitefish Sampling Data Summaries

Table C1: Summary of life history information, surgeries for tag implantation and release of adult mountain whitefish tagged in October 2008.

Sample No.	Capture Location[a]	Water temp (°C)	Species	Fork Length (mm)	Weight (g)	Surgery Date	Surgery Initials	Anaesthetic Start Time	Anaesthetic End Time	Surgery Start Time	Surgery End Time	Radio Tag Tested Y/N	Radio Tag Frequency	Radio Tag Code	Acoustic Tag Tested Y/N	Acoustic Tag Code	PIT or PIP Tag No	Fish Released WithTags(Y/N)	Release Date	Release Time	Release Location
1	ES2-1	12.1	MW	351	665	7-Oct	LH	20:50	20:54	20:56	20:03	Y	460	35	Y	52610	985120031284239	Y	7-Oct-08	21:23	Beaver Creek Launch
Comments	Female, wound bled a bit, full of eggs.																				
2	ES2-2	12.1	MW	401	1115	7-Oct	LH	23:26	23:29	23:31	23:38	Y	460	25	Y	52613	985120031272218	Y	7-Oct-08	0:40	Beaver Creek Launch
Comments	Female																				
3	ES2-2	12.1	MW	390	925	7-Oct	BH	23:39	23:44	23:45	23:55	Y	460	20	Y	52615	985120061253201	Y	7-Oct-08	0:40	Beaver Creek Launch
Comments	Female																				
4	ES2-2	12.1	MW	398	1029	7-Oct	BH	00:03	00:07	00:08	00:15	Y	460	28	Y	52611	985120031267581	Y	7-Oct-08	0:40	Beaver Creek Launch
Comments	Male																				
5	ES2-2	12.1	MW	278	322	7-Oct	LH	00:16	00:20	00:14	00:23	Y	460	11	Y	52614	985120031251494	Y	7-Oct-08	0:40	Beaver Creek Launch
Comments	Male																				
6	ES10	11.4	MW	382	851	9-Oct	LH	20:33	20:37	20:38	20:43	Y	460	18	Y	52602	985120031269382	Y	9-Oct-08	21:10	d/s end of ES9
Comments	Female																				
7	ES10	11.4	MW	284	342	9-Oct	LH	20:46	20:49	20:50	20:55	Y	460	33	Y	52604	985120031286249	Y	9-Oct-08	21:10	d/s end of ES9
Comments	Male																				
8	ES10	11.4	MW	391	993	9-Oct	LH	20:57	21:00	21:02	21:05	Y	460	14	Y	52603	985120031282442	Y	9-Oct-08	21:40	d/s end of ES9
Comments	Female																				
9	ES10	11.4	MW	385	613	9-Oct	LH	21:27	21:31	21:32	21:37	Y	460	26	Y	52609	985120031277264	Y	9-Oct-08	22:10	d/s end of ES9
Comments	Male, bruising on mouth																				
10	ES10	11.3	MW	384	766	22-Oct	BH	20:58	21:09	21:03	21:08	Y	460	15	Y	52587	985120031282301	Y	22-Oct-08	21:35	u/s end of Kootenay Eddy
Comments	Male																				

[a] See Figures A1 to A3 for site locations.

Table C1: Continued.

Sample No.	Capture Location[a]	Water temp (ºC)	Species	Fork Length (mm)	Weight (g)	Surgery Date	Surgery Initials	Anaesthetic Start Time	Anaesthetic End Time	Surgery Start Time	Surgery End Time	Radio Tag Tested Y/N	Radio Tag Frequency	Radio Tag Code	Acoustic Tag Tested Y/N	Acoustic Tag Code	PIT or PIP Tag No	Fish Released WithTags(Y/N)	Release Date	Release Time	Release Location
11	ES10	11.4	MW	398	966	9-Oct	LH	21:59	21:03	22:03	22:06	Y	460	19	Y	52608	985120031242333	Y	9-Oct-08	22:10	d/s end of ES9
Comments		Female																			
12	ES29	12.1	MW	372	659	10-Oct	LH	19:35	19:38	19:40	19:43	Y	780	59	Y	52606	985120031273962	Y	10-Oct-08	20:34	d/s end of Balfour Bay
Comments		Female																			
13	ES29	12.1	MW	354	647	10-Oct	LH	19:45	19:49	19:50	19:53	Y	780	50	Y	52607	985120031243185	Y	10-Oct-08	20:34	d/s end of Balfour Bay
Comments		Female																			
14	ES29	12.1	MW	326	428	10-Oct	LH	19:56	20:00	20:01	20:05	Y	460	17	Y	52599	985120031279707	Y	10-Oct-08	20:35	d/s end of Balfour Bay
Comments		Male																			
15	ES29	12.1	MW	373	674	10-Oct	LH	20:07	20:11	20:12	20:15	Y	460	27	Y	52605	985120031283756	Y	10-Oct-08	20:35	d/s end of Balfour Bay
Comments		Female - looks like old floy wound, ulceration on back near dorsal fin																			
16	ES29	12.1	MW	321	523	10-Oct	BH	20:45	20:49	20:50	20:55	Y	780	56	Y	52596	985120031284430	Y	10-Oct-08	21:33	d/s Balfour Bay
Comments		Female																			
17	ES29	12.1	MW	360	560	10-Oct	BH	21:00	21:04	21:05	21:12	Y	780	46	Y	52597	985120031277415	Y	10-Oct-08	21:34	d/s Balfour Bay
Comments		Male - tubercles																			
18	ES29	12.1	MW	324	484	10-Oct	BH	21:15	21:21	21:21	21:27	Y	780	36	Y	52598	900010000044386	Y	10-Oct-08	21:46	d/s Balfour Bay
Comments		Female																			
19	ESK1	11.7	MW	264	284	11-Oct	LH	19:36	19:39	19:40	19:44	Y	780	43	Y	52601	985120031285173	Y	11-Oct-08	20:31	u/s end of Kootenay Eddy
Comments		Male																			
20	ESK1	11.7	MW	336	568	11-Oct	LH	19:46	19:50	19:51	19:54	Y	780	45	Y	52590	985120031233929	Y	11-Oct-08	20:31	u/s end of Kootenay Eddy
Comments		Female																			
21	ESK1	11.7	MW	379	680	11-Oct	LH	19:56	20:00	20:01	20:04	Y	780	47	Y	52595	985120031261446	Y	11-Oct-08	20:31	u/s end of Kootenay Eddy
Comments		Female																			

[a] See Figures A1 to A3 for site locations.

Table C1: Continued.

Sample No.	Capture Location[a]	Water temp (ºC)	Species	Fork Length (mm)	Weight (g)	Surgery Date	Surgery Initials	Anaesthetic Start Time	Anaesthetic End Time	Surgery Start Time	Surgery End Time	Radio Tag Tested Y/N	Radio Tag Frequency	Radio Tag Code	Acoustic Tag Tested Y/N	Acoustic Tag Code	PIT or PIP Tag No	Fish Released WithTags(Y/N)	Release Date	Release Time	Release Location
22	ESK1	11.7	MW	366	709	11-Oct	LH	20:06	20:10	20:11	20:15	Y	780	53	Y	52593	985120031276676	Y	11-Oct-08	20:45	u/s end of Kootenay Eddy
Comments	Female																				
23	ESK1	11.7	MW	386	869	11-Oct	LH	20:17	20:21	20:22	20:26	Y	780	55	Y	52594	985120031277595	Y	11-Oct-08	21:15	u/s end of Kootenay Eddy
Comments	Male																				
24	ESK1	11.7	MW	317	426	11-Oct	BH	20:50	20:54	20:55	21:00	Y	780	42	Y	52592	985120031292335	Y	11-Oct-08	21:15	u/s end of Kootenay Eddy
Comments	Female																				
25	ESK1	11.7	MW	336	560	11-Oct	BH	21:03	21:07	21:08	21:14	Y	780	37	Y	52591	985120031285042	Y	11-Oct-08	21:39	u/s end of Kootenay Eddy
Comments	Male																				
26	ESK1	11.7	MW	308	441	11-Oct	BH	21:15	21:19	21:20	21:27	Y	460	16	Y	52600	985120031243445	Y	11-Oct-08	21:52	u/s end of Kootenay Eddy
Comments	Female																				
27	ES10	11.3	MW	400	903	22-Oct	BH	20:06	20:11	20:12	20:17	Y	460	29	Y	52586	985120031239136	Y	22-Oct-08	21:10	d/s end of ES9
Comments	Male																				
28	ES10	11.3	MW	395	1031	22-Oct	BH	20:19	20:23	20:24	20:29	Y	460	30	Y	52584	985120031274941	Y	22-Oct-08	21:10	d/s end of ES9
Comments	Female																				
29	ES10	11.3	MW	316	472	22-Oct	BC	20:30	20:34	20:36	20:41	Y	460	13	Y	52585	985120031277122	Y	22-Oct-08	21:22	d/s end of ES9
Comments	Female																				
30	ES10	11.3	MW	391	937	22-Oct	BH	20:45	20:49	20:50	20:54	Y	460	24	Y	52588	985120031268562	Y	22-Oct-08	21:10	d/s end of ES9
Comments	Female																				
31	ES1-1	11.3	MW	300	388	23-Oct	LH	20:11	20:15	20:17	20:20	Y	460	34	Y	52589	985120031282433	Y	23-Oct-08	21:23	Beaver Creek Launch
Comments	Male																				
32	ES2-1	10.5	MW	397	965	23-Oct	LH	21:44	21:49	21:49	21:52	Y	460	21	Y	52578	985120031293831	Y	23-Oct-08	22:20	Beaver Creek Launch
Comments	Female - tubercles																				

[a] See Figures A1 to A3 for site locations.

Table C1: Continued.

Sample No.	Capture Location[a]	Water temp (ºC)	Species	Fork Length (mm)	Weight (g)	Surgery Date	Surgery Initials	Anaesthetic Start Time	Anaesthetic End Time	Surgery Start Time	Surgery End Time	Radio Tag Tested Y/N	Radio Tag Frequency	Radio Tag Code	Acoustic Tag Tested Y/N	Acoustic Tag Code	PIT or PIP Tag No	Fish Released WithTags(Y/N)	Release Date	Release Time	Release Location
33	ES2-1	10.5	MW	336	578	23-Oct	LH	21:54	21:58	21:59	22:02	Y	460	12	Y	52581	985120031250124	Y	23-Oct-08	22:23	Beaver Creek Launch
Comments	Female - tubercles																				
34	ES2-1	10.5	MW	370	772	23-Oct	LH	22:05	22:09	22:10	22:14	Y	460	22	Y	52580	985120031265967	Y	23-Oct-08	22:33	Beaver Creek Launch
Comments	Female - tubercles																				
35	ES29	10.1	MW	369	574	24-Oct	LH	19:43	19:47	19:49	19:53	Y	780	51	Y	52575	985120031258537	Y	24-Oct-08	20:41	d/s end of Balfour Bay
Comments	Male																				
36	ES29	10.1	MW	326	527	24-Oct	LH	19:54	19:58	19:59	20:03	Y	780	48	Y	52579	985120031284062	Y	24-Oct-08	20:41	d/s end of Balfour Bay
Comments	Female																				
37	ES29	10.1	MW	369	714	24-Oct	LH	20:05	20:09	20:11	20:15	Y	780	58	Y	52574	985120031291967	Y	24-Oct-08	20:41	d/s end of Balfour Bay
Comments	Female																				
38	ES29	10.1	MW	336	475	24-Oct	LH	20:17	20:18	20:23	20:26	Y	780	54	Y	52572	985120031269507	Y	24-Oct-08	20:41	d/s end of Balfour Bay
Comments	Male																				
39	ES29	10.1	MW	308	398	24-Oct	LH	20:28	20:32	20:33	20:37	Y	460	23	Y	52583	985120031283387	Y	24-Oct-08	21:10	d/s end of Balfour Bay
Comments	Female																				
40	ES29	10.1	MW	354	579	24-Oct	BH	20:46	20:50	20:51	20:55	Y	780	57	Y	52582	985120031270131	Y	24-Oct-08	21:35	d/s end of Balfour Bay
Comments	Female - fish had PIT tag prior to surgery, did not pick it up until we tested new tag, tagged previously with PIT tag 985120028859238																				
41	ES29	10.1	MW	338	499	24-Oct	BH	20:59	21:03	21:04	21:09	Y	780	49	Y	52573	985120031281508	Y	24-Oct-08	21:35	d/s end of Balfour Bay
Comments	Female																				
42	ES29	10.1	MW	308	416	24-Oct	BH	21:10	21:14	21:15	21:19	Y	780	52	Y	52576	900010000062971	Y	24-Oct-08	21:35	d/s end of Balfour Bay
Comments	Female																				
43	ESK-1	9.7	MW	379	831	25-Oct	BH	20:28	20:32	20:35	20:39	Y	780	40	Y	52577	985120031268684	Y	25-Oct-08	21:10	u/s end of Kootenay Eddy
Comments	Male																				

[a] See Figures A1 to A3 for site locations.

Table C1: Concluded.

Sample No.	Capture Location[a]	Water temp (ºC)	Species	Fork Length (mm)	Weight (g)	Surgery Date	Surgery Initials	Anaesthetic Start Time	Anaesthetic End Time	Surgery Start Time	Surgery End Time	Radio Tag Tested Y/N	Radio Tag Frequency	Radio Tag Code	Acoustic Tag Tested Y/N	Acoustic Tag Code	PIT or PIP Tag No	Fish Released WithTags(Y/N)	Release Date	Release Time	Release Location
44	ESK-1	9.7	MW	320	440	25-Oct	BH	20:45	20:49	20:51	20:55	Y	460	31	Y	52570	985120031275532	Y	25-Oct-08	21:26	u/s end of Kootenay Eddy
Comments	Male																				
45	ES-K1	9.7	MW	399	554	25-Oct	BH	20:57	21:02	21:04	21:10	Y	780	38	Y	52566	985120031268176	Y	25-Oct-08	21:26	u/s end of Kootenay Eddy
Comments	Male																				
46	ESK-1	9.7	MW	392	854	25-Oct	LH	19:30	19:34	19:35	19:39	Y	460	32	Y	52612	985120031243691	Y	25-Oct-08	20:25	u/s end of Kootenay Eddy
Comments	Male - tubercles																				
47	ESK-1	9.7	MW	420	971	25-Oct	LH	19:41	19:45	19:47	19:50	Y	780	39	Y	52569	985120031276545	Y	25-Oct-08	20:25	u/s end of Kootenay Eddy
Comments	Female - slight tubercles																				
48	ESK-1	9.7	MW	405	982	25-Oct	LH	19:51	19:56	19:58	20:01	Y	780	44	Y	52571	985120031247039	Y	25-Oct-08	20:25	u/s end of Kootenay Eddy
Comments	Female																				
49	ESK-1	9.7	MW	334	533	25-Oct	LH	20:03	20:07	20:08	20:12	Y	780	41	Y	52567	985120031283546	Y	25-Oct-08	21:10	u/s end of Kootenay Eddy
Comments	Male - fish had PIT tag prior to surgery, did not pick it up until we tested new tag, tagged previously with PIT tag 985120031274069																				
50	ESK-1	9.7	MW	315	412	25-Oct	LH	20:15	20:19	20:21	20:24	Y	780	60	Y	52568	985120031277720	Y	25-Oct-08	21:10	u/s end of Kootenay Eddy
Comments	Male																				

[a] See Figures A1 to A3 for site locations.

Table C2: 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 C2: 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	-	-	-	-	

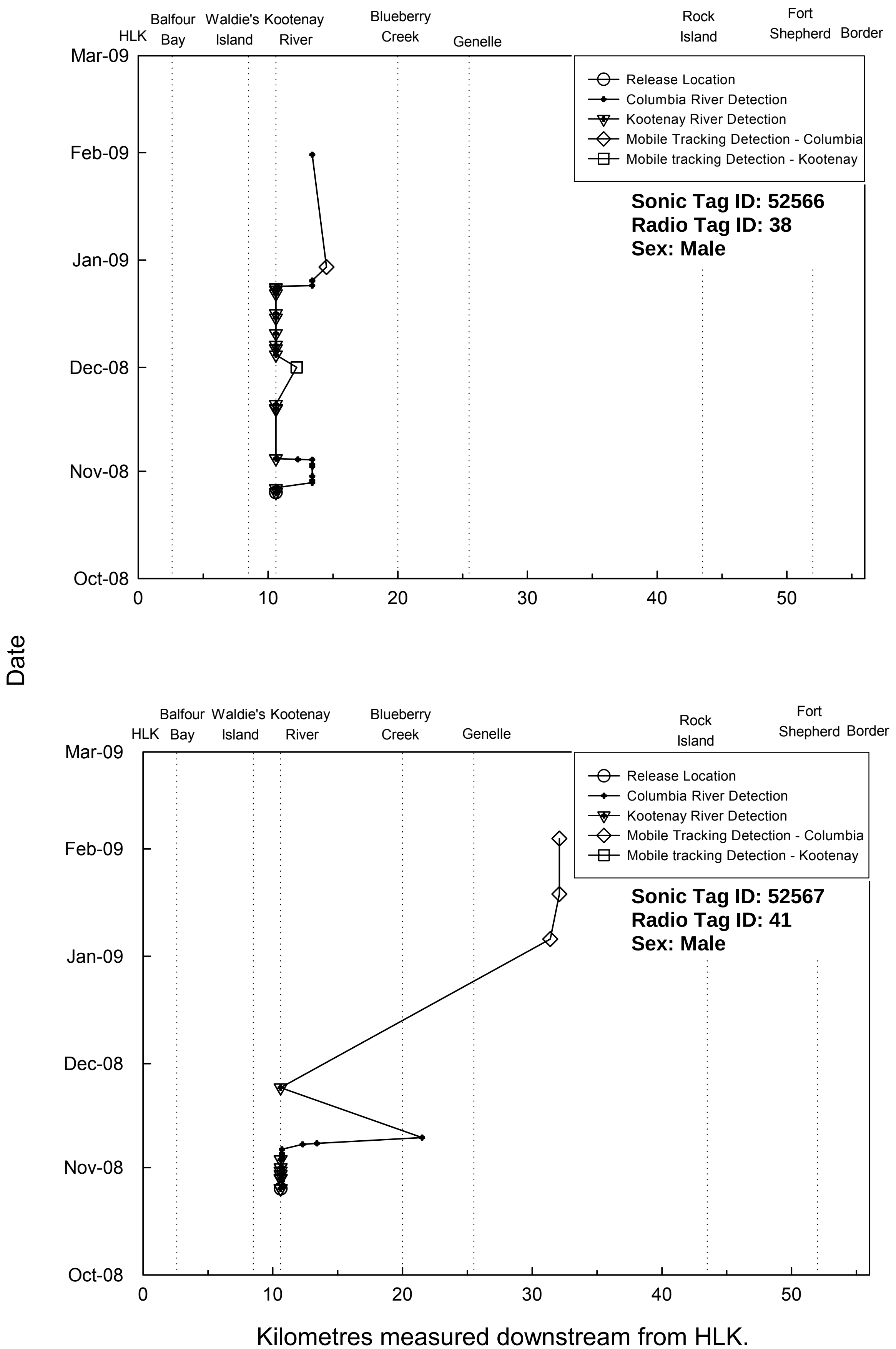
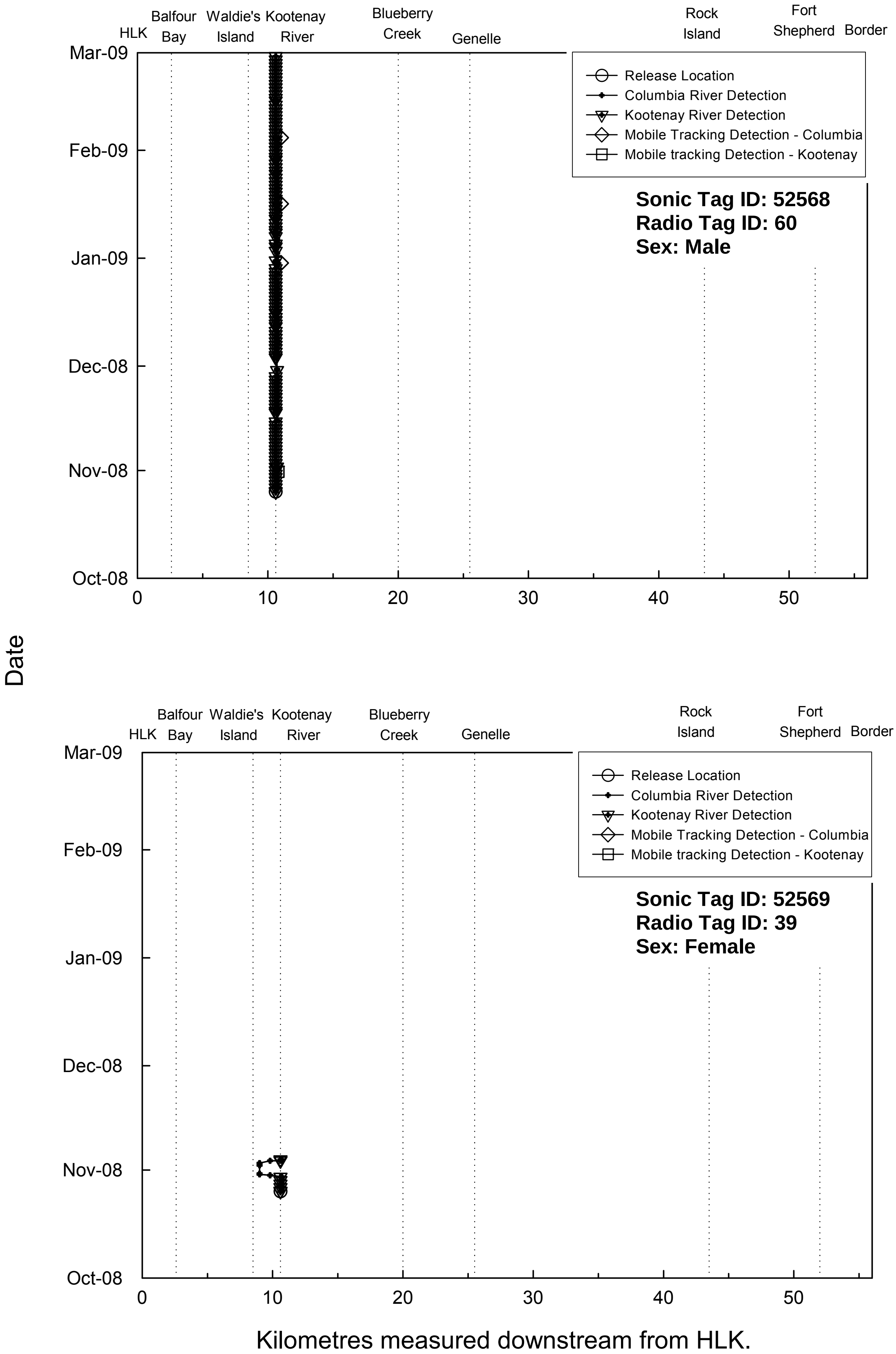


Figure C1 Summary of all sonic and radio telemetry detections for mountain whitefish tagged in October 2008 from HLK Dam to the Canada/ U.S. border.



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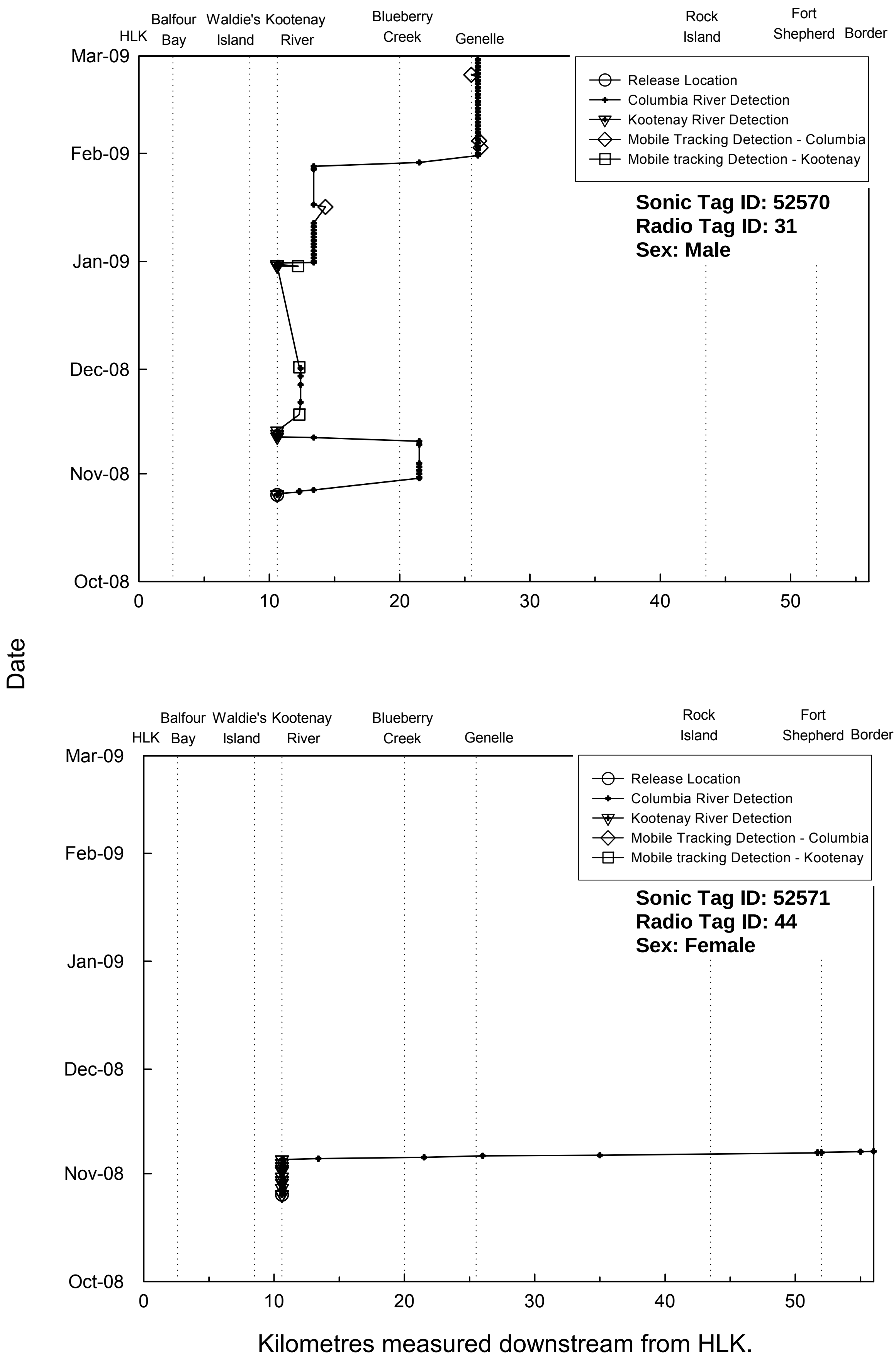

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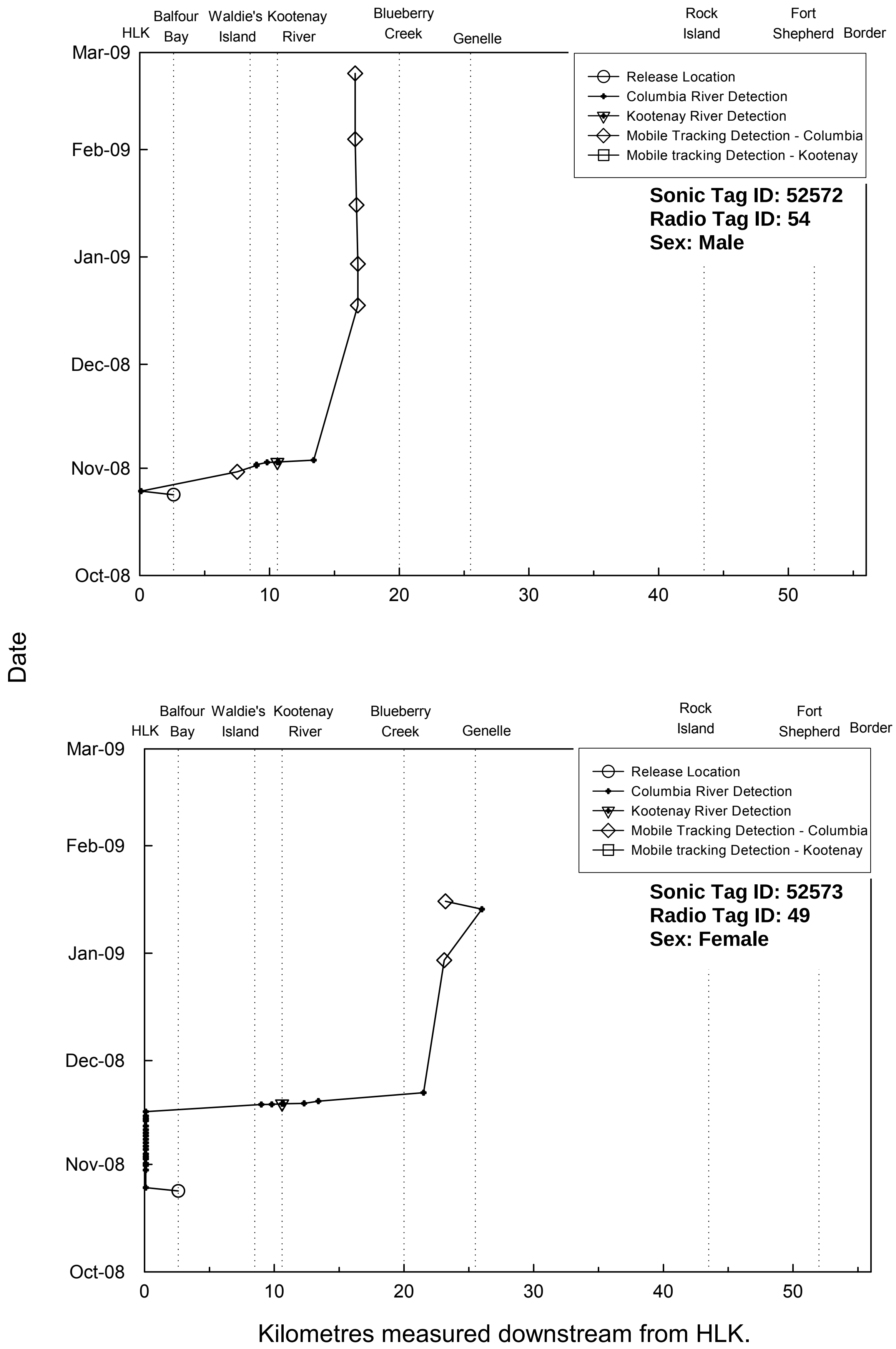

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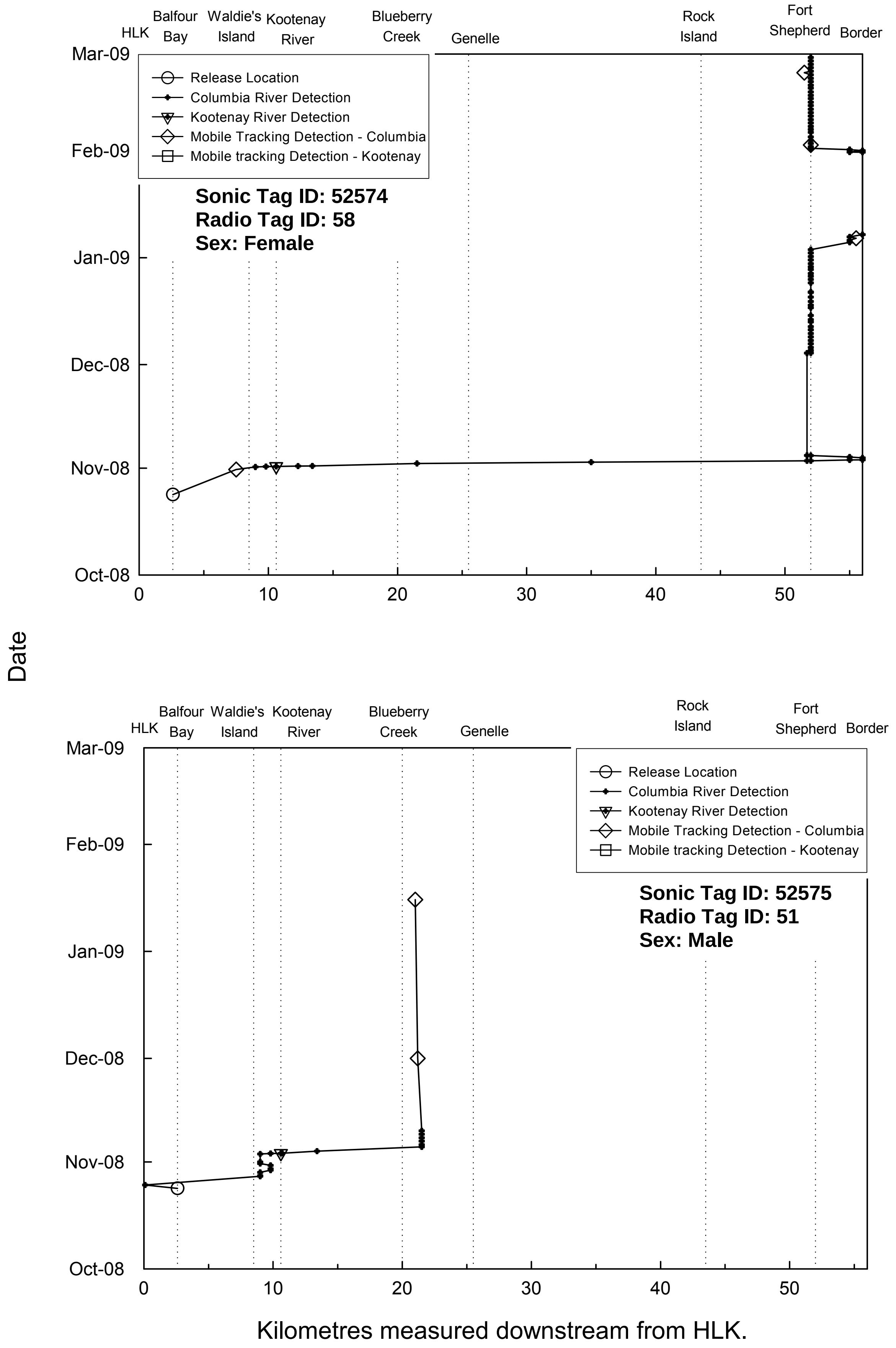

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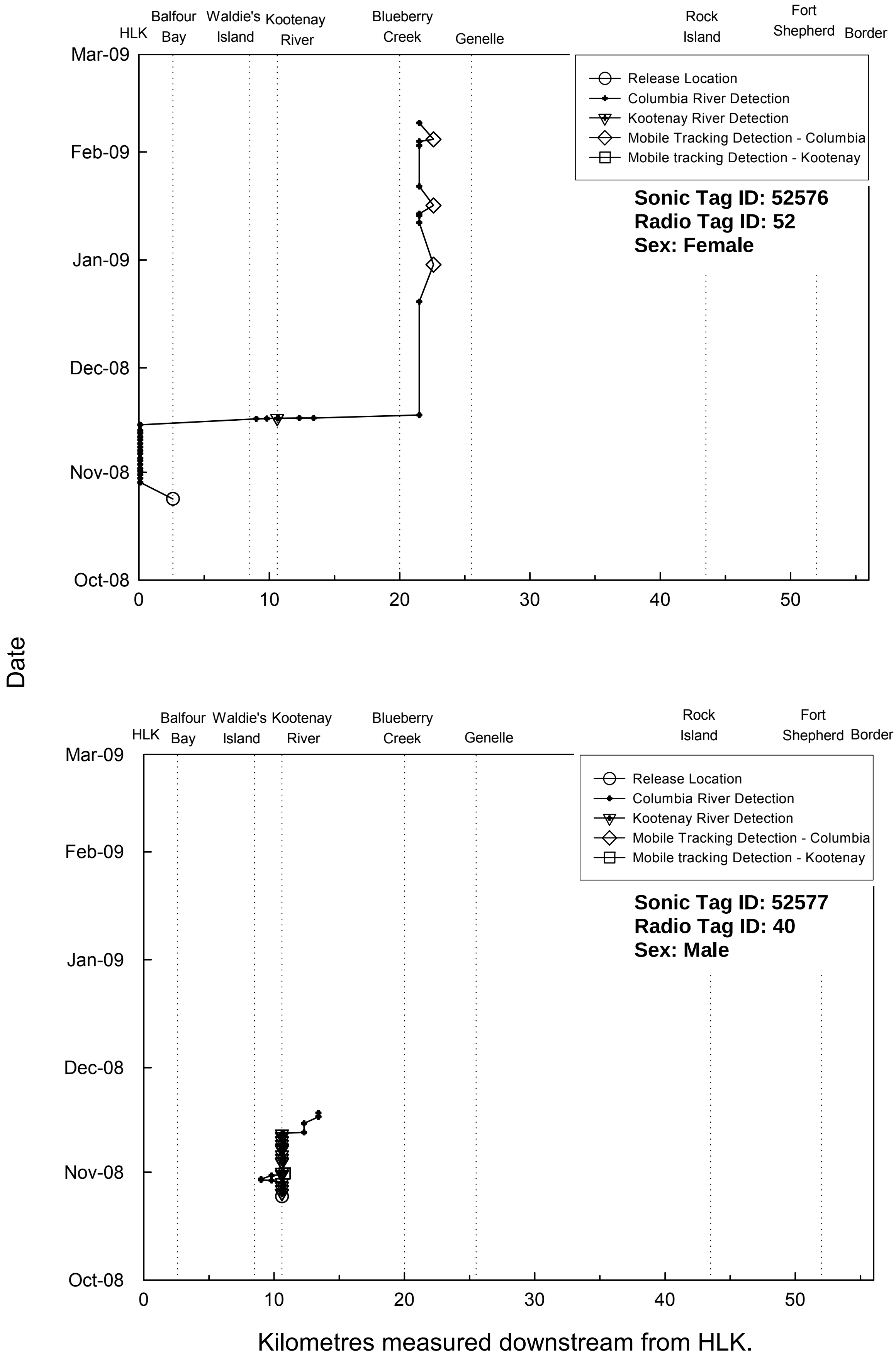

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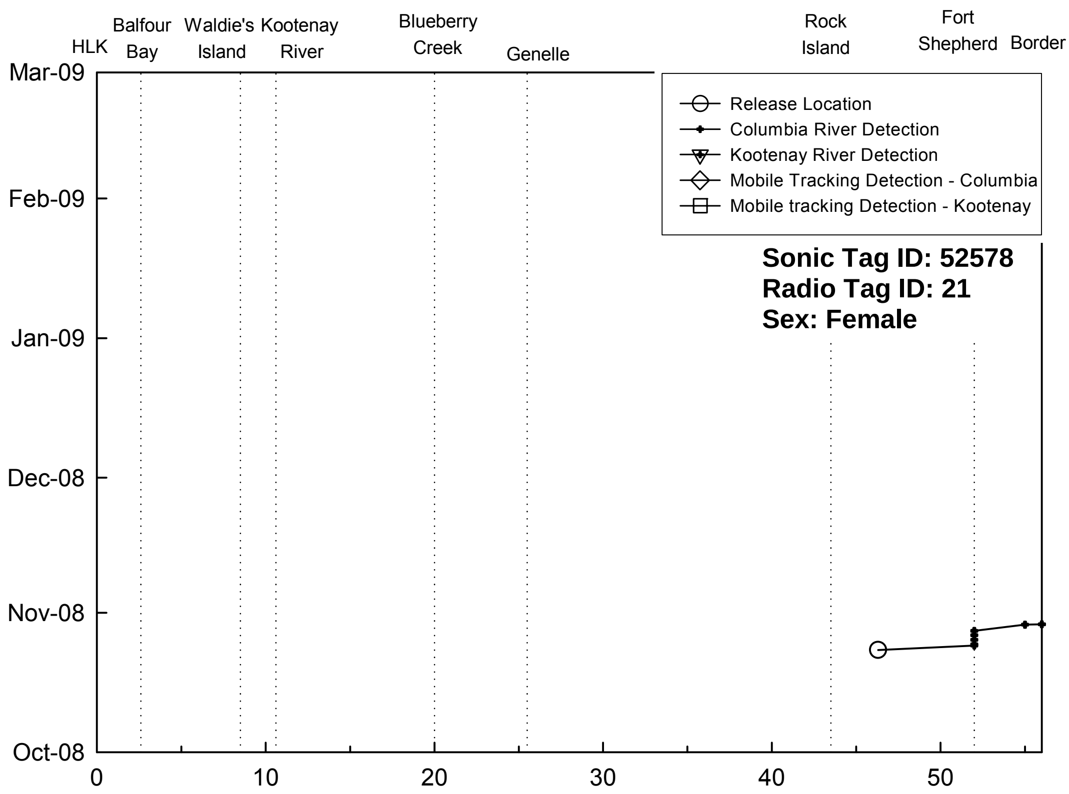

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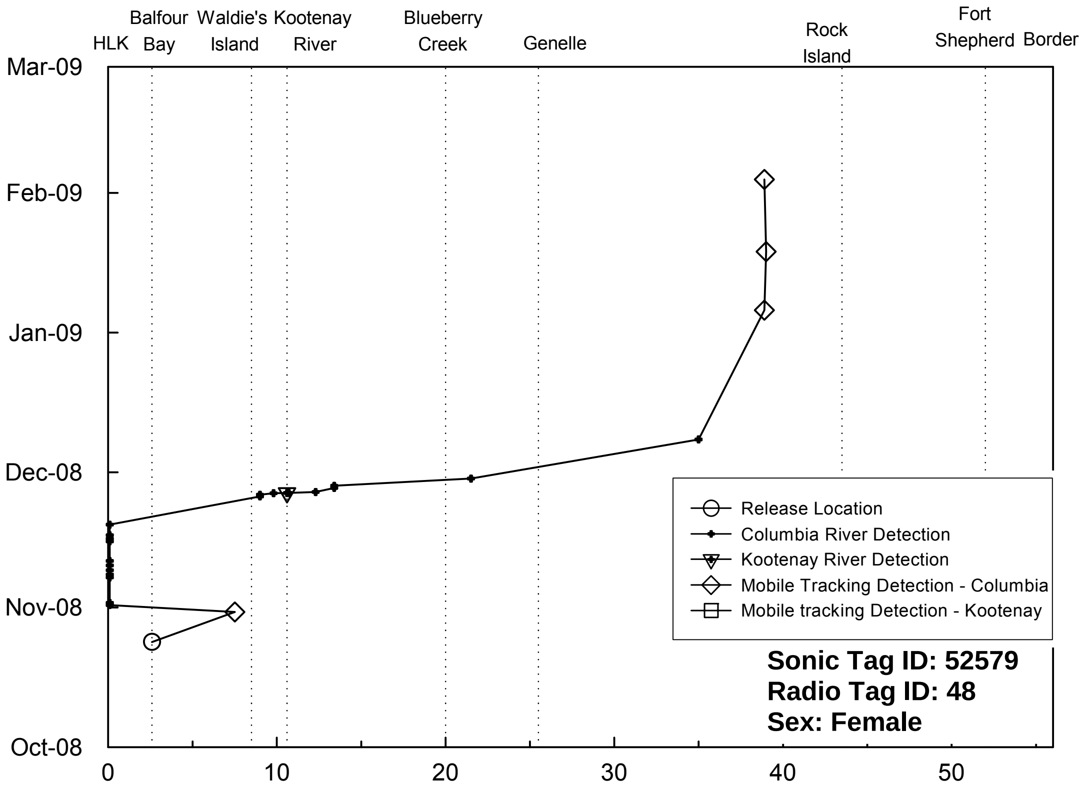
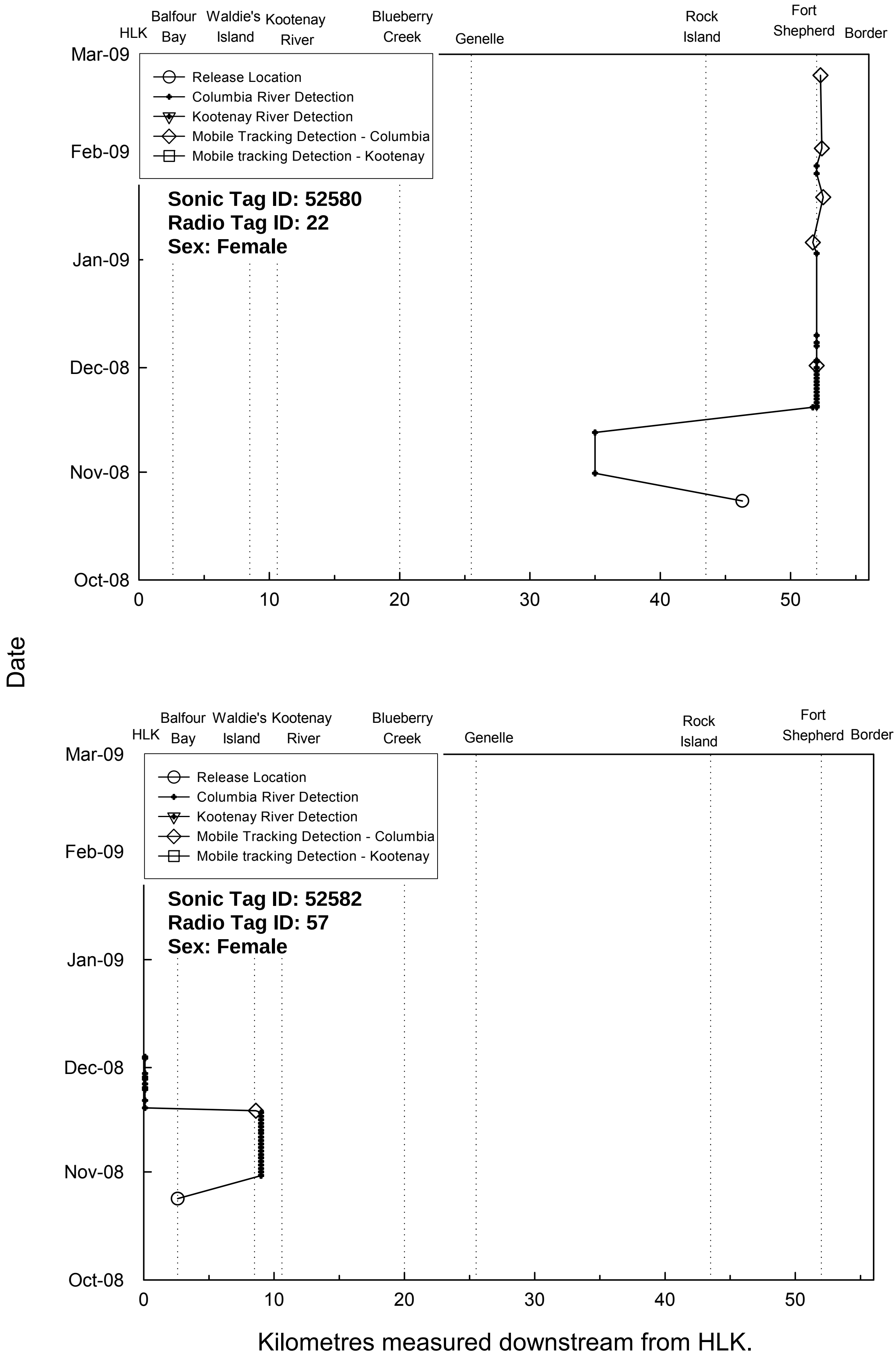


Kilometres measured downstream from HLK.

Figure C1 Continued.



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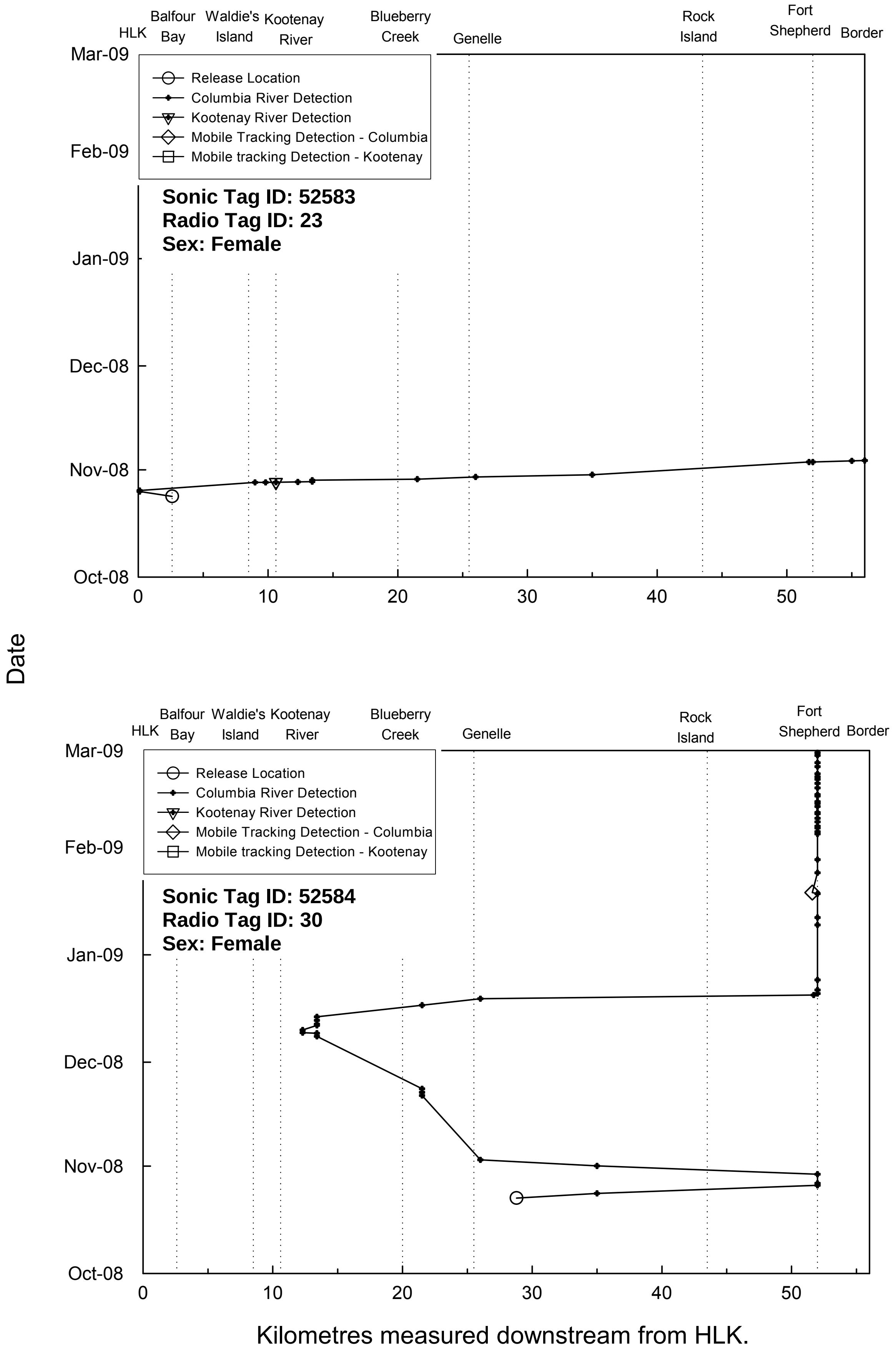

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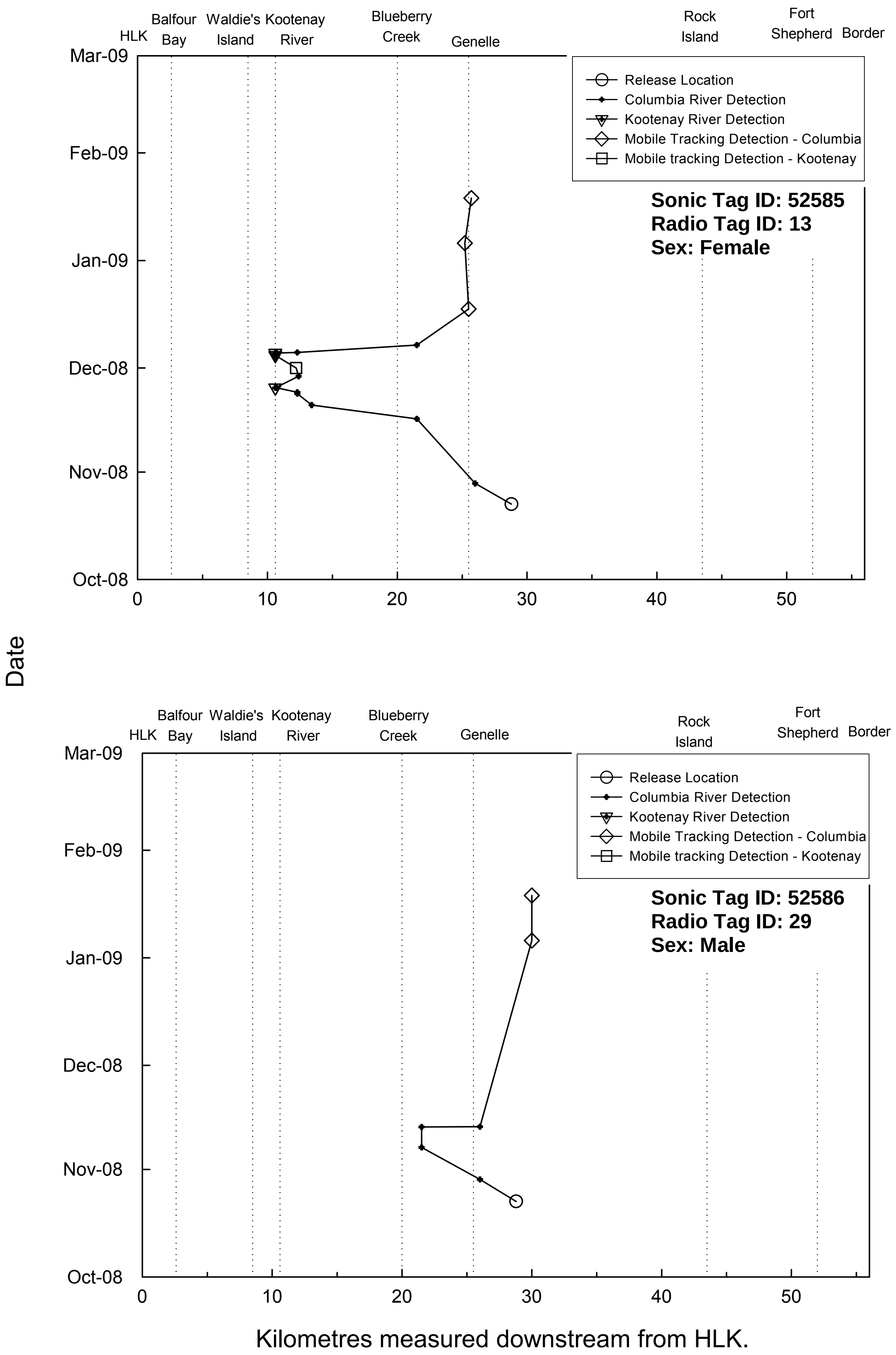

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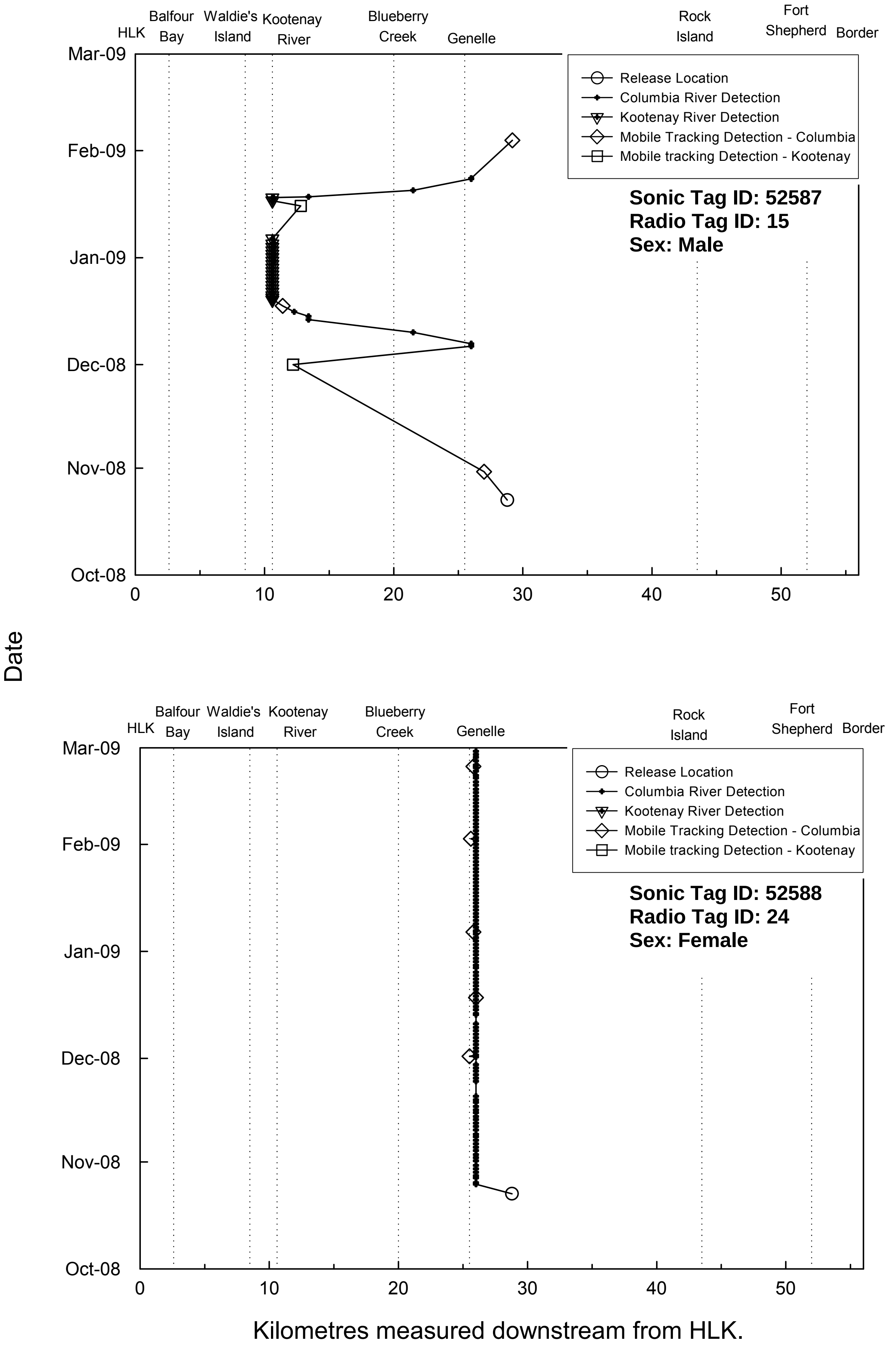

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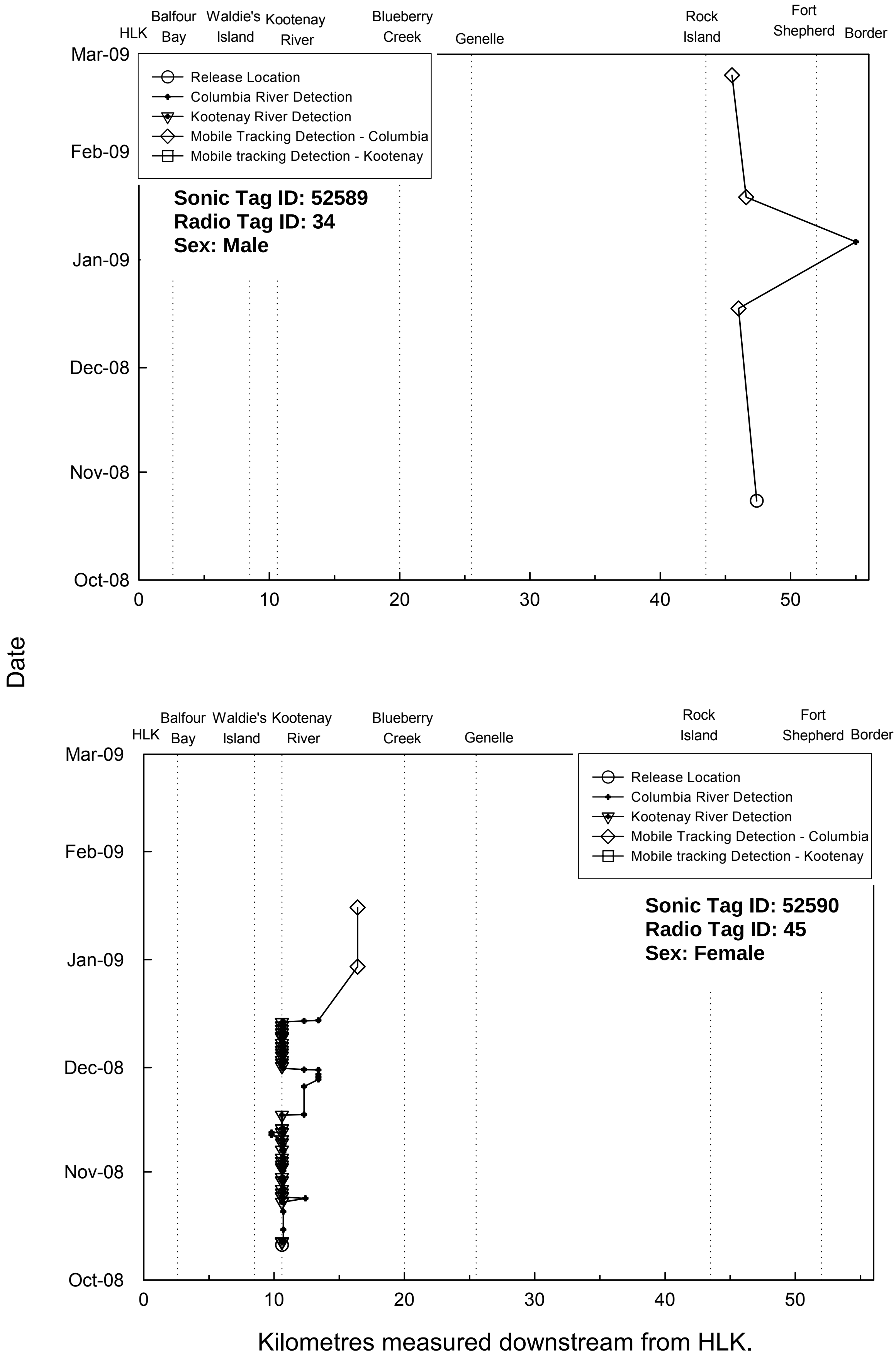

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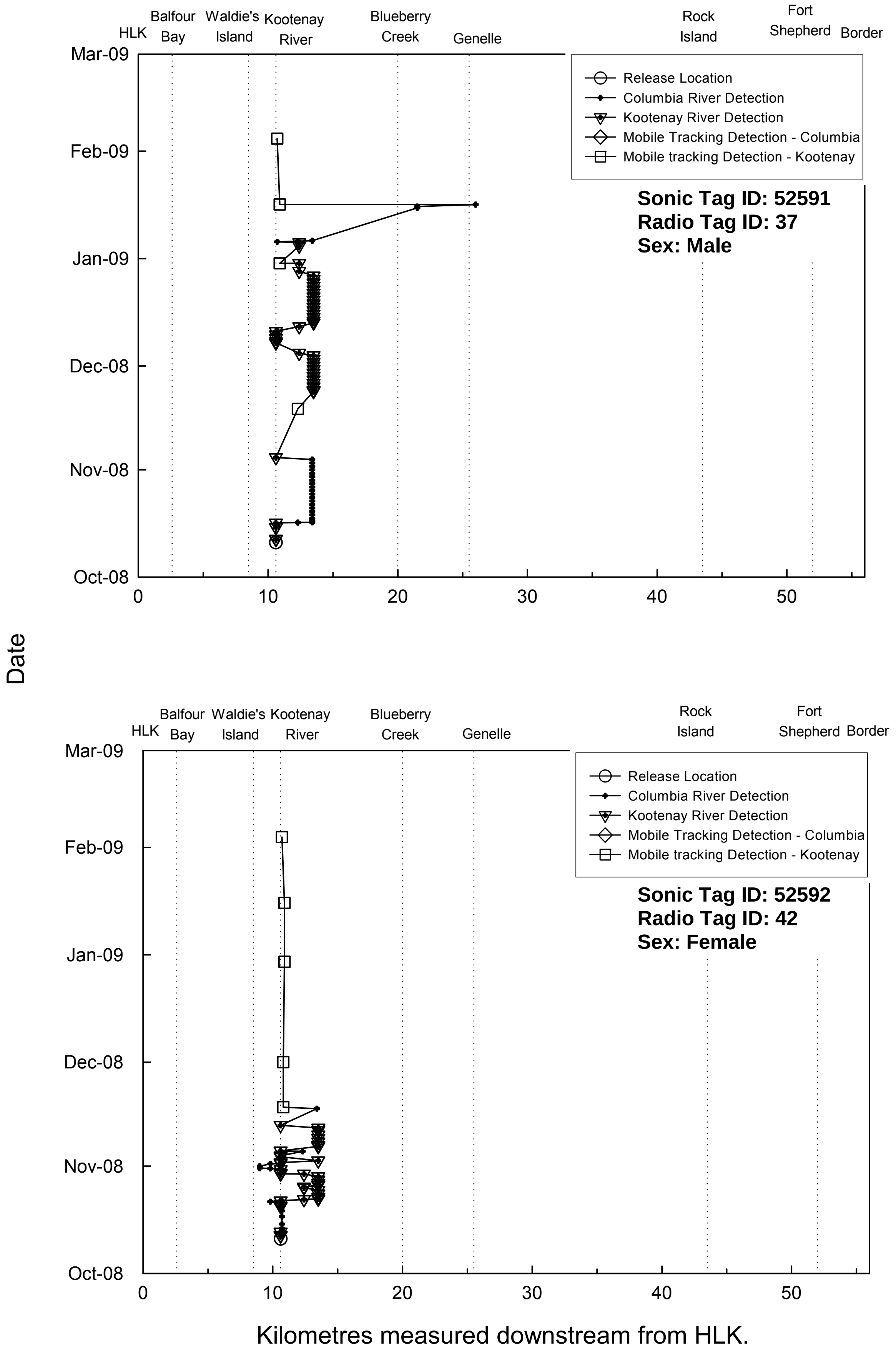

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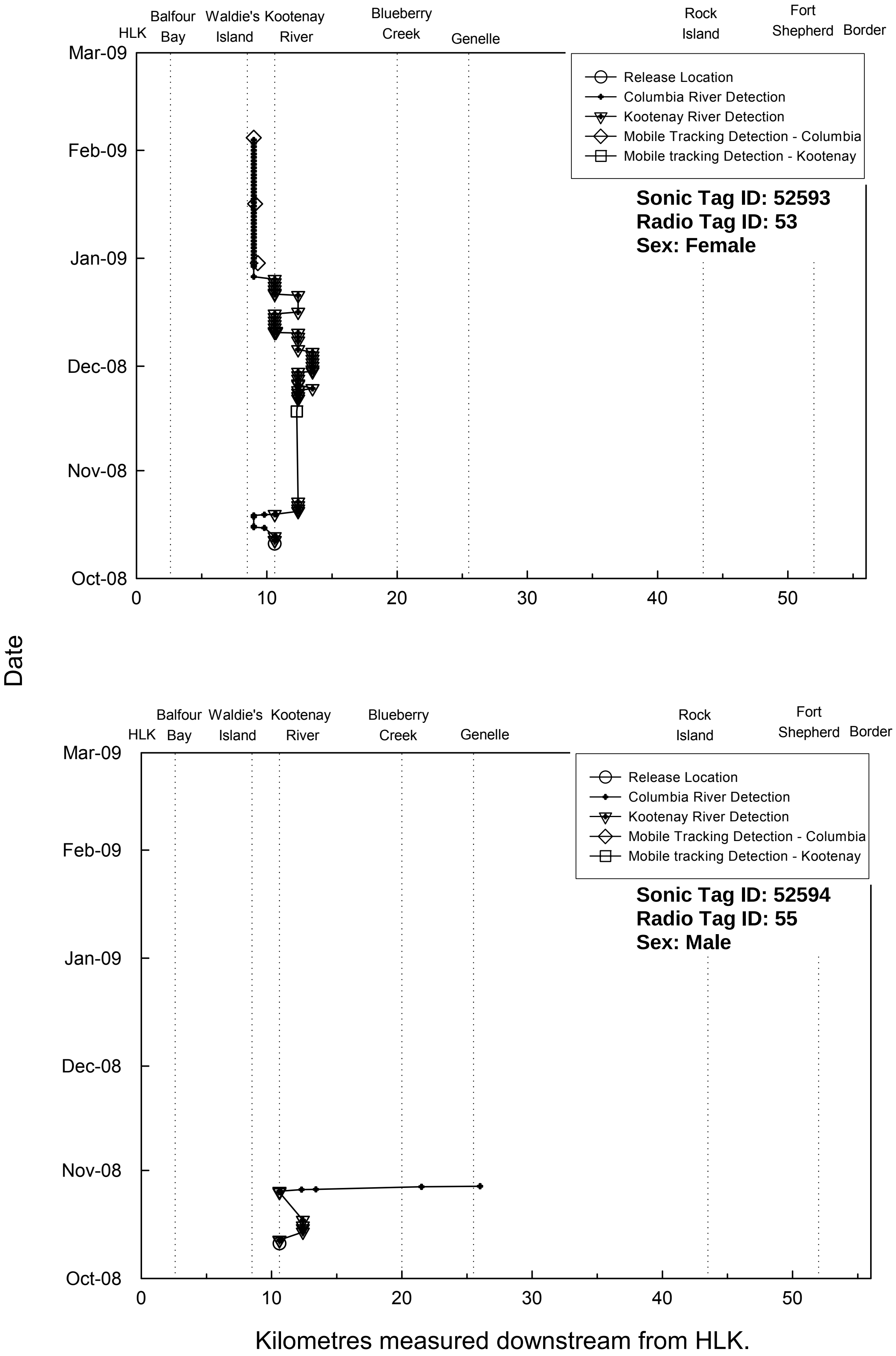

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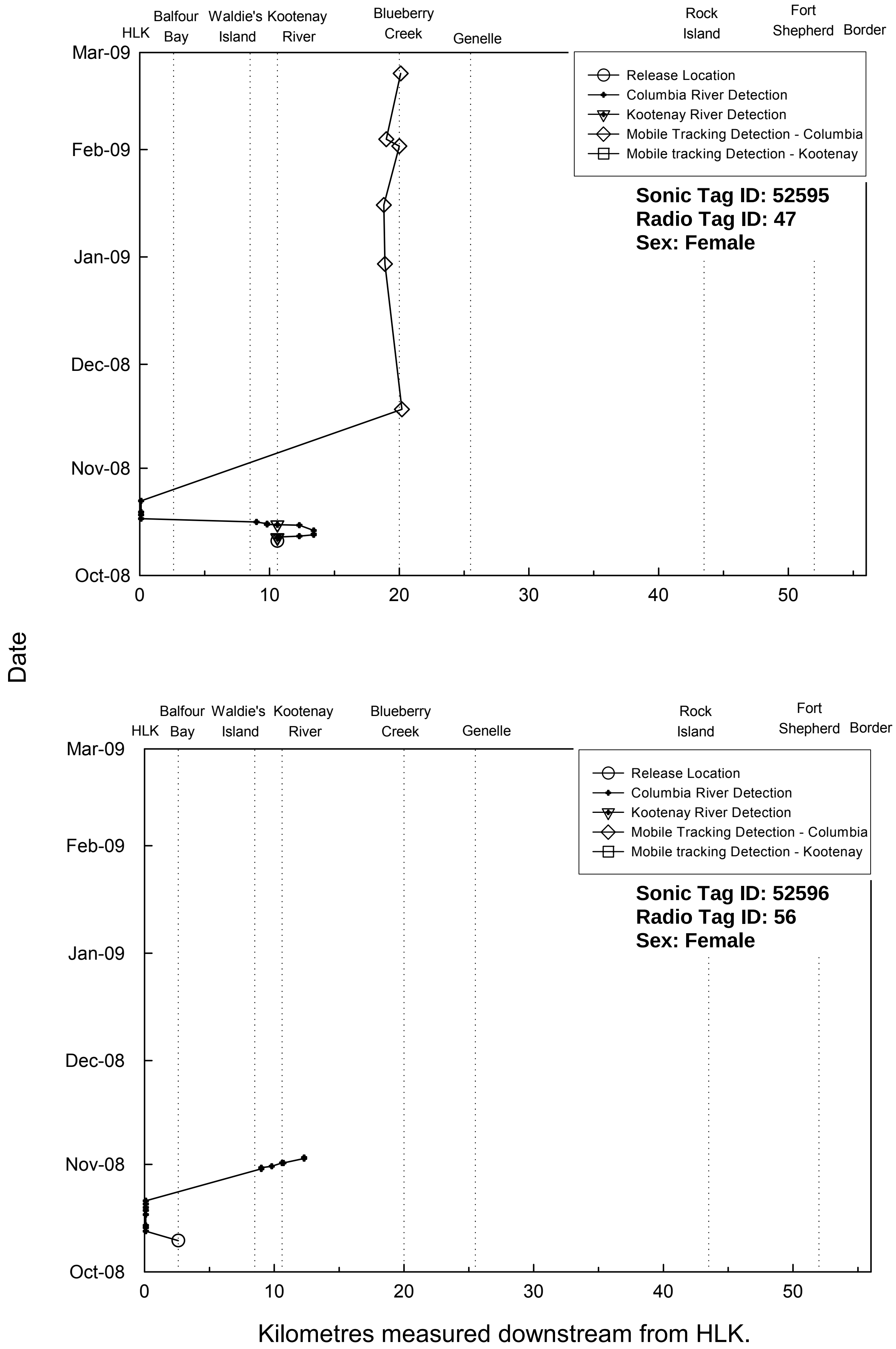

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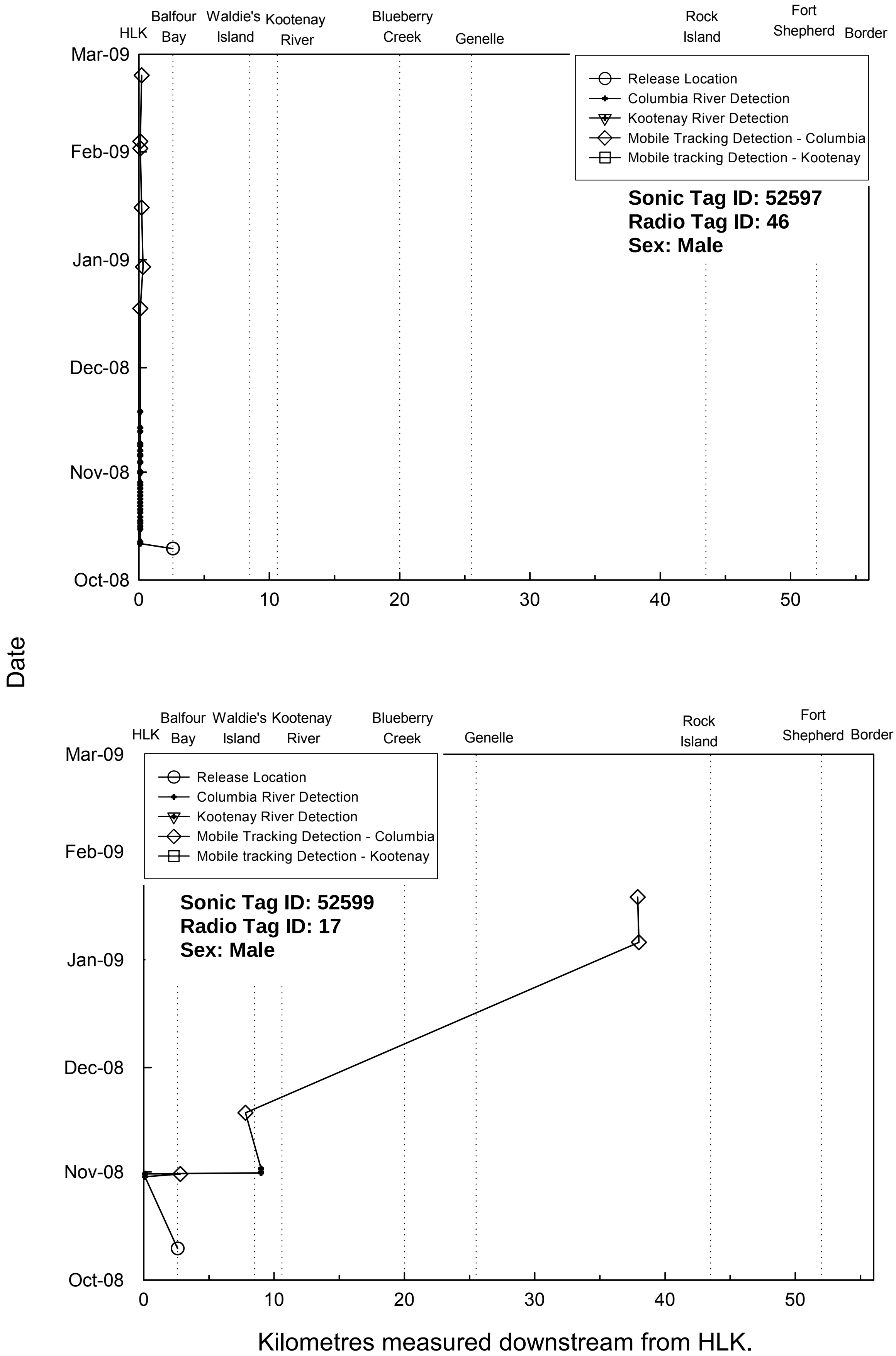

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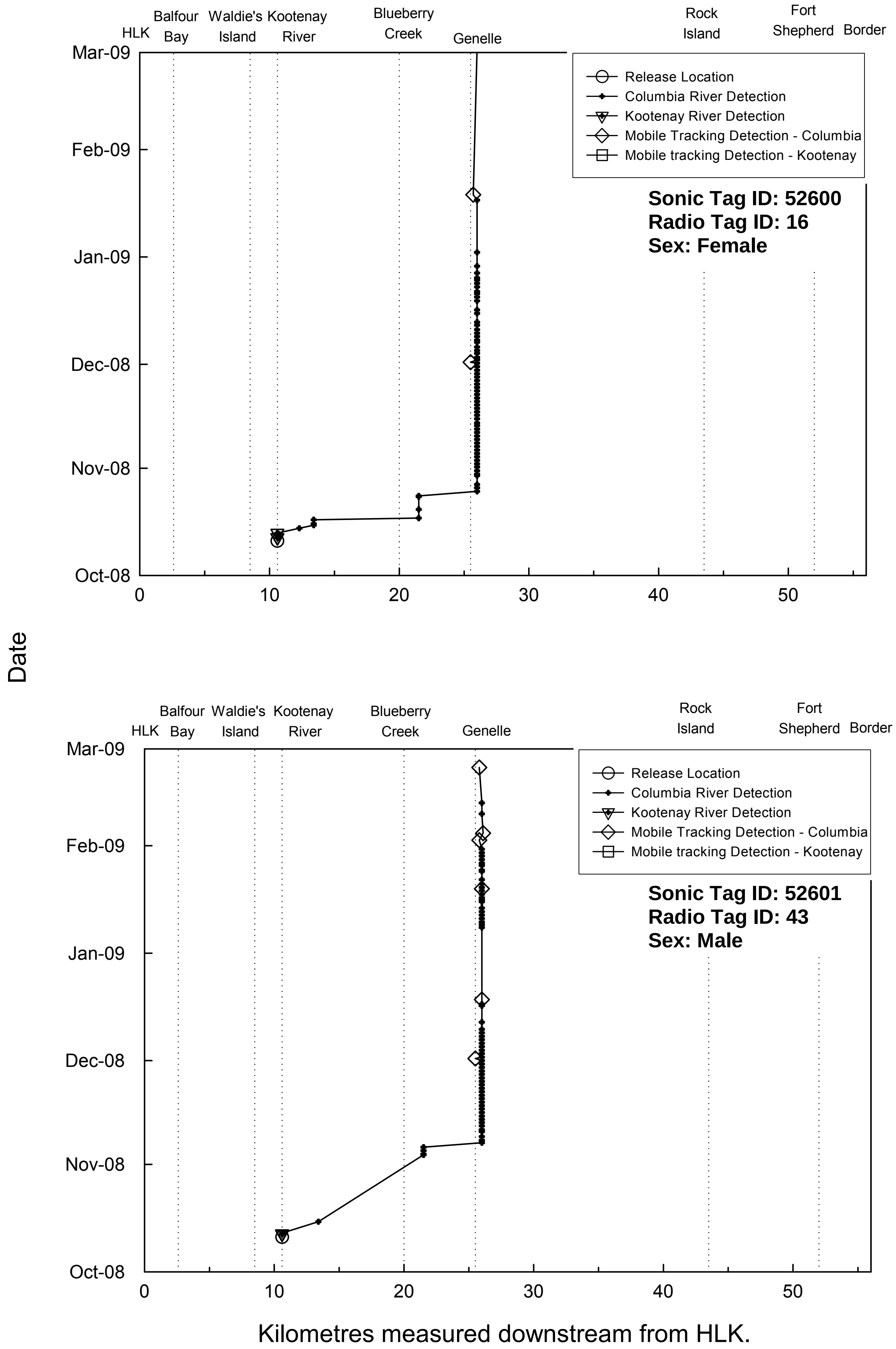

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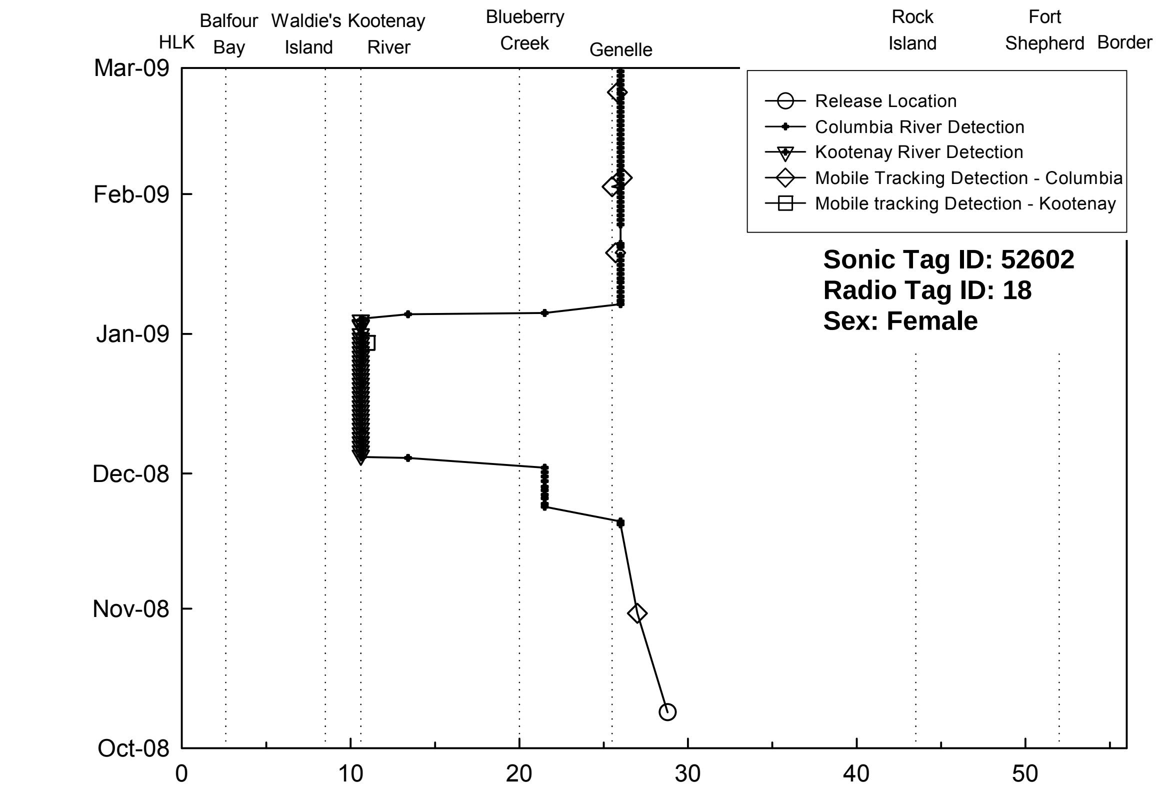

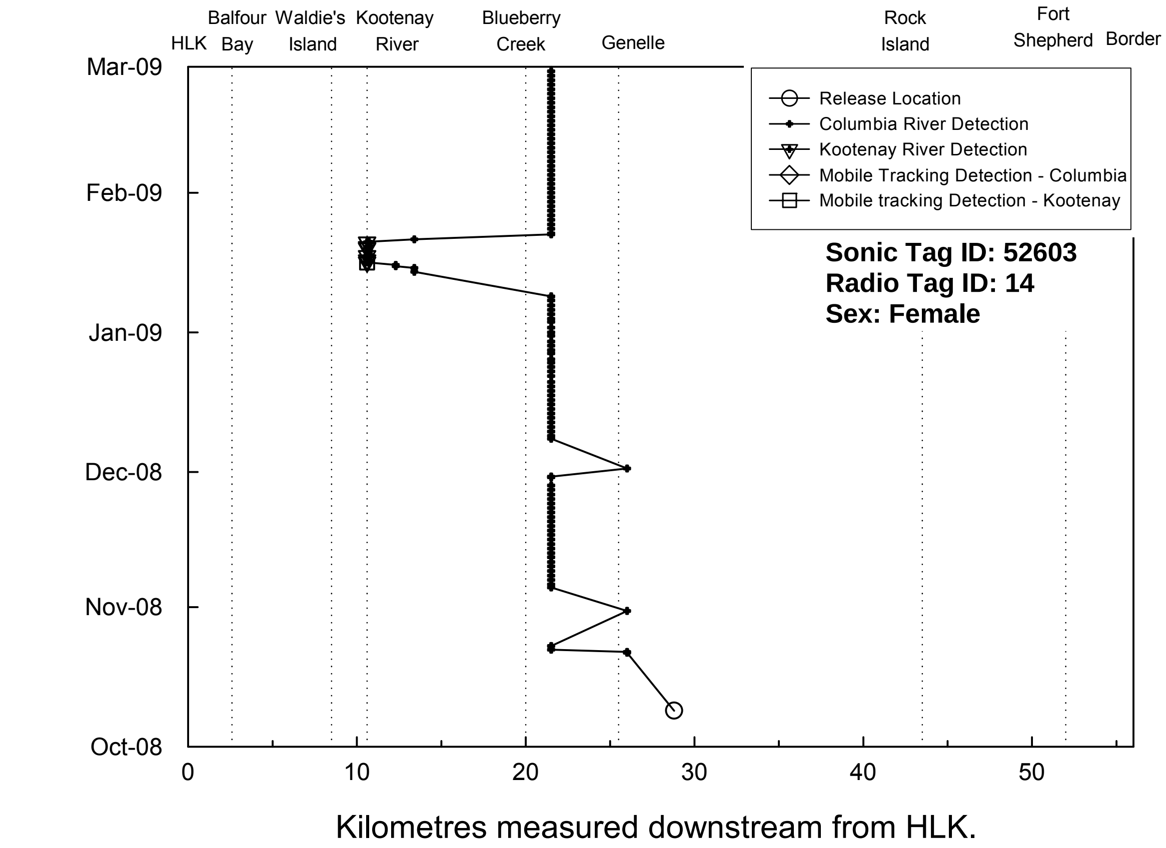

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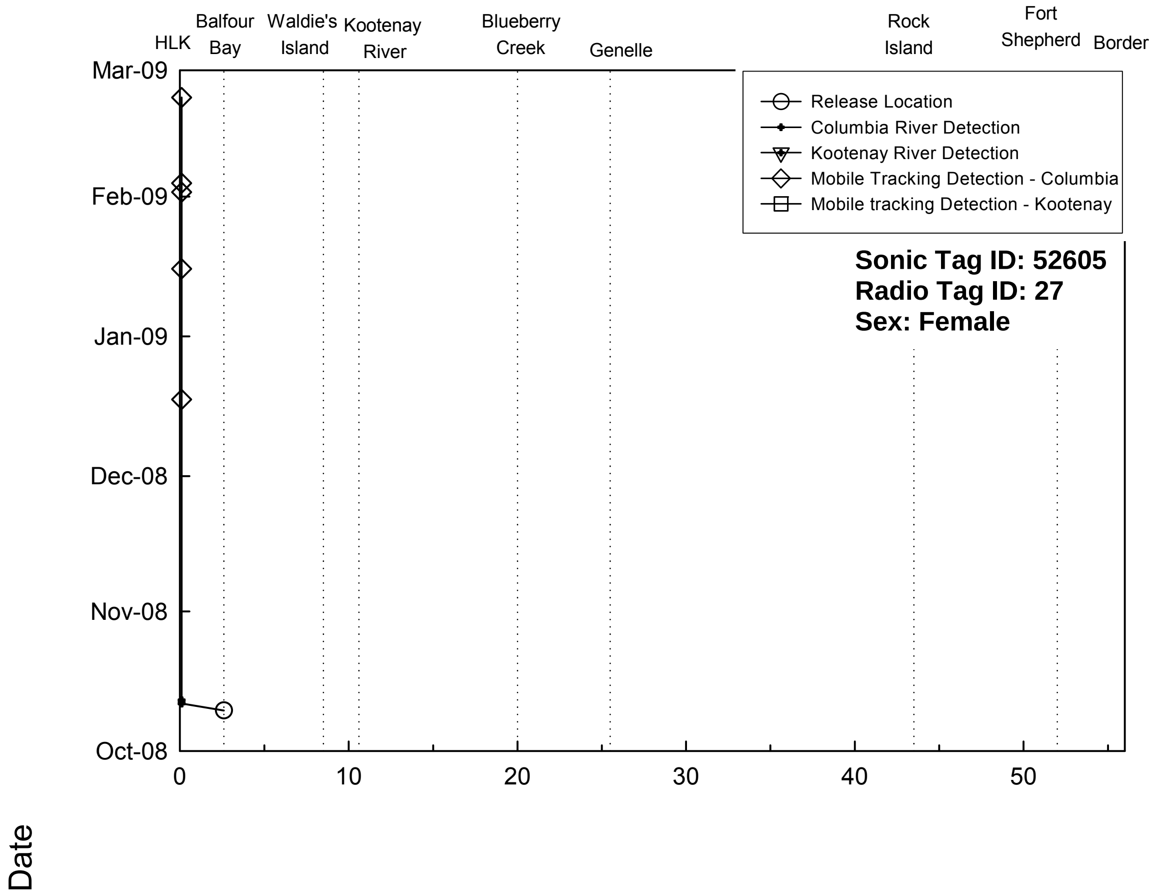

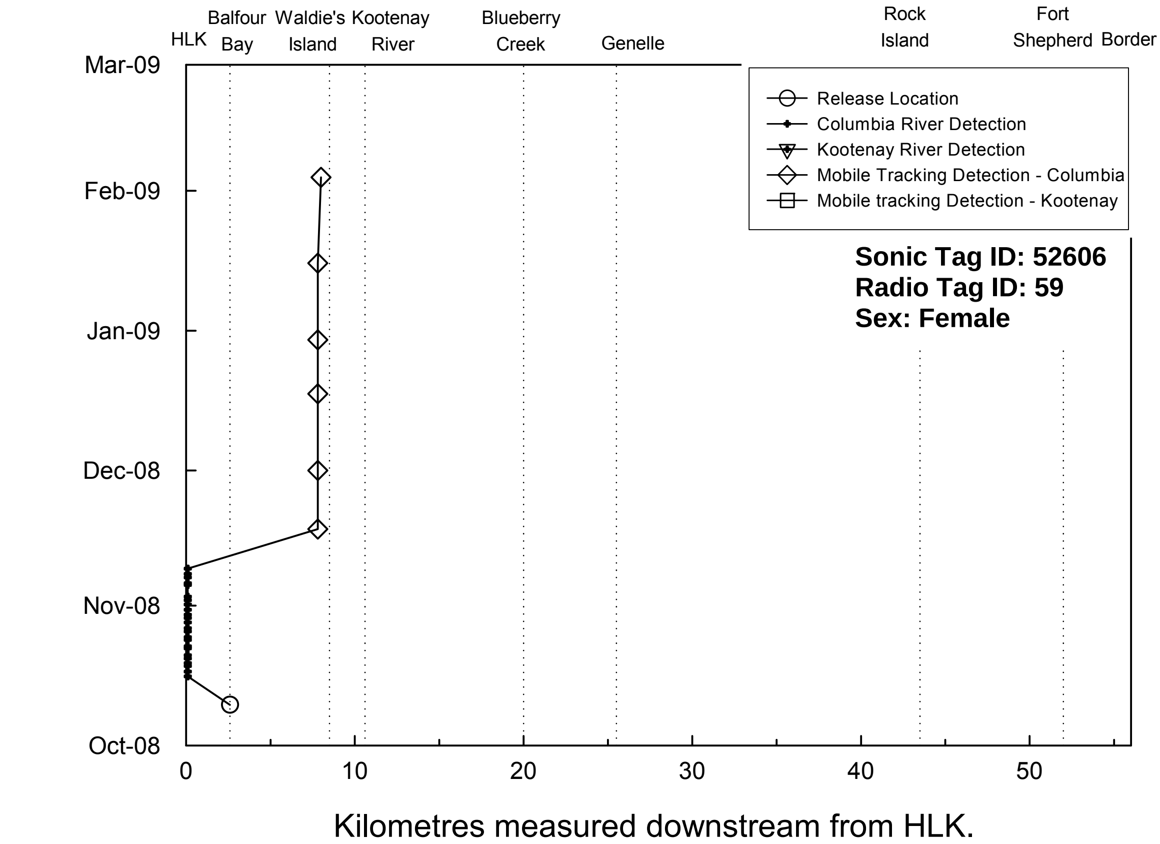

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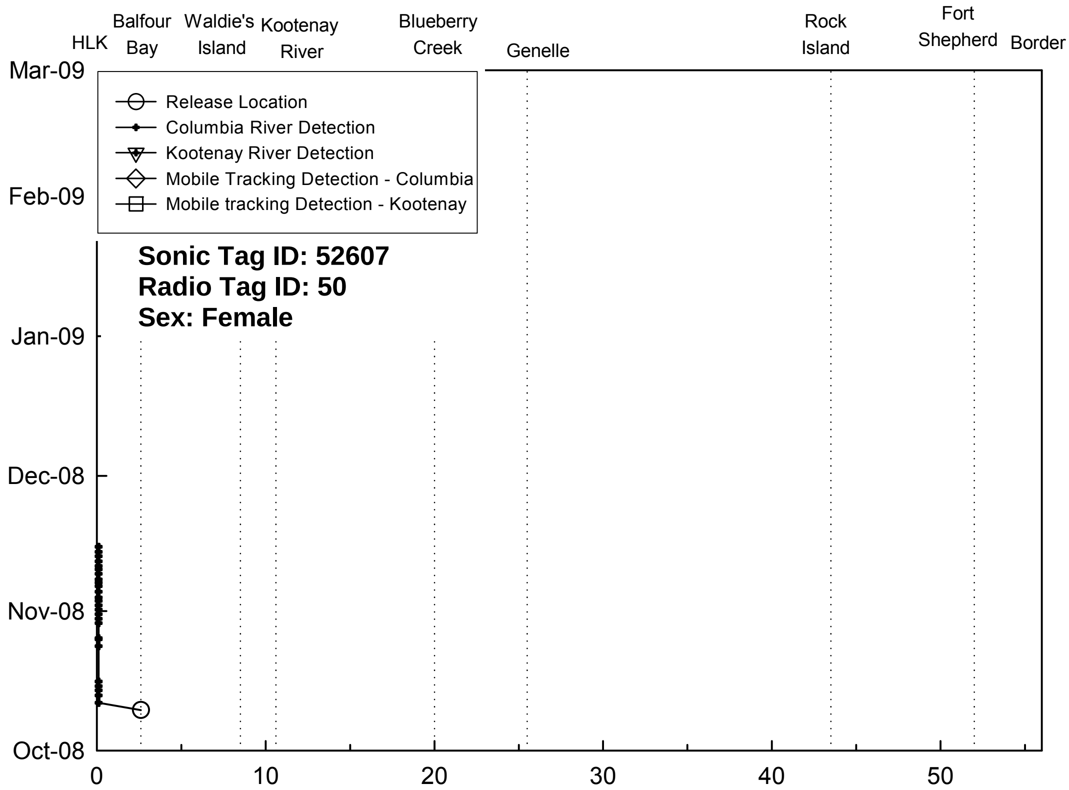

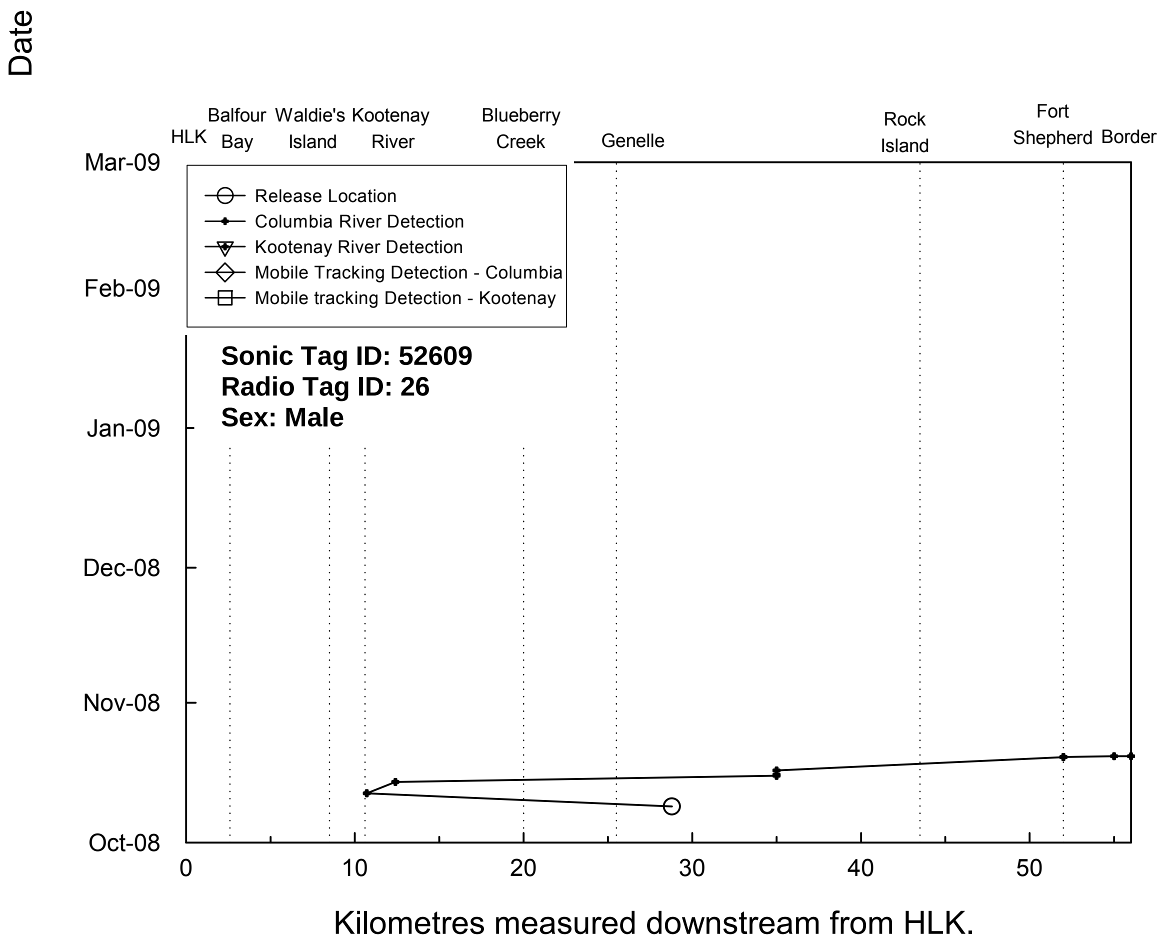

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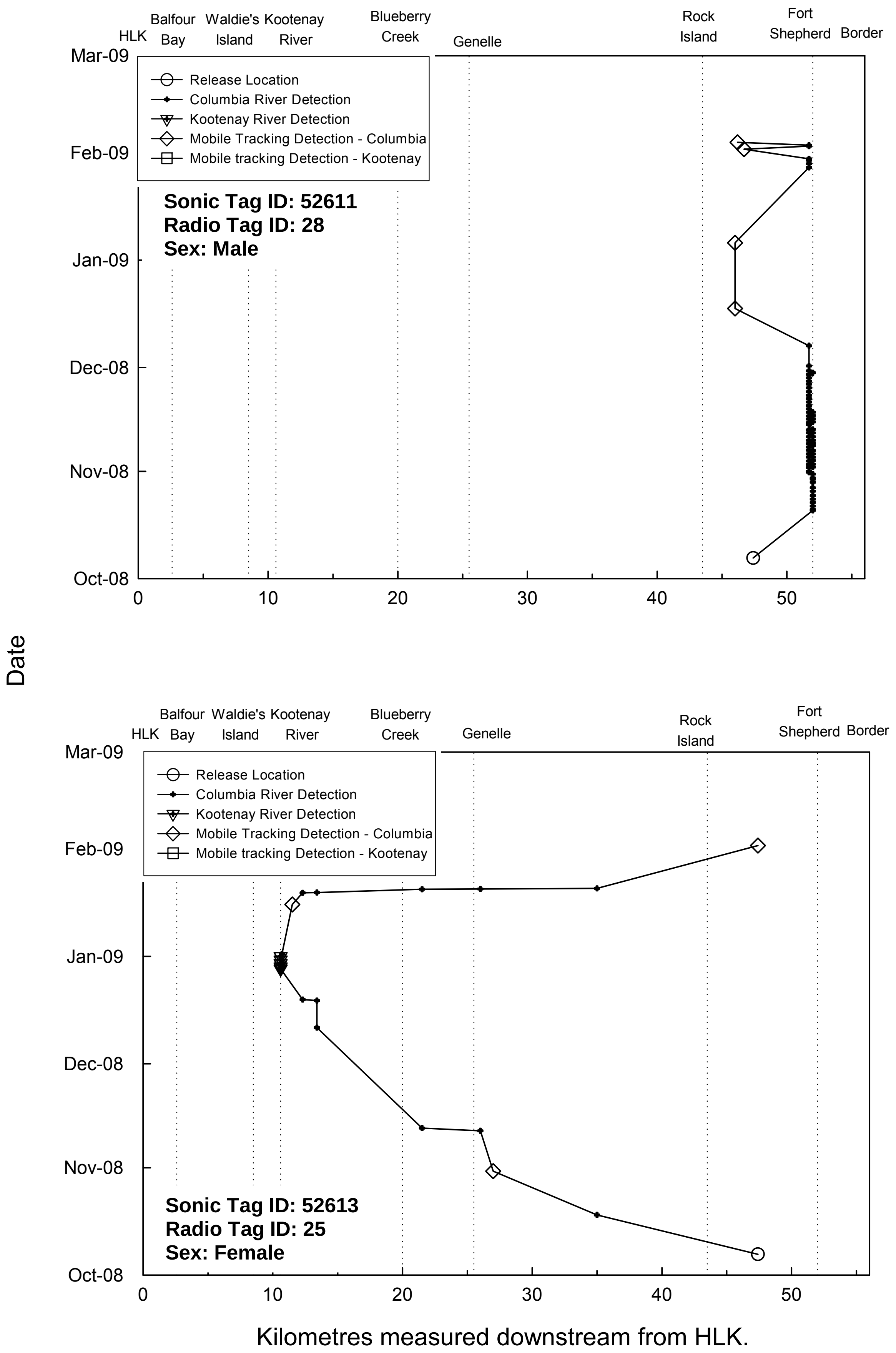

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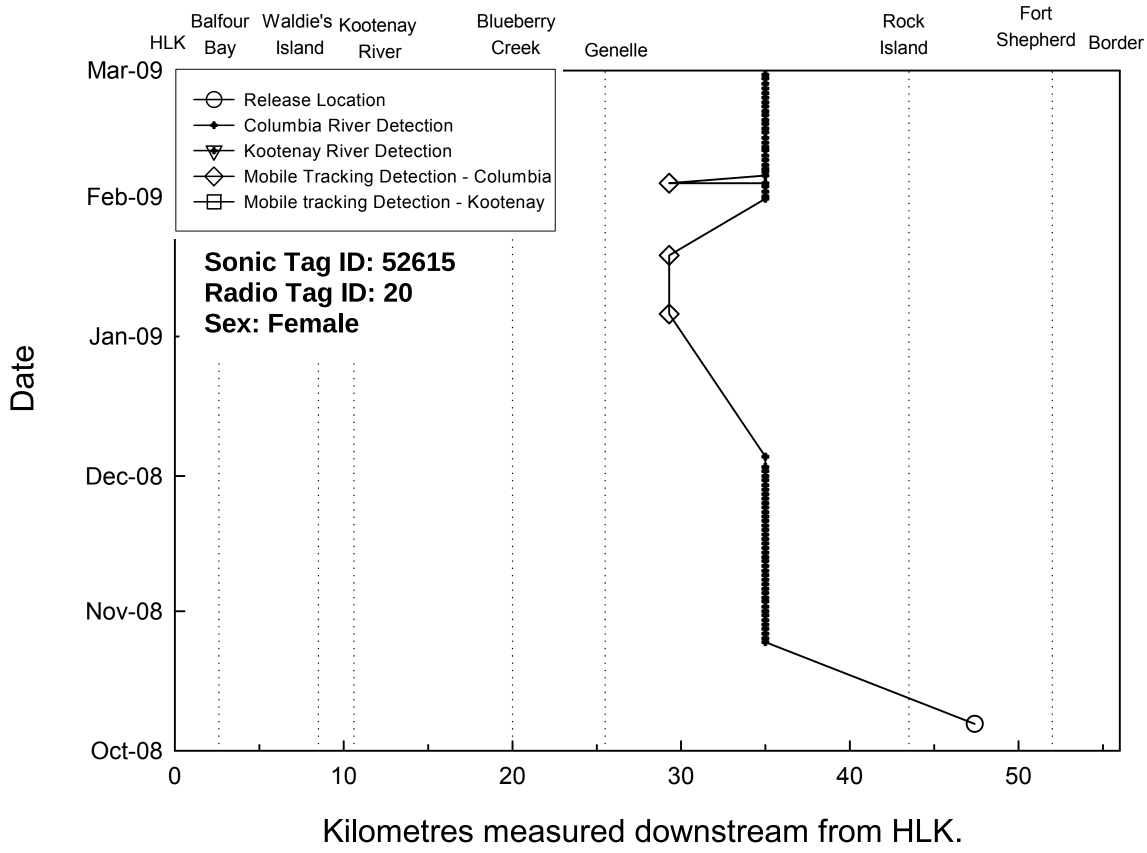

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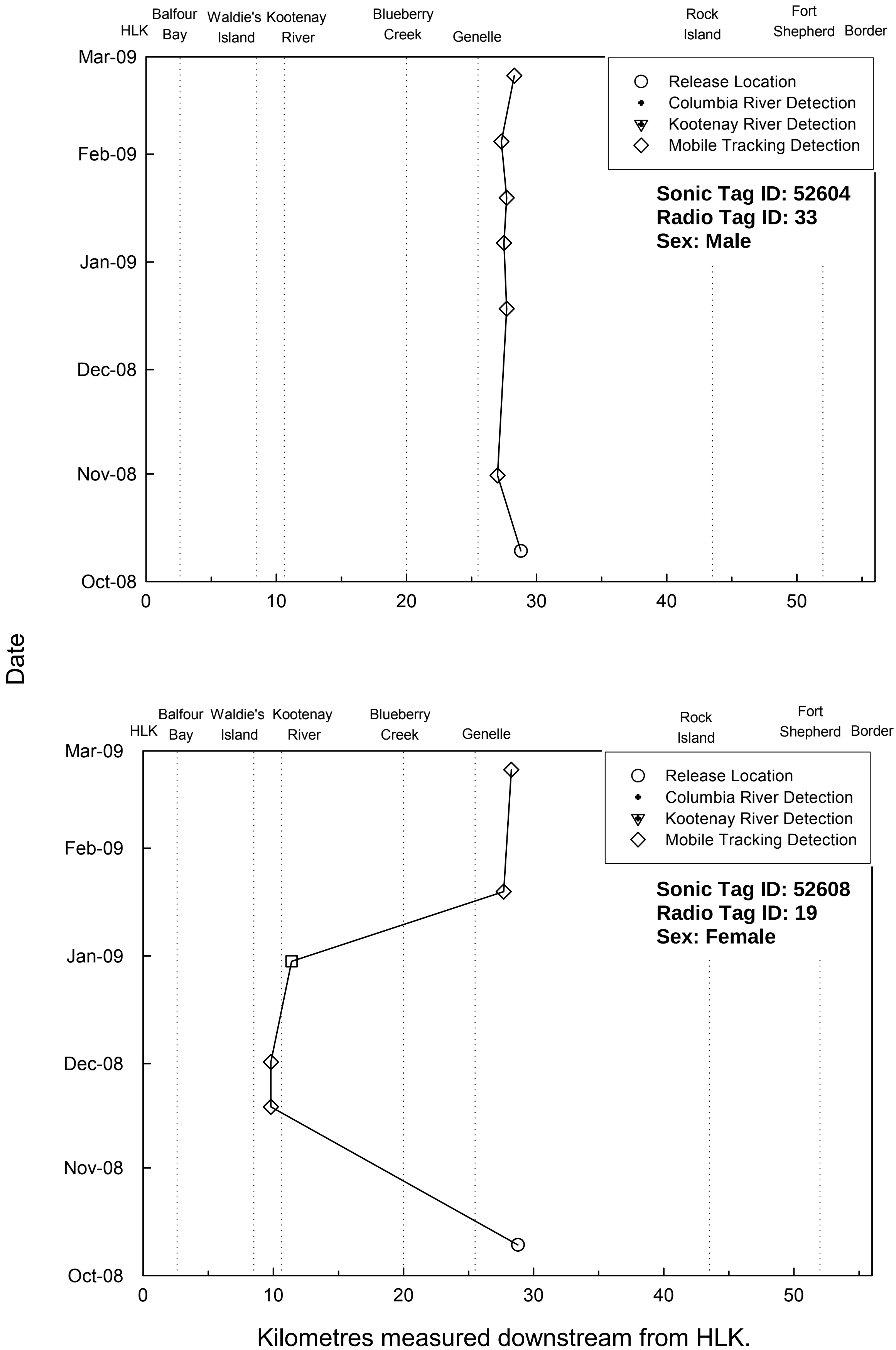
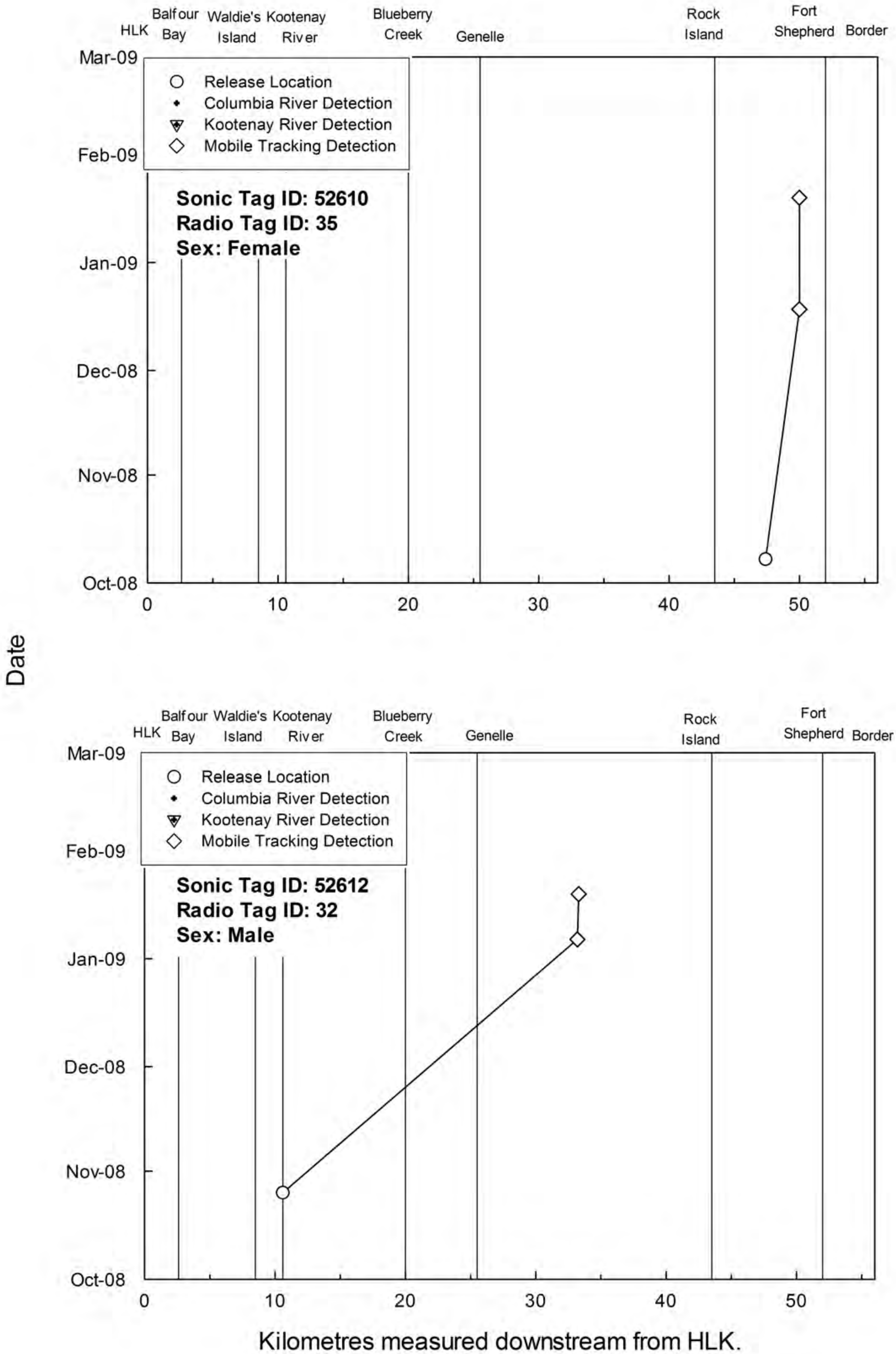


Figure C2 Summary of detections for tagged mountain whitefish only detected by radio tracking from HLK Dam to the Canada/U.S. border October 2008 to March 2009.



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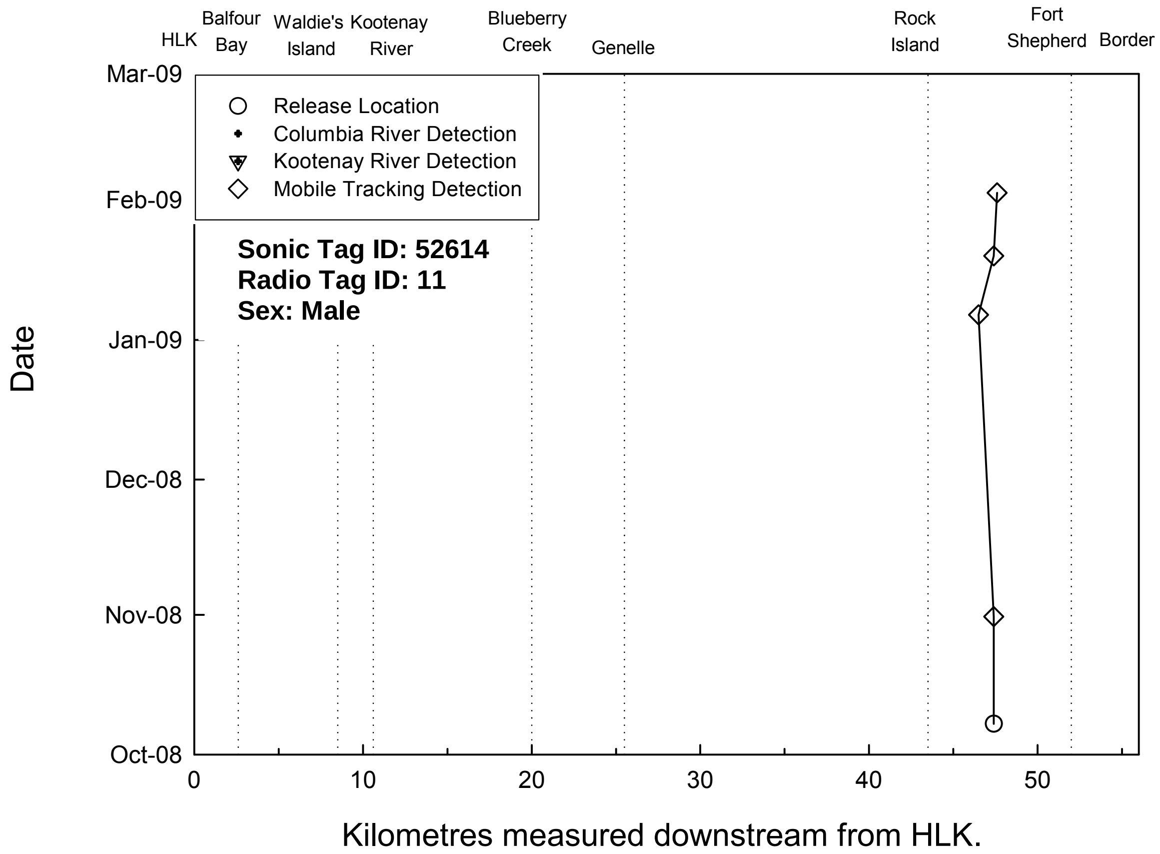

Figure C2 Concluded.

APPENDIX D

Mountain Whitefish Spawning and Egg Sampling Data Summaries

Table D1: Summary of mountain whitefish (MW) eggs collected by egg collection mats deployed in the CLBMON-48 study area, December 7, 2009 to February 18, 2010 (Year 2).

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			
1.0KL	7-Dec-09 10:28	11-Dec-09 10:41	96.2	4.0	3.3	2.8	0.4	RR	0	0	0	192.4	*0.00*
1.0KM	7-Dec-09 12:19	11-Dec-09 09:55	93.6	4.0	3.3	5.7	1.8	n/a	3	2	5	187.2	*0.64*
1.0KR	7-Dec-09 10:58	11-Dec-09 10:56	96.0	4.0	3.3	2.6	1.0	B/C	1	1	2	191.9	*0.25*
0.8KL	7-Dec-09 10:14	11-Dec-09 12:16	98.0	4.0	3.3	2.2	0.9	C/B	1	0	1	196.1	*0.12*
0.8KM	7-Dec-09 12:46	11-Dec-09 09:31	92.7	4.0	3.3	5.9	1.9	n/a	4	9	13	185.5	*1.68*
0.8KR	7-Dec-09 10:02	11-Dec-09 11:18	97.3	4.0	3.3	2.7	1.8	C/B	1	8	9	194.5	*1.11*
0.5KL	7-Dec-09 09:25	11-Dec-09 12:33	99.1	4.0	3.3	1.9	1.5	C/G	1	2	3	198.3	*0.36*
0.5KM	7-Dec-09 13:15	11-Dec-09 09:55	92.7	4.0	3.3	5.7	1.8	n/a	2	5	7	185.3	*0.91*
0.5KR	7-Dec-09 09:09	11-Dec-09 12:53	99.7	4.0	3.3	2.8	1.3	C/B	6	0	6	199.5	*0.72*
8.5L	8-Dec-09 10:12	14-Dec-09 10:42	144.5	4.7	4.9	2.9	2.1	C/G	2	7	9	289.0	*0.75*
8.5M	8-Dec-09 11:40	14-Dec-09 09:30	141.8	4.7	4.9	9.0	2.2	n/a	1	0	1	283.7	*0.08*
8.5R	8-Dec-09 09:06	14-Dec-09 11:13	146.1	4.7	4.9	2.0	1.8	C/G	9	16	25	292.2	*2.05*
8.6L	8-Dec-09 09:52	14-Dec-09 13:32	147.7	4.7	4.9	2.5	2.3	C/G	2	2	4	295.3	*0.33*
8.6M	8-Dec-09 12:04	14-Dec-09 10:10	142.1	4.7	4.9	7.6	2.4	n/a	2	8	7	284.2	*0.59*
8.6R	8-Dec-09 09:16	14-Dec-09 12:25	147.1	4.7	4.9	2.6	1.2	C/G	2	1	3	294.3	*0.24*
8.7L	8-Dec-09 09:42	14-Dec-09 14:01	148.3	4.7	4.9	2.5	2.1	C/G	0	15	15	296.6	*1.21*
8.7M	8-Dec-09 12:34	MISSING	n/a	4.7	4.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	*n/a*
8.7R	8-Dec-09 09:30	14-Dec-09 12:54	147.4	4.7	4.9	2.7	2.1	C	38	7	45	294.8	*3.66*
18.2L	9-Dec-09 09:56	17-Dec-09 10:30	192.6	4.1	4.8	2.0	1.5	C/G	2	2	4	385.1	*0.25*
18.2M	9-Dec-09 11:21	17-Dec-09 09:31	190.2	4.1	4.8	7.1	2.3	n/a	0	0	0	380.3	*0.00*
18.2R	9-Dec-09 09:45	17-Dec-09 10:05	192.3	4.1	4.8	3.3	1.8	C	6	1	7	384.7	*0.44*
18.5L	9-Dec-09 09:11	17-Dec-09 11:23	194.2	4.1	4.8	2.2	2.0	C/G	2	7	9	388.4	*0.56*
18.5M	9-Dec-09 12:09	MISSING	n/a	4.1	4.8	5.4	n/a	n/a	n/a	n/a	n/a	n/a	*n/a*
18.5R	9-Dec-09 09:25	17-Dec-09 11:49	194.4	4.1	4.8	2.5	2.3	C	2	4	6	388.8	*0.37*
24.3L	10-Dec-09 09:20	18-Dec-09 08:48	191.5	3.6	4.7	2.0	1.5	C	1	14	15	382.9	*0.94*
24.5L	10-Dec-09 09:34	18-Dec-09 09:12	191.6	3.6	4.7	2.9	1.6	C	4	4	8	383.3	*0.50*
24.6L	10-Dec-09 10:05	18-Dec-09 10:35	192.5	3.6	4.7	1.6	1.1	G/F	4	2	6	385.0	*0.37*
24.9L	10-Dec-09 09:52	18-Dec-09 09:36	191.7	3.6	4.7	1.9	2.2	G/C	67	18	85	383.5	*5.32*
25I	10-Dec-09 13:14	18-Dec-09 10:58	189.7	3.6	4.7	2.2	2.0	C/G	14	1	15	379.5	*0.95*
25.5I	10-Dec-09 12:58	18-Dec-09 11:29	190.5	3.6	4.7	1.8	1.7	G	1	10	11	381.0	*0.69*
25.6I	10-Dec-09 12:45	18-Dec-09 12:12	191.4	3.6	4.7	2.7	2.3	C/G	1	2	3	382.9	*0.19*
26I	10-Dec-09 12:32	18-Dec-09 12:33	192.0	3.6	4.7	1.9	2.0	C/G	3	1	4	384.0	*0.25*
26.4I	10-Dec-09 11:31	18-Dec-09 13:03	193.5	3.6	4.7	3.4	1.9	G	2	0	2	387.1	*0.12*
26.9I	10-Dec-09 11:20	18-Dec-09 13:30	194.2	3.6	4.7	2.3	1.8	G	1	3	4	388.3	*0.25*
26.8aI	10-Dec-09 11:07	18-Dec-09 13:59	194.9	3.6	4.7	1.2	1.6	G	1	0	1	389.7	*0.06*
26.8bR	10-Dec-09 10:57	18-Dec-09 14:21	195.4	3.6	4.7	1.4	2.7	C/B	0	0	0	390.8	*0.00*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
1.0KL	11-Dec-09 10:54	16-Dec-09 11:20	120.4	3.3	3.6	3.6	0.8	R/R	0	0	0	240.9	*0.00*
1.0KM	11-Dec-09 09:25	16-Dec-09 08:59	119.6	3.3	3.6	5.1	1.1	n/a	7	10	17	239.1	*1.71*
1.0KR	11-Dec-09 11:12	16-Dec-09 10:54	119.7	3.3	3.6	2.5	1.0	B/C	5	11	16	239.4	*1.60*
0.8KL	11-Dec-09 12:30	16-Dec-09 12:32	120.0	3.3	3.6	2.3	0.9	C/B	2	0	2	240.1	*0.20*
0.8KM	11-Dec-09 09:50	16-Dec-09 09:34	119.7	3.3	3.6	5.7	2.0	n/a	15	5	20	239.5	*2.00*
0.8KR	11-Dec-09 11:42	16-Dec-09 11:36	119.9	3.3	3.6	3.6	1.2	B/C	50	27	77	239.8	*7.71*
0.5KL	11-Dec-09 12:49	16-Dec-09 13:19	120.5	3.3	3.6	2.2	1.2	C	7	5	12	241.0	*1.20*
0.5KM	11-Dec-09 10:35	16-Dec-09 10:01	119.4	3.3	3.6	5.7	1.9	n/a	5	33	38	238.9	*3.82*
0.5KR	11-Dec-09 13:12	16-Dec-09 12:56	119.7	3.3	3.6	2.1	0.8	C/B	1	4	5	239.5	*0.50*
8.2R	14-Dec-09 14:41	21-Dec-09 09:21	162.7	4.9	5.2	3.2	n/a	G/C	1	1	2	325.3	*0.15*
8.5L	14-Dec-09 11:08	21-Dec-09 10:33	167.4	4.9	5.2	2.5	n/a	C/G	1	6	7	334.8	*0.50*
8.5R	14-Dec-09 11:42	21-Dec-09 09:46	166.1	4.9	5.2	1.5	n/a	C/G	40	18	58	332.1	*4.19*
8.6L	14-Dec-09 13:52	21-Dec-09 10:50	165.0	4.9	5.2	2.2	n/a	C/G	15	2	17	329.9	*1.24*
8.6M	14-Dec-09 10:38	21-Dec-09 09:03	166.4	4.9	5.2	7.7	n/a	n/a	0	1	1	332.8	*0.07*
8.6R	14-Dec-09 12:47	21-Dec-09 11:16	166.5	4.9	5.2	1.3	n/a	C	1	9	10	333.0	*0.72*
8.7L	14-Dec-09 14:25	21-Dec-09 12:24	166.0	4.9	5.2	2.4	n/a	C/G	2	6	8	332.0	*0.58*
8.7R	14-Dec-09 13:23	21-Dec-09 11:47	166.4	4.9	5.2	1.2	n/a	C/G	98	8	106	332.8	*7.64*
1.0KL	16-Dec-09 11:32	22-Dec-09 12:08	144.6	3.6	4.2	3.2	n/a	R/R	0	2	2	289.2	*0.17*
1.0KM	16-Dec-09 09:29	22-Dec-09 08:50	143.3	3.6	4.2	4.5	n/a	C/F	3	4	7	286.7	*0.59*
1.0KR	16-Dec-09 11:14	22-Dec-09 10:37	143.4	3.6	4.2	2.4	n/a	B/C	7	2	9	286.8	*0.75*
0.8KL	16-Dec-09 12:50	22-Dec-09 12:29	143.7	3.6	4.2	2.0	n/a	B/C	1	0	1	287.3	*0.08*
0.8KM	16-Dec-09 09:57	22-Dec-09 09:12	143.3	3.6	4.2	5.6	n/a	C/B	41	24	65	286.5	*5.45*
0.8KR	16-Dec-09 12:28	22-Dec-09 10:57	142.5	3.6	4.2	3.2	n/a	B/C	12	14	26	285.0	*2.19*
0.5KL	16-Dec-09 13:35	22-Dec-09 12:47	143.2	3.6	4.2	2.3	n/a	C/G	2	4	6	286.4	*0.50*
0.5KM	16-Dec-09 10:43	22-Dec-09 09:42	143.0	3.6	4.2	5.6	n/a	C	12	78	90	286.0	*7.55*
0.5KR	16-Dec-09 13:13	22-Dec-09 11:27	142.2	3.6	4.2	2.9	n/a	C/B	5	1	6	284.5	*0.51*
18.2L	17-Dec-09 11:15	30-Dec-09 09:25	310.2	4.8	4.1	4.3	n/a	C/B	1	2	3	620.3	*0.12*
18.2M	17-Dec-09 10:00	30-Dec-09 08:59	311.0	4.8	4.1	7.2	n/a	n/a	1	1	2	622.0	*0.08*
18.2R	17-Dec-09 10:26	30-Dec-09 09:49	311.4	4.8	4.1	3.3	n/a	C	11	23	34	622.8	*1.31*
18.5L	17-Dec-09 11:44	30-Dec-09 11:11	311.4	4.8	4.1	2.9	n/a	C	6	3	9	622.9	*0.35*
18.5R	17-Dec-09 12:09	30-Dec-09 10:43	310.6	4.8	4.1	2.2	n/a	C/G	5	2	7	621.1	*0.27*
24.3L	18-Dec-09 09:09	23-Dec-09 08:28	119.3	4.7	4.5	n/a	1.4	C/F	6	1	7	238.6	*0.70*
24.5L	18-Dec-09 09:28	23-Dec-09 09:01	119.6	4.7	4.5	n/a	1.3	C/F	2	2	4	239.1	*0.40*
24.6L	18-Dec-09 10:04	23-Dec-09 09:50	119.8	4.7	4.5	1.8	0.2	G/C	0	0	0	239.5	*0.00*
24.9L	18-Dec-09 10:31	23-Dec-09 09:20	118.8	4.7	4.5	1.3	1.6	G/C	21	3	24	237.6	*2.42*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
25I	18-Dec-09 11:21	23-Dec-09 10:14	118.9	4.7	4.5	0.9	1.6	G/C	5	16	21	237.8	*2.12*
25.5I	18-Dec-09 11:50	23-Dec-09 11:07	119.3	4.7	4.5	2.3	1.5	G	2	1	3	238.6	*0.30*
25.6I	18-Dec-09 12:27	23-Dec-09 11:35	119.1	4.7	4.5	2.0	1.7	G/C	2	0	2	238.3	*0.20*
26I	18-Dec-09 12:58	23-Dec-09 11:56	119.0	4.7	4.5	1.3	1.7	C/G	0	0	0	237.9	*0.00*
26.4I	18-Dec-09 13:26	23-Dec-09 12:32	119.1	4.7	4.5	1.4	2.5	G	0	2	2	238.2	*0.20*
26.9I	18-Dec-09 13:54	23-Dec-09 12:53	119.0	4.7	4.5	1.6	1.8	G	1	4	5	238.0	*0.50*
26.8aI	18-Dec-09 14:19	23-Dec-09 13:14	118.9	4.7	4.5	0.5	1.7	G/C	1	0	1	237.8	*0.10*
26.8bR	18-Dec-09 14:41	23-Dec-09 13:29	118.8	4.7	4.5	1.9	2.8	G/C	0	0	0	237.6	*0.00*
8.2R	21-Dec-09 09:45	28-Dec-09 11:46	170.0	5.2	4.5	3.2	0.6	G/F	3	3	6	340.0	*0.42*
8.5L	21-Dec-09 10:46	28-Dec-09 10:05	167.3	5.2	4.5	2.4	1.4	G/C	3	5	8	334.6	*0.57*
8.5R	21-Dec-09 10:27	28-Dec-09 12:12	169.7	5.2	4.5	3.5	1.6	G/C	23	10	33	339.5	*2.33*
8.6L	21-Dec-09 11:14	28-Dec-09 10:27	167.2	5.2	4.5	2.5	1.7	C/G	2	6	8	334.4	*0.57*
8.6M	21-Dec-09 09:19	28-Dec-09 08:43	167.4	5.2	4.5	7.4	2.1	n/a	0	5	5	334.8	*0.36*
8.6R	21-Dec-09 11:44	28-Dec-09 09:19	165.6	5.2	4.5	2.2	1.7	C/G	5	1	6	331.2	*0.43*
8.7L	21-Dec-09 12:15	28-Dec-09 10:56	166.7	5.2	4.5	2.0	2.3	C/B	5	6	11	333.4	*0.79*
8.7R	21-Dec-09 12:27	28-Dec-09 12:46	168.3	5.2	4.5	1.4	2.3	C/B	92	6	98	336.6	*6.99*
1.0KL	22-Dec-09 12:25	29-Dec-09 11:59	167.6	4.2	3.2	2.6	0.5	R/R	3	7	10	335.1	*0.72*
1.0KM	22-Dec-09 09:09	29-Dec-09 08:48	167.7	4.2	3.2	4.9	0.6	C/G	11	13	24	335.3	*1.72*
1.0KR	22-Dec-09 10:54	29-Dec-09 12:18	169.4	4.2	3.2	1.8	0.6	B/C	4	9	13	338.8	*0.92*
0.8KL	22-Dec-09 12:42	29-Dec-09 13:32	168.8	4.2	3.2	1.5	0.6	B/C	1	1	2	337.7	*0.14*
0.8KM	22-Dec-09 09:38	29-Dec-09 09:15	167.6	4.2	3.2	4.7	1.1	B/C	440	22	462	335.2	*33.08*
0.8KR	22-Dec-09 11:23	29-Dec-09 12:42	169.3	4.2	3.2	2.5	0.8	B/C	49	45	94	338.6	*6.66*
0.5KL	22-Dec-09 13:07	29-Dec-09 13:51	168.7	4.2	3.2	1.2	0.7	C/B	0	6	6	337.5	*0.43*
0.5KM	22-Dec-09 10:33	29-Dec-09 10:46	168.2	4.2	3.2	5.1	1.4	n/a	30	129	159	336.4	*11.34*
0.5KR	22-Dec-09 12:02	29-Dec-09 14:13	170.2	4.2	3.2	2.1	0.6	B/C	1	0	1	340.4	*0.07*
24.3L	23-Dec-09 08:35	31-Dec-09 08:45	192.2	4.5	4.0	1.4	1.2	C/G	4	9	13	384.3	*0.81*
24.5L	23-Dec-09 09:15	31-Dec-09 09:09	191.9	4.5	4.0	1.9	1.3	C/G	4	1	5	383.8	*0.31*
24.6L	23-Dec-09 10:10	31-Dec-09 10:10	192.0	4.5	4.0	0.9	0.3	G/C	0	0	0	384.0	*0.00*
24.9L	23-Dec-09 09:45	31-Dec-09 09:30	191.8	4.5	4.0	1.2	1.6	G/C	6	4	10	383.5	*0.63*
25I	23-Dec-09 10:39	31-Dec-09 10:26	191.8	4.5	4.0	0.8	0.8	C/F	4	4	8	383.6	*0.50*
25.5I	23-Dec-09 11:30	31-Dec-09 10:51	191.3	4.5	4.0	1.6	1.4	G/C	1	3	4	382.7	*0.25*
25.6I	23-Dec-09 11:49	31-Dec-09 11:27	191.6	4.5	4.0	2.9	2.0	C/G	2	2	4	383.3	*0.25*
26I	23-Dec-09 12:10	31-Dec-09 11:48	191.6	4.5	4.0	1.3	2.0	C/G	2	1	3	383.3	*0.19*
26.4I	23-Dec-09 12:48	31-Dec-09 12:10	191.4	4.5	4.0	1.7	1.9	G/C	1	1	2	382.7	*0.13*
26.9I	23-Dec-09 13:07	31-Dec-09 12:37	191.5	4.5	4.0	1.4	1.5	G/C	1	2	3	383.0	*0.19*
26.8aI	23-Dec-09 13:25	31-Dec-09 13:24	192.0	4.5	4.0	0.4	1.7	G/C	0	0	0	384.0	*0.00*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
26.8bR	23-Dec-09 13:43	31-Dec-09 13:02	191.3	4.5	4.0	0.8	2.4	C/B	0	0	0	382.6	*0.00*
8.2R	28-Dec-09 12:08	5-Jan-10 10:42	190.6	4.5	4.3	3.8	0.6	G/F	5	2	7	381.1	*0.44*
8.5L	28-Dec-09 10:22	5-Jan-10 08:51	190.5	4.5	4.3	2.3	1.6	C/G	3	14	17	381.0	*1.07*
8.5R	28-Dec-09 12:39	5-Jan-10 11:41	191.0	4.5	4.3	2.8	1.4	C/G	64	19	83	382.1	*5.21*
8.6L	28-Dec-09 10:51	5-Jan-10 09:28	190.6	4.5	4.3	2.5	1.9	C	3	11	13	381.2	*0.82*
8.6M	28-Dec-09 09:13	5-Jan-10 08:26	191.2	4.5	4.3	6.8	2.6	n/a	5	3	8	382.4	*0.50*
8.6R	28-Dec-09 09:44	5-Jan-10 12:22	194.6	4.5	4.3	2.1	1.6	C	26	11	37	389.3	*2.28*
8.7L	28-Dec-09 10:56	5-Jan-10 09:59	191.1	4.5	4.3	2.6	2.1	C	7	10	17	382.1	*1.07*
8.7R	28-Dec-09 13:29	5-Jan-10 12:52	191.4	4.5	4.3	1.1	2.2	C/G	302	82	384	382.8	*24.08*
1.0KL	29-Dec-09 12:15	4-Jan-10 10:21	142.1	3.2	3.2	3.5	1.2	R/R	0	1	1	284.2	*0.08*
1.0KM	29-Dec-09 09:12	4-Jan-10 08:20	143.1	3.2	3.2	5.2	1.5	C/G	14	9	23	286.3	*1.93*
1.0KR	29-Dec-09 12:39	4-Jan-10 10:39	142.0	3.2	3.2	1.0	1.0	B	1	3	4	284.0	*0.34*
0.8KL	29-Dec-09 13:47	4-Jan-10 11:31	141.7	3.2	3.2	2.1	0.6	B/C	0	0	0	283.5	*0.00*
0.8KM	29-Dec-09 10:42	4-Jan-10 08:46	142.1	3.2	3.2	5.2	1.3	C/B	128	77	205	284.1	*17.32*
0.8KR	29-Dec-09 13:14	4-Jan-10 10:57	141.7	3.2	3.2	3.1	1.6	B	76	23	99	283.4	*8.38*
0.5KL	29-Dec-09 14:09	4-Jan-10 10:44	140.6	3.2	3.2	2.3	1.1	C/G	1	5	6	281.2	*0.51*
0.5KM	29-Dec-09 11:22	4-Jan-10 09:32	142.2	3.2	3.2	5.5	1.8	C/B	7	52	59	284.3	*4.98*
0.5KR	29-Dec-09 14:31	4-Jan-10 12:00	141.5	3.2	3.2	2.3	0.8	B/C	0	0	0	283.0	*0.00*
18.2L	30-Dec-09 09:45	6-Jan-10 09:33	167.8	4.1	3.9	2.9	1.0	C/B	0	0	0	335.6	*0.00*
18.2M	30-Dec-09 09:19	6-Jan-10 09:07	167.8	4.1	3.9	6.6	2.2	n/a	0	1	1	335.6	*0.07*
18.2R	30-Dec-09 10:18	6-Jan-10 10:30	168.2	4.1	3.9	4.1	1.4	C/G	3	4	7	336.4	*0.50*
18.5L	30-Dec-09 11:33	6-Jan-10 09:52	166.3	4.1	3.9	1.5	2.4	C/B	0	2	2	332.6	*0.14*
18.5R	30-Dec-09 11:06	6-Jan-10 11:06	168.0	4.1	3.9	1.7	1.7	C/G	2	0	2	336.0	*0.14*
24.3L	31-Dec-09 09:06	6-Jan-10 12:10	147.1	4.0	3.9	2.0	0.9	C/B	2	3	5	294.1	*0.41*
24.5L	31-Dec-09 09:23	6-Jan-10 12:33	147.2	4.0	3.9	3.2	1.2	C/B	13	13	26	294.3	*2.12*
24.6L	31-Dec-09 10:19	7-Jan-10 09:15	166.9	4.0	3.9	0.8	0.0	G/C	1	0	1	333.9	*0.07*
24.9L	31-Dec-09 10:04	6-Jan-10 12:59	146.9	4.0	3.9	1.2	2.3	G/C	1	1	2	293.8	*0.16*
25I	31-Dec-09 10:45	7-Jan-10 08:53	166.1	4.0	3.9	1.3	1.4	C/G	2	2	4	332.3	*0.29*
25.5I	31-Dec-09 11:09	7-Jan-10 09:42	166.5	4.0	3.9	1.5	1.3	G	0	1	1	333.1	*0.07*
25.6I	31-Dec-09 11:43	7-Jan-10 10:56	167.2	4.0	3.9	1.2	1.5	C/G	7	32	39	334.4	*2.80*
26I	31-Dec-09 12:06	7-Jan-10 11:30	167.4	4.0	3.9	1.1	1.8	C/G	0	0	0	334.8	*0.00*
26.4I	31-Dec-09 12:28	7-Jan-10 11:49	167.3	4.0	3.9	1.6	2.3	G/F	0	1	1	334.7	*0.07*
26.9I	31-Dec-09 12:59	7-Jan-10 12:17	167.3	4.0	3.9	1.5	1.7	G/F	1	0	1	334.6	*0.07*
26.8aI	31-Dec-09 13:35	7-Jan-10 13:00	167.4	4.0	3.9	<0.5	1.0	G	0	0	0	334.8	*0.00*
26.8bR	31-Dec-09 13:22	7-Jan-10 13:31	168.2	4.0	3.9	1.5	2.6	C/B	0	0	0	336.3	*0.00*
1.0KL	4-Jan-10 10:35	11-Jan-10 11:02	168.5	3.2	2.8	3.1	0.0	R/R	0	2	2	336.9	*0.14*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
1.0KM	4-Jan-10 08:43	11-Jan-10 09:17	168.6	3.2	2.8	4.0	0.8	C/F	5	8	13	337.1	*0.93*
1.0KR	4-Jan-10 10:52	11-Jan-10 11:23	168.5	3.2	2.8	1.6	0.5	B/C	0	0	0	337.0	*0.00*
0.8KL	4-Jan-10 10:41	11-Jan-10 12:19	169.6	3.2	2.8	0.8	0.4	C/B	0	0	0	339.3	*0.00*
0.8KM	4-Jan-10 09:28	11-Jan-10 09:42	168.2	3.2	2.8	4.1	1.3	C/B	45	45	90	336.5	*6.42*
0.8KR	4-Jan-10 11:25	11-Jan-10 11:35	168.2	3.2	2.8	3.1	0.9	B/C	7	5	12	336.3	*0.86*
0.5KL	4-Jan-10 11:57	11-Jan-10 12:36	168.7	3.2	2.8	1.2	0.8	C/B	0	2	2	337.3	*0.14*
0.5KM	4-Jan-10 10:06	11-Jan-10 10:12	168.1	3.2	2.8	4.7	1.4	C/B	7	30	37	336.2	*2.64*
0.5KR	4-Jan-10 12:12	11-Jan-10 12:54	168.7	3.2	2.8	1.7	0.4	C/B	1	1	2	337.4	*0.14*
8.5L	5-Jan-10 09:14	13-Jan-10 14:13	197.0	4.3	4.0	2.3	1.3	C/G	1	0	1	394.0	*0.06*
8.5M	5-Jan-10 10:48	13-Jan-10 08:44	189.9	4.3	4.0	7.8	1.8	n/a	8	7	15	379.9	*0.95*
8.5R	5-Jan-10 12:19	13-Jan-10 10:28	190.2	4.3	4.0	2.8	1.2	C/B	17	19	36	380.3	*2.27*
8.6L	5-Jan-10 09:55	13-Jan-10 13:53	196.0	4.3	4.0	1.7	1.6	C/G	3	2	5	391.9	*0.31*
8.6M	5-Jan-10 08:48	13-Jan-10 09:18	192.5	4.3	4.0	6.6	2.4	n/a	0	10	10	385.0	*0.62*
8.6R	5-Jan-10 12:45	13-Jan-10 10:55	190.2	4.3	4.0	2.2	1.5	C	15	55	70	380.3	*4.42*
8.7L	5-Jan-10 10:22	13-Jan-10 13:23	195.0	4.3	4.0	1.7	1.9	B/C	4	8	12	390.0	*0.74*
8.7R	5-Jan-10 14:00	13-Jan-10 11:55	189.9	4.3	4.0	0.9	2.0	C/B	187	91	278	379.8	*17.57*
8.7M	8-Jan-10 09:38	13-Jan-10 10:01	120.4	3.9	4.0	6.3	2.4	n/a	5	1	6	240.8	*0.60*
8.8R	8-Jan-10 10:37	13-Jan-10 12:47	122.2	3.9	4.0	1.6	2.7	C/B	11	9	20	244.3	*1.96*
18.2L	6-Jan-10 09:47	14-Jan-10 09:32	191.8	3.9	3.8	3.0	1.1	C/B	0	0	0	383.5	*0.00*
18.2M	6-Jan-10 09:27	14-Jan-10 09:13	191.8	3.9	3.8	6.6	1.8	n/a	0	0	0	383.5	*0.00*
18.2R	6-Jan-10 10:59	14-Jan-10 10:43	191.7	3.9	3.8	3.5	1.2	B/C	1	4	5	383.5	*0.31*
18.5L	6-Jan-10 10:10	14-Jan-10 09:57	191.8	3.9	3.8	2.3	2.1	B/C	8	0	8	383.6	*0.50*
18.5R	6-Jan-10 11:33	14-Jan-10 11:22	191.8	3.9	3.8	1.4	1.6	C/F	0	0	0	383.6	*0.00*
24.3L	6-Jan-10 12:30	15-Jan-10 08:57	212.4	3.9	3.8	1.1	1.0	C/B	1	2	3	424.9	*0.17*
24.5L	6-Jan-10 12:54	15-Jan-10 09:21	212.4	3.9	3.8	2.1	0.9	C/B	1	6	7	424.9	*0.40*
24.6L	7-Jan-10 09:31	15-Jan-10 15:22	197.9	3.9	3.8	0.8	-0.1	G/C	0	0	0	395.7	*0.00*
24.9L	6-Jan-10 13:24	15-Jan-10 09:45	212.3	3.9	3.8	1.3	2.1	G/C	1	0	1	424.7	*0.06*
25I	7-Jan-10 09:06	15-Jan-10 10:28	193.4	3.9	3.8	1.0	1.1	C/G	1	0	1	386.7	*0.06*
25.5I	7-Jan-10 10:01	15-Jan-10 11:00	193.0	3.9	3.8	3.4	2.1	G/C	1	2	3	386.0	*0.19*
25.6I	7-Jan-10 11:22	15-Jan-10 11:36	192.2	3.9	3.8	1.2	2.0	C/G	3	4	7	384.5	*0.44*
26I	7-Jan-10 11:46	15-Jan-10 12:08	192.4	3.9	3.8	0.6	1.6	C/G	0	0	0	384.7	*0.00*
26.4I	7-Jan-10 12:11	15-Jan-10 12:54	192.7	3.9	3.8	1.4	2.0	G	0	0	0	385.4	*0.00*
26.9I	7-Jan-10 12:32	15-Jan-10 13:30	193.0	3.9	3.8	0.8	1.1	G	0	1	1	385.9	*0.06*
26.6R	7-Jan-10 13:27	15-Jan-10 13:58	192.5	3.9	3.8	2.0	1.3	B/C	0	0	0	385.0	*0.00*
1.0KL	11-Jan-10 11:20	18-Jan-10 13:17	170.0	2.8	3.4	2.6	0.1	R/R	0	2	2	339.9	*0.14*
1.0KM	11-Jan-10 09:38	18-Jan-10 09:03	167.4	2.8	3.4	4.3	0.7	C/F	4	5	9	334.8	*0.65*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
1.0KR	11-Jan-10 11:31	18-Jan-10 13:34	170.1	2.8	3.4	1.3	0.4	B/C	0	1	3	340.1	*0.21*
0.8KL	11-Jan-10 12:32	18-Jan-10 14:12	169.7	2.8	3.4	1.2	0.4	C/B	0	0	0	339.3	*0.00*
0.8KM	11-Jan-10 10:09	18-Jan-10 09:43	167.6	2.8	3.4	4.4	0.9	B/C	94	87	181	335.1	*12.96*
0.8KR	11-Jan-10 11:49	18-Jan-10 14:26	170.6	2.8	3.4	2.8	0.9	B/C	6	23	29	341.2	*2.04*
0.5KL	11-Jan-10 12:48	18-Jan-10 14:55	170.1	2.8	3.4	0.7	0.7	G/C	4	3	7	340.2	*0.49*
0.5KM	11-Jan-10 10:51	18-Jan-10 11:02	168.2	2.8	3.4	4.4	1.2	C/B	11	57	68	336.4	*4.85*
0.5KR	11-Jan-10 13:06	18-Jan-10 15:30	170.4	2.8	3.4	1.5	0.4	C/F	0	0	0	340.8	*0.00*
0.3KM	11-Jan-10 12:15	18-Jan-10 11:52	167.6	2.8	3.4	2.6	1.4	B/C	393	49	442	335.2	*31.64*
0.3KR	11-Jan-10 13:25	18-Jan-10 15:49	170.4	2.8	3.4	1.4	1.1	C/B	82	60	142	340.8	*10.00*
8.5L	13-Jan-10 14:30	19-Jan-10 11:35	141.1	4.0	4.0	1.9	0.5	C/G	0	0	0	282.2	*0.00*
8.5M	13-Jan-10 09:15	19-Jan-10 08:30	143.3	4.0	4.0	7.0	1.6	n/a	6	5	11	286.5	*0.92*
8.5R	13-Jan-10 10:51	19-Jan-10 11:52	145.0	4.0	4.0	2.4	0.9	C/B	10	18	28	290.0	*2.32*
8.6L	13-Jan-10 14:09	19-Jan-10 13:19	143.2	4.0	4.0	1.4	0.3	C/B	3	1	4	286.3	*0.34*
8.6M	13-Jan-10 09:55	19-Jan-10 09:25	143.5	4.0	4.0	5.9	2.4	n/a	2	11	13	287.0	*1.09*
8.6R	13-Jan-10 11:50	19-Jan-10 12:25	144.6	4.0	4.0	2.2	1.5	C	1	15	16	289.2	*1.33*
8.7L	13-Jan-10 13:49	19-Jan-10 13:43	143.9	4.0	4.0	2.5	2.1	C/B	1	7	8	287.8	*0.67*
8.7M	13-Jan-10 10:25	19-Jan-10 10:41	144.3	4.0	4.0	5.4	2.3	n/a	15	6	21	288.5	*1.75*
8.7R	13-Jan-10 12:45	19-Jan-10 14:00	145.3	4.0	4.0	1.2	1.7	C/B	61	22	83	290.5	*6.86*
8.8R	13-Jan-10 13:19	19-Jan-10 14:37	145.3	4.0	4.0	1.5	1.1	C/B	74	40	114	290.6	*9.42*
18.2L	14-Jan-10 09:51	20-Jan-10 09:32	143.7	3.8	3.5	1.8	0.9	C/B	0	1	1	287.4	*0.08*
18.2M	14-Jan-10 09:27	20-Jan-10 09:08	143.7	3.8	3.5	5.5	1.9	n/a	0	0	0	287.4	*0.00*
18.2R	14-Jan-10 11:17	20-Jan-10 10:26	143.2	3.8	3.5	1.7	1.1	C/G	0	3	3	286.3	*0.25*
18.5L	14-Jan-10 10:38	20-Jan-10 09:50	143.2	3.8	3.5	1.1	1.3	C/B	1	0	1	286.4	*0.08*
18.5R	14-Jan-10 11:41	20-Jan-10 11:03	143.4	3.8	3.5	1.7	1.7	C/G	0	0	0	286.7	*0.00*
24.3L	15-Jan-10 09:17	21-Jan-10 08:33	143.3	3.8	3.8	2.0	1.3	C/G	0	0	0	286.5	*0.00*
24.5L	15-Jan-10 09:38	21-Jan-10 09:00	143.4	3.8	3.8	1.1	0.2	G/C	2	0	2	286.7	*0.17*
24.9L	15-Jan-10 10:23	21-Jan-10 09:23	143.0	3.8	3.8	0.6	1.6	G/C	2	2	4	286.0	*0.34*
25I	15-Jan-10 10:55	21-Jan-10 10:22	143.4	3.8	3.8	0.5	1.4	G/C	0	0	0	286.9	*0.00*
25.5I	15-Jan-10 11:29	21-Jan-10 10:54	143.4	3.8	3.8	1.3	1.5	G/C	0	1	1	286.8	*0.08*
25.6I	15-Jan-10 12:03	21-Jan-10 11:22	143.3	3.8	3.8	2.3	1.7	G/C	1	14	15	286.6	*1.26*
26I	15-Jan-10 12:52	21-Jan-10 12:05	143.2	3.8	3.8	0.2	0.9	C/G	0	1	1	286.4	*0.08*
26.4I	15-Jan-10 13:22	21-Jan-10 12:58	143.6	3.8	3.8	0.6	2.0	G/C	0	2	2	287.2	*0.17*
26.9I	15-Jan-10 13:52	21-Jan-10 13:35	143.7	3.8	3.8	1.6	2.1	G/C	1	0	1	287.4	*0.08*
26.6R	15-Jan-10 13:58	21-Jan-10 14:42	144.7	3.8	3.8	1.1	0.5	G/C	0	0	0	289.5	*0.00*
1.0KL	18-Jan-10 13:32	22-Jan-10 11:59	94.5	3.4	3.5	4.6	0.6	R/R	0	0	0	188.9	*0.00*
1.0KM	18-Jan-10 09:38	22-Jan-10 08:43	95.1	3.4	3.5	3.6	1.0	n/a	1	7	8	190.2	*1.01*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
1.0KR	18-Jan-10 14:08	22-Jan-10 12:18	94.2	3.4	3.5	1.3	0.8	B	3	0	3	188.3	*0.38*
0.8KL	18-Jan-10 14:23	22-Jan-10 12:34	94.2	3.4	3.5	0.9	0.5	B/G	0	0	0	188.4	*0.00*
0.8KM	18-Jan-10 10:41	22-Jan-10 09:18	94.6	3.4	3.5	3.6	1.3	n/a	46	35	81	189.2	*10.27*
0.8KR	18-Jan-10 14:52	22-Jan-10 12:50	94.0	3.4	3.5	0.9	0.7	B	1	4	5	187.9	*0.64*
0.5KL	18-Jan-10 15:15	22-Jan-10 13:13	94.0	3.4	3.5	1.0	0.8	C/B	21	0	21	187.9	*2.68*
0.5KM	18-Jan-10 11:48	22-Jan-10 09:57	94.1	3.4	3.5	3.8	2.1	C	11	17	28	188.3	*3.57*
0.5KR	18-Jan-10 15:42	22-Jan-10 13:46	94.1	3.4	3.5	1.7	0.8	C/B	0	1	1	188.1	*0.13*
0.3KM	18-Jan-10 13:09	22-Jan-10 10:36	93.4	3.4	3.5	2.1	2.2	C/B	50	39	89	186.9	*11.43*
0.3KR	18-Jan-10 16:22	22-Jan-10 14:03	93.7	3.4	3.5	1.3	1.7	C/B	83	21	104	187.4	*13.32*
8.5L	19-Jan-10 11:49	25-Jan-10 10:26	142.6	4.0	3.5	1.5	1.2	C/G	0	3	3	285.2	*0.25*
8.5M	19-Jan-10 09:21	25-Jan-10 08:26	143.1	4.0	3.5	6.8	1.3	n/a	2	2	4	286.2	*0.34*
8.5R	19-Jan-10 12:23	25-Jan-10 10:46	142.4	4.0	3.5	1.4	0.6	C	1	3	4	284.8	*0.34*
8.6L	19-Jan-10 13:39	25-Jan-10 11:23	141.7	4.0	3.5	1.6	1.1	C/G	0	1	1	283.5	*0.08*
8.6M	19-Jan-10 10:39	25-Jan-10 08:56	142.3	4.0	3.5	5.4	1.5	n/a	3	3	6	284.6	*0.51*
8.6R	19-Jan-10 12:55	25-Jan-10 12:49	143.9	4.0	3.5	1.5	1.2	G/C	10	15	25	287.8	*2.08*
8.7L	19-Jan-10 14:00	25-Jan-10 12:24	142.4	4.0	3.5	1.2	1.7	C/B	2	1	3	284.8	*0.25*
8.7M	19-Jan-10 11:32	25-Jan-10 09:32	142.0	4.0	3.5	5.1	1.9	n/a	3	2	5	284.0	*0.42*
8.7R	19-Jan-10 14:32	25-Jan-10 13:27	142.9	4.0	3.5	2.4	1.8	C	41	11	52	285.8	*4.37*
8.8R	19-Jan-10 15:04	25-Jan-10 14:06	143.0	4.0	3.5	1.9	1.7	C	66	32	98	286.1	*8.22*
18.2L	20-Jan-10 09:44	27-Jan-10 09:23	167.7	3.5	3.5	1.8	1.1	C/G	0	0	0	335.3	*0.00*
18.2M	20-Jan-10 09:28	27-Jan-10 08:57	167.5	3.5	3.5	5.4	1.9	n/a	0	1	1	335.0	*0.07*
18.2R	20-Jan-10 10:53	27-Jan-10 10:21	167.5	3.5	3.5	1.4	1.0	C/G	0	1	1	334.9	*0.07*
18.5L	20-Jan-10 10:23	27-Jan-10 11:15	168.9	3.5	3.5	1.0	0.5	C/B	1	1	2	337.7	*0.14*
18.5R	20-Jan-10 11:21	27-Jan-10 10:52	167.5	3.5	3.5	1.4	1.6	C/G	0	0	0	335.0	*0.00*
24.3L	21-Jan-10 08:47	27-Jan-10 12:50	148.0	3.8	4.0	1.8	1.4	C/B	0	0	0	296.1	*0.00*
24.5L	21-Jan-10 09:14	27-Jan-10 12:25	147.2	3.8	4.0	1.9	0.5	C/B	0	0	0	294.4	*0.00*
24.9L	21-Jan-10 10:19	27-Jan-10 13:14	146.9	3.8	4.0	0.8	1.4	G/C	0	0	0	293.8	*0.00*
25I	21-Jan-10 10:47	28-Jan-10 09:20	166.5	3.8	4.0	0.5	1.3	G/C	0	0	0	333.1	*0.00*
25.5I	21-Jan-10 11:15	28-Jan-10 09:55	166.7	3.8	4.0	1.8	1.5	G	0	0	0	333.3	*0.00*
25.6I	21-Jan-10 11:52	28-Jan-10 10:20	166.5	3.8	4.0	1.9	2.2	C/G	0	0	0	332.9	*0.00*
25.8I	21-Jan-10 14:32	28-Jan-10 11:07	164.6	3.8	4.0	1.6	1.7	C/G	0	1	1	329.2	*0.07*
26I	21-Jan-10 12:54	28-Jan-10 11:37	166.7	3.8	4.0	0.6	2.3	C/F	0	0	0	333.4	*0.00*
26.4I	21-Jan-10 13:29	28-Jan-10 12:02	166.5	3.8	4.0	1.9	2.2	G/C	1	3	4	333.1	*0.29*
26.9I	21-Jan-10 14:00	28-Jan-10 12:55	166.9	3.8	4.0	1.6	0.4	B/G	1	1	2	333.8	*0.14*
26.6R	21-Jan-10 14:51	28-Jan-10 14:00	167.2	3.8	4.0	0.9	2.3	C/F	0	0	0	334.3	*0.00*
1.0KL	22-Jan-10 12:14	26-Jan-10 11:25	95.2	3.5	3.5	3.2	0.8	R/R	0	0	0	190.4	*0.00*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
1.0KM	22-Jan-10 09:11	26-Jan-10 08:58	95.8	3.5	3.5	3.2	0.9	C/G	0	1	1	191.6	*0.13*
1.0KR	22-Jan-10 12:30	26-Jan-10 11:39	95.2	3.5	3.5	0.9	0.6	B/C	0	0	0	190.3	*0.00*
0.8KL	22-Jan-10 12:46	26-Jan-10 11:54	95.1	3.5	3.5	0.8	0.5	C/B	1	0	1	190.3	*0.13*
0.8KM	22-Jan-10 09:53	26-Jan-10 09:15	95.4	3.5	3.5	3.6	1.2	C/B	18	20	38	190.7	*4.78*
0.8KR	22-Jan-10 13:09	26-Jan-10 12:12	95.0	3.5	3.5	1.9	1.0	B	1	4	5	190.1	*0.63*
0.5KL	22-Jan-10 14:40	26-Jan-10 13:10	94.5	3.5	3.5	0.9	1.2	B/C	0	2	2	189.0	*0.25*
0.5KM	22-Jan-10 10:32	26-Jan-10 09:58	95.4	3.5	3.5	3.7	1.8	C/B	14	24	38	190.9	*4.78*
0.5KR	22-Jan-10 14:00	26-Jan-10 13:30	95.5	3.5	3.5	1.9	0.6	C/B	0	0	0	191.0	*0.00*
0.3KM	22-Jan-10 11:49	26-Jan-10 10:58	95.2	3.5	3.5	2.0	2.2	B/C	9	12	21	190.3	*2.65*
0.3KR	22-Jan-10 14:36	26-Jan-10 13:52	95.3	3.5	3.5	0.9	1.0	C/G	15	50	65	190.5	*8.19*
8.5L	25-Jan-10 10:42	1-Feb-10 13:01	170.3	3.5	4.0	1.5	1.3	C/G	1	1	2	340.6	*0.14*
8.5M	25-Jan-10 08:52	1-Feb-10 08:20	167.5	3.5	4.0	6.5	1.7	n/a	2	2	4	334.9	*0.29*
8.5R	25-Jan-10 11:16	1-Feb-10 10:06	166.8	3.5	4.0	1.4	0.8	G/C	0	0	0	333.7	*0.00*
8.6L	25-Jan-10 11:42	1-Feb-10 13:23	169.7	3.5	4.0	1.8	1.1	C/G	2	0	2	339.4	*0.14*
8.6M	25-Jan-10 09:29	1-Feb-10 08:45	167.3	3.5	4.0	5.4	2.1	n/a	1	0	1	334.5	*0.07*
8.6R	25-Jan-10 13:22	1-Feb-10 10:26	165.1	3.5	4.0	1.9	1.6	C/G	18	17	35	330.1	*2.54*
8.7L	25-Jan-10 12:44	1-Feb-10 13:48	169.1	3.5	4.0	<1	1.6	C/B	1	0	1	338.1	*0.07*
8.7M	25-Jan-10 10:00	1-Feb-10 09:11	167.2	3.5	4.0	5.1	2.1	n/a	3	1	4	334.4	*0.29*
8.7R	25-Jan-10 14:04	1-Feb-10 11:05	165.0	3.5	4.0	2.3	2.0	C/G	3	4	7	330.0	*0.51*
8.8R	25-Jan-10 14:41	1-Feb-10 11:39	165.0	3.5	4.0	1.7	1.9	C/G	56	75	131	329.9	*9.53*
1.0KL	26-Jan-10 11:36	29-Jan-10 11:19	71.7	3.5	3.5	4.1	0.7	R/R	0	0	0	143.4	*0.00*
1.0KM	26-Jan-10 09:11	29-Jan-10 08:59	71.8	3.5	3.5	3.6	0.6	C/G	0	1	1	143.6	*0.17*
1.0KR	26-Jan-10 11:50	29-Jan-10 11:33	71.7	3.5	3.5	1.2	0.6	B/C	0	0	0	143.4	*0.00*
0.8KL	26-Jan-10 12:07	29-Jan-10 11:47	71.7	3.5	3.5	4.4	0.4	C/B	0	0	0	143.3	*0.00*
0.8KM	26-Jan-10 09:47	29-Jan-10 09:23	71.6	3.5	3.5	3.4	1.2	C/G	12	9	21	143.2	*3.52*
0.8KR	26-Jan-10 12:30	29-Jan-10 12:10	71.7	3.5	3.5	1.3	1.0	B/C	0	2	2	143.3	*0.33*
0.5KL	26-Jan-10 13:07	29-Jan-10 13:07	72.0	3.5	3.5	0.8	0.9	C/B	0	0	0	144.0	*0.00*
0.5KM	26-Jan-10 10:33	29-Jan-10 09:59	71.4	3.5	3.5	4.0	1.6	C/B	8	8	16	142.9	*2.69*
0.5KR	26-Jan-10 13:47	29-Jan-10 13:27	71.7	3.5	3.5	1.9	0.8	C/G	0	0	0	143.3	*0.00*
0.3KM	26-Jan-10 11:18	29-Jan-10 10:49	71.5	3.5	3.5	2.0	2.1	B/G	1	2	3	143.0	*0.50*
0.3KR	26-Jan-10 14:25	29-Jan-10 13:47	71.4	3.5	3.5	1.0	1.5	C/G	4	19	23	142.7	*3.87*
18.2L	27-Jan-10 09:38	3-Feb-10 10:09	168.5	3.5	3.5	1.5	1.1	C/B	0	0	0	337.0	*0.00*
18.2M	27-Jan-10 09:18	3-Feb-10 09:00	167.7	3.5	3.5	5.1	1.7	C/B	0	0	0	335.4	*0.00*
18.2R	27-Jan-10 10:38	3-Feb-10 09:48	167.2	3.5	3.5	1.6	1.0	G/C	1	1	2	334.3	*0.14*
18.5L	27-Jan-10 11:32	3-Feb-10 11:00	167.5	3.5	3.5	1.1	1.3	C/B	0	0	0	334.9	*0.00*
18.5R	27-Jan-10 11:09	3-Feb-10 10:30	167.3	3.5	3.5	1.5	1.5	G/C	1	1	2	334.7	*0.14*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
24.3L	27-Jan-10 13:04	3-Feb-10 12:00	166.9	4.0	3.5	2.0	1.6	C/G	2	1	3	333.9	*0.22*
24.5L	27-Jan-10 12:42	3-Feb-10 12:32	167.8	4.0	3.5	2.1	0.3	C/G	0	0	0	335.7	*0.00*
24.9L	27-Jan-10 13:32	3-Feb-10 12:54	167.4	4.0	3.5	0.7	1.1	G/C	0	1	1	334.7	*0.07*
25.2I	28-Jan-10 09:52	4-Feb-10 09:15	167.4	4.0	3.5	1.1	1.3	C/G	0	0	0	334.8	*0.00*
25.5I	28-Jan-10 10:09	4-Feb-10 09:40	167.5	4.0	3.5	1.2	1.7	C/G	0	0	0	335.0	*0.00*
25.6I	28-Jan-10 10:35	4-Feb-10 10:04	167.5	4.0	3.5	1.2	1.8	C/G	0	4	4	335.0	*0.29*
25.8I	28-Jan-10 11:34	4-Feb-10 11:04	167.5	4.0	3.5	1.6	1.4	C/G	0	0	0	335.0	*0.00*
26I	28-Jan-10 11:53	4-Feb-10 11:25	167.5	4.0	3.5	0.6	2.5	C/G	0	1	1	335.1	*0.07*
26.4I	28-Jan-10 12:28	4-Feb-10 12:10	167.7	4.0	3.5	1.4	1.3	G	0	0	0	335.4	*0.00*
26.9I	28-Jan-10 13:10	4-Feb-10 12:35	167.4	4.0	3.5	1.2	2.4	C	1	0	1	334.8	*0.07*
1.0KL	29-Jan-10 11:29	2-Feb-10 10:59	95.5	3.5	3.5	2.9	0.0	R/R	0	0	0	191.0	*0.00*
1.0KM	29-Jan-10 09:19	2-Feb-10 08:37	95.3	3.5	3.5	3.5	0.9	G/C	0	1	1	190.6	*0.13*
1.0KR	29-Jan-10 11:45	2-Feb-10 11:11	95.4	3.5	3.5	1.0	0.6	C/B	0	0	0	190.9	*0.00*
0.8KL	29-Jan-10 12:04	2-Feb-10 11:56	95.9	3.5	3.5	1.4	0.5	C/G	0	0	0	191.7	*0.00*
0.8KM	29-Jan-10 09:55	2-Feb-10 09:00	95.1	3.5	3.5	1.1	1.1	B/C	12	22	34	190.2	*4.29*
0.8KR	29-Jan-10 12:30	2-Feb-10 11:30	95.0	3.5	3.5	1.4	1.0	C/G	2	0	2	190.0	*0.25*
0.5KL	29-Jan-10 13:21	2-Feb-10 12:44	95.4	3.5	3.5	1.1	1.0	C/G	0	1	1	190.8	*0.13*
0.5KM	29-Jan-10 10:22	2-Feb-10 09:34	95.2	3.5	3.5	4.1	1.8	G/B	0	6	6	190.4	*0.76*
0.5KR	29-Jan-10 13:39	2-Feb-10 13:06	95.4	3.5	3.5	1.7	0.7	C/G	0	0	0	190.9	*0.00*
0.3KM	29-Jan-10 11:14	2-Feb-10 10:12	95.0	3.5	3.5	1.9	2.0	C/B	8	9	17	189.9	*2.15*
0.3KR	29-Jan-10 14:12	2-Feb-10 13:26	95.2	3.5	3.5	0.9	1.8	C/G	0	4	4	190.5	*0.50*
8.5L	1-Feb-10 13:19	5-Feb-10 10:11	92.9	4.0	3.5	1.3	0.6	C/B	0	0	0	185.7	*0.00*
8.5M	1-Feb-10 08:40	5-Feb-10 08:34	95.9	4.0	3.5	6.5	0.9	n/a	2	0	2	191.8	*0.25*
8.5R	1-Feb-10 10:23	5-Feb-10 11:36	97.2	4.0	3.5	1.3	0.7	G/C	0	0	0	194.4	*0.00*
8.6L	1-Feb-10 13:45	5-Feb-10 10:27	92.7	4.0	3.5	1.2	1.2	C/B	0	1	1	185.4	*0.13*
8.6M	1-Feb-10 09:08	5-Feb-10 09:00	95.9	4.0	3.5	5.6	1.4	n/a	3	3	6	191.7	*0.75*
8.6R	1-Feb-10 10:59	5-Feb-10 11:57	97.0	4.0	3.5	1.7	1.1	C	9	3	12	193.9	*1.49*
8.7L	1-Feb-10 14:14	5-Feb-10 10:45	92.5	4.0	3.5	1.6	1.4	C/B	1	2	3	185.0	*0.39*
8.7M	1-Feb-10 09:37	5-Feb-10 09:25	95.8	4.0	3.5	4.9	2.0	n/a	2	0	2	191.6	*0.25*
8.7R	1-Feb-10 11:36	5-Feb-10 12:21	96.8	4.0	3.5	1.8	1.6	C/G	3	5	8	193.5	*0.99*
8.8R	1-Feb-10 12:31	5-Feb-10 12:50	96.3	4.0	3.5	2.2	1.7	C/B	13	9	22	192.6	*2.74*
1.0KL	2-Feb-10 11:08	8-Feb-10 11:04	143.9	3.5	3.8	3.6	0.7	R/R	0	0	0	287.9	*0.00*
1.0KM	2-Feb-10 08:55	8-Feb-10 09:08	144.2	3.5	3.8	3.3	0.7	C/B	0	0	0	288.4	*0.00*
1.0KR	2-Feb-10 11:27	8-Feb-10 11:26	144.0	3.5	3.8	1.1	0.7	B/C	0	0	0	288.0	*0.00*
0.8KL	2-Feb-10 12:17	8-Feb-10 12:42	144.4	3.5	3.8	1.1	0.8	C/B	0	0	0	288.8	*0.00*
0.8KM	2-Feb-10 09:31	8-Feb-10 09:21	143.8	3.5	3.8	4.5	1.6	C/B	11	10	21	287.7	*1.75*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
0.8KR	2-Feb-10 11:51	8-Feb-10 11:42	143.9	3.5	3.8	2.0	0.9	B/C	1	0	1	287.7	*0.08*
0.5KL	2-Feb-10 13:02	8-Feb-10 12:56	143.9	3.5	3.8	1.1	1.3	C/B	0	0	0	287.8	*0.00*
0.5KM	2-Feb-10 10:05	8-Feb-10 09:47	143.7	3.5	3.8	4.0	1.3	B/C	1	6	7	287.4	*0.58*
0.5KR	2-Feb-10 13:23	8-Feb-10 13:17	143.9	3.5	3.8	1.9	0.7	C/B	0	0	0	287.8	*0.00*
0.3KM	2-Feb-10 10:35	8-Feb-10 10:32	144.0	3.5	3.8	2.0	2.0	B/C	27	1	28	287.9	*2.33*
0.3KR	2-Feb-10 13:52	8-Feb-10 13:38	143.8	3.5	3.8	1.0	1.5	C/B	1	3	4	287.5	*0.33*
18.2L	3-Feb-10 10:23	10-Feb-10 11:30	169.1	3.5	3.7	2.0	1.3	C/B	0	0	0	338.2	*0.00*
18.2M	3-Feb-10 09:20	10-Feb-10 09:58	168.6	3.5	3.7	4.9	1.4	B/C	0	1	1	337.3	*0.07*
18.2R	3-Feb-10 10:06	10-Feb-10 10:16	168.2	3.5	3.7	1.4	0.9	C/B	0	0	0	336.3	*0.00*
18.5L	3-Feb-10 11:10	10-Feb-10 11:53	168.7	3.5	3.7	0.8	1.0	B/C	0	0	0	337.4	*0.00*
18.5R	3-Feb-10 10:55	10-Feb-10 10:38	167.7	3.5	3.7	1.7	1.7	G/C	0	0	0	335.4	*0.00*
24.3L	3-Feb-10 12:26	11-Feb-10 09:09	188.7	3.5	4.0	2.0	1.1	C/G	0	0	0	377.4	*0.00*
24.5L	3-Feb-10 12:46	11-Feb-10 09:30	188.7	3.5	4.0	2.4	0.7	C/G	0	0	0	377.5	*0.00*
24.9L	3-Feb-10 13:18	11-Feb-10 09:54	188.6	3.5	4.0	0.6	1.0	G/C	0	0	0	377.2	*0.00*
25.2I	4-Feb-10 09:37	11-Feb-10 10:34	169.0	3.5	4.0	1.2	1.6	C/G	0	0	0	337.9	*0.00*
25.5I	4-Feb-10 09:58	11-Feb-10 10:42	168.7	3.5	4.0	1.1	1.3	G/C	0	0	0	337.5	*0.00*
25.6I	4-Feb-10 10:27	11-Feb-10 11:15	168.8	3.5	4.0	2.0	1.7	C/G	0	2	2	337.6	*0.14*
25.8I	4-Feb-10 11:22	11-Feb-10 12:49	169.5	3.5	4.0	1.2	0.9	C/G	0	0	0	338.9	*0.00*
26I	4-Feb-10 11:51	11-Feb-10 11:48	168.0	3.5	4.0	0.6	2.3	G	0	0	0	335.9	*0.00*
26.4I	4-Feb-10 12:30	11-Feb-10 12:21	167.8	3.5	4.0	1.4	2.1	C/G	0	0	0	335.7	*0.00*
26.9I	4-Feb-10 12:57	11-Feb-10 13:11	168.2	3.5	4.0	1.3	2.4	C/G	0	0	0	336.5	*0.00*
8.5L	5-Feb-10 10:24	9-Feb-10 10:00	95.6	3.5	3.5	1.6	0.6	C/G	0	0	0	191.2	*0.00*
8.5M	5-Feb-10 08:55	9-Feb-10 08:36	95.7	3.5	3.5	6.4	1.6	n/a	0	0	0	191.4	*0.00*
8.5R	5-Feb-10 11:53	9-Feb-10 10:53	95.0	3.5	3.5	1.2	0.5	C/G	4	2	6	190.0	*0.76*
8.6L	5-Feb-10 10:38	9-Feb-10 10:17	95.6	3.5	3.5	1.0	0.8	C/G	0	0	0	191.3	*0.00*
8.6M	5-Feb-10 09:23	9-Feb-10 08:57	95.6	3.5	3.5	5.2	2.1	C/B	0	0	0	191.1	*0.00*
8.6R	5-Feb-10 12:16	9-Feb-10 11:53	95.6	3.5	3.5	2.5	1.0	C/B	1	0	1	191.2	*0.13*
8.7L	5-Feb-10 11:33	9-Feb-10 10:37	95.1	3.5	3.5	2.1	1.7	C/B	0	0	0	190.1	*0.00*
8.7M	5-Feb-10 10:02	9-Feb-10 09:15	95.2	3.5	3.5	4.8	2.1	C/B	1	1	2	190.4	*0.25*
8.7R	5-Feb-10 12:47	9-Feb-10 12:18	95.5	3.5	3.5	2.0	1.8	C/B	6	2	8	191.0	*1.01*
8.8R	5-Feb-10 13:17	9-Feb-10 12:50	95.5	3.5	3.5	2.1	1.4	C/B	0	3	3	191.1	*0.38*
1.0KL	8-Feb-10 11:19	12-Feb-10 11:11	95.9	3.8	4.0	2.9	-0.1	R/R	0	0	0	191.7	*0.00*
1.0KM	8-Feb-10 09:17	12-Feb-10 08:38	95.3	3.8	4.0	3.4	0.8	C/B	1	0	1	190.7	*0.13*
1.0KR	8-Feb-10 11:38	12-Feb-10 10:52	95.2	3.8	4.0	1.6	0.8	B	0	0	0	190.5	*0.00*
0.8KL	8-Feb-10 12:54	12-Feb-10 11:30	94.6	3.8	4.0	1.1	0.6	C/B	0	0	0	189.2	*0.00*
0.8KM	8-Feb-10 09:45	12-Feb-10 08:58	95.2	3.8	4.0	4.1	1.2	B/C	16	10	26	190.4	*3.28*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
0.8KR	8-Feb-10 12:38	12-Feb-10 11:49	95.2	3.8	4.0	0.4	1.1	B	0	1	1	190.4	*0.13*
0.5KL	8-Feb-10 13:14	12-Feb-10 13:25	96.2	3.8	4.0	1.0	1.1	B/C	0	1	1	192.4	*0.12*
0.5KM	8-Feb-10 10:27	12-Feb-10 09:28	95.0	3.8	4.0	4.2	1.8	B/C	2	1	3	190.0	*0.38*
0.5KR	8-Feb-10 13:36	12-Feb-10 12:46	95.2	3.8	4.0	1.7	0.6	C/B	0	0	0	190.3	*0.00*
0.3KM	8-Feb-10 11:00	12-Feb-10 10:23	95.4	3.8	4.0	2.1	2.2	B/C	6	4	10	190.8	*1.26*
0.3KR	8-Feb-10 13:55	12-Feb-10 13:04	95.2	3.8	4.0	1.0	1.4	C/G	0	1	1	190.3	*0.13*
8.5L	9-Feb-10 10:15	17-Feb-10 11:09	192.9	3.5	4.0	1.8	0.7	C/G	0	0	0	385.8	*0.00*
8.5M	9-Feb-10 08:54	17-Feb-10 08:19	191.4	3.5	4.0	6.5	1.0	n/a	0	1	1	382.8	*0.06*
8.5R	9-Feb-10 11:48	17-Feb-10 13:52	194.1	3.5	4.0	1.6	0.4	C	5	0	5	388.1	*0.31*
8.6L	9-Feb-10 10:35	17-Feb-10 11:26	192.9	3.5	4.0	1.2	1.2	C/B	0	0	0	385.7	*0.00*
8.6M	9-Feb-10 09:12	17-Feb-10 08:39	191.5	3.5	4.0	5.6	1.4	n/a	1	1	2	382.9	*0.13*
8.6R	9-Feb-10 12:15	17-Feb-10 13:26	193.2	3.5	4.0	1.1	0.4	C	2	0	2	386.4	*0.12*
8.7L	9-Feb-10 10:50	17-Feb-10 11:47	192.9	3.5	4.0	1.3	1.7	C/B	1	0	1	385.9	*0.06*
8.7M	9-Feb-10 09:58	17-Feb-10 09:04	191.1	3.5	4.0	4.9	2.1	n/a	1	0	1	382.2	*0.06*
8.7R	9-Feb-10 12:45	17-Feb-10 12:45	192.0	3.5	4.0	2.0	1.7	B/C	0	1	1	384.0	*0.06*
8.8R	9-Feb-10 13:13	17-Feb-10 12:24	191.2	3.5	4.0	2.3	2.0	C/B	1	0	1	382.4	*0.06*
18.2L	10-Feb-10 11:51	15-Feb-10 10:06	118.2	3.7	4.0	1.2	0.9	C/B	0	0	0	236.5	*0.00*
18.2M	10-Feb-10 10:08	15-Feb-10 08:55	118.8	3.7	4.0	5.1	1.2	n/a	0	0	0	237.6	*0.00*
18.2R	10-Feb-10 10:31	15-Feb-10 09:45	119.2	3.7	4.0	0.9	0.8	C/G	0	0	0	238.5	*0.00*
18.5L	10-Feb-10 12:10	15-Feb-10 10:28	118.3	3.7	4.0	1.1	1.2	C/G	0	0	0	236.6	*0.00*
18.5R	10-Feb-10 11:24	15-Feb-10 10:52	119.5	3.7	4.0	0.8	1.0	C/G	0	0	0	238.9	*0.00*
24.3L	11-Feb-10 09:25	15-Feb-10 11:48	98.4	4.0	4.0	1.4	1.0	C/G	0	0	0	196.8	*0.00*
24.5L	11-Feb-10 09:45	15-Feb-10 12:10	98.4	4.0	4.0	1.6	0.6	C	0	0	0	196.8	*0.00*
24.9L	11-Feb-10 10:08	15-Feb-10 12:48	98.7	4.0	4.0	0.5	1.0	G/C	0	0	0	197.3	*0.00*
25.2I	11-Feb-10 10:51	16-Feb-10 09:11	118.3	4.0	4.0	1.0	1.3	C/G	0	0	0	236.7	*0.00*
25.5I	11-Feb-10 11:11	16-Feb-10 09:31	118.3	4.0	4.0	0.9	1.1	G	0	0	0	236.7	*0.00*
25.6I	11-Feb-10 11:38	16-Feb-10 09:59	118.4	4.0	4.0	1.9	1.4	C/G	0	0	0	236.7	*0.00*
25.8I	11-Feb-10 12:43	16-Feb-10 10:45	118.0	4.0	4.0	1.3	1.5	C	1	0	1	236.1	*0.10*
26I	11-Feb-10 12:00	16-Feb-10 11:35	119.6	4.0	4.0	0.6	2.0	G/C	0	0	0	239.2	*0.00*
26.4I	11-Feb-10 13:07	16-Feb-10 11:55	118.8	4.0	4.0	1.3	2.6	G/C	0	0	0	237.6	*0.00*
26.9I	11-Feb-10 13:28	16-Feb-10 12:37	119.1	4.0	4.0	1.3	2.7	C/B	0	0	0	238.3	*0.00*
1.0KL	12-Feb-10 11:23	18-Feb-10 14:18	146.9	4.0	4.0	3.7	0.1	R/R	0	0	0	293.8	*0.00*
1.0KM	12-Feb-10 08:54	18-Feb-10 09:14	144.3	4.0	4.0	3.7	0.6	C/B	0	0	0	288.7	*0.00*
1.0KR	12-Feb-10 11:07	18-Feb-10 12:35	145.5	4.0	4.0	1.6	0.7	B/C	0	0	0	290.9	*0.00*
0.8KL	12-Feb-10 11:47	18-Feb-10 14:39	146.9	4.0	4.0	1.3	0.4	C/G	0	0	0	293.7	*0.00*
0.8KM	12-Feb-10 09:24	18-Feb-10 09:32	144.1	4.0	4.0	3.5	1.1	C/B	13	8	21	288.3	*1.75*

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D1: 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			
0.8KR	12-Feb-10 12:10	18-Feb-10 10:52	142.7	4.0	4.0	2.5	0.9	B/C	0	1	1	285.4	*0.08*
0.5KL	12-Feb-10 13:43	18-Feb-10 15:11	145.5	4.0	4.0	1.2	0.9	G/C	0	0	0	290.9	*0.00*
0.5KM	12-Feb-10 09:57	18-Feb-10 10:05	144.1	4.0	4.0	4.0	1.4	G/C	0	0	0	288.3	*0.00*
0.5KR	12-Feb-10 13:00	18-Feb-10 13:16	144.3	4.0	4.0	1.8	0.7	C/B	0	0	0	288.5	*0.00*
0.3KM	12-Feb-10 10:48	18-Feb-10 10:25	143.6	4.0	4.0	2.0	2.2	C/B	3	1	4	287.2	*0.33*
0.3KL	12-Feb-10 13:21	18-Feb-10 13:41	144.3	4.0	4.0	0.8	1.7	C/G	1	0	1	288.7	*0.08*
Totals			**59138.0**						**3744**	**2516**	**6259**	**118276.1**	***1.27***

[a] See Figures A4 to A7 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: Summary of mountain whitefish (MW) eggs collected by egg collection mats deployed in the CLBMON-48 study area, December 7, 2010 to February 9, 2011 (Year 3).

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	7-Dec-10 11:42	15-Dec-10 09:14	189.5	5.1	5.1	2.3	0.7	C/G/B	0	2	2	379.1	*0.13*
8.5 ML	7-Dec-10 12:51	15-Dec-10 10:03	189.2	5.1	5.1	n/a	n/a	n/a	2	1	3	378.4	*0.19*
8.5 M	7-Dec-10 11:30	15-Dec-10 08:21	188.9	5.1	5.1	n/a	n/a	n/a	5	4	9	377.7	*0.57*
8.5 MR	7-Dec-10 14:26	15-Dec-10 11:14	188.8	5.1	5.1	n/a	n/a	n/a	3	11	14	377.6	*0.89*
8.5R	7-Dec-10 11:10	15-Dec-10 11:45	192.6	5.1	5.1	3.7	1.7	G/F/C	13	1	14	385.2	*0.87*
WALD1	7-Dec-10 13:02	15-Dec-10 13:26	192.4	5.1	5.1	1.6	0.5	B/C/F	1	2	3	384.8	*0.19*
8.6 L	7-Dec-10 12:38	15-Dec-10 09:40	189.0	5.1	5.1	2.6	1.6	C/G/B	1	0	1	378.1	*0.06*
8.6 ML	7-Dec-10 12:54	15-Dec-10 09:59	189.1	5.1	5.1	n/a	n/a	n/a	2	6	8	378.2	*0.51*
8.6 M	7-Dec-10 11:35	15-Dec-10 08:18	188.7	5.1	5.1	n/a	n/a	n/a	2	9	11	377.4	*0.70*
8.6 MR	7-Dec-10 14:30	15-Dec-10 11:18	188.8	5.1	5.1	n/a	n/a	n/a	0	2	2	377.6	*0.13*
8.6 R	7-Dec-10 11:19	15-Dec-10 12:24	193.1	5.1	5.1	2.5	1.4	C/G/F	0	3	3	386.2	*0.19*
8.7 L	7-Dec-10 12:46	15-Dec-10 10:04	189.3	5.1	5.1	2.4	1.6	B/C	1	3	4	378.6	*0.25*
8.7 ML	7-Dec-10 12:59	15-Dec-10 09:55	188.9	5.1	5.1	n/a	n/a	n/a	1	8	9	377.9	*0.57*
8.7 M	7-Dec-10 11:40	15-Dec-10 08:13	188.6	5.1	5.1	n/a	n/a	n/a	4	3	7	377.1	*0.45*
8.7 MR	7-Dec-10 14:34	15-Dec-10 11:22	188.8	5.1	5.1	n/a	n/a	n/a	0	1	1	377.6	*0.06*
8.7 R	7-Dec-10 11:29	15-Dec-10 12:54	193.4	5.1	5.1	1.9	2.3	C/G/B	6	1	7	386.8	*0.43*
8.8 L	7-Dec-10 13:41	15-Dec-10 10:33	188.9	5.1	5.1	2.3	2.0	C/B	17	3	20	377.7	*1.27*
8.8 R	7-Dec-10 14:33	15-Dec-10 12:42	190.2	5.1	5.1	2.6	2.5	B	1	1	2	380.3	*0.13*
8.9 L	7-Dec-10 13:51	15-Dec-10 11:20	189.5	5.1	5.1	2.7	2.6	C/G	0	1	1	379.0	*0.06*
8.9 MR	8-Dec-10 09:46	16-Dec-10 13:30	195.7	5.1	5.1	3.5	2.8	n/a	0	0	0	391.5	*0.00*
1.0KL	8-Dec-10 11:46	16-Dec-10 10:41	190.9	4.7	4.7	6.5	0.2	R/R	1	2	3	381.8	*0.19*
1.0KML	8-Dec-10 10:52	16-Dec-10 09:22	190.5	4.7	4.8	n/a	n/a	n/a	2	4	6	381.0	*0.38*
1.0KM	8-Dec-10 10:29	16-Dec-10 09:42	191.2	4.7	4.8	n/a	n/a	n/a	7	2	9	382.4	*0.56*
1.0KMR	8-Dec-10 11:21	16-Dec-10 10:08	190.8	4.7	4.8	n/a	n/a	n/a	83	17	100	381.6	*6.29*
1.0KR	8-Dec-10 11:59	16-Dec-10 11:07	191.1	4.7	4.7	1.8	0.7	B/C	2	5	7	382.3	*0.44*
0.8KL	8-Dec-10 12:12	16-Dec-10 11:34	191.4	4.7	4.7	2.3	0.9	C/G	1	1	2	382.7	*0.13*
0.8KML	8-Dec-10 13:38	16-Dec-10 11:20	189.7	4.7	4.9	n/a	n/a	n/a	8	15	23	379.4	*1.45*
0.8KM	8-Dec-10 13:06	16-Dec-10 11:18	190.2	4.7	4.9	n/a	n/a	n/a	10	21	31	380.4	*1.96*
0.8KMR	8-Dec-10 13:52	16-Dec-10 10:50	189.0	4.7	4.9	6.8	1.9	n/a	29	2	31	377.9	*1.97*
0.8KR	8-Dec-10 12:33	16-Dec-10 12:36	192.0	4.7	4.7	2.4	2.1	B/G	22	40	62	384.1	*3.87*
0.5KL	8-Dec-10 12:46	16-Dec-10 13:10	192.4	4.7	4.7	1.7	0.9	C/B	18	9	27	384.8	*1.68*
0.5KML	8-Dec-10 14:49	16-Dec-10 11:57	189.1	4.7	4.7	n/a	n/a	n/a	4	1	5	378.3	*0.32*
0.5KM	8-Dec-10 14:23	16-Dec-10 11:53	189.5	4.7	4.8	n/a	n/a	n/a	32	4	36	379.0	*2.28*
0.5KMR	8-Dec-10 15:16	16-Dec-10 11:38	188.4	4.7	4.8	n/a	n/a	n/a	3	0	3	376.7	*0.19*
0.5KR	8-Dec-10 12:57	16-Dec-10 13:48	192.8	4.7	4.7	1.9	0.6	B/C	0	8	8	385.7	*0.50*
0.25KL	9-Dec-10 10:55	16-Dec-10 14:14	171.3	4.7	4.7	1.9	1.8	C/G	36	30	66	342.6	*4.62*
0.25KML	9-Dec-10 12:39	16-Dec-10 08:55	164.3	4.7	4.8	3.5	n/a	n/a	14	545	559	328.5	*40.84*
0.25KM	9-Dec-10 11:31	16-Dec-10 08:52	165.3	4.7	4.8	3.5	n/a	n/a	16	20	36	330.7	*2.61*
0.25KMR	9-Dec-10 12:04	16-Dec-10 08:25	164.3	4.7	4.8	4.1	1.6	C/B	4	2	6	328.7	*0.44*
0.25KR	9-Dec-10 09:48	16-Dec-10 14:47	173.0	4.7	4.7	3.5	1.6	C/G	76	1949	2025	346.0	*140.48*
0.15KL	9-Dec-10 11:10	16-Dec-10 15:04	171.9	4.7	4.7	0.9	1.5	C/B	30	85	115	343.8	*8.03*
0.1KML	9-Dec-10 12:47	16-Dec-10 12:31	167.7	4.7	4.8	5.1	0.7	C/G	19	28	47	335.5	*3.36*
0.1KM	9-Dec-10 13:32	16-Dec-10 12:58	167.4	4.7	4.7	8.7	n/a	n/a	52	13	65	334.9	*4.66*
0.1KMR	9-Dec-10 13:03	16-Dec-10 13:01	168.0	4.7	4.7	11.3	n/a	n/a	1	23	24	335.9	*1.71*
0.1KR	9-Dec-10 10:05	16-Dec-10 15:44	173.6	4.7	4.7	n/a	n/a	n/a	13	3	16	347.3	*1.11*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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			
8.5 L	15-Dec-10 09:34	21-Dec-10 09:07	143.6	5.1	4.4	2.4	0.9	C/G	0	0	0	287.1	*0.00*
8.5 ML	15-Dec-10 11:03	21-Dec-10 10:57	143.9	5.1	4.2	6.6	1.4	n/a	4	1	5	287.8	*0.42*
8.5 M	15-Dec-10 09:50	21-Dec-10 09:07	143.3	5.1	4.2	8.0	1.4	n/a	3	5	8	286.6	*0.67*
8.5 MR	15-Dec-10 12:33	21-Dec-10 12:37	144.1	5.1	4.2	8.1	1.5	n/a	4	0	4	288.1	*0.33*
8.5R	15-Dec-10 12:20	21-Dec-10 11:21	143.0	5.1	4.4	1.8	1.0	C/G	6	0	6	286.0	*0.50*
WALD1	15-Dec-10 13:45	21-Dec-10 12:28	142.7	4.7	4.4	1.6	0.3	C/G	2	5	7	285.4	*0.59*
8.6 L	15-Dec-10 09:56	21-Dec-10 09:22	143.4	5.1	4.4	3.3	1.5	C/G	0	3	3	286.9	*0.25*
8.6 ML	15-Dec-10 11:07	21-Dec-10 10:53	143.8	5.1	4.2	6.0	2.4	n/a	1	4	5	287.5	*0.42*
8.6 M	15-Dec-10 09:46	21-Dec-10 09:02	143.3	5.1	4.2	6.9	1.7	n/a	4	2	6	286.5	*0.50*
8.6 MR	15-Dec-10 12:35	21-Dec-10 12:32	144.0	5.1	4.2	7.1	1.6	n/a	3	4	7	287.9	*0.58*
8.6 R	15-Dec-10 12:45	21-Dec-10 11:45	143.0	5.1	4.4	2.5	1.3	C/G	1	0	1	286.0	*0.08*
8.7 L	15-Dec-10 10:26	21-Dec-10 09:47	143.3	5.1	4.4	3.3	1.8	C/B	1	1	2	286.7	*0.17*
8.7 ML	15-Dec-10 11:09	21-Dec-10 10:49	143.7	5.1	4.2	4.0	2.6	C/G	0	1	1	287.3	*0.08*
8.7 M	15-Dec-10 09:42	21-Dec-10 08:57	143.3	5.1	4.2	5.0	2.3	n/a	5	6	11	286.5	*0.92*
8.7 MR	15-Dec-10 12:38	21-Dec-10 12:28	143.8	5.1	4.2	6.1	2.2	n/a	0	0	0	287.7	*0.00*
8.7 R	15-Dec-10 13:16	21-Dec-10 12:07	142.9	5.1	4.4	1.9	1.9	C/B	4	7	11	285.7	*0.92*
8.8 L	15-Dec-10 11:13	21-Dec-10 10:08	142.9	5.1	4.4	3.1	1.8	B/C	8	7	15	285.8	*1.26*
8.8 R	15-Dec-10 13:19	21-Dec-10 12:57	143.6	5.1	4.2	2.1	2.6	C	8	0	8	287.3	*0.67*
8.9 L	15-Dec-10 11:39	21-Dec-10 10:52	143.2	5.1	4.4	2.9	1.3	B/C	1	1	2	286.4	*0.17*
1.0KL	16-Dec-10 11:02	22-Dec-10 09:01	142.0	4.7	3.9	4.8	1.1	R/R	0	0	0	284.0	*0.00*
1.0KML	16-Dec-10 09:39	22-Dec-10 08:55	143.3	4.8	3.8	7.3	1.5	n/a	6	1	7	286.5	*0.59*
1.0KM	16-Dec-10 10:07	22-Dec-10 09:21	143.2	4.8	3.8	4.1	1.5	C	23	1	24	286.5	*2.01*
1.0KMR	16-Dec-10 10:46	22-Dec-10 09:51	143.1	4.8	3.8	3.9	0.6	B/C	6	2	8	286.2	*0.67*
1.0KR	16-Dec-10 11:29	22-Dec-10 09:21	141.9	4.7	3.9	2.4	1.2	B/C	2	3	5	283.7	*0.42*
0.8KL	16-Dec-10 12:31	22-Dec-10 09:44	141.2	4.7	3.9	1.7	0.9	C/G	2	0	2	282.4	*0.17*
0.8KML	16-Dec-10 12:06	22-Dec-10 10:13	142.1	4.9	3.8	3.6	1.4	C/G	10	16	26	284.2	*2.20*
0.8KM	16-Dec-10 13:18	22-Dec-10 10:52	141.6	4.8	3.8	6.5	2.0	n/a	10	2	12	283.1	*1.02*
0.8KMR	16-Dec-10 11:16	22-Dec-10 11:19	144.0	4.9	3.8	7.1	2.4	n/a	7	6	13	288.1	*1.08*
0.8KR	16-Dec-10 13:06	22-Dec-10 10:27	141.4	4.7	3.9	3.3	1.8	B/C	12	12	24	282.7	*2.04*
0.5KL	16-Dec-10 13:44	22-Dec-10 10:38	140.9	4.7	3.9	1.4	1.7	C/B	25	9	34	281.8	*2.90*
0.5KML	16-Dec-10 13:29	22-Dec-10 12:13	142.7	4.8	3.8	4.5	2.0	C/G	34	31	65	285.5	*5.46*
0.5KM	16-Dec-10 13:26	22-Dec-10 11:26	142.0	4.8	3.7	6.2	2.5	n/a	10	19	29	284.0	*2.45*
0.5KMR	16-Dec-10 11:52	22-Dec-10 11:50	144.0	4.9	3.8	4.0	2.3	C/B	0	1	1	287.9	*0.08*
0.5KR	16-Dec-10 14:08	22-Dec-10 11:09	141.0	4.7	3.9	2.3	1.0	C/B	2	2	4	282.0	*0.34*
0.25KL	16-Dec-10 14:42	22-Dec-10 11:34	140.9	4.7	3.9	2.0	2.3	C/G	157	100	257	281.7	*21.89*
0.25KML	16-Dec-10 13:47	23-Dec-10 10:24	164.6	4.8	4.1	3.8	2.3	C/G	42	37	79	329.2	*5.76*
0.25KM	16-Dec-10 13:45	22-Dec-10 13:10	143.4	4.8	3.8	2.7	2.6	C/G	11	71	82	286.8	*6.86*
0.25KMR	16-Dec-10 13:42	22-Dec-10 13:48	144.1	4.8	3.8	4.2	2.4	C/G	6	10	16	288.2	*1.33*
0.25KR	16-Dec-10 16:17	22-Dec-10 12:18	140.0	4.7	3.9	3.8	n/a	n/a	65	314	379	280.0	*32.48*
0.15KL	16-Dec-10 15:34	22-Dec-10 13:01	141.5	4.7	3.9	1.5	1.7	C	86	546	632	282.9	*53.62*
0.1KML	16-Dec-10 12:55	22-Dec-10 14:44	145.8	4.8	3.8	5.9	1.1	C/G	2	20	22	291.6	*1.81*
0.1KM	16-Dec-10 14:15	22-Dec-10 14:31	144.3	4.8	3.8	9.2	1.7	n/a	188	57	245	288.5	*20.38*
0.1KMR	16-Dec-10 14:19	22-Dec-10 14:25	144.1	4.8	3.8	4.3	2.1	n/a	25	48	73	288.2	*6.08*
0.1KR	16-Dec-10 16:00	22-Dec-10 14:05	142.1	4.7	3.9	7.0	0.5	n/a	42	19	61	284.2	*5.15*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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			
8.5 L	21-Dec-10 09:18	28-Dec-10 08:52	167.6	4.4	4.7	1.2	0.8	C/G	0	1	1	335.1	*0.07*
8.5 ML	21-Dec-10 12:18	28-Dec-10 10:08	165.8	4.3	4.1	6.8	1.6	n/a	12	18	30	331.7	*2.17*
8.5 M	21-Dec-10 10:17	28-Dec-10 08:41	166.4	4.2	4.1	8.8	1.1	n/a	1	23	24	332.8	*1.73*
8.5 MR	21-Dec-10 13:46	28-Dec-10 12:07	166.4	4.2	4.1	8.3	1.5	n/a	0	2	2	332.7	*0.14*
8.5R	21-Dec-10 11:41	28-Dec-10 11:28	167.8	4.4	4.7	2.9	0.8	C/B	3	0	3	335.6	*0.21*
WALD1	21-Dec-10 12:46	28-Dec-10 12:33	167.8	4.4	4.7	3.6	1.0	B/G	6	7	13	335.6	*0.93*
8.6 L	21-Dec-10 09:43	28-Dec-10 09:18	167.6	4.4	4.7	2.1	1.3	C/B	0	0	0	335.2	*0.00*
8.6 ML	21-Dec-10 12:21	28-Dec-10 10:12	165.9	4.3	4.1	6.4	2.0	n/a	1	16	17	331.7	*1.23*
8.6 M	21-Dec-10 10:20	28-Dec-10 08:38	166.3	4.2	4.1	7.3	2.1	n/a	3	1	4	332.6	*0.29*
8.6 MR	21-Dec-10 13:49	28-Dec-10 12:02	166.2	4.2	4.1	7.2	2.0	n/a	2	7	9	332.4	*0.65*
8.6 R	21-Dec-10 12:03	28-Dec-10 11:53	167.8	4.4	4.7	2.4	1.3	C/G	0	0	0	335.7	*0.00*
8.7 L	21-Dec-10 10:04	28-Dec-10 09:38	167.6	4.4	4.7	2.2	2.0	C/B	0	1	1	335.1	*0.07*
8.7 ML	21-Dec-10 12:23	28-Dec-10 10:17	165.9	4.3	4.1	4.2	2.2	C	lost	5	5	331.8	*0.36*
8.7 M	21-Dec-10 10:22	28-Dec-10 08:35	166.2	4.2	4.1	6.1	2.6	n/a	2	3	5	332.4	*0.36*
8.7 MR	21-Dec-10 13:51	28-Dec-10 11:57	166.1	4.2	4.1	6.2	2.6	n/a	0	4	4	332.2	*0.29*
8.7 R	21-Dec-10 12:25	28-Dec-10 12:12	167.8	4.4	4.7	1.1	1.4	B/C	6	3	9	335.6	*0.64*
8.8 L	21-Dec-10 10:47	28-Dec-10 10:00	167.2	4.4	4.7	1.8	1.5	B/C	8	1	9	334.4	*0.65*
8.8 R	21-Dec-10 13:27	28-Dec-10 13:27	168.0	4.2	4.1	1.6	0.7	B/F	30	6	36	336.0	*2.57*
8.9 L	21-Dec-10 11:12	28-Dec-10 10:36	167.4	4.4	4.7	2.2	0.2	B/C	0	0	0	334.8	*0.00*
1.0KL	22-Dec-10 09:17	29-Dec-10 09:04	167.8	3.9	3.9	5.2	n/a	n/a	2	2	4	335.6	*0.29*
1.0KML	22-Dec-10 09:17	29-Dec-10 08:45	167.5	3.8	4.0	7.8	n/a	n/a	6	9	15	334.9	*1.07*
1.0KM	22-Dec-10 09:47	29-Dec-10 09:08	167.4	3.9	3.9	4.0	n/a	n/a	13	16	29	334.7	*2.08*
1.0KMR	22-Dec-10 10:10	29-Dec-10 09:28	167.3	3.8	3.9	4.6	n/a	n/a	12	7	19	334.6	*1.36*
1.0KR	22-Dec-10 09:39	29-Dec-10 09:26	167.8	3.9	3.9	2.3	n/a	n/a	9	1	10	335.6	*0.72*
0.8KL	22-Dec-10 10:01	29-Dec-10 09:47	167.8	3.9	3.9	1.8	n/a	n/a	0	1	1	335.5	*0.07*
0.8KML	22-Dec-10 10:48	29-Dec-10 09:50	167.0	3.8	3.8	4.1	n/a	n/a	19	106	125	334.1	*8.98*
0.8KM	22-Dec-10 11:16	29-Dec-10 10:32	167.3	3.8	3.9	5.9	n/a	n/a	34	21	55	334.5	*3.95*
0.8KMR	22-Dec-10 11:45	29-Dec-10 11:03	167.3	3.8	3.9	7.0	n/a	n/a	15	23	38	334.6	*2.73*
0.8KR	22-Dec-10 10:34	29-Dec-10 10:17	167.7	3.9	3.9	2.6	n/a	n/a	43	42	85	335.4	*6.08*
0.5KL	22-Dec-10 11:04	29-Dec-10 10:49	167.8	3.9	3.9	1.7	n/a	n/a	63	40	103	335.5	*7.37*
0.5KML	22-Dec-10 12:59	29-Dec-10 11:28	166.5	3.8	3.9	4.6	n/a	n/a	234	35	269	333.0	*19.39*
0.5KM	23-Dec-10 12:04	29-Dec-10 12:18	144.2	3.7	3.7	5.9	n/a	n/a	6	9	15	288.5	*1.25*
0.5KMR	22-Dec-10 12:09	29-Dec-10 12:47	168.6	3.8	3.8	3.9	n/a	n/a	4	2	6	337.3	*0.43*
0.5KR	22-Dec-10 11:29	29-Dec-10 11:51	168.4	3.9	3.9	2.1	n/a	n/a	9	67	76	336.7	*5.42*
0.25KL	22-Dec-10 12:14	29-Dec-10 12:25	168.2	3.9	3.9	2.0	n/a	n/a	107	84	191	336.4	*13.63*
0.25KML	23-Dec-10 11:14	29-Dec-10 13:05	145.9	3.7	3.7	3.8	n/a	n/a	64	105	169	291.7	*13.90*
0.25KM	22-Dec-10 13:45	29-Dec-10 13:43	168.0	3.8	3.7	2.9	n/a	n/a	57	166	223	335.9	*15.93*
0.25KMR	22-Dec-10 14:15	29-Dec-10 14:27	168.2	3.8	3.7	4.8	n/a	n/a	9	3	12	336.4	*0.86*
0.25KR	22-Dec-10 12:55	29-Dec-10 13:18	168.4	3.9	3.9	3.9	n/a	n/a	133	279	412	336.8	*29.36*
0.1KML	22-Dec-10 15:14	29-Dec-10 14:58	167.7	3.8	3.7	6.0	n/a	n/a	9	41	50	335.5	*3.58*
0.1KM	22-Dec-10 15:14	29-Dec-10 15:19	168.1	3.8	3.7	9.7	n/a	n/a	116	31	147	336.2	*10.49*
0.1KMR	22-Dec-10 14:59	29-Dec-10 14:50	167.9	3.8	3.7	11.2	n/a	n/a	39	8	47	335.7	*3.36*
0.1KR	22-Dec-10 14:36	29-Dec-10 14:25	167.8	3.9	3.9	3.6	n/a	n/a	4	38	42	335.6	*3.00*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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			
8.5 L	28-Dec-10 09:13	4-Jan-11 08:50	167.6	4.7	3.5	1.7	0.7	C	0	1	1	335.2	*0.07*
8.5 ML	28-Dec-10 11:47	4-Jan-11 10:32	166.7	4.2	3.6	6.7	1.7	n/a	7	11	18	333.5	*1.30*
8.5 M	28-Dec-10 10:10	4-Jan-11 08:40	166.5	4.2	3.6	7.6	1.5	n/a	2	0	2	333.0	*0.14*
8.5 MR	28-Dec-10 13:18	4-Jan-11 12:53	167.6	4.2	3.6	8.1	1.4	n/a	0	2	2	335.2	*0.14*
8.5R	28-Dec-10 11:49	4-Jan-11 11:48	168.0	4.7	3.5	2.9	0.7	C/B	2	5	7	336.0	*0.50*
WALD1	28-Dec-10 12:54	4-Jan-11 13:16	168.4	4.7	3.5	2.6	0.0	C/B	3	6	9	336.7	*0.64*
8.6 L	28-Dec-10 09:32	4-Jan-11 09:19	167.8	4.7	3.5	2.1	1.2	C/G	0	2	2	335.6	*0.14*
8.6 ML	28-Dec-10 11:50	4-Jan-11 10:24	166.6	4.2	3.6	5.3	2.0	C/G	3	6	9	333.1	*0.65*
8.6 M	28-Dec-10 10:02	4-Jan-11 08:33	166.5	4.2	3.6	6.9	2.0	n/a	4	10	14	333.0	*1.01*
8.6 MR	28-Dec-10 13:20	4-Jan-11 12:47	167.4	4.2	3.6	6.5	1.7	n/a	3	20	23	334.9	*1.65*
8.6 R	28-Dec-10 12:09	4-Jan-11 12:15	168.1	4.7	3.5	2.5	1.3	C/B	2	0	2	336.2	*0.14*
8.7 L	28-Dec-10 09:56	4-Jan-11 09:48	167.9	4.7	3.5	1.6	1.3	C/B	3	0	3	335.7	*0.21*
8.7 ML	28-Dec-10 11:54	4-Jan-11 10:11	166.3	4.2	3.6	4.0	2.3	C/B	2	1	3	332.6	*0.22*
8.7 M	28-Dec-10 10:04	4-Jan-11 08:28	166.4	4.2	3.6	6.5	2.3	n/a	6	7	13	332.8	*0.94*
8.7 MR	28-Dec-10 13:22	4-Jan-11 12:41	167.3	4.2	3.6	5.9	2.3	C	0	3	3	334.6	*0.22*
8.7 R	28-Dec-10 12:29	4-Jan-11 12:44	168.2	4.7	3.5	1.2	1.3	C/B/G	14	24	38	336.5	*2.71*
8.8 L	28-Dec-10 10:30	4-Jan-11 10:25	167.9	4.7	3.5	2.4	1.8	C/G	12	3	15	335.8	*1.07*
8.8 R	28-Dec-10 13:43	4-Jan-11 13:54	168.2	4.1	3.6	2.0	2.7	B/C	1	3	4	336.4	*0.29*
8.9 L	28-Dec-10 10:53	4-Jan-11 10:52	168.0	4.7	3.5	1.5	2.3	C	0	9	9	336.0	*0.64*
1.0KL	29-Dec-10 09:21	5-Jan-11 08:52	167.5	3.9	2.6	5.7	1.4	R/R	2	3	5	335.0	*0.36*
1.0KML	29-Dec-10 09:06	5-Jan-11 08:31	167.4	3.7	2.6	7.6	1.3	n/a	16	13	29	334.8	*2.08*
1.0KM	29-Dec-10 09:26	5-Jan-11 08:56	167.5	3.7	2.6	4.2	1.6	n/a	12	42	54	335.0	*3.87*
1.0KMR	29-Dec-10 09:48	5-Jan-11 09:27	167.7	3.7	2.6	4.2	0.7	C/B/F	7	8	15	335.3	*1.07*
1.0KR	29-Dec-10 09:42	5-Jan-11 09:21	167.6	3.9	2.6	1.7	1.0	B/C	1	4	5	335.3	*0.36*
0.8KL	29-Dec-10 10:12	5-Jan-11 09:53	167.7	3.9	2.6	1.3	0.8	B/C/G	0	0	0	335.4	*0.00*
0.8KML	29-Dec-10 10:28	5-Jan-11 09:59	167.5	3.7	2.6	2.8	0.8	B/C	11	23	34	335.0	*2.44*
0.8KM	29-Dec-10 10:39	5-Jan-11 10:34	167.9	3.7	2.6	5.4	2.3	B/C	66	30	96	335.8	*6.86*
0.8KMR	29-Dec-10 11:25	5-Jan-11 11:11	167.8	3.7	2.6	6.2	2.2	n/a	24	14	38	335.5	*2.72*
0.8KR	29-Dec-10 10:41	5-Jan-11 10:14	167.5	3.9	2.6	1.9	1.5	B/C	60	134	194	335.1	*13.89*
0.5KL	29-Dec-10 11:18	5-Jan-11 10:48	167.5	3.9	2.6	1.4	1.4	C/B	89	3	92	335.0	*6.59*
0.5KML	29-Dec-10 12:15	5-Jan-11 11:49	167.6	3.7	2.6	4.5	2.0	B/C	83	22	105	335.1	*7.52*
0.5KM	29-Dec-10 12:42	6-Jan-11 11:39	191.0	3.7	2.6	5.8	2.5	n/a	7	26	33	381.9	*2.07*
0.5KMR	29-Dec-10 13:02	5-Jan-11 12:29	167.4	3.7	2.6	2.5	2.7	B/C	7	3	10	334.9	*0.72*
0.5KR	29-Dec-10 12:21	5-Jan-11 11:37	167.3	3.9	2.6	1.7	0.7	B/C/G	0	6	6	334.5	*0.43*
0.25KL	29-Dec-10 13:10	5-Jan-11 12:02	166.9	3.9	2.6	1.6	1.9	C/G/B	95	93	188	333.7	*13.52*
0.25KML	29-Dec-10 13:41	5-Jan-11 12:53	167.2	3.7	2.6	3.3	2.3	C/B/G	18	192	210	334.4	*15.07*
0.25KM	29-Dec-10 14:24	5-Jan-11 13:45	167.3	3.7	2.6	2.5	2.6	C/B	702	139	841	334.7	*60.30*
0.25KMR	29-Dec-10 14:46	5-Jan-11 14:52	168.1	3.6	2.6	4.1	2.6	C/G	11	39	50	336.2	*3.57*
0.25KR	29-Dec-10 14:18	5-Jan-11 12:42	166.4	3.9	2.6	3.5	1.6	C/B	97	216	313	332.8	*22.57*
0.1KML	29-Dec-10 15:26	5-Jan-11 14:09	166.7	3.9	2.6	5.6	1.1	n/a	44	6	50	333.4	*3.60*
0.1KM	29-Dec-10 16:00	6-Jan-11 10:28	186.5	3.7	2.6	9.7	2.1	n/a	39	54	93	372.9	*5.98*
0.1KMR	29-Dec-10 15:17	6-Jan-11 11:04	187.8	3.7	2.6	11.4	2.2	n/a	49	11	60	375.6	*3.83*
0.1KR	29-Dec-10 14:53	5-Jan-11 13:47	166.9	3.9	2.6	3.5	0.7	G/C/F	3	6	9	333.8	*0.65*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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)
8.5 L	4-Jan-11 09:14	11-Jan-11 09:48	168.6	3.5	3.1	2.3	1.7	C/G	0	4	4	337.1	*0.28*
8.5 ML	4-Jan-11 12:28	11-Jan-11 11:41	167.2	3.5	2.9	7.2	2.0	n/a	4	5	9	334.4	*0.65*
8.5 M	4-Jan-11 10:07	11-Jan-11 09:36	167.5	3.5	2.9	7.9	2.2	n/a	24	4	28	335.0	*2.01*
8.5 MR	4-Jan-11 14:32	11-Jan-11 14:03	167.5	3.5	2.9	8.0	1.7	n/a	5	13	18	335.0	*1.29*
8.5R	4-Jan-11 12:10	11-Jan-11 12:40	168.5	3.5	3.1	2.2	1.6	G/C	9	21	30	337.0	*2.14*
WALD1	4-Jan-11 13:48	11-Jan-11 14:00	168.2	3.5	3.1	1.6	0.9	C/G	2	1	3	336.4	*0.21*
8.6 L	4-Jan-11 09:40	11-Jan-11 10:15	168.6	3.5	3.1	2.5	1.6	G/C	4	2	6	337.2	*0.43*
8.6 ML	4-Jan-11 12:32	11-Jan-11 11:47	167.3	3.5	2.9	5.9	2.7	n/a	2	4	6	334.5	*0.43*
8.6 M	4-Jan-11 10:11	11-Jan-11 09:30	167.3	3.5	2.9	7.1	2.3	n/a	4	7	11	334.6	*0.79*
8.6 MR	4-Jan-11 14:37	11-Jan-11 13:57	167.3	3.5	2.9	6.7	1.9	n/a	2	21	23	334.7	*1.65*
8.6 R	4-Jan-11 12:34	11-Jan-11 13:08	168.6	3.5	3.1	2.3	2.6	C/G	3	6	9	337.1	*0.64*
8.7 L	4-Jan-11 10:14	11-Jan-11 10:42	168.5	3.5	3.1	1.8	1.7	C/G	4	2	6	336.9	*0.43*
8.7 ML	4-Jan-11 12:37	11-Jan-11 11:55	167.3	3.5	2.9	4.2	3.2	n/a	2	3	5	334.6	*0.36*
8.7 M	4-Jan-11 10:15	11-Jan-11 09:36	167.3	3.5	2.9	6.1	2.9	n/a	3	2	5	334.7	*0.36*
8.7 MR	4-Jan-11 14:40	11-Jan-11 13:48	167.1	3.5	2.9	4.8	2.6	g/c	1	0	1	334.3	*0.07*
8.7 R	4-Jan-11 13:09	11-Jan-11 13:34	168.4	3.5	3.1	1.8	2.3	C/G	13	17	30	336.8	*2.14*
8.8 L	4-Jan-11 10:47	11-Jan-11 11:06	168.3	3.5	3.1	2.0	2.1	C/G	28	8	36	336.6	*2.57*
8.8 R	4-Jan-11 14:21	11-Jan-11 14:32	168.2	3.5	3.1	1.9	2.6	C/G	28	4	32	336.4	*2.28*
8.9 L	4-Jan-11 11:16	11-Jan-11 11:34	168.3	3.5	3.1	2.6	0.2	C/F	1	2	3	336.6	*0.21*
1.0KL	5-Jan-11 09:17	12-Jan-11 09:36	168.3	2.6	2.6	4.2	0.5	R/R	7	1	8	336.6	*0.57*
1.0KML	5-Jan-11 08:54	12-Jan-11 09:02	168.1	2.6	1.9	7.6	0.8	n/a	0	2	2	336.3	*0.14*
1.0KM	5-Jan-11 09:26	12-Jan-11 09:32	168.1	2.6	1.9	3.4	0.7	G/C	5	4	9	336.2	*0.64*
1.0KMR	5-Jan-11 09:57	12-Jan-11 10:08	168.2	2.6	1.9	4.0	0.3	B/C	1	0	1	336.4	*0.07*
1.0KR	5-Jan-11 09:47	12-Jan-11 10:04	168.3	2.6	2.6	1.5	0.5	B/C	1	5	6	336.6	*0.43*
0.8KL	5-Jan-11 10:10	12-Jan-11 10:23	168.2	2.6	2.6	2.0	0.5	C/G	0	0	0	336.4	*0.00*
0.8KML	5-Jan-11 10:31	12-Jan-11 10:38	168.1	2.6	1.9	2.9	0.9	C/G	3	2	5	336.2	*0.36*
0.8KM	5-Jan-11 11:08	12-Jan-11 11:05	168.0	2.6	1.9	4.7	1.6	B/C	165	16	181	335.9	*12.93*
0.8KMR	5-Jan-11 11:43	12-Jan-11 11:42	168.0	2.6	1.9	5.7	1.5	n/a	18	5	23	336.0	*1.64*
0.8KR	5-Jan-11 10:45	12-Jan-11 10:43	168.0	2.6	2.6	2.0	1.0	B/C	3	45	48	335.9	*3.43*
0.5KL	5-Jan-11 11:00	12-Jan-11 11:11	168.2	2.6	2.6	0.8	0.9	C/G	23	3	26	336.4	*1.86*
0.5KML	5-Jan-11 12:27	12-Jan-11 12:18	167.8	2.6	1.9	3.9	1.3	B/C	30	2	32	335.7	*2.29*
0.5KM	6-Jan-11 12:30	12-Jan-11 12:51	144.3	2.6	1.9	5.1	1.6	C/G	59	6	65	288.7	*5.40*
0.5KMR	5-Jan-11 12:50	12-Jan-11 13:29	168.7	2.6	1.9	3.6	1.6	C/G	10	8	18	337.3	*1.28*
0.5KR	5-Jan-11 11:58	12-Jan-11 12:10	168.2	2.6	2.6	1.6	0.8	C/B	1	1	2	336.4	*0.14*
0.25KL	5-Jan-11 12:35	12-Jan-11 12:23	167.8	2.6	2.6	1.1	1.2	C/G	105	38	143	335.6	*10.23*
0.25KML	5-Jan-11 13:41	12-Jan-11 13:52	168.2	2.6	1.9	3.1	1.4	C	39	515	554	336.4	*39.53*
0.25KM	5-Jan-11 15:14	13-Jan-11 10:20	187.1	2.6	2.6	2.2	1.6	C/G	71	745	816	374.2	*52.34*
0.25KMR	5-Jan-11 15:22	13-Jan-11 11:34	188.2	2.6	2.6	3.9	1.6	C/G	89	238	327	376.4	*20.85*
0.25KR	5-Jan-11 13:40	12-Jan-11 13:23	167.7	2.6	2.6	3.7	0.8	C/G	20	141	161	335.4	*11.52*
0.1KML	5-Jan-11 14:42	12-Jan-11 14:35	167.9	2.6	2.6	4.6	0.8	G/C	1	5	6	335.8	*0.43*
0.1KM	6-Jan-11 11:02	13-Jan-11 12:35	169.5	2.6	2.6	9.1	0.9	n/a	201	30	231	339.1	*16.35*
0.1KMR	6-Jan-11 11:30	13-Jan-11 13:19	169.8	2.6	2.6	10.8	1.2	n/a	9	7	16	339.6	*1.13*
0.1KR	5-Jan-11 14:05	12-Jan-11 14:07	168.0	2.6	2.6	4.1	0.3	G/F	2	8	10	336.1	*0.71*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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)
8.5 L	11-Jan-11 10:09	18-Jan-11 08:44	166.6	3.1	3.4	2.0	1.1	C/G	3	3	6	333.2	*0.43*
8.5 ML	11-Jan-11 13:37	18-Jan-11 11:08	165.5	2.9	3.2	6.5	2.3	n/a	3	3	6	331.0	*0.44*
8.5 M	11-Jan-11 11:22	18-Jan-11 08:56	165.6	2.9	3.2	8.7	1.9	n/a	31	1	32	331.1	*2.32*
8.5 MR	11-Jan-11 15:29	18-Jan-11 13:04	165.6	2.9	3.2	8.6	1.7	n/a	14	16	30	331.2	*2.17*
8.5R	11-Jan-11 13:03	18-Jan-11 11:59	166.9	3.1	3.4	3.2	1.5	C/G	19	43	62	333.9	*4.46*
WALD1	11-Jan-11 14:24	18-Jan-11 13:48	167.4	3.1	3.4	3.2	1.8	B/C	4	3	7	334.8	*0.50*
8.6 L	11-Jan-11 10:34	18-Jan-11 09:10	166.6	3.1	3.4	2.4	1.4	C/G	0	1	1	333.2	*0.07*
8.6 ML	11-Jan-11 13:40	18-Jan-11 11:04	165.4	2.9	3.2	5.6	2.5	n/a	2	1	3	330.8	*0.22*
8.6 M	11-Jan-11 11:30	18-Jan-11 08:49	165.3	2.9	3.2	7.7	2.0	n/a	2	1	3	330.6	*0.22*
8.6 MR	11-Jan-11 15:33	18-Jan-11 12:59	165.4	2.9	3.2	7.7	2.0	n/a	2	3	5	330.9	*0.36*
8.6 R	11-Jan-11 13:27	18-Jan-11 12:49	167.4	3.1	3.4	2.8	1.4	G/C	0	8	8	334.7	*0.57*
8.7 L	11-Jan-11 11:01	18-Jan-11 10:01	167.0	3.1	3.4	1.7	1.9	C/B	7	1	8	334.0	*0.57*
8.7 ML	11-Jan-11 13:43	18-Jan-11 10:58	165.2	2.9	3.2	4.3	2.6	n/a	2	3	5	330.5	*0.36*
8.7 M	11-Jan-11 11:36	18-Jan-11 08:43	165.1	2.9	3.2	6.4	2.7	n/a	3	8	11	330.2	*0.80*
8.7 MR	11-Jan-11 15:36	18-Jan-11 12:52	165.3	2.9	3.2	6.3	2.8	n/a	0	2	2	330.5	*0.15*
8.7 R	11-Jan-11 13:56	18-Jan-11 13:19	167.4	3.1	3.4	2.9	2.3	C/G	7	8	15	334.8	*1.08*
8.8 L	11-Jan-11 11:34	18-Jan-11 10:28	166.9	3.1	3.4	2.4	1.8	C/B	13	4	17	333.8	*1.22*
8.8 R	11-Jan-11 15:59	18-Jan-11 14:14	166.2	3.1	3.4	2.8	2.7	C/B	12	0	12	332.5	*0.87*
8.9 L	11-Jan-11 12:00	18-Jan-11 11:00	167.0	3.1	3.4	2.6	0.5	G/C	1	0	1	334.0	*0.07*
1.0KL	12-Jan-11 09:58	19-Jan-11 08:53	166.9	2.6	2.6	6.5	0.1	B/C	2	0	2	333.8	*0.14*
1.0KML	12-Jan-11 09:29	19-Jan-11 12:39	171.2	1.9	2.4	9.0	1.1	n/a	5	2	7	342.3	*0.49*
1.0KM	12-Jan-11 10:06	19-Jan-11 12:43	170.6	1.9	2.4	3.8	1.1	G/C	21	24	45	341.2	*3.16*
1.0KMR	12-Jan-11 10:35	19-Jan-11 12:46	170.2	1.9	2.4	4.0	0.3	C/B	1	2	3	340.4	*0.21*
1.0KR	12-Jan-11 10:19	19-Jan-11 09:13	166.9	2.6	2.6	2.0	0.9	B/C	0	3	3	333.8	*0.22*
0.8KL	12-Jan-11 10:37	19-Jan-11 09:36	167.0	2.6	2.6	1.7	0.5	C/B	0	0	0	334.0	*0.00*
0.8KML	12-Jan-11 11:02	19-Jan-11 11:27	168.4	1.9	2.4	3.9	0.9	C/F	4	2	6	336.8	*0.43*
0.8KM	12-Jan-11 11:40	19-Jan-11 11:23	167.7	1.9	2.4	5.3	1.6	C/B	64	11	75	335.4	*5.37*
0.8KMR	12-Jan-11 12:15	19-Jan-11 11:20	167.1	1.9	2.4	7.1	1.3	n/a	6	4	10	334.2	*0.72*
0.8KR	12-Jan-11 11:07	19-Jan-11 09:56	166.8	2.6	2.6	2.3	1.1	B/C	2	13	15	333.6	*1.08*
0.5KL	12-Jan-11 11:35	19-Jan-11 10:17	166.7	2.6	2.6	1.8	1.1	C/B	9	3	12	333.4	*0.86*
0.5KML	12-Jan-11 12:49	19-Jan-11 10:28	165.7	1.9	2.4	4.7	1.3	B/C	8	2	10	331.3	*0.72*
0.5KM	12-Jan-11 13:35	19-Jan-11 10:31	164.9	1.9	2.4	5.8	1.6	C/G	4	35	39	329.9	*2.84*
0.5KMR	12-Jan-11 13:50	19-Jan-11 10:33	164.7	1.9	2.4	4.5	1.5	C/B	18	2	20	329.4	*1.46*
0.5KR	12-Jan-11 12:29	19-Jan-11 10:40	166.2	2.6	2.6	2.7	0.7	C/B	2	2	4	332.4	*0.29*
0.25KL	12-Jan-11 13:17	19-Jan-11 11:55	166.6	2.6	2.6	1.5	1.2	C/G	63	29	92	333.3	*6.63*
0.25KML	12-Jan-11 15:04	19-Jan-11 08:45	161.7	1.7	2.4	3.9	1.7	C/G	95	41	136	323.4	*10.09*
0.25KM	13-Jan-11 11:29	19-Jan-11 09:38	142.1	1.7	2.4	2.7	1.2	C/G	189	156	345	284.3	*29.12*
0.25KMR	13-Jan-11 12:30	19-Jan-11 09:28	141.0	1.7	2.4	4.8	1.7	C/G	18	4	22	281.9	*1.87*
0.25KR	12-Jan-11 14:01	19-Jan-11 11:26	165.4	2.6	2.6	3.9	0.7	C/B	13	10	23	330.8	*1.67*
0.1KML	12-Jan-11 14:59	19-Jan-11 12:53	165.9	2.6	2.6	5.8	1.0	C/G	0	1	1	331.8	*0.07*
0.1KM	13-Jan-11 13:16	19-Jan-11 13:20	144.1	1.7	2.6	9.9	1.1	n/a	16	7	23	288.1	*1.92*
0.1KMR	13-Jan-11 13:48	19-Jan-11 13:54	144.1	1.7	2.6	11.4	0.9	n/a	12	10	22	288.2	*1.83*
0.1KR	12-Jan-11 14:31	19-Jan-11 12:28	165.9	2.6	2.6	6.0	0.1	G/B	4	15	19	331.9	*1.37*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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)
8.5 L	18-Jan-11 09:06	25-Jan-11 08:41	167.6	3.4	3.4	1.9	1.3	C/B	0	1	1	335.2	*0.07*
8.5 ML	18-Jan-11 12:40	25-Jan-11 11:03	166.4	3.2	3.0	7.4	2.1	n/a	0	3	3	332.8	*0.22*
8.5 M	18-Jan-11 10:46	25-Jan-11 08:59	166.2	3.2	3.0	9.2	1.6	n/a	1	2	3	332.4	*0.22*
8.5 MR	18-Jan-11 15:06	25-Jan-11 13:17	166.2	3.2	3.0	8.7	1.8	n/a	7	8	15	332.4	*1.08*
8.5R	18-Jan-11 12:42	25-Jan-11 00:00	155.3	3.4	3.4	3.2	2.0	C/G	12	5	17	310.6	*1.31*
WALD1	18-Jan-11 14:06	25-Jan-11 13:22	167.3	3.4	3.4	2.7	1.1	C/B	8	7	15	334.5	*1.08*
8.6 L	18-Jan-11 09:23	25-Jan-11 09:05	167.7	3.4	3.4	2.6	1.7	C/G	1	0	1	335.4	*0.07*
8.6 ML	18-Jan-11 12:44	25-Jan-11 10:57	166.2	3.2	3.0	6.2	2.5	n/a	0	2	2	332.4	*0.14*
8.6 M	18-Jan-11 10:51	25-Jan-11 08:53	166.0	3.2	3.0	7.7	2.0	n/a	38	1	39	332.1	*2.82*
8.6 MR	18-Jan-11 15:09	25-Jan-11 13:11	166.0	3.2	3.0	7.6	2.2	n/a	2	9	11	332.1	*0.80*
8.6 R	18-Jan-11 13:12	25-Jan-11 12:08	166.9	3.4	3.4	3.0	1.6	C/G	0	3	3	333.9	*0.22*
8.7 L	18-Jan-11 10:24	25-Jan-11 09:30	167.1	3.4	3.4	2.2	1.7	B/C	4	1	5	334.2	*0.36*
8.7 ML	18-Jan-11 12:40	25-Jan-11 10:52	166.2	3.2	3.0	4.7	2.8	n/a	2	3	5	332.4	*0.36*
8.7 M	18-Jan-11 10:54	25-Jan-11 08:48	165.9	3.2	3.0	6.2	2.5	n/a	2	9	11	331.8	*0.80*
8.7 MR	18-Jan-11 15:14	25-Jan-11 13:05	165.8	3.2	3.0	6.2	2.8	n/a	0	1	1	331.7	*0.07*
8.7 R	18-Jan-11 13:42	25-Jan-11 12:46	167.1	3.4	3.4	1.8	2.0	B/G	4	10	14	334.1	*1.01*
8.8 L	18-Jan-11 10:53	25-Jan-11 10:00	167.1	3.4	3.4	2.2	1.5	B/C	9	1	10	334.2	*0.72*
8.8 R	18-Jan-11 14:40	25-Jan-11 13:55	167.3	3.4	3.4	2.8	3.0	B/G	5	0	5	334.5	*0.36*
8.9 L	18-Jan-11 12:44	25-Jan-11 10:31	165.8	3.4	3.4	4.5	2.2	B/G	0	0	0	331.6	*0.00*
1.0KL	19-Jan-11 09:07	26-Jan-11 08:29	167.4	2.6	3.4	5.2	0.4	R/R	0	1	1	334.7	*0.07*
1.0KML	19-Jan-11 13:59	26-Jan-11 08:19	162.3	2.4	2.8	7.6	1.0	n/a	2	2	4	324.7	*0.30*
1.0KM	19-Jan-11 14:02	26-Jan-11 08:43	162.7	2.4	2.8	4.3	1.3	C/G	18	23	41	325.4	*3.02*
1.0KMR	19-Jan-11 14:05	26-Jan-11 09:07	163.0	2.4	2.8	3.9	0.4	G/C	10	3	13	326.1	*0.96*
1.0KR	19-Jan-11 09:32	26-Jan-11 08:46	167.2	2.6	3.4	2.4	0.7	B/C	0	0	0	334.5	*0.00*
0.8KL	19-Jan-11 09:50	26-Jan-11 09:03	167.2	2.6	3.4	1.8	0.5	B/C	0	0	0	334.4	*0.00*
0.8KML	19-Jan-11 14:08	26-Jan-11 09:27	163.3	2.4	2.8	3.7	0.7	C/B	3	4	7	326.6	*0.51*
0.8KM	19-Jan-11 14:11	26-Jan-11 09:57	163.8	2.4	2.8	5.5	1.5	B/C	70	2	72	327.5	*5.28*
0.8KMR	19-Jan-11 14:14	26-Jan-11 10:32	164.3	2.4	2.8	6.7	1.5	C/B	8	6	14	328.6	*1.02*
0.8KR	19-Jan-11 10:13	26-Jan-11 09:18	167.1	2.6	3.4	2.1	0.9	B/G	5	9	14	334.2	*1.01*
0.5KL	19-Jan-11 10:36	26-Jan-11 09:41	167.1	2.6	3.4	1.9	1.0	C/B	2	0	2	334.2	*0.14*
0.5KML	19-Jan-11 14:25	26-Jan-11 11:00	164.6	2.4	2.8	4.6	1.3	B	11	49	60	329.2	*4.37*
0.5KM	19-Jan-11 14:27	26-Jan-11 11:35	165.1	2.4	2.8	6.1	1.4	C/B	49	13	62	330.3	*4.51*
0.5KMR	19-Jan-11 14:37	26-Jan-11 12:06	165.5	2.4	2.8	4.2	1.5	C/B	4	12	16	331.0	*1.16*
0.5KR	19-Jan-11 10:56	26-Jan-11 10:21	167.4	2.6	3.4	1.8	0.7	B/C	0	1	1	334.8	*0.07*
0.25KL	19-Jan-11 12:23	26-Jan-11 10:42	166.3	2.6	3.4	1.8	1.1	C/B	107	10	117	332.6	*8.44*
0.25KML	19-Jan-11 14:37	26-Jan-11 12:41	166.1	2.4	2.8	3.9	1.4	C/B	67	40	107	332.1	*7.73*
0.25KM	19-Jan-11 14:40	26-Jan-11 13:24	166.7	2.4	2.8	2.9	1.3	B/G	6	89	95	333.5	*6.84*
0.25KMR	19-Jan-11 14:42	26-Jan-11 13:56	167.2	2.4	2.8	4.6	1.5	C/G	3	10	13	334.5	*0.93*
0.25KR	19-Jan-11 11:50	26-Jan-11 11:16	167.4	2.6	3.4	4.4	0.8	C/G	9	5	14	334.9	*1.00*
0.1KML	19-Jan-11 13:16	26-Jan-11 13:19	168.0	2.6	3.4	6.0	0.7	n/a	0	0	0	336.1	*0.00*
0.1KM	19-Jan-11 13:51	26-Jan-11 12:44	166.9	2.6	3.4	9.5	1.0	n/a	38	3	41	333.8	*2.95*
0.1KMR	19-Jan-11 14:00	26-Jan-11 12:19	166.3	2.6	3.4	11.5	1.2	n/a	1	10	11	332.6	*0.79*
0.1KR	19-Jan-11 12:49	26-Jan-11 11:45	166.9	2.6	3.4	6.9	0.3	B/F	0	5	5	333.9	*0.36*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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			
8.5 L	25-Jan-11 09:02	1-Feb-11 08:48	167.8	3.4	3.1	2.0	1.0	C/G	0	0	0	335.5	*0.00*
8.5 ML	25-Jan-11 12:54	1-Feb-11 11:00	166.1	3.0	2.6	7.7	2.2	n/a	0	1	1	332.2	*0.07*
8.5 M	25-Jan-11 10:42	1-Feb-11 08:58	166.3	3.0	2.6	9.9	1.8	n/a	7	1	8	332.5	*0.58*
8.5 MR	25-Jan-11 14:58	1-Feb-11 13:03	166.1	3.0	2.7	9.1	1.4	n/a	1	5	6	332.2	*0.43*
8.5R	25-Jan-11 12:06	1-Feb-11 11:13	167.1	3.4	3.1	3.3	1.5	C/G	6	5	11	334.2	*0.79*
WALD1	25-Jan-11 13:47	1-Feb-11 12:36	166.8	3.4	3.1	1.3	1.0	C	0	1	1	333.6	*0.07*
8.6 L	25-Jan-11 09:25	1-Feb-11 09:12	167.8	3.4	3.1	2.2	1.5	C/G	0	0	0	335.6	*0.00*
8.6 ML	25-Jan-11 12:57	1-Feb-11 10:55	166.0	3.0	2.6	6.4	2.5	n/a	0	0	0	331.9	*0.00*
8.6 M	25-Jan-11 10:45	1-Feb-11 08:51	166.1	3.0	2.6	8.1	1.9	n/a	2	1	3	332.2	*0.22*
8.6 MR	25-Jan-11 14:54	1-Feb-11 12:57	166.0	3.0	2.7	7.9	2.4	n/a	2	0	2	332.1	*0.14*
8.6 R	25-Jan-11 12:41	1-Feb-11 11:46	167.1	3.4	3.1	1.9	1.5	C/G	0	0	0	334.2	*0.00*
8.7 L	25-Jan-11 09:57	1-Feb-11 09:35	167.6	3.4	3.1	2.3	2.2	C/B	1	0	1	335.3	*0.07*
8.7 ML	25-Jan-11 13:01	1-Feb-11 10:48	165.8	3.0	2.6	5.2	2.6	n/a	2	1	3	331.6	*0.22*
8.7 M	25-Jan-11 10:48	1-Feb-11 08:44	165.9	3.0	2.6	6.8	3.1	n/a	3	2	5	331.9	*0.36*
8.7 MR	25-Jan-11 14:59	1-Feb-11 12:52	165.9	3.0	2.7	6.5	3.1	n/a	0	2	2	331.8	*0.14*
8.7 R	25-Jan-11 13:16	1-Feb-11 12:14	167.0	3.4	3.1	2.1	2.5	C/B	0	0	0	333.9	*0.00*
8.8 L	25-Jan-11 10:20	1-Feb-11 10:01	167.7	3.4	3.1	1.8	1.8	C/B	4	0	4	335.4	*0.29*
8.8 R	25-Jan-11 14:24	1-Feb-11 13:01	166.6	3.4	3.1	2.5	2.3	C/B	2	0	2	333.2	*0.14*
8.9 L	25-Jan-11 10:48	1-Feb-11 10:31	167.7	3.4	3.1	2.6	2.4	C/B	0	0	0	335.4	*0.00*
1.0KL	26-Jan-11 08:42	2-Feb-11 08:50	168.1	3.4	2.6	4.5	0.7	R/R	1	0	1	336.3	*0.07*
1.0KML	26-Jan-11 08:41	2-Feb-11 08:31	167.8	2.8	2.2	8.0	1.0	n/a	1	0	1	335.7	*0.07*
1.0KM	26-Jan-11 09:06	2-Feb-11 08:52	167.8	2.2	2.8	4.0	0.9	C/G	1	4	5	335.5	*0.36*
1.0KMR	26-Jan-11 09:24	2-Feb-11 09:15	167.8	2.2	2.8	4.1	0.5	C/F	0	1	1	335.7	*0.07*
1.0KR	26-Jan-11 08:59	2-Feb-11 09:09	168.2	3.4	2.6	2.4	0.6	B/C	0	0	0	336.3	*0.00*
0.8KL	26-Jan-11 09:15	2-Feb-11 09:25	168.2	3.4	2.6	2.3	0.5	C/B	0	0	0	336.3	*0.00*
0.8KML	26-Jan-11 09:55	2-Feb-11 09:40	167.8	2.8	2.2	3.7	1.2	C/G	2	0	2	335.5	*0.14*
0.8KM	26-Jan-11 10:25	2-Feb-11 10:00	167.6	2.8	2.2	5.1	1.3	C/B	7	3	10	335.2	*0.72*
0.8KMR	26-Jan-11 10:58	2-Feb-11 10:24	167.4	2.8	2.2	6.8	1.5	n/a	1	4	5	334.9	*0.36*
0.8KR	26-Jan-11 09:36	2-Feb-11 09:41	168.1	3.4	2.6	2.4	0.7	B/C	3	0	3	336.2	*0.21*
0.5KL	26-Jan-11 09:57	2-Feb-11 09:57	168.0	3.4	2.6	1.6	0.8	C/G	1	1	2	336.0	*0.14*
0.5KML	26-Jan-11 11:32	2-Feb-11 10:51	167.3	2.8	2.2	4.1	1.4	C/B	2	7	9	334.6	*0.65*
0.5KM	26-Jan-11 12:03	2-Feb-11 11:30	167.4	2.8	2.2	5.7	1.6	C/B	6	5	11	334.9	*0.79*
0.5KMR	26-Jan-11 12:38	2-Feb-11 11:58	167.3	2.8	2.2	3.4	1.4	B/C	8	0	8	334.7	*0.57*
0.5KR	26-Jan-11 10:38	2-Feb-11 10:17	167.6	3.4	2.6	1.7	0.3	C/B	0	0	0	335.3	*0.00*
0.25KL	26-Jan-11 11:12	2-Feb-11 10:33	167.3	3.4	2.6	2.0	1.1	G/C	17	0	17	334.7	*1.22*
0.25KML	26-Jan-11 13:22	2-Feb-11 12:25	167.1	2.8	2.2	3.1	1.0	G/C	18	28	46	334.1	*3.30*
0.25KM	26-Jan-11 13:55	2-Feb-11 13:04	167.2	2.8	2.2	1.8	1.8	G/C	2	38	40	334.3	*2.87*
0.25KMR	26-Jan-11 14:42	2-Feb-11 13:36	166.9	2.8	2.2	4.4	1.6	G/C	11	2	13	333.8	*0.93*
0.25KR	26-Jan-11 11:38	2-Feb-11 10:55	167.3	3.4	2.6	4.7	0.9	C/G	4	3	7	334.6	*0.50*
0.1KML	26-Jan-11 13:41	2-Feb-11 12:54	167.2	3.4	2.6	5.5	0.9	G/C	0	1	1	334.4	*0.07*
0.1KM	26-Jan-11 13:17	2-Feb-11 12:31	167.2	3.4	2.6	9.7	1.3	n/a	1	11	12	334.5	*0.86*
0.1KMR	26-Jan-11 12:42	2-Feb-11 12:10	167.5	3.4	2.6	11.6	1.6	n/a	2	7	9	334.9	*0.64*
0.1KR	26-Jan-11 12:15	2-Feb-11 11:47	167.5	3.4	2.6	6.2	0.3	G/B	3	1	4	335.1	*0.29*

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D2: 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			
8.5 L	1-Feb-11 09:08	8-Feb-11 08:55	167.8	3.1	2.9	1.5	1.0	G/C	0	0	0	335.6	*0.00*
8.5 ML	1-Feb-11 12:40	8-Feb-11 10:32	165.9	2.6	2.6	6.9	1.7	n/a	1	1	2	331.7	*0.14*
8.5 M	1-Feb-11 10:37	8-Feb-11 09:01	166.4	2.6	2.6	8.5	1.2	n/a	2	0	2	332.8	*0.14*
8.5 MR	1-Feb-11 14:36	8-Feb-11 12:03	165.5	2.6	2.6	7.9	1.3	n/a	4	1	5	330.9	*0.36*
8.5R	1-Feb-11 11:41	8-Feb-11 10:42	167.0	3.1	2.9	3.7	0.7	G/C	1	3	4	334.0	*0.29*
WALD1	1-Feb-11 12:51	8-Feb-11 11:44	166.9	3.1	2.9	1.0	1.1	C/F	0	0	0	333.8	*0.00*
8.6 L	1-Feb-11 09:30	8-Feb-11 09:12	167.7	3.1	2.9	1.9	1.3	G/C	0	1	1	335.4	*0.07*
8.6 ML	1-Feb-11 12:43	8-Feb-11 10:27	165.7	2.6	2.6	6.2	2.1	n/a	0	0	0	331.5	*0.00*
8.6 M	1-Feb-11 10:40	8-Feb-11 08:54	166.2	2.6	2.6	7.2	1.9	n/a	6	0	6	332.5	*0.43*
8.6 MR	1-Feb-11 14:40	8-Feb-11 11:58	165.3	2.6	2.6	7.2	2.7	n/a	0	2	2	330.6	*0.15*
8.6 R	1-Feb-11 12:07	8-Feb-11 11:09	167.0	3.1	2.9	2.0	1.7	G/C	0	0	0	334.1	*0.00*
8.7 L	1-Feb-11 09:58	8-Feb-11 09:29	167.5	3.1	2.9	2.9	1.8	C/G	0	1	1	335.0	*0.07*
8.7 ML	1-Feb-11 00:48	8-Feb-11 10:18	177.5	2.6	2.6	4.1	2.5	C/G	1	0	1	355.0	*0.07*
8.7 M	1-Feb-11 10:45	8-Feb-11 08:49	166.1	2.6	2.6	6.0	2.4	n/a	0	1	1	332.1	*0.07*
8.7 MR	1-Feb-11 14:47	8-Feb-11 11:52	165.1	2.6	2.6	5.9	2.8	n/a	0	0	0	330.2	*0.00*
8.7 R	1-Feb-11 12:32	8-Feb-11 11:24	166.9	3.1	2.9	1.7	1.9	C/B	0	0	0	333.7	*0.00*
8.8 L	1-Feb-11 10:24	8-Feb-11 09:46	167.4	3.1	2.9	1.9	1.6	G/C	0	0	0	334.7	*0.00*
8.8 R	1-Feb-11 13:31	8-Feb-11 12:07	166.6	3.1	2.9	1.9	2.3	C/B	1	0	1	333.2	*0.07*
8.9 L	1-Feb-11 11:09	8-Feb-11 10:06	166.9	3.1	2.9	2.3	1.7	B/C	0	0	0	333.9	*0.00*
1.0KL	2-Feb-11 09:05	9-Feb-11 08:40	167.6	2.6	2.6	6.1	1.2	R/R	0	0	0	335.2	*0.00*
1.0KML	2-Feb-11 08:50	9-Feb-11 08:39	167.8	2.2	2.4	6.7	1.0	C/G	0	0	0	335.6	*0.00*
1.0KM	2-Feb-11 09:12	9-Feb-11 09:00	167.8	2.2	2.4	3.2	1.0	G/C	2	0	2	335.6	*0.14*
1.0KMR	2-Feb-11 09:38	9-Feb-11 09:23	167.8	2.2	2.4	3.5	0.9	B/F	1	4	5	335.5	*0.36*
1.0KR	2-Feb-11 09:22	9-Feb-11 08:55	167.6	2.6	2.6	2.6	0.9	B/C	0	0	0	335.1	*0.00*
0.8KL	2-Feb-11 09:37	9-Feb-11 09:07	167.5	2.6	2.6	2.1	0.5	C/B	0	0	0	335.0	*0.00*
0.8KML	2-Feb-11 09:57	9-Feb-11 09:49	167.9	2.2	2.4	2.9	0.9	G/C	2	2	4	335.7	*0.29*
0.8KM	2-Feb-11 10:22	9-Feb-11 10:10	167.8	2.2	2.4	4.8	1.6	B/F	2	8	10	335.6	*0.72*
0.8KMR	2-Feb-11 10:47	9-Feb-11 10:58	168.2	2.2	2.4	6.1	1.5	B/F	1	3	4	336.4	*0.29*
0.8KR	2-Feb-11 09:55	9-Feb-11 09:22	167.4	2.6	2.6	2.3	1.2	B/G	4	1	5	334.9	*0.36*
0.5KL	2-Feb-11 10:14	9-Feb-11 09:53	167.7	2.6	2.6	1.0	0.4	C/B	2	1	3	335.3	*0.21*
0.5KML	2-Feb-11 11:28	9-Feb-11 11:19	167.9	2.2	2.4	3.9	1.6	B/C	8	15	23	335.7	*1.64*
0.5KM	2-Feb-11 11:56	9-Feb-11 11:58	168.0	2.2	2.4	5.2	1.6	G/B	2	3	5	336.1	*0.36*
0.5KMR	2-Feb-11 12:21	9-Feb-11 12:33	168.2	2.2	2.4	3.2	1.8	B/C	9	2	11	336.4	*0.78*
0.5KR	2-Feb-11 10:30	9-Feb-11 10:09	167.7	2.6	2.6	2.1	0.5	C/B	0	1	1	335.3	*0.07*
0.25KL	2-Feb-11 10:51	9-Feb-11 10:23	167.5	2.6	2.6	1.2	1.1	C/G	37	3	40	335.1	*2.87*
0.25KML	2-Feb-11 13:02	9-Feb-11 12:55	167.9	2.2	2.4	2.7	2.1	C/F	27	9	36	335.8	*2.57*
0.25KM	2-Feb-11 13:32	9-Feb-11 13:58	168.4	2.2	2.4	2.2	1.5	C/F	2	7	9	336.9	*0.64*
0.25KMR	2-Feb-11 13:56	9-Feb-11 14:27	168.5	2.2	2.4	3.4	1.5	C/G	6	0	6	337.0	*0.43*
0.25KR	2-Feb-11 11:42	9-Feb-11 11:30	167.8	2.6	2.6	3.9	0.9	C/B	7	19	26	335.6	*1.86*
0.1KML	2-Feb-11 13:13	9-Feb-11 13:12	168.0	2.6	2.6	5.1	0.5	C/F	13	0	13	336.0	*0.93*
0.1KM	2-Feb-11 12:51	9-Feb-11 12:48	168.0	2.6	2.6	8.1	1.4	n/a	13	3	16	335.9	*1.14*
0.1KMR	2-Feb-11 12:28	9-Feb-11 12:27	168.0	2.6	2.6	11.0	1.7	n/a	2	2	4	336.0	*0.29*
0.1KR	2-Feb-11 12:04	9-Feb-11 11:54	167.8	2.6	2.6	5.8	1.0	F/G	0	1	1	335.7	*0.07*
Totals			**64908.8**						**6426**	**9731**	**16157**	**129817.6**	***2.99***

[a] See Figurea A4 and A5 for sample locations.

[b] Substrates listed in order of dominance. Abbreviations: R/R = rip rap, B = boulder, C = cobble, G = gravel, F = fines.

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

Table D3: 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 (Year 4).

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 A4 and A7 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 D3: 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 A4 and A7 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 D3: 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 A4 and A7 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 D3: 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 A4 and A7 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 D3: 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 A4 and A7 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 D3: 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 A4 and A7 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 D3: 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 A4 and A7 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 D3: 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 A4 and A7 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 D3: Concluded.

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)
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 A4 and A7 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 D4: Summary of Mountain Whitefish (MW) eggs collected by egg collection mats deployed in the CLBMON-48 study area, December 19, 2012 to January 30, 2013 (Year 5).

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			
.8KL	19-Dec-12 10:53	27-Dec-12 10:17	191.4	5.1	4.7	7.9	2.62	dnr[d]	10	10	20	1.25	0.05
.8KM	19-Dec-12 11:29	27-Dec-12 11:47	192.3	5.1	4.7	6.9	2.79	dnr[d]	31	113	144	8.99	0.37
.8KR	19-Dec-12 12:01	27-Dec-12 13:57	193.9	5.1	4.7	3.7	1.95	dnr[d]	262	98	360	22.28	0.93
.5KL	19-Dec-12 12:53	27-Dec-12 09:40	188.8	5.1	4.7	2.9	0.40	C/G	36	59	95	6.04	0.25
.5KM	19-Dec-12 13:05	27-Dec-12 10:54	189.8	5.1	4.7	4.0	1.82	B/C	20	37	57	3.60	0.15
.5KR	19-Dec-12 13:14	27-Dec-12 11:21	190.1	5.1	4.7	2.6	1.39	C/B	7	6	13	0.82	0.03
.25KL	19-Dec-12 13:33	27-Dec-12 12:48	191.3	5.1	4.7	4.1	1.53	B/C	64	13	77	4.83	0.20
.25KM	19-Dec-12 13:43	27-Dec-12 13:21	191.6	5.1	4.7	2.6	1.52	C/B	25	96	121	7.58	0.32
.25KR	19-Dec-12 14:16	27-Dec-12 14:42	192.4	5.1	4.7	4.6	1.76	B/C	139	204	343	21.39	0.89
.8KL	27-Dec-12 10:11	2-Jan-13 09:32	143.3	4.7	3.9	2.5	0.46	C/B	55	90	145	12.14	0.51
.8KM	27-Dec-12 10:50	2-Jan-13 10:19	143.5	4.7	3.9	8.1	2.14	dnr[d]	5	22	27	2.26	0.09
.8KR	27-Dec-12 11:18	2-Jan-13 10:53	143.6	4.7	3.9	3.4	1.75	B/C	126	34	160	13.37	0.56
.5KL	27-Dec-12 11:43	2-Jan-13 11:46	144.0	4.3	3.9	2.6	1.42	C/B	20	75	95	7.91	0.33
.5KM	27-Dec-12 12:28	2-Jan-13 12:25	144.0	4.3	3.9	6.8	2.43	dnr[d]	64	110	174	14.51	0.60
.5KR	27-Dec-12 13:16	2-Jan-13 13:04	143.8	4.3	3.9	1.7	0.67	B/C	88	11	99	8.26	0.34
.25KL	27-Dec-12 13:54	2-Jan-13 13:46	143.9	4.3	3.9	1.4	1.83	C/B	150	96	246	20.52	0.85
.25KM	27-Dec-12 14:39	2-Jan-13 14:27	143.8	4.3	3.9	3.5	2.13	C/G	198	143	341	28.46	1.19
.25KR	27-Dec-12 15:24	2-Jan-13 15:05	143.7	1.7	3.9	4.0	1.71	B/C	105	58	163	13.61	0.57
.8KL	2-Jan-13 10:11	9-Jan-13 09:12	167.0	3.9	3.4	3.0	0.29	C/G	9	6	15	1.08	0.04
.8KM	2-Jan-13 10:22	9-Jan-13 09:40	167.3	3.9	3.4	6.8	1.47	dnr[d]	46	160	206	14.78	0.62
.8KR	2-Jan-13 11:42	9-Jan-13 10:20	166.6	3.9	3.4	3.7	0.98	B/G	13	8	21	1.51	0.06
.5KL	2-Jan-13 12:23	9-Jan-13 10:56	166.5	3.9	3.4	3.4	1.04	B/C	2	5	7	0.50	0.02
.5KM	2-Jan-13 12:29	9-Jan-13 11:22	166.9	3.9	3.4	6.7	1.71	dnr[d]	56	72	128	9.20	0.38
.5KR	2-Jan-13 13:42	9-Jan-13 12:10	166.5	3.9	3.4	3.8	1.05	B/C	6	2	8	0.58	0.02
.25KL	2-Jan-13 14:24	9-Jan-13 12:39	166.3	3.9	3.4	2.0	1.07	B/C	22	21	43	3.10	0.13
.25KM	2-Jan-13 14:29	9-Jan-13 13:13	166.7	3.9	3.4	3.2	1.63	B/C	210	136	346	24.90	1.04
.25KR	2-Jan-13 15:10	9-Jan-13 14:02	166.9	3.9	3.4	4.2	1.54	B/C	94	61	155	11.15	0.46
.8KL	9-Jan-13 09:37	16-Jan-13 09:19	167.7	3.4	2.9	2.2	0.65	B/C	0	0	0	0.00	0.00
.8KM	9-Jan-13 09:43	16-Jan-13 09:44	168.0	3.4	2.9	7.8	1.26	dnr[d]	655	151	806	57.57	2.40
.8KR	9-Jan-13 10:42	16-Jan-13 11:22	168.7	3.4	2.9	3.1	1.18	B/C	50	21	71	5.05	0.21
.5KL	9-Jan-13 11:18	16-Jan-13 11:51	168.6	3.4	2.9	2.6	0.83	B/C	1	0	1	0.07	0.00
.5KM	9-Jan-13 11:24	16-Jan-13 12:09	168.8	3.4	2.9	6.7	1.41	dnr[d]	256	20	276	19.63	0.82
.5KR	9-Jan-13 12:32	16-Jan-13 12:54	168.4	3.4	2.9	3.1	0.72	B/C	8	2	10	0.71	0.03
.25KL	9-Jan-13 13:10	16-Jan-13 13:14	168.1	3.4	2.9	2.4	1.16	C/G	13	78	91	6.50	0.27
.25KM	9-Jan-13 13:15	16-Jan-13 13:58	168.7	3.4	2.9	3.8	1.23	C/G	17	55	72	5.12	0.21
.25KR	9-Jan-13 14:04	16-Jan-13 14:30	168.4	3.4	2.9	4.0	1.04	C/G	124	32	156	11.11	0.46

[a] See Figure A5 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 D4: 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			
.8KL	16-Jan-13 09:42	24-Jan-13 09:09	191.4	2.9	3.2	2.5	0.52	B/G	2	0	2	0.1	0.01
.8KM	16-Jan-13 09:46	24-Jan-13 09:29	191.7	2.9	3.2	8.2	1.43	dnr[d]	23	26	49	3.1	0.13
.8KR	16-Jan-13 11:48	24-Jan-13 09:55	190.1	2.9	3.2	4.8	1.15	B/C	14	7	21	1.3	0.06
.5KL	16-Jan-13 12:08	24-Jan-13 10:26	190.3	2.9	3.2	2.1	0.78	C/G	1	0	1	0.1	0.00
.5KM	16-Jan-13 12:13	24-Jan-13 10:45	190.5	2.9	3.2	6.9	1.51	dnr[d]	166	21	187	11.8	0.49
.5KR	16-Jan-13 13:12	24-Jan-13 11:37	190.4	2.9	3.2	3.2	0.94	B/C	3	2	5	0.3	0.01
.25KL	16-Jan-13 13:56	24-Jan-13 11:55	190.0	2.9	3.2	2.3	0.98	C/G	5	17	22	1.4	0.06
.25KM	16-Jan-13 14:00	24-Jan-13 12:21	190.3	2.9	3.2	3.8	1.04	C/G	47	27	74	4.7	0.19
.25KR	16-Jan-13 14:32	24-Jan-13 12:53	190.4	2.9	3.2	4.4	1.07	C/G	8	14	22	1.4	0.06
.8KL	24-Jan-13 09:23	30-Jan-13 12:57	147.6	3.2	3.6	3.0	0.49	C/G	1	0	1	0.1	0.00
.8KM	24-Jan-13 09:33	30-Jan-13 09:04	143.5	3.2	3.6	7.2	1.22	dnr[d]	154	42	196	16.4	0.68
.8KR	24-Jan-13 10:21	30-Jan-13 13:13	146.9	3.2	3.6	3.2	1.14	B/C	3	5	8	0.7	0.03
.5KL	24-Jan-13 10:41	30-Jan-13 13:29	146.8	3.2	3.6	2.8	0.82	B/C	0	0	0	0.0	0.00
.5KM	24-Jan-13 10:45	30-Jan-13 09:52	143.1	3.2	3.6	6.8	1.51	dnr[d]	17	10	27	2.3	0.09
.5KR	24-Jan-13 11:51	30-Jan-13 13:48	145.9	3.2	3.6	3.6	1.01	B/G	3	2	5	0.4	0.02
.25KL	24-Jan-13 12:18	30-Jan-13 14:10	145.9	3.2	3.6	1.7	1.20	B/C	0	3	3	0.2	0.01
.25KM	24-Jan-13 12:21	30-Jan-13 10:43	142.4	3.2	3.6	3.6	1.32	B/C	51	53	104	8.8	0.37
.25KR	24-Jan-13 12:53	30-Jan-13 11:31	142.6	3.2	3.6	5.5	1.26	C/G	6	8	14	1.2	0.05
Totals			**9051.1**						**3491**	**2342**	**5833**	**424.5**	**13.74**

[a] See Figure A5 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 D5: Developmental stages of mountain whitefish (MW) eggs collected on substrate mats in the CLBMON-48 study area, 2009/2010 (Year 2), adapted from Rajagopal (1969).

Location	Site	Date	MW Eggs		Number of eggs at Each Developmental Stage											
			Alive	Dead	Unfertilized	1	2	3	4	5	6	7	8	9	10	11
Kootenay	1.0KM	11-Dec-09	4			1	2	1								
	1.0KR	11-Dec-09	2				2									
	0.8KL	11-Dec-09	1				1									
	0.8KM	11-Dec-09	13			4	5	4								
	0.8KR	11-Dec-09	8		2	2	1	3								
	0.5KL	11-Dec-09	3				2	1								
	0.5KM	11-Dec-09	7		1	2	1	3								
	0.5KR	11-Dec-09	6		1	1	4									
Columbia (CPR Island)	8.5L	14-Dec-09	6			1	1	4								
	8.5M	14-Dec-09	1					1								
	8.5R	14-Dec-09	15		5	2	2	6								
	8.6L	14-Dec-09	4		1	1	1	1								
	8.6M	14-Dec-09	7		1	3		3								
	8.6R	14-Dec-09	3		1		2									
	8.7L	14-Dec-09	12	1	3	5		3				1				
	8.7R	14-Dec-09	36		5	16	6	9								
Kootenay	1.0KM	16-Dec-09	16			6	3	7								
	1.0KR	16-Dec-09	16			8	5	3								
	0.8KL	16-Dec-09	2					2								
	0.8KM	16-Dec-09	19		1	2	11	5								
	0.8KR	16-Dec-09	47		1	7	5	34								
	0.5KL	16-Dec-09	11			1	5	5								
	0.5KM	16-Dec-09	37		3		17	17								
	0.5KR	16-Dec-09	4				1	3								
Columbia (Blueberry)	18.2L	17-Dec-09	4					4								
	18.2R	17-Dec-09	7					7								
	18.5L	17-Dec-09	9			1	1	6			1					
	18.5R	17-Dec-09	6					6								
Columbia (Genelle)	24.3L	18-Dec-09	15			3		12								
	24.5L	18-Dec-09	8			2		6								
	24.6L	18-Dec-09	6				3	3								
	24.9L	18-Dec-09	52			13		38		1						
	25.0I	18-Dec-09	15			3		11		1						
	25.5I	18-Dec-09	12			3		8	1							
	25.6I	18-Dec-09	3			1		2								
	26.0I	18-Dec-09	2	1				2								
	26.4I	18-Dec-09	2					2								
	26.9I	18-Dec-09	3	2				3								
	26.8BI	18-Dec-09	1					1								
Columbia (CPR Island)	8.2R	21-Dec-09	2		1		1									
	8.5L	21-Dec-09	7		1	1		5								
	8.5R	21-Dec-09	33		4	6	9	14								
	8.6L	21-Dec-09	15		1	3	3	8								
	8.6M	21-Dec-09	1					1								
	8.6R	21-Dec-09	10		2	5	2	1								
	8.7L	21-Dec-09	7		5			2								
	8.7R	21-Dec-09	35		2	6	9	18								
Kootenay	1.0KL	22-Dec-09	2			1		1								
	1.0KM	22-Dec-09	7			3		4								
	1.0KR	22-Dec-09	7			3		4								
	0.8KL	22-Dec-09	1					1								
	0.8KM	22-Dec-09	29			10	1	18								
	0.8KR	22-Dec-09	25		2	8		15								
	0.5KL	22-Dec-09	6			1		5								
	0.5KM	22-Dec-09	31			9	1	21								
	0.5KR	22-Dec-09	6			1		2	2	1						

Table D5: Continued.

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	11
Columbia (Genelle)	24.3L	23-Dec-09	7		2			5								
	24.5L	23-Dec-09	6			3	1		2							
	24.9L	23-Dec-09	21		2	1	1	8	9							
	25.0I	23-Dec-09	20		3	2	2	13								
	25.5I	23-Dec-09	3		2			1								
	25.6I	23-Dec-09	2		1			1								
	26.4I	23-Dec-09	2		1			1								
	26.9I	23-Dec-09	5					5								
	26.8BI	23-Dec-09	1				1									
Columbia (CPR Island)	8.2R	28-Dec-09	6			2	1	1	1	1						
	8.5L	28-Dec-09	8	1	1	2		2	3							
	8.5R	28-Dec-09	34		5	7	5	12	4				1			
	8.6L	28-Dec-09	6		1	3	1		1							
	8.6M	28-Dec-09	5		3	1			1							
	8.6R	28-Dec-09	5			1	3					1				
	8.7L	28-Dec-09	10		1	4	3	2								
	8.7R	28-Dec-09	40		3	7	16	9	5							
Kootenay	1.0KL	29-Dec-09	10		1	4		5								
	1.0KM	29-Dec-09	24			12		8	3	1						
	1.0KR	29-Dec-09	12		1	1		9	1							
	0.8KL	29-Dec-09	2					1	1							
	0.8KM	29-Dec-09	72		4	3	13	51	1							
	0.8KR	29-Dec-09	31		1	8		22								
	0.5KL	29-Dec-09	5					4	1							
	0.5KM	29-Dec-09	42			5		33	3	1						
	0.5KR	29-Dec-09		1												
Columbia (Blueberry)	18.2L	30-Dec-09	3			2			1							
	18.2M	30-Dec-09	2			1		1								
	18.2R	30-Dec-09	31		3	1	1	14	11	1						
	18.5L	30-Dec-09	9				1	5	3							
	18.5R	30-Dec-09	7		1			2	3	1						
Columbia (Genelle)	24.3L	31-Dec-09	10		2	3		2	3							
	24.5L	31-Dec-09	5			2	1	2								
	24.9L	31-Dec-09	9		3	1		4	1							
	25.0I	31-Dec-09	8		2	2	1	3								
	25.5I	31-Dec-09	3		2			1								
	25.6I	31-Dec-09	4			1	2	1								
	26.0I	31-Dec-09	1					1								
	26.4I	31-Dec-09	1						1							
	26.9I	31-Dec-09	3		2						1					
Kootenay	1.0KL	4-Jan-10	1				1									
	1.0KM	4-Jan-10	23		1		5	15	2							
	1.0KR	4-Jan-10	4		2	1		1								
	0.8KM	4-Jan-10	45		2	5	9	29								
	0.8KR	4-Jan-10	46		5	2	12	26	1							
	0.5KL	4-Jan-10	4		2			2								
	0.5KM	4-Jan-10	32	1	1	6	7	16	2							
Columbia (CPR Island)	8.2R	5-Jan-10	7		2	1	1	2						1		
	8.5L	5-Jan-10	13		2	2		2	1	6						
	8.5R	5-Jan-10	34		1	7	12	12	1	1						
	8.6L	5-Jan-10	13			5	3	1	1	3						
	8.6M	5-Jan-10	8				4	4								
	8.6R	5-Jan-10	33		1	8	15	9								
	8.7L	5-Jan-10	17			1	3	6	7							
	8.7R	5-Jan-10	49		3	5	10	25	6							

Table D5: Continued.

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	11
Columbia (Blueberry)	18.2M	6-Jan-10	1					1								
	18.2R	6-Jan-10	5			1			3	1						
	18.5L	6-Jan-10	2	1	1				1							
	18.5R	6-Jan-10	2		1						1					
Columbia (Genelle)	24.3L	6-Jan-10	5					1	4							
	24.5L	6-Jan-10	28			7	12	8	1							
	24.6L	7-Jan-10	1							1						
	25.0I	7-Jan-10	4				1	2		1						
	25.5I	7-Jan-10	1					1								
	25.6I	7-Jan-10	39		5		18	16								
	26.4I	7-Jan-10	1				1									
	26.9I	7-Jan-10	1		1											
Kootenay	1.0KL	11-Jan-10	2				1	1								
	1.0KM	11-Jan-10	12			2	5	5								
	0.8KM	11-Jan-10	30		2	6	13	9								
	0.8KR	11-Jan-10	11		2		1	4	3	1						
	0.5KL	11-Jan-10	2					1	1							
	0.5KM	11-Jan-10	33		1	5	13	13	1							
	0.5KR	11-Jan-10	3							3						
Columbia (CPR Island)	8.5L	13-Jan-10	1						1							
	8.5M	13-Jan-10	15			4	3	7	1							
	8.5R	13-Jan-10	30		1	8	5	13	2	1						
	8.6L	13-Jan-10	5					3	2							
	8.6M	13-Jan-10	9		2	3	1	2	1							
	8.6R	13-Jan-10	29		1	4	8	16								
	8.7L	13-Jan-10	11		1		3	5	1	1						
	8.7M	13-Jan-10	6			3	2		1							
	8.7R	13-Jan-10	32		2	3	8	14	3			1		1		
	8.8R	13-Jan-10	21			3	14	4								
Columbia (Blueberry)	18.2R	14-Jan-10	4						1	3						
	18.5L	14-Jan-10	7		3			1		3						
Columbia (Genelle)	24.3L	15-Jan-10	3							1		2				
	24.5L	15-Jan-10	7		2			5								
	25.5I	15-Jan-10	2					1			1					
	25.6I	15-Jan-10	6		1			2	2	1						
	26.4I	15-Jan-10	4			1			1			2				
	26.9I	15-Jan-10	1						1							
Kootenay	1.0KL	18-Jan-10	2					2								
	1.0KM	18-Jan-10	8					3	3	1	1					
	1.0KR	18-Jan-10	1							1						
	0.8KM	18-Jan-10	30					30								
	0.8KR	18-Jan-10	29					23	6							
	0.5KL	18-Jan-10	7		1	1	2	2	1							
	0.5KM	18-Jan-10	30				1	28	1							
	0.3KM	18-Jan-10	39		3			36								
	0.3KR	18-Jan-10	30					30								
Columbia (CPR Island)	8.5M	19-Jan-10	8			1	4	2	1							
	8.5R	19-Jan-10	25		1	3	1	10	9	1						
	8.6L	19-Jan-10	4				1		1	1	1					
	8.6M	19-Jan-10	12		1	2	2	3	3	1						
	8.6R	19-Jan-10	16			1	4	8	3							
	8.7L	19-Jan-10	9			1	3	5								
	8.7M	19-Jan-10	21		2	6	5	8								
	8.7R	19-Jan-10	29		1	2	8	11	6	1						
	8.8R	19-Jan-10	29		1	2	14	12								
Columbia (Blueberry)	18.2R	20-Jan-10	1									1				

Table D5: Continued.

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	11
Columbia (Genelle)	24.5L	21-Jan-10	2						1	1						
	24.9L	21-Jan-10	1		1											
	25.6I	21-Jan-10	14		3		1	3	3	4						
	26.0I	21-Jan-10	1						1							
	26.4I	21-Jan-10	1					1								
	26.9I	21-Jan-10	1					1								
Kootenay	1.0KM	22-Jan-10	7				2	1		4						
	0.8KM	22-Jan-10	30			6	8	11	4	1						
	0.8KR	22-Jan-10	5				1	2	1	1						
	0.5KL	22-Jan-10	23		1	2	13	5	1			1				
	0.5KM	22-Jan-10	26			4	12	8		2						
	0.5KR	22-Jan-10	1									1				
	0.3KM	22-Jan-10	30			5	13	10			2					
	0.3KR	22-Jan-10	28			3	13	12								
Columbia (CPR Island)	8.5L	25-Jan-10	3			1				2						
	8.5M	25-Jan-10	4			2	1	1								
	8.5R	25-Jan-10	4						2	2						
	8.6L	25-Jan-10	1					1								
	8.6M	25-Jan-10	4	1		1		2		1						
	8.6R	25-Jan-10	25		1	2	1	11	5	5						
	8.7L	25-Jan-10	3			1		1				1				
	8.7M	25-Jan-10	4		1			1	2							
	8.7R	25-Jan-10	33		1	2		24	5		1					
	8.8R	25-Jan-10	32		1	2	2	26	1							
Kootenay	1.0KM	26-Jan-10	1				1									
	0.8KM	26-Jan-10	35			9	6	9	9	1		1				
	0.8KR	26-Jan-10	4				3	1								
	0.5KL	26-Jan-10	2			1		1								
	0.5KM	26-Jan-10	29			10	10	8	1							
	0.3KM	26-Jan-10	20				16	3	1							
	0.3KR	26-Jan-10	29	1		1	18	9	1							
Columbia (Blueberry)	18.2M	27-Jan-10	1							1						
	18.2R	27-Jan-10	1									1				
Columbia (Genelle)	25.8I	28-Jan-10	1					1								
	26.4I	28-Jan-10	2			1	1									
Kootenay	1.0KM	29-Jan-10	1					1								
	0.8KM	29-Jan-10	19		1	1	6	9	1	1						
	0.8KR	29-Jan-10	2				1			1						
	0.5KM	29-Jan-10	8			1	6	1								
	0.3KM	29-Jan-10	3				1	1			1					
	0.3KR	29-Jan-10	21		1	2	3	12	3							
Columbia (CPR Island)	8.5M	1-Feb-10	4				3	1								
	8.6L	1-Feb-10	2						1	1						
	8.6M	1-Feb-10	1				1									
	8.6R	1-Feb-10	33	2	1	8	4	15	1	3		1				
	8.7L	1-Feb-10	1							1						
	8.7M	1-Feb-10	2				1	1								
	8.7R	1-Feb-10	7		1		1	1		3		1				
	8.8R	1-Feb-10	30			3	13	14								
Kootenay	1.0KM	2-Feb-10	1						1							
	0.8KM	2-Feb-10	35			5	7	18	2	3						
	0.8KR	2-Feb-10	2						1			1				
	0.5KL	2-Feb-10	1								1					
	0.5KM	2-Feb-10	7			3	1	3								
	0.3KM	2-Feb-10	17			1	1	3	10	2						
	0.3KR	2-Feb-10	4					4								

Table D5: 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	11
Columbia (Genelle)	24.3L	3-Feb-10	3									2	1			
	25.6I	4-Feb-10	4			2		2								
	26.0I	4-Feb-10	1									1				
Columbia (CPR Island)	8.5M	5-Feb-10	2					2								
	8.6L	5-Feb-10	1									1				
	8.6M	5-Feb-10	6			2	1		1	1		1				
	8.6R	5-Feb-10	12			2	5	4	1							
	8.7L	5-Feb-10	3						1	2						
	8.7R	5-Feb-10	8					1		4	2	1				
	8.8R	5-Feb-10	23			4	1	12	5	1						
Kootenay	0.8KM	8-Feb-10	21			2	6	9	1	2	1					
	0.8KR	8-Feb-10	1									1				
	0.5KM	8-Feb-10	7			1	1	2	2		1					
	0.3KM	8-Feb-10	28	1	1			1	4	22						
	0.3KR	8-Feb-10	4			1	1	1		1						
Columbia (CPR Island)	8.5R	9-Feb-10	5								2	3				
	8.6R	9-Feb-10	1		1											
	8.7M	9-Feb-10	1		1											
	8.7R	9-Feb-10	8					3				5				
	8.8R	9-Feb-10	3					1	2							
Columbia (Genelle)	25.6I	11-Feb-10	2					2								
Kootenay	0.8KR	12-Feb-10	1					1								
	0.8KM	12-Feb-10	26			3	11	9	1	1		1				
	0.5KL	12-Feb-10	1							1						
	0.5KM	12-Feb-10	2				2									
	0.3KM	12-Feb-10	7	1					3	3		1				
	0.3KR	12-Feb-10	1						1							
Columbia (Genelle)	25.8I	16-Feb-10	1					1								
Columbia (CPR Island)	8.5M	17-Feb-10	1					1								
	8.5R	17-Feb-10	4									2	2			
	8.6M	17-Feb-10	2					1		1						
	8.6R	17-Feb-10	2					1	1							
	8.7L	17-Feb-10	1									1				
	8.7M	17-Feb-10	1							1						
	8.7R	17-Feb-10	1									1				
	8.8R	17-Feb-10	1						1							
Kootenay	0.8KM	18-Feb-10	21					19		1		1				
	0.8KR	18-Feb-10	1										1			
	0.3KM	18-Feb-10	3									3				
	0.3KR	18-Feb-10	1							1						
Totals			**2990**	**14**	**164**	**430**	**595**	**1383**	**230**	**123**	**17**	**41**	**5**	**2**	**0**	**0**

Table D6: Developmental stages of mountain whitefish (MW) eggs collected on substrate mats in the CLBMON-48 study area, 2010/2011 (Year 3), 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	15-Dec-10	2			1		1							
	8.5ML	15-Dec-10	3				1	2							
	8.5M	15-Dec-10	9		6	1		2							
	8.5MR	15-Dec-10	14			2	3	8		1					
	8.5R	15-Dec-10	4			1	1	2							
	WALD1	15-Dec-10	2				2								
	8.6L	15-Dec-10	1				1								
	8.6ML	15-Dec-10	8					3				5			
	8.6M	15-Dec-10	11			1	3	7							
	8.6MR	15-Dec-10	2					2							
	8.6R	15-Dec-10	1				1								
	8.7L	15-Dec-10	2					2							
	8.7ML	15-Dec-10	7	2		1	3	2				1			
	8.7M	15-Dec-10	7		1		1	4		1					
	8.7R	15-Dec-10	3				1	2							
	8.8L	15-Dec-10	5				1	4							
	8.8R	15-Dec-10	1				1								
	8.9L	15-Dec-10	1					1							
Kootenay	1.0KL	16-Dec-10	3				2	1							
	1.0KML	16-Dec-10	6		2		2	2							
	1.0KM	16-Dec-10	9			2	2	5							
	1.0KMR	16-Dec-10	31		2	3	14	12							
	1.0KR	16-Dec-10	5			1	2	2							
	0.8KL	16-Dec-10	2				2								
	0.8KML	16-Dec-10	32		1	1	21	9							
	0.8KM	16-Dec-10	20		1		12	7							
	0.8KMR	16-Dec-10	20			4	6	10							
	0.8KR	16-Dec-10	30			1	13	15	1						
	0.5KL	16-Dec-10	27			3	15	9							
	0.5KML	16-Dec-10	5				4	1							
	0.5KM	16-Dec-10	27			1	15	11							
	0.5KMR	16-Dec-10	3		2		1								
	0.5KR	16-Dec-10	2					1	1						
	0.25KL	16-Dec-10	30			1	25	4							
	0.25KML	16-Dec-10	26				16	10							
	0.25KM	16-Dec-10	30				9	21							
	0.25KMR	16-Dec-10	6			2	2	2							
	0.25KR	16-Dec-10	31			2	22	6				1			
	0.15KL	16-Dec-10	29			1	15	13							
	0.1KML	16-Dec-10	30		1	1	23	5							
	0.1KM	16-Dec-10	29			1	24	4							
	0.1KMR	16-Dec-10	31		2	2	14	12		1					
Columbia	8.5ML	21-Dec-10	5			1	3		1						
	8.5M	21-Dec-10	8		1	2	2	3							
	8.5MR	21-Dec-10	4			1	1	1		1					
	8.5R	21-Dec-10	6						1	5					
	WALD1	21-Dec-10	7			1	3	2	1						
	8.6L	21-Dec-10	3				2	1							
	8.6ML	21-Dec-10	5			1	4								
	8.6M	21-Dec-10	5		1	1	1	2							
	8.6MR	21-Dec-10	7				4	3							
	8.6R	21-Dec-10	1							1					
	8.7L	21-Dec-10	2					2							
	8.7ML	21-Dec-10	1				1								
	8.7M	21-Dec-10	11			3	4	2		2					
	8.7R	21-Dec-10	11		1	1	5	2	1	1					
	8.8L	21-Dec-10	15				7	8							
	8.8R	21-Dec-10	8				3	3	1			1			
	8.9L	21-Dec-10	2				2								

Table D6: Continued.

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
Kootenay	1.0KML	22-Dec-10	7			2	3	2							
	1.0KM	22-Dec-10	23			3	7	9	3	1					
	1.0KMR	22-Dec-10	8			1	4	3							
	1.0KR	22-Dec-10	4			1	2	1							
	0.8KL	22-Dec-10	2			1				1					
	0.8KML	22-Dec-10	26			1	15	10							
	0.8KM	22-Dec-10	12		4		1	5	1	1					
	0.8KMR	22-Dec-10	13			1	9	2	1						
	0.8KR	22-Dec-10	28		1	3	16	8							
	0.5KL	22-Dec-10	30			1	20	8	1						
	0.5KML	22-Dec-10	30			4	15	10		1					
	0.5KM	23-Dec-10	26	3		3	10	11	2						
	0.5KMR	22-Dec-10	1				1								
	0.5KR	22-Dec-10	4			1	1	1				1			
	0.25KL	22-Dec-10	30				17	12	1						
	0.25KML	23-Dec-10	28	2		1	6	21							
	0.25KM	22-Dec-10	30				17	13							
	0.25KMR	22-Dec-10	16				10	5	1						
	0.25KR	22-Dec-10	31		1	7	15	8							
	0.15KL	22-Dec-10	30			2	16	12							
	0.1KML	22-Dec-10	20		2	3	5	6	3	1					
	0.1KM	22-Dec-10	30			1	16	11			1	1			
	0.1KMR	22-Dec-10	31		1	1	18	11							
	0.1KR	22-Dec-10	30			7	17	4	1	1					
Columbia	8.5L	28-Dec-10	1							1					
	8.5ML	28-Dec-10	30				24	5	1						
	8.5M	28-Dec-10	24				10	7	3	4					
	8.5MR	28-Dec-10	2				1	1							
	8.5R	28-Dec-10	3				1	2							
	WALD1	28-Dec-10	13			2	7	4							
	8.6ML	28-Dec-10	16				14	1		1					
	8.6M	28-Dec-10	3	2			1	2							
	8.6MR	28-Dec-10	9		1	1	2	4		1					
	8.7L	28-Dec-10	1				1								
	8.7ML	28-Dec-10	5				1	4							
	8.7M	28-Dec-10	4					1	2	1					
	8.7MR	28-Dec-10	4				3	1							
	8.7R	28-Dec-10	9			1	6	2							
	8.8L	28-Dec-10	8				5	3							
	8.8R	28-Dec-10	16				12	4							
Kootenay	1.0KL	29-Dec-10	4				3		1						
	1.0KML	29-Dec-10	12			2	5	5							
	1.0KM	29-Dec-10	25			1	7	17							
	1.0KMR	29-Dec-10	20			1	11	8							
	1.0KR	29-Dec-10	10				8	2							
	0.8KL	29-Dec-10	1				1								
	0.8KML	29-Dec-10	30				14	15	1						
	0.8KM	29-Dec-10	30		1	2	13	13	1						
	0.8KMR	29-Dec-10	30		1	2	15	12							
	0.8KR	29-Dec-10	32		1	1	25	5							
	0.5KL	29-Dec-10	29				16	13							
	0.5KML	29-Dec-10	29			7	9	13							
	0.5KM	29-Dec-10	15		1	1	7	5	1						
	0.5KMR	29-Dec-10	6				4	1	1						
	0.5KR	29-Dec-10	30			1	22	6	1						
	0.25KL	29-Dec-10	30		1		12	14	3						
	0.25KML	29-Dec-10	30		3	1	16	9	1						
	0.25KM	29-Dec-10	30				15	15							
	0.25KMR	29-Dec-10	12		1	2	3	5	1						
	0.25KR	29-Dec-10	32		2	1	18	10				1			
	0.1KM	29-Dec-10	30		1		8	21							
	0.1KML	29-Dec-10	31			1	17	10	1	1		1			
	0.1KMR	29-Dec-10	27	2	1	3	10	13							
	0.1KR	29-Dec-10	29		4		12	8	5						

Table D6: Continued.

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
	8.5L	4-Jan-11	1				1								
	8.5ML	4-Jan-11	16		1	1	5	3	6						
	8.5M	4-Jan-11	2				1	1							
	8.5MR	4-Jan-11	2			1	1								
	8.5R	4-Jan-11	5				2	3							
	WALD1	4-Jan-11	9				4	5							
	8.6L	4-Jan-11	2				1			1					
	8.6ML	4-Jan-11	5	1	2				2	1					
	8.6M	4-Jan-11	13	1	1	4	3	5							
Columbia	8.6MR	4-Jan-11	23		2	1	15	4	1						
	8.6R	4-Jan-11	2					2							
	8.7L	4-Jan-11	3			1		1	1						
	8.7ML	4-Jan-11	4				3		1						
	8.7M	4-Jan-11	11	2	3		5	1	2						
	8.7MR	4-Jan-11	3		1		1	1							
	8.7R	4-Jan-11	29	1	1	2	18	7			1				
	8.8L	4-Jan-11	15		2	2	4	5		1	1				
	8.8R	4-Jan-11	4		1		2	1							
	8.9L	4-Jan-11	8			2	2	4							
	1.0KL	5-Jan-11	5				4	1							
	1.0KML	5-Jan-11	29		3	2	11	8	5						
	1.0KM	5-Jan-11	28			2	9	10	6	1					
	1.0KMR	5-Jan-11	15				6	9							
	1.0KR	5-Jan-11	5				2	3							
	0.8KML	5-Jan-11	30			5	11	13	1						
	0.8KM	5-Jan-11	30			4	13	12	1						
	0.8KMR	5-Jan-11	20		3		5	11		1					
	0.8KR	5-Jan-11	30				14	16							
	0.5KL	5-Jan-11	31				13	18							
	0.5KML	5-Jan-11	29		2	2	9	13	3						
Kootenay	0.5KM	6-Jan-11	20			1	13	6							
	0.5KMR	5-Jan-11	9			1	3	5							
	0.5KR	5-Jan-11	6				2	2	2						
	0.25KL	5-Jan-11	30			2	17	11							
	0.25KML	5-Jan-11	30		1	1	12	16							
	0.25KM	5-Jan-11	32		4	3	15	10							
	0.25KMR	5-Jan-11	30			5	15	10							
	0.25KR	5-Jan-11	31		1	5	14	11							
	0.1KML	5-Jan-11	30		1	3	5	18	2	1					
	0.1KM	6-Jan-11	31				13	15	1	1		1			
	0.1KMR	6-Jan-11	22		6	2	2	10	2						
	0.1KR	5-Jan-11	9			1	4	3	1						
	8.5L	11-Jan-11	5				2	3							
	8.5ML	11-Jan-11	7	1	2	1		4							
	8.5M	11-Jan-11	28		2	6	6	11		2	1				
	8.5MR	11-Jan-11	17	1	6	2	4	5							
	8.5R	11-Jan-11	30		1		12	16			1				
	WALD1	11-Jan-11	3		1		2								
	8.6L	11-Jan-11	5			2	1	1		1					
	8.6ML	11-Jan-11	6		2	2		2							
	8.6M	11-Jan-11	8		4	1	2	1							
Columbia	8.6MR	11-Jan-11	23		4	3	6	10							
	8.6R	11-Jan-11	9				5	4							
	8.7L	11-Jan-11	5	1			4	1							
	8.7ML	11-Jan-11	5		1	2	1	1							
	8.7M	11-Jan-11	5		3	1		1							
	8.7MR	11-Jan-11	1				1								
	8.7R	11-Jan-11	29	1	1	4	9	14	1						
	8.8L	11-Jan-11	30		4	4	10	9	1	2					
	8.8R	11-Jan-11	30		3	5	8	10	3	1					
	8.9L	11-Jan-11	1				1								

Table D6: Continued.

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
Kootenay	1.0KL	12-Jan-11	8			1	4	3							
	1.0KML	12-Jan-11	2				1	1							
	1.0KM	12-Jan-11	9		1		1	1	3	3					
	1.0KR	12-Jan-11	6					3	3						
	0.8KML	12-Jan-11	3	3				1	2						
	0.8KM	12-Jan-11	26	6	10	2	8	5	1						
	0.8KMR	12-Jan-11	22		3	1	12	6							
	0.8KR	12-Jan-11	31		1	6	11	12	1						
	0.5KL	12-Jan-11	26			5	7	6	7	1					
	0.5KML	12-Jan-11	25		2		2	4	6	11					
	0.5KM	12-Jan-11	31	1		2	18	7	2	1		1			
	0.5KMR	12-Jan-11	18			1	12	4	1						
	0.5KR	12-Jan-11	2		1					1					
	0.25KL	12-Jan-11	30		6	1	6	4	11	2					
	0.25KML	12-Jan-11	29	1	2	4	15	7				1			
	0.25KM	13-Jan-11	31		2	1	17	11							
	0.25KMR	13-Jan-11	31			2	16	12	1						
	0.25KR	13-Jan-11	30		3	2	13	10		1		1			
	0.1KML	12-Jan-11	5		3					2					
	0.1KM	13-Jan-11	30		1		2	4	23						
	0.1KMR	13-Jan-11	15		2		2	4	6			1			
	0.1KR	12-Jan-11	9		2				3	4					
Columbia	8.5L	18-Jan-11	6				1	3	1			1			
	8.5ML	18-Jan-11	6				2	4							
	8.5M	18-Jan-11	27	3	1	1	14	9		2					
	8.5MR	18-Jan-11	30		2		11	11	4	2					
	8.5R	18-Jan-11	30		1	5	10	14							
	WALD1	18-Jan-11	7			1	4	2							
	8.6L	18-Jan-11	1			1									
	8.6ML	18-Jan-11	2	1				1	1						
	8.6M	18-Jan-11	2	1			1	1							
	8.6MR	18-Jan-11	5				2	2	1						
	8.6R	18-Jan-11	8				3	5							
	8.7L	18-Jan-11	8				5	2					1		
	8.7ML	18-Jan-11	5			2	2	1							
	8.7M	18-Jan-11	10		2		5	3							
	8.7MR	18-Jan-11	1					1							
	8.7R	18-Jan-11	15		2	2	2	3	2	3			1		
	8.8L	18-Jan-11	18		1		2	5	3	4		3			
	8.8R	18-Jan-11	11		3			3	5						
	8.9L	18-Jan-11	1					1							
Kootenay	1.0KL	19-Jan-11	2				1	1							
	1.0KML	19-Jan-11	6		1	1		1		3					
	1.0KM	19-Jan-11	33		2	3	12	9	3	2		2			
	1.0KMR	19-Jan-11	3				1	2							
	1.0KR	19-Jan-11	3		1				2						
	0.8KML	19-Jan-11	6			1	3			2					
	0.8KM	19-Jan-11	35		9	2	8	13	2	1					
	0.8KR	19-Jan-11	15			2	3	4	4	2					
	0.5KL	19-Jan-11	12			1	7		2	2					
	0.5KML	19-Jan-11	9	1	4				1	4					
	0.5KM	19-Jan-11	34				26	6	1	1					
	0.5KMR	19-Jan-11	20		1		13	6							
	0.5KR	19-Jan-11	4				1		2	1					
	0.25KL	19-Jan-11	30		1	1	20	6	1			1			
	0.25KML	19-Jan-11	29	1			18	10	1						
	0.25KM	19-Jan-11	30			1	21	8							
	0.25KMR	19-Jan-11	22		3	1	7	11							
	0.25KR	19-Jan-11	19	1		1	10	3	4	1					
	0.1KML	19-Jan-11	1							1					
	0.1KM	19-Jan-11	20				5	2	10	3					
	0.1KMR	19-Jan-11	13		2		4	1	1	3	1	1			
	0.1KR	19-Jan-11	15		1		2		2	2	6	2			

Table D6: Continued.

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	25-Jan-11	1						1						
	8.5ML	25-Jan-11	3				2		1						
	8.5M	25-Jan-11	3				2		1						
	8.5MR	25-Jan-11	15				8	7							
	8.5R	25-Jan-11	17		1		9	4	2	1					
	WALD1	25-Jan-11	15				8	7							
	8.6L	25-Jan-11	1							1					
	8.6ML	25-Jan-11	2		1				1						
	8.6M	25-Jan-11	10		6			3		1					
	8.6MR	25-Jan-11	11		1		2	5	2				1		
	8.6R	25-Jan-11	3		1			2							
	8.7L	25-Jan-11	5					1	3	1					
	8.7ML	25-Jan-11	5			1	2	1	1						
	8.7M	25-Jan-11	11				6	5							
	8.7MR	25-Jan-11	1				1								
	8.7R	25-Jan-11	11	1			3	5		3					
	8.8L	25-Jan-11	10		1	3	5		1						
	8.8R	25-Jan-11	4	1			1			3					
Kootenay	1.0KL	26-Jan-11	1							1					
	1.0KML	26-Jan-11	3				3								
	1.0KM	26-Jan-11	19		5		6	5	1	1		1			
	1.0KMR	26-Jan-11	13				10	1	1			1			
	0.8KML	26-Jan-11	6		1		3	1				1			
	0.8KM	26-Jan-11	22		2		11	7	1	1					
	0.8KMR	26-Jan-11	13			1	3	6	1	1	1				
	0.8KR	26-Jan-11	14		3		3	4		4					
	0.5KL	26-Jan-11	2							1			1		
	0.5KML	26-Jan-11	28	1	5		8	10	2		2			1	
	0.5KM	26-Jan-11	21		4	1	12	3		1					
	0.5KMR	26-Jan-11	15	1	4		4	1	1	3	1	1			
	0.5KR	26-Jan-11	1							1					
	0.25KL	26-Jan-11	30		1	4	13	5		5		2			
	0.25KML	26-Jan-11	30		3		16	10	1						
	0.25KM	26-Jan-11	33			1	13	18		1					
	0.25KMR	26-Jan-11	13				4	4	3	2					
	0.25KR	26-Jan-11	14		1	1	3	5		3		1			
	0.1KM	26-Jan-11	30			2	7	11	1	8		1			
	0.1KMR	26-Jan-11	11				3	2	2	3		1			
	0.1KR	26-Jan-11	5									5			
Columbia	8.5ML	1-Feb-11	1		1										
	8.5M	1-Feb-11	8		3	1	3	1							
	8.5MR	1-Feb-11	6	1			4	2							
	8.5R	1-Feb-11	10	1			3	5	1	1					
	WALD1	1-Feb-11	1					1							
	8.6M	1-Feb-11	3		1	1		1							
	8.6MR	1-Feb-11	2				2								
	8.7L	1-Feb-11	1							1					
	8.7ML	1-Feb-11	3		1			2							
	8.7M	1-Feb-11	3	2	2		1								
	8.7MR	1-Feb-11	2				2								
	8.8L	1-Feb-11	3				1			2					
	8.8R	1-Feb-11	2							1		1			
Kootenay	1.0KL	2-Feb-11	1							1					
	1.0KML	2-Feb-11	1				1								
	1.0KM	2-Feb-11	4				1	1	1						1
	1.0KMR	2-Feb-11	1							1					
	0.8KML	2-Feb-11	2				1					1			
	0.8KM	2-Feb-11	6		1	1	3		1						
	0.8KMR	2-Feb-11	3				1		1			1			
	0.8KR	2-Feb-11	4					2	1	1					
	0.5KL	2-Feb-11	2									2			
	0.5KML	2-Feb-11	7		1	1	3					1			1
	0.5KM	2-Feb-11	6					3	3						

Table D6: 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
Kootenay	0.5KMR	2-Feb-11	3				1					2			
	0.25KL	2-Feb-11	9			2	1	4		1		1			
	0.25KML	2-Feb-11	23		2	3	8	8		1	1				
	0.25KM	2-Feb-11	20			4	9	5	1			1			
	0.25KR	2-Feb-11	7			1	4	1					1		
	0.1KML	2-Feb-11	1				1								
	0.1KM	2-Feb-11	7				4					3			
	0.1KMR	2-Feb-11	8			1	4	1		1		1			
	0.1KR	2-Feb-11	2									2			
Columbia	8.5ML	8-Feb-11	2					1	1						
	8.5M	8-Feb-11	2					2							
	8.5MR	8-Feb-11	5				3	1		1					
	8.5R	8-Feb-11	4					3	1						
	8.6L	8-Feb-11	1				1								
	8.6M	8-Feb-11	4			1		2	1						
	8.6MR	8-Feb-11	2				2								
	8.7L	8-Feb-11		1											
	8.7ML	8-Feb-11	1							1					
	8.7M	8-Feb-11	2				1	1							
	8.8R	8-Feb-11	1			1									
Kootenay	1.0KM	9-Feb-11	1						1						
	1.0KMR	9-Feb-11	3		1				1				1		
	0.8KML	9-Feb-11	3							2		1			
	0.8KM	9-Feb-11	5		1			1		1		1	1		
	0.8KMR	9-Feb-11	2							1		1			
	0.8KR	9-Feb-11	2						1				1		
	0.5KL	9-Feb-11	1									1			
	0.5KML	9-Feb-11	8		1		1	1	1	1	2		1		
	0.5KM	9-Feb-11	2		1		1								
	0.5KMR	9-Feb-11	3						1	2					
	0.5KR	9-Feb-11	1				1								
	0.25KL	9-Feb-11	6					3	1			1	1		
	0.25KML	9-Feb-11	14		1		1	7	1	2		1	1		
	0.25KM	9-Feb-11	4		1		1	1	1						
	0.25KMR	9-Feb-11	3				1	1		1					
	0.25KR	9-Feb-11	5	1				2	1		1	1			
	0.1KML	9-Feb-11	13		2				1	2	3	5			
	0.1KM	9-Feb-11	4				3	1							
	0.1KMR	9-Feb-11	2				2								
	0.1KR	9-Feb-11	1										1		
Totals			**4470**	**50**	**253**	**289**	**1896**	**1490**	**258**	**177**	**23**	**69**	**12**	**1**	**2**

Table D7: Developmental stages of Mountain Whitefish (MW) eggs collected on substrate mats in the CLBMON-48 study area, 2011/2012 (Year 4), 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 D7: 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
	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							
Columbia	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**

Table D8: Developmental stages of Mountain Whitefish (MW) eggs collected on substrate mats in the CLBMON-48 study area, 2012/2013 (Year 5), 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
Kootenay	.25KM	27-Dec-12	30	0	0		10	18	2						
	.25KR	27-Dec-12	29	1	3		11	12	3						
	.25KL	27-Dec-12	28	0	0	2	10	13	3						
	.5KR	27-Dec-12	28	0	0	1	12	11	4						
	.5KM	27-Dec-12	31	0	1	2	7	17	4						
	.5KL	27-Dec-12	13	0	0	2	2	6	3						
	.8KR	27-Dec-12	30	0	0	2	15	10	3						
	.8KM	27-Dec-12	19	0	0		7	9	3						
	.8KL	27-Dec-12	31	0	0	1	17	9	4						
	.25KM	2-Jan-13	30	0	0	2	16	12							
	.25KR	2-Jan-13	30	0	0	1	11	13	3	2					
	.25KL	2-Jan-13	30	0	2	1	3	22	1	1					
	.5KM	2-Jan-13	30	0	0	2	12	15		1					
	.5KR	2-Jan-13	30	0	1	2	13	12	2						
	.5KL	2-Jan-13	29	0	3	1	5	19	1						
	.8KR	2-Jan-13	30	0	1	3	13	11	2						
	.8KM	2-Jan-13	27	0	5	5	9	7	1						
	.8KL	2-Jan-13	31	0	0	5	12	13	1						
	.25KL	9-Jan-13	30	0	2		9	11	8						
	.25KM	9-Jan-13	30	0	0		12	18							
	.25KR	9-Jan-13	30	0	1		7	22							
	.5KR	9-Jan-13	8	0	1		1	5	1						
	.5KM	9-Jan-13	32	0	1		13	14	4						
	.5KL	9-Jan-13	9	0	2			3	4						
	.8KL	9-Jan-13	15	0	3		1	9	2						
	.8KR	9-Jan-13	19	0	2	1		11	5						
	.8KM	9-Jan-13	29	0		1	10	18							
	.25KR	16-Jan-13	31	0	1	3	8	17	2						
	.25KL	16-Jan-13	29	1	1		11	15	1	1					
	.25KM	16-Jan-13	31	0	1	1	9	17	3						
	.5KM	16-Jan-13	30	0	0	2	14	14							
	.5KR	16-Jan-13	7	0	0		2	2	2	1					
	.8KM	16-Jan-13	29	0	6	2	7	13	1						
	.8KR	16-Jan-13	30	0	1	1	14	13	1						
	.25KR	24-Jan-13	22	0	1		1	10	8	2					
	.25KL	24-Jan-13	17	0	1	1	8	3	3		1				
	.25KM	24-Jan-13	36	0	6	1	12	13	2	2					
	.5KR	24-Jan-13	6	0	3			2	1						
	.5KM	24-Jan-13	31	0	9	2	4	10	5					1	
	.5KL	24-Jan-13	2	0	1					1					
	.8KR	24-Jan-13	21	0	1		1	8	9	1		1			
	.8KM	24-Jan-13	30	0	5		6	18	1						
	.25KM	30-Jan-13	30		8		9	6	6	1					
	.25KR	30-Jan-13	12	0			1	4	3	4					
	.25KL	30-Jan-13	2	0					2						
	.5KR	30-Jan-13	4	0	1							3			
	.5KM	30-Jan-13	23	0	3	1		8	9	2					
	.8KL	30-Jan-13	1	0								1			
	.8KR	30-Jan-13	8	0			1	4	2			1			
	.8KM	30-Jan-13	27	3	4	4	3	16							
Totals			**1167**	**5**	**81**	**52**	**349**	**533**	**125**	**19**	**1**	**6**	**0**	**1**	**0**

Table D9: Summary of results from kick net sampling in Norn's Creek, February 2013 (Year 5).

Date	Kick Net Sample #	Area (m^2)	Live Mountain Whitefish Eggs	Dead Mountain Whitefish Eggs	Mountain Whitefish Casings	Easting	Northing
8-Feb-13	1	1	24	0	0	452115	5465591
8-Feb-13	2	1	57	0	0	452065	5465609
8-Feb-13	3	1	23	0	0	452039	5465608
8-Feb-13	4	1	0	1	0	451932	5465599
8-Feb-13	5	1	27	0	0	451927	5465609
8-Feb-13	6	1	4	0	0	451913	5465615
8-Feb-13	7	1	16	0	0	451937	5465604
8-Feb-13	8	1	0	0	1	451939	5465613
8-Feb-13	9	0.5	0	0	0	451939	5465613
8-Feb-13	10	0.5	0	0	0	451937	5465611
8-Feb-13	11	1	0	0	2	451916	5465597
8-Feb-13	12	1	4	0	0	451906	5465605
8-Feb-13	13	1	0	0	2	451899	5465593
8-Feb-13	14	1	0	0	0	451906	5465590
8-Feb-13	15	1	0	0	0	451901	5465586
8-Feb-13	16	1	47	0	2	451894	5465563
8-Feb-13	17	1	22	0	0	451890	5465567
8-Feb-13	18	1	2	1	0	451879	5465540
8-Feb-13	19	1	3	0	0	451871	5465541
8-Feb-13	20	1	2	0	0	451875	5465524
8-Feb-13	21	1	13	0	0	451867	5465523
8-Feb-13	22	1	3	0	0	451859	5465509
8-Feb-13	23	1	0	0	0	451864	5465514
8-Feb-13	24	1	21	0	0	451859	5465520
8-Feb-13	25	1	15	0	0	451862	5465518
8-Feb-13	26	1	14	0	1	451860	5465512
8-Feb-13	27	1	37	0	1	451860	5465502
8-Feb-13	28	1	50	0	1	451856	5465493
8-Feb-13	30	1	2	0	1	451847	5465470
8-Feb-13	31	1	10	0	0	451864	5465479
8-Feb-13	32	1	16	0	1	451847	5465467
8-Feb-13	33	1	78	0	0	451847	5465456
8-Feb-13	34	1	21	0	0	451846	5465454
8-Feb-13	35	1	71	1	2	451845	5465452
8-Feb-13	36	1	26	0	0	451827	5465427
8-Feb-13	37	1	134	0	6	451827	5465433
8-Feb-13	38	1	52	0	1	n/a	n/a
8-Feb-13	39	1	5	0	0	451811	5465399
8-Feb-13	40	1	36	0	4	451806	5465393
8-Feb-13	41	1	17	0	0	451801	5465388
8-Feb-13	42	1	87	0	2	451796	5465390
8-Feb-13	43	1	47	0	3	451775	5465384
8-Feb-13	44	1	8	0	2	451770	5465377
8-Feb-13	45	1	141	1	7	451755	5465371
8-Feb-13	46	1	11	0	1	451763	5465368
8-Feb-13	47	1	46	0	2	451754	5465364
8-Feb-13	48	1	22	0	0	451736	5465358

Table D9: Continued.

Date	Kick Net Sample #	Area (m^2)	Live Mountain Whitefish Eggs	Dead Mountain Whitefish Eggs	Mountain Whitefish Casings	Easting	Northing
8-Feb-13	49	1	23	0	1	451748	5465372
8-Feb-13	50	1	26	0	0	451726	5465352
8-Feb-13	51	1	65	3	1	451722	5465352
8-Feb-13	52	1	43	0	3	451719	5465347
8-Feb-13	53	1	73	0	1	451704	5465333
8-Feb-13	54	1	110	0	3	451702	5465338
8-Feb-13	55	1	13	1	1	451696	5465326
8-Feb-13	56	1	0	0	0	451695	5465306
8-Feb-13	57	1	5	0	1	451688	5465295
8-Feb-13	58	1	13	2	2	451692	5465308
8-Feb-13	59	1	6	0	0	451679	5465296
8-Feb-13	60	1	3	0	1	451682	5465292
8-Feb-13	61	1	1	0	1	451677	5465280
8-Feb-13	62	1	17	0	1	451671	5465282
8-Feb-13	63	1	3	0	2	451666	5465266
8-Feb-13	64	1	17	0	1	451656	5465243
8-Feb-13	65	1	102	0	1	451656	5465247
8-Feb-13	66	1	34	0	1	451665	5465227
8-Feb-13	67	1	0	3	7	451679	5465213
8-Feb-13	68	1	1	0	0	451682	5465208
8-Feb-13	69	1	0	0	0	451691	5465207
8-Feb-13	70	1	0	2	1	451693	5465207
8-Feb-13	71	1	0	0	0	451697	5465204
8-Feb-13	72	1	0	0	0	451709	5465195
8-Feb-13	73	1	1	0	0	451718	5465192
8-Feb-13	74	1	0	0	0	451724	5465166
8-Feb-13	75	1	2	0	0	451733	5465161
8-Feb-13	76	1	11	0	0	451733	5465162
8-Feb-13	77	1	9	0	0	451732	5465161
8-Feb-13	78	1	2	0	0	451731	5465132
8-Feb-13	79	1	22	0	0	451736	5465147
8-Feb-13	80	1	6	0	0	451729	5465130
8-Feb-13	81	1	6	0	0	451754	5465137
8-Feb-13	82	1	73	0	0	451756	5465123
8-Feb-13	83	1	30	1	0	451733	5465118
8-Feb-13	84	1	12	0	0	451751	5465103
8-Feb-13	85	1	61	2	4	451739	5465109
8-Feb-13	86	1	2	0	0	451745	5465080
8-Feb-13	87	1	32	0	0	451742	5465093
8-Feb-13	88	1	5	0	0	451732	5465063
8-Feb-13	89	1	6	0	1	451732	5465059
8-Feb-13	90	1	2	0	0	451717	5465038
8-Feb-13	91	1	12	0	1	451718	5465032
8-Feb-13	92	1	0	0	0	451723	5465031
8-Feb-13	93	1	36	6	1	451703	5465006
8-Feb-13	94	1	1	0	3	451710	5465014
8-Feb-13	95	1	2	2	3	451703	5464989
8-Feb-13	96	1	27	28	6	451701	5464992
8-Feb-13	98	1	11	0	0	451690	5464906
8-Feb-13	99	1	5	0	0	451690	5464902

Table D9: Continued.

Date	Kick Net Sample #	Area (m^2)	Live Mountain Whitefish Eggs	Dead Mountain Whitefish Eggs	Mountain Whitefish Casings	Easting	Northing
8-Feb-13	100	1	4	0	0	451682	5464896
8-Feb-13	101	1	2	1	2	451682	5464892
8-Feb-13	102	1	7	1	0	451683	5464874
8-Feb-13	103	1	31	2	0	451680	5464869
8-Feb-13	104	1	1	3	0	451675	5464868
8-Feb-13	105	1	0	0	0	451668	5464863
13-Feb-13	106	1	4	0	0	451871	5465626
13-Feb-13	107	1	1	0	0	451876	5465629
13-Feb-13	108	1	4	0	0	451871	5465626
13-Feb-13	109	1	4	0	0	451853	5465642
13-Feb-13	110	1	6	0	0	451849	5465641
13-Feb-13	111	1	60	0	0	451857	5465638
13-Feb-13	112	1	8	0	0	451836	5465658
13-Feb-13	113	1	4	0	0	451828	5465666
13-Feb-13	114	1	1	0	0	451824	5465669
13-Feb-13	115	1	1	0	0	451825	5465682
13-Feb-13	116	1	2	0	0	451824	5465680
13-Feb-13	117	1	2	0	0	451814	5465685
13-Feb-13	118	1	3	0	0	451806	5465704
13-Feb-13	119	1	0	0	0	451807	5465704
13-Feb-13	120	1	0	0	0	451795	5465728
13-Feb-13	121	1	2	0	0	451797	5465732
13-Feb-13	122	1	0	0	0	451780	5465765
13-Feb-13	123	1	4	0	0	451794	5465775
13-Feb-13	124	1	4	0	0	451780	5465775
13-Feb-13	125	1	4	0	0	451788	5465785
13-Feb-13	126	1	6	0	0	451777	5465801
13-Feb-13	127	1	5	0	0	451777	5465808
13-Feb-13	128	1	1	0	0	451772	5465813
13-Feb-13	129	1	11	0	0	451768	5465821
13-Feb-13	130	1	5	0	0	451770	5465835
13-Feb-13	131	1	1	0	0	451768	5465843
13-Feb-13	132	1	1	0	0	451772	5465857
13-Feb-13	133	1	2	0	0	451765	5465869
13-Feb-13	134	1	2	0	0	451764	5465868
13-Feb-13	135	1	3	0	0	451767	5465872
13-Feb-13	136	1	16	0	0	451760	5465876
13-Feb-13	137	1	8	0	0	451766	5465883
13-Feb-13	138	1	49	0	0	451762	5465887
13-Feb-13	139	1	8	0	0	451768	5465911
13-Feb-13	140	1	4	0	0	451760	5465907
13-Feb-13	141	1	8	0	0	451762	5465919
13-Feb-13	142	1	4	0	0	451765	5465932
13-Feb-13	143	1	1	0	0	451755	5465925
13-Feb-13	144	1	3	0	2	451765	5465944
13-Feb-13	145	1	6	0	0	451770	5465948
13-Feb-13	146	1	6	0	0	451763	5465970
13-Feb-13	147	1	8	0	0	451767	5465970
13-Feb-13	148	1	1	0	0	451767	5465981
13-Feb-13	149	1	1	0	0	451768	5465988

Table D9: Concluded.

Date	Kick Net Sample #	Area (m^2)	Live Mountain Whitefish Eggs	Dead Mountain Whitefish Eggs	Mountain Whitefish Casings	Easting	Northing
13-Feb-13	150	1	4	0	0	451770	5465987
13-Feb-13	151	1	4	0	0	451772	5466017
13-Feb-13	152	1	3	0	0	451764	5465996
13-Feb-13	153	1	7	0	0	451758	5466015
13-Feb-13	154	1	0	0	0	451755	5466011
13-Feb-13	155	1	1	0	0	451754	5466016
13-Feb-13	156	1	2	0	0	451763	5466036
13-Feb-13	157	1	1	0	0	451764	5466060
13-Feb-13	158	1	3	0	0	451754	5466056
13-Feb-13	159	1	4	0	0	451739	5466065
13-Feb-13	160	1	4	0	0	451740	5466072
13-Feb-13	161	1	0	0	0	451739	5466081
13-Feb-13	162	1	5	0	0	451739	5466086
13-Feb-13	163	1	1	0	0	451739	5466093
13-Feb-13	164	1	5	0	0	451742	5466123
13-Feb-13	165	1	1	0	0	451738	5466131
13-Feb-13	166	1	17	0	0	451744	5466135
13-Feb-13	167	1	0	0	0	451728	5466158
13-Feb-13	168	1	1	0	0	451725	5466158
13-Feb-13	169	1	3	0	0	451728	5466192
13-Feb-13	170	1	0	0	0	451733	5466188
13-Feb-13	171	1	0	0	0	451746	5466216
13-Feb-13	172	1	1	0	0	451739	5466270
13-Feb-13	173	1	1	0	0	451745	5466266
13-Feb-13	174	1	0	0	0	451698	5466417
13-Feb-13	175	1	0	0	0	451704	5466417
13-Feb-13	176	1	0	0	0	451715	5466420
13-Feb-13	177	1	0	0	0	451715	5466423
13-Feb-13	178	1	0	0	0	451715	5466419
Totals		**175**	**2532**	**61**	**94**		

Table D10: Summary of results during Mountain Whitefish egg stranding surveys in the Columbia and Kootenay Rivers, January 12, 2010 to February 16, 2013.

Study Year	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 ($eggs/m^2$)
Year 2 (2009 – 2010)	12-Jan-10	CPR Island (8.6)	17	1	2.9	0.2	0.6	6	*10.00*
				2	9.6	0.2	1.9	152	*80.00*
				3	10.0	0.2	2.0	699	*349.50*
		Kootenay RUB (0.8K)	22	4	3.7	0.2	0.7	442	*631.43*
				5	3.4	0.2	0.7	917	*1310.00*
				6	5.1	0.2	1.0	374	*374.00*
	14-Jan-10	Kinnaird Rapids RUB (12.0)	31	7	13.8	0.2	2.8	23	*8.21*
				8	13.6	0.2	2.7	41	*15.19*
				9	11.9	0.2	2.4	57	*23.75*
		Tin Cup RUB (10.0)	39	10	11.2	0.2	2.2	1	*0.45*
				11	10.1	0.2	2.0	0	*0.00*
				12	3.2	0.2	0.6	0	*0.00*
Year 2 Totals							**19.6**	**2712**	***138.37***
Year 3 (2010 – 2011)	1-Apr-11	CPR Island Area (8.7)	17	1	4.2	0.2	0.8	317	*396.25*
				2	5.9	0.2	1.2	323	*269.17*
Year 3 Totals							**2.0**	**640**	***320.00***
Year 4 (2011 – 2012)	2-Apr-12	CPR Island (8.7)	17	1	5.0	0.3	1.5	302	*201.33*
				2	4.0	0.3	1.2	258	*215.00*
		Kootenay RUB (0.8K)	39	1	3.2	0.2	0.6	16	*26.67*
				2	3.0	0.2	0.6	16	*26.67*
Year 4 Totals							**3.9**	**592**	***151.79***
Year 5 (2012 – 2013)	16-Feb-13	Kootenay RUB (0.8K)	39	1	3.8	0.4	1.5	679	*452.67*
		Kootenay LUB (0.8K)		2	4.0	0.4	1.6	1	*0.63*
		Kootenay RUB (0.5K)		3	10.3	0.4	4.1	40	*9.76*
		Kootenay LUB (0.5K)		4	3.0	0.4	1.2	9	*7.50*
		Kootenay RUB (0.25K)		5	6.4	0.4	2.6	526	*202.31*
		Kootenay LUB (0.25K)		6	3.9	0.4	1.6	91	*56.88*
Year 5 Totals							**12.6**	**1346**	***106.83***

[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.

Table D11: 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.

Study Year	Date	Location and River Bank (River Kilometre Downstream from HLK)	Number of Egg Grids Conducted	Area of Each Grid (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)
Year 4 (2011 – 2012)	4-Feb-12	Tin Cup Rapids RUB (10.0)	10	1	10	15	*1.50*	*0.20 (Year 2)*
		Kinnaird Rapids RUB (11.0)	10	1	10	406	*40.60*	*15.40 (Year 2)*

Table D12: Numbers of Mountain Whitefish larvae encountered during larval stranding surveys, March 30 and 31, 2010 (Year 2).

Date	Site	Section	Number of Interstitially Stranded Larvae	Approximate Number of Larvae in Isolated Pools[b]	Approximate Number of Larvae Observed in Nearshore Areas[b]
30-Mar-10	ESMW2[a]	Upper	0	0	0
	ESMW4[a]	Upper	0	0	2
	ESMW5[a]	Upper	5	26	45
	Norn's Fan	Upper	0	445	200
	CPR Island	Upper	0	0	0
	Kootenay RUB	Upper	0	0	35
	Genelle	Middle	0	0	100
30-Mar-10 Total			**5**	**471**	**382**
31-Mar-10	Norn's Fan	Upper	6	213	5,500
	Waldies Island	Upper	0	0	0
	Kootenay RUB	Upper	30	33	0
31-Mar-10 Total			**36**	**246**	**5,500**
Grand Total			**41**	**717**	**5,882**

[a] See Appendix A, Figures A1 for site locations.

[b] Derived from estimates of large schools and observations of individuals.

Table D13: Number of Mountain Whitefish larvae encountered during larval surveys, March 28 to May 23, 2013 (Year 5).

Date	Approximate size of schools observed at Site (RKm)															
	Balfour Bay (2.5)	D/S of Balfour Bay (3.0)	Sturgeon Island (6.5)	Norn's Creek Mouth (7.5)	Norn's Creek Fan (8.0)	Waldies Island (8.75)	Tin Cup Rapids (9.00)	Millenium Park (9.75)	Kootenay Eddy (10.5)	Kootenay Oxbow Area (10.5)	Zuckerberg Island (10.5)	Kinnard Rapids (12.5)	D/S of Kinnaird Bridge (14.75)	Waterloo Eddy (16.75)	Sandbar Eddy (21.25)	Genelle (25)
28-Mar-13	0	dns[a]	dns[a]	dns[a]	5*	0	dns[a]	0	0	0	dns[a]	dns[a]	0	0	300*	8* (did not have time to sample entire site)
4-Apr-13	0	dns[a]	dns[a]	2000, 29*	1000, 200, 58*	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	200	dns
9-Apr-13	30*	100, 150, 20*	dns	500, 200, 40*	500, 300, 300, 500, 100	60*	dns[a]	dns[a]	0	2*	dns[a]	dns[a]	dns[a]	dns[a]	40*	dns
12-Apr-13	0	0	dns	250, 200, 1000, 50*	200, 100, 100, 500, 200, 300, 100, 250*	dns[a]	dns[a]	23	dns[a]	dns	0	dns[a]	dns[a]	dns[a]	18*	dns
16-Apr-13	0	5*	22*	100, 70, 75, 100, 115, 111*	80, 90, 80, 300, 70, 130*	110, 64*	0	80, 4*	dns[a]	17*	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns
23-Apr-13	0	39*	dns	160, 100, 150, 400*	100, 150, 100, 325, 80, 408*	75, 100, 280*	dns[a]	dns[a]	0	50, 200*	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns
30-Apr-13	dns[a]	16*	5*	33*	Cancelled remainder of survey due to high winds reducing visibility											
1-May-13	dns[a]	dns[a]	dns[a]	250*	150, 100, 200, 100, 225, 100, 1000*	dns[a]	dns[a]	dns[a]	dns[a]	600*	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]
7-May-13	dns[a]	100, 150, 420*	dns[a]	175*	150, 370*	540*	dns[a]	dns[a]	dns[a]	375*	dns[a]	dns[a]	dns[a]	0	240*	dns[a]
Flows increased substantially in this period, and increased water levels flooded habitat previously sampled.																
14-May-13	dns[a]	70*	dns[a]	13*	110*	60*	dns[a]	0	0	0	dns[a]	dns[a]	dns[a]	dns[a]	0	dns[a]
17-May-13	dns[a]	dns[a]	dns[a]	8*	4*	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	dns[a]	166*
23-May-13	dns[a]	dns[a]	dns[a]	dns[a]	0	3*	dns[a]	dns[a]	0	0	17*	3*	dns[a]	dns[a]	dns[a]	dns[a]

* denotes larvae observed in small schools (<50) or solitary

[a] dns = did not sample this site on this day.

Table D14: Habitat data summary from habitats used by large aggregations of larval Mountain Whitefish in study years 2 and 5.

Date and Study Year	Site	Number of Transects	Estimated number of observed larvae	Depth (cm)		Velocity (m/s)		Dominant Substrate[a]		Cover Types[b]
				Mean	SD	Mean	SD	Mean	SD	
31-Mar-10 (Year 2)	Norn's Fan	10	5000	3.47	2.96	0.03	0.04	4.37	1.69	INT, AV, SWD
	Norn's Fan	5	500	6.61	5.65	0.00	0.00	4.86	0.98	INT, SWD
4-Apr-13 (Year 5)	Norn's Creek Mouth	5	2000	25.26	14.79	0.00	0.00	2.12	2.09	INT, OD, SWD, LWD
	Norn's Fan	3	1000	15.47	7.36	0.00	0.00	4.1	1.47	INT, SWD, AV
12-Apr-2013 (Year 5)	Norn's Creek Mouth	3	1000	10.23	6.64	0.02	0.01	1.53	0.08	SWD, INT

[a] Dominant substrate based on Modified Wentworth values: 1 = silt, 2 = sand, 3 = fine gravel (2-8mm), 4 = medium gravel (8-17mm), 5 = large gravel (18-32mm).
[b] Cover Type: INT = interstices, AV = aquatic vegetation, SWD = small woody debris, OD = organic debris, LWD = large woody debris.

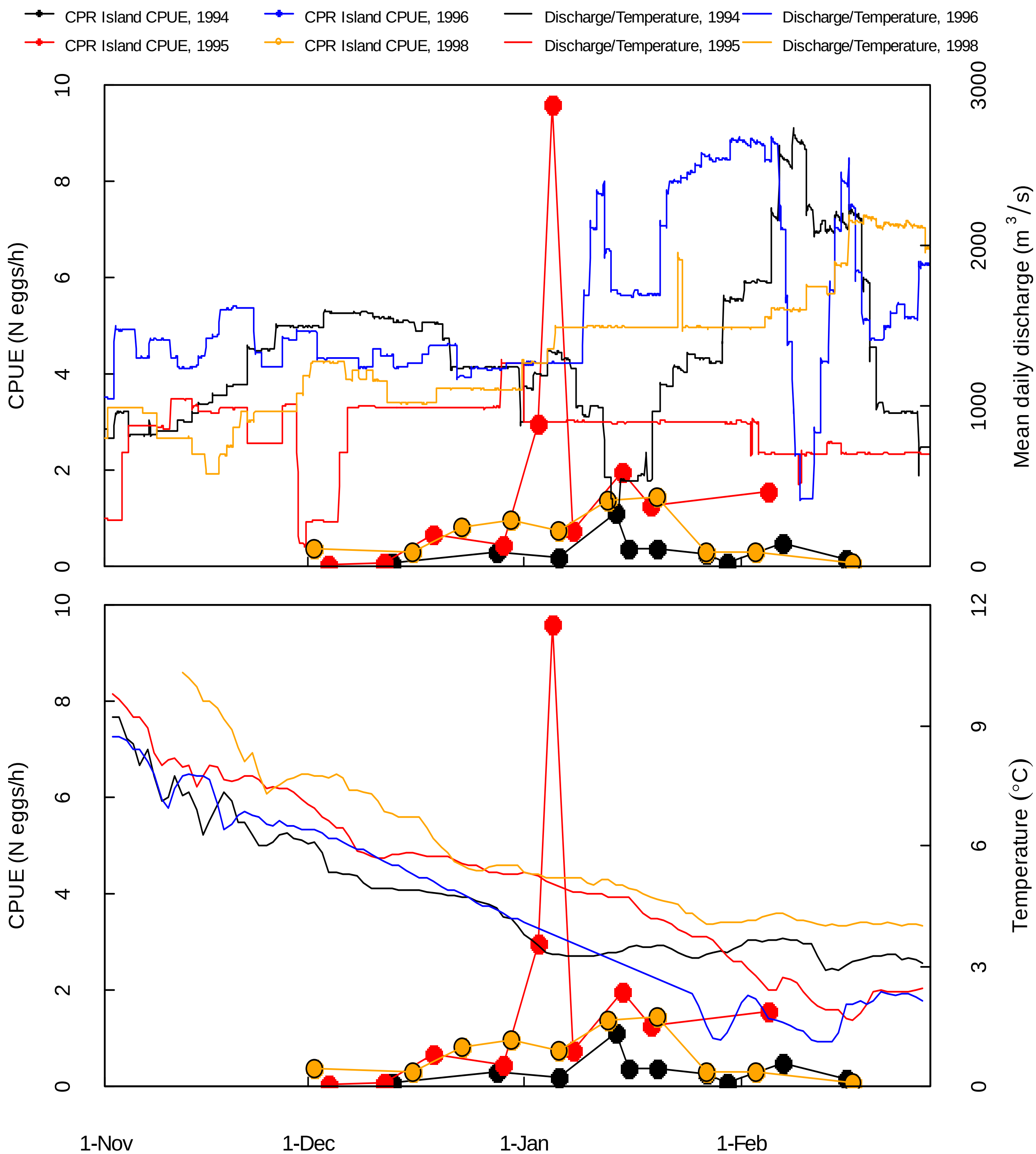

Figure D1: Catch per unit effort (CPUE; N eggs/h) of Mountain Whitefish eggs at CPR Island during 1994-1998 (points) and mean hourly discharge (m³/s; top panel) and mean hourly temperature (°C; bottom panel) of the Columbia River at HLK Dam (1994-1998; solid lines; secondary y-axis).

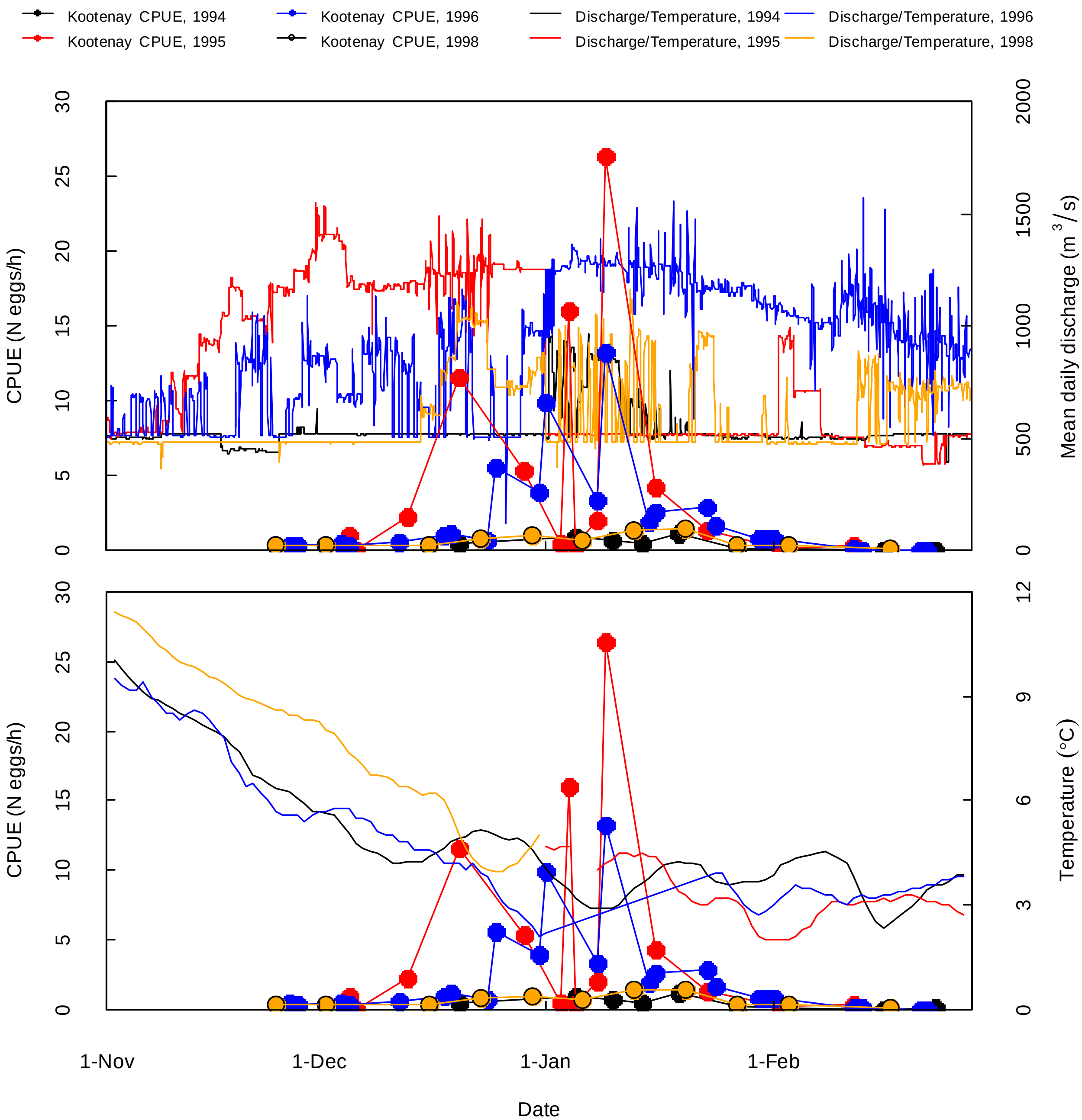

Figure D2: Catch per unit effort (CPUE; N eggs/h) of Mountain Whitefish eggs at Kootenay sampling sites during 1994-1998 (points) and mean hourly discharge (m^3/s; top panel) and mean hourly temperature (°C; bottom panel) of the Kootenay River at Brilliant (1994-1998; solid lines; secondary y-axis).

APPENDIX E

Juvenile Mountain Whitefish Sampling Data Summaries

Table E1: Catches and CPUEs of juvenile mountain whitefish (MW) captured by site in the CLBMON-48 study area, September 9 to 20, 2008 (Year 1).

Section	Date	Session	Site[a]	Bank Habitat Type[b]	Effort (hrs)	Length Sampled (km)	Juvenile MW		Total	CPUE (fish/km/hr)
							Captured	Observed		
Upper	9-Sep-08	1	ESMW1	A2	0.11	0.28	0	0	0	*0.0*
			ESMW2	D1	0.10	0.30	1	2	3	*96.1*
			ESMW3	D1/A1	0.45	1.02	5	10	15	*32.5*
			ESMW4	D1	0.36	0.57	29	24	53	*259.7*
			ESMW5	D1	0.35	0.88	55	130	185	*603.0*
			ESMW6	D1/A1	0.42	0.96	29	53	82	*205.4*
			ESMW7	D1	0.17	0.52	8	17	25	*289.9*
Subtotals					**1.96**	**4.53**	**127**	**236**	**363**	***40.9***
Middle	10-Sep-08	1	ESMW8	D1+D2	0.10	0.39	3	2	5	*126.9*
			ESMW9	D1+D2	0.29	0.53	3	5	8	*52.6*
			ESMW10	D2	0.15	0.80	35	25	60	*514.0*
			ESMW11	D2	0.12	0.67	11	22	33	*420.7*
			ESMW12	A2+A3/D2/A5	0.24	0.62	0	1	1	*6.7*
			ESMW13	A2	0.30	1.15	5	7	12	*34.9*
			ESMW14	BW	0.15	0.25	3	1	4	*109.0*
Subtotals					**1.34**	**4.41**	**60**	**63**	**123**	***20.9***
Lower	11-Sep-08	1	ESMW15	D1+D2	0.24	0.69	6	6	12	*72.5*
			ESMW16	D1/A1+A2	0.26	0.70	1	2	3	*16.6*
			ESMW17	D1+D2/BW	0.31	1.12	2	3	5	*14.3*
			ESMW18	A2	0.32	1.17	0	3	3	*7.9*
			ESMW19	D2/BW	0.21	0.88	1	1	2	*10.7*
			ESMW20	EDDY/A1	0.21	0.56	1	0	1	*8.4*
			ESMW21	BW/A6	0.18	0.68	0	0	0	*0.0*
Subtotals					**1.74**	**5.80**	**11**	**15**	**26**	***2.6***
Upper	12-Sep-08	1	ESMW4	D1	0.17	0.47	15	17	32	*399.0*
			ESMW5	D1	0.34	0.88	57	100	157	*520.5*
			ESMW6	D1/A1	0.43	0.96	10	15	25	*61.2*
			ESMW23	D1+D2	0.54	1.26	48	200	248	*360.8*
			ESMWKR	D2/BW/A2+A3	0.26	1.40	5	5	10	*27.2*
			ESMWKL	D1+D2/EDDY	0.13	0.60	5	30	35	*463.9*
Subtotals					**1.87**	**5.57**	**140**	**367**	**507**	***48.6***
Session 1 Grand Totals					**6.91**	**20.31**	**338**	**681**	**1019**	***7.3***
Upper	16-Sep-08	2	ESMW4	D1	0.25	0.57	21	13	34	*237.6*
			ESMW5	D1	0.37	0.88	47	300	347	*1073.6*
			ESMW6	D1/A1	0.45	0.96	25	42	67	*154.5*
			ESMW22	A1/D1	0.54	1.10	1	3	4	*6.8*
			ESMW23	D1+D2	0.48	1.26	23	63	86	*142.4*
			ESMW24	D1	0.45	1.40	2	0	2	*3.1*
Subtotals					**2.54**	**6.17**	**119**	**421**	**540**	***34.5***
Middle	18-Sep-08	2	ESMW8	D1+D2	0.09	0.39	3	7	10	*286.2*
			ESMW9	D1+D2	0.26	0.53	2	4	6	*44.1*
			ESMW10	D2	0.14	0.80	11	33	44	*385.7*
			ESMW11	D2	0.03	0.11	4	11	15	*4898.9*
			ESMW25	D1+D2/A1	0.27	0.33	0	14	14	*156.4*
			ESMW26	D2	0.08	0.70	7	11	18	*338.9*
			ESMW27	A1/A5	0.21	0.79	1	6	7	*42.9*
			ESMW28	D2	0.12	0.31	5	15	20	*541.4*
Subtotals					**1.19**	**3.96**	**33**	**101**	**134**	***28.4***
Lower	19-Sep-08	2	ESMW15	D1+D2	0.24	0.69	7	15	22	*134.2*
			ESMW29	D1+D2/A2	0.21	0.34	4	3	7	*95.2*
			ESMW30	A1/D2	0.17	0.96	6	6	12	*73.1*
			ESMW31	EDDY	0.10	0.32	0	0	0	*0.0*
Subtotals					**0.73**	**2.31**	**17**	**24**	**41**	***24.5***
Upper	20-Sep-08	2	ESMW4	D1	0.20	0.57	22	55	77	*687.3*
			ESMW5	D1	0.40	0.88	54	250	304	*861.6*
			ESMW6	D1/A1	0.37	0.96	22	40	62	*173.3*
			ESMW23	D1+D2	0.42	1.26	24	32	56	*105.3*
			ESMWKL	D1+D2/EDDY	0.13	0.60	7	20	27	*349.4*
			ESMW32	D2	0.16	0.43	14	16	30	*434.1*
Subtotals					**1.68**	**4.70**	**143**	**413**	**556**	***70.4***
Session 2 Grand Totals					**6.14**	**17.13**	**312**	**959**	**1271**	***12.1***

[a] See Figures A1 to A3 for site locations.

[b] Bank habitat types listed in order of dominance within site, see Appendix E, Table E8 for descriptions.

Table E2: Catches and CPUEs of juvenile mountain whitefish (MW) captured by site in the CLBMON-48 study area, September 10 to 21, 2010 (Year 2).

Section	Date	Session	Site[a]	Bank Habitat Type[b]	Effort (hrs)	Length Sampled (km)	Juvenile MW		Total	CPUE (fish/km/hr)
							Captured	Observed		
Upper	10-Sep-09	1	ESMW4	D1	0.17	0.57	29	23	52	*529.7*
			ESMW5	D1	0.30	0.88	34	70	104	*391.2*
			ESMW6	D1/A1	0.40	0.95	45	57	102	*269.3*
			ESMW7	D1	0.20	0.52	6	11	17	*164.9*
			ESMW23	D1+D2	0.36	1.07	22	22	44	*113.0*
Subtotals					**1.44**	**3.99**	**136**	**183**	**319**	**55.7**
Middle	11-Sep-09	1	ESMW8	D1+D2	0.09	0.39	20	10	30	*850.8*
			ESMW9	D1+D2	0.27	0.53	17	8	25	171.5
			ESMW10	D2	0.12	0.80	7	11	18	*191.4*
			ESMW11	D2	0.11	0.67	2	5	7	*97.0*
			ESMW14	BW	0.11	0.25	3	0	3	*109.8*
			ESMW25	D1+D2/A1	0.25	0.33	2	3	5	*61.3*
			ESMW26	D2	0.09	0.70	4	5	9	*142.8*
			ESMW28	D2	0.11	0.31	2	4	6	*176.0*
Subtotals					**1.15**	**3.98**	**57**	**46**	**103**	***22.5***
Lower	12-Sep-09	1	ESMW15	D1+D2	0.16	0.69	11	5	16	*144.0*
			ESMW16	D1/A1+A2	0.18	0.70	1	0	1	*8.1*
			ESMW17	D1+D2/BW	0.30	1.12	23	14	37	*110.5*
			ESMW18	A2	0.27	1.17	8	5	13	*40.8*
			ESMW19	D2/BW	0.12	0.84	3	5	8	*78.3*
			ESMW20	EDDY/A1	0.16	0.56	2	1	3	*32.7*
			ESMW29	D1+D2/A2	0.11	0.34	1	2	3	*81.5*
			ESMW30	A1/D2	0.10	0.96	5	5	10	*101.0*
Subtotals					**1.40**	**6.38**	**54**	**37**	**91**	***10.2***
Upper	13-Sep-09	1	ESMW4	D1	0.14	0.57	17	10	27	*346.2*
			ESMW5	D1	0.27	0.88	34	50	84	*349.8*
			ESMW6	D1/A1	0.32	0.96	51	69	120	*387.7*
			ESMW7	D1	0.22	0.52	14	19	33	*291.3*
			ESMW23	D1+D2	0.31	1.14	57	50	107	*300.1*
			ESMWKL	D1+D2/EDDY	0.13	0.60	4	9	13	*168.6*
			ESMW32	D2	0.13	0.43	6	19	25	*438.8*
Subtotals					**1.53**	**5.09**	**183**	**226**	**409**	***52.6***
Session 1 Grand Totals					**5.52**	**19.44**	**430**	**492**	**922**	***8.6***
Upper	16-Sep-09	2	ESMW4	D1	0.18	0.54	26	50	76	*802.1*
			ESMW5	D1	0.31	0.88	18	60	78	*288.6*
			ESMW6	D1/A1	0.42	0.96	37	105	142	*356.7*
			ESMW7	D1	0.19	0.52	7	24	31	*321.9*
			ESMW23	D1+D2	0.36	1.26	63	85	148	*322.5*
Subtotals					**1.45**	**4.16**	**151**	**324**	**475**	***78.9***
Middle	17-Sep-09	2	ESMW8	D1+D2	0.10	0.39	7	15	22	*543.2*
			ESMW9	D1+D2	0.28	0.53	13	38	51	*338.2*
			ESMW10	D2	0.11	0.80	10	70	80	*875.4*
			ESMW11	D2	0.16	0.67	10	80	90	*821.8*
			ESMW14	BW	0.11	0.25	4	11	15	*539.4*
			ESMW25	D1+D2/A1	0.24	0.33	2	23	25	*314.3*
			ESMW26	D2	0.08	0.70	3	10	13	*226.5*
			ESMW28	D2	0.11	0.31	6	11	17	*478.1*
Subtotals					**1.22**	**3.98**	**55**	**258**	**313**	***64.7***
Lower	18-Sep-09	2	ESMW15	D1+D2	0.20	0.69	7	48	55	*407.5*
			ESMW16	D1/A1+A2	0.22	0.70	2	7	9	*58.1*
			ESMW17	D1+D2/BW	0.30	1.12	8	34	42	*125.3*
			ESMW18	A2	0.26	1.17	1	8	9	*29.6*
			ESMW29	D1+D2/A2	0.16	0.34	0	14	14	*248.0*
			ESMW30	A1/D2	0.16	0.96	5	16	21	*133.8*
Subtotals					**1.30**	**4.99**	**23**	**127**	**150**	***23.1***
Upper	21-Sep-09	2	ESMW4	D1	0.21	0.57	18	62	80	*683.3*
			ESMW5	D1	0.32	0.88	14	69	83	*296.6*
			ESMW6	D1/A1	0.41	0.96	28	107	135	*346.2*
			ESMW7	D1	0.24	0.52	13	35	48	*393.8*
			ESMW23	D1+D2	0.41	1.26	25	75	100	*191.0*
			ESMWKL	D1+D2/EDDY	0.13	0.60	2	8	10	*131.4*
			ESMW32	D2	0.14	0.43	2	12	14	*239.7*
Subtotals					**1.84**	**5.22**	**102**	**368**	**470**	***48.9***
Session 2 Grand Totals					**5.81**	**18.34**	**331**	**1077**	**1408**	***13.2***

[a] See Figures A1 to A3 for site locations.

[b] Bank habitat types listed in order of dominance within site, see Appendix E, Table E8 for descriptions.

Table E3: Catches and CPUEs of juvenile mountain whitefish (MW) captured by site in the CLBMON-48 study area, September 7 to 23, 2010 (Year 3).

Section	Date	Session	Site[a]	Bank Habitat Type[b]	Effort (hrs)	Length Sampled (km)	Juvenile MW		Total	CPUE (fish/km/hr)
							Captured	Observed		
Upper	7-Sep-10	1	ESMW4	D1	0.24	0.57	14	7	21	*154.97*
	9-Sep-10		ESMW5	D1	0.32	0.68	53	70	123	*564.96*
	10-Sep-10		ESMW6	D1/A1	0.58	0.96	25	7	32	*57.50*
			ESMW7	D1	0.29	0.52	6	4	10	*67.28*
			ESMW23	D1+D2	0.35	1.26	41	34	75	*168.56*
Subtotals					**1.78**	**3.99**	**139**	**122**	**261**	**36.80**
Upper	13-Sep-10	1	ESMW4	D1	0.17	0.28	16	5	21	*443.52*
			ESMW5	D1	0.34	0.78	18	40	58	*220.27*
			ESMW6	D1/A1	0.46	0.96	8	2	10	*22.66*
			ESMW7	D1	0.24	0.52	3	1	4	*32.40*
			ESMW23	D1+D2	0.44	1.26	19	23	42	*76.33*
Subtotals					**1.64**	**3.80**	**64**	**71**	**135**	***21.66***
Session 1 Grand Totals					**3.42**	**7.79**	**203**	**193**	**396**	***14.87***
Upper	17-Sep-10	2	ESMW4	D1	0.23	0.57	19	11	30	*229.12*
			ESMW5	D1	0.32	0.88	15	28	43	*152.73*
			ESMW6	D1/A1	0.43	0.96	9	5	14	*34.34*
			ESMW7	D1	0.23	0.52	4	0	4	*33.53*
			ESMW23	D1+D2	0.43	1.26	14	13	27	*49.61*
Subtotals					**1.64**	**4.19**	**61**	**57**	**118**	***17.21***
Upper	23-Sep-10	2	ESMW4	D1	0.46	0.55	21	5	26	*102.29*
			ESMW5	D1	0.22	0.88	16	7	23	*120.03*
			ESMW6	D1/A1	0.43	0.96	13	13	26	*63.77*
			ESMW7	D1	0.31	0.47	3	3	6	*41.18*
			ESMW23	D1+D2	0.62	1.26	2	3	5	*6.36*
Subtotals					**2.04**	**4.12**	**55**	**31**	**86**	***10.24***
Session 2 Grand Totals					**3.67**	**8.31**	**116**	**88**	**204**	***6.68***

[a] See Figure A1 for site locations.

[b] Bank habitat types listed in order of dominance within site, see Appendix E, Table E8 for descriptions.

Table E4: Summary of Aggregations observed during boat-electroshocking for juvenile Mountain Whitefish, Study Years 1 to 3.

Reach	Date	Study Year	Sample Session	Site[a]	Easting	Northing	Size of Aggregation
Upper	9-Sep-08	1	1	ESMW5	446801	5465586	>50
	12-Sep-08			ESMW5	446801	5465586	>50
	16-Sep-08		2	ESMW23	451501	5464595	>50
Lower	18-Sep-08	1	2	ESMW15	455156	5435650	>25
Upper	10-Sep-09	2	1	ESMW4	446315	5465795	5 - 10
	10-Sep-09			ESMW4	446394	5465768	5 - 10
	10-Sep-09			ESMW4	446434	5465732	5 - 10
	10-Sep-09			ESMW5	446776	5465571	15 - 20
	10-Sep-09			ESMW5	446801	5465586	15 - 20
	10-Sep-09			ESMW6	447458	5465443	5 - 10
	10-Sep-09			ESMW23	451518	5464595	15 - 20
	13-Sep-09			ESMW4	446507	5465608	10 - 15
	13-Sep-09			ESMW5	446776	5465571	25
	13-Sep-09			ESMW5	446801	5465586	25
	13-Sep-09			ESMW6	447576	5465410	15 - 20
	13-Sep-09			ESMW6	447808	5465372	10
	13-Sep-09			ESMW7	448537	5464799	10
	13-Sep-09			ESMW23	451485	5464595	15 - 20
	13-Sep-09			ESMW32	452468	5462978	20
	16-Sep-09		2	ESMW6	447576	5465410	20
	16-Sep-09			ESMW6	447808	5465372	20
	21-Sep-09			ESMW4	446315	5465795	10 - 20
	21-Sep-09			ESMW4	446394	5465768	10 - 20
	21-Sep-09			ESMW4	446434	5465732	10 - 20
	21-Sep-09			ESMW5	446776	5465571	5 - 10
	21-Sep-09			ESMW5	446801	5465586	5 - 10
	21-Sep-09			ESMW5	446531	5465581	30
	21-Sep-09			ESMW6	447458	5465443	5
	21-Sep-09			ESMW6	447576	5465410	5
	21-Sep-09			ESMW6	447808	5465372	5
	21-Sep-09			ESMW6	447611	5465425	10 - 20
	21-Sep-09			ESMW6	447704	5465398	10 - 20
Middle	11-Sep-09	2	1	ESMW28	450600	5451668	6
	11-Sep-09			ESMW8	450379	5450836	15
	11-Sep-09			ESMW8	450367	5450798	15
	11-Sep-09			ESMW9	448904	5450495	5
	11-Sep-09			ESMW10	448256	5449867	5 - 10
	17-Sep-09		2	ESMW8	450362	5450784	5 - 10
	17-Sep-09			ESMW9	448861	5450501	20
	17-Sep-09			ESMW10	448163	5449260	20
	17-Sep-09			ESMW10	448150	5449427	30 - 50
	17-Sep-09			ESMW11	448366	5449230	20 - 30
Lower	12-Sep-09	2	1	ESMW15	455157	5435647	5 - 10
	12-Sep-09			ESMW17	454982	5434490	5 - 10
	18-Sep-09		2	ESMW15	455157	5435647	5 - 10
	18-Sep-09			ESMW15	455056	5436053	5
	18-Sep-09			ESMW15	455174	5435402	20
	18-Sep-09			ESMW16	455311	5434998	5
	18-Sep-09			ESMW17	454973	5434418	5
Upper	7-Sep-10	3	1	ESMW4	446398	5465757	5-10
	9-Sep-10			ESMW5	446746	5465561	5-10
	9-Sep-10			ESMW5	446789	5465576	5-10
	9-Sep-10			ESMW5	446825	5465588	10-20
	10-Sep-10			ESMW6	447703	5465390	5-10
	10-Sep-10			ESMW23	451124	5464674	5-10
	10-Sep-10			ESMW23	451524	5464597	20-50
	13-Sep-10			ESMW4	446057	5465788	5-10
	13-Sep-10			ESMW4	446084	5465789	5-10
	13-Sep-10			ESMW5	446756	5465570	5-10
	13-Sep-10			ESMW5	446631	5465581	20-50
	13-Sep-10			ESMW5	446533	5465576	5-10
	13-Sep-10			ESMW5	446765	5465562	5-10
	13-Sep-10			ESMW23	451132	5464672	5-10
	13-Sep-10			ESMW23	451528	5464601	10-20
	17-Sep-10		2	ESMW4	446310	5465794	5-10
	17-Sep-10			ESMW5	446736	5465567	20-50
	17-Sep-10			ESMW23	451099	5464686	10-20
	23-Sep-10			ESMW4	446505	5465622	5-10

[a] See Figures A1 to A3 for site locations.

Table E5: Catches and recaptures of juvenile mountain whitefish captured by site in the CLBMON-48 study area, September 9 to 20, 2008 (Year 1).

Reach	Date	Site[a]	Captures	Recaptures
Upper	9-Sep-08	ESMW1	0	0
		ESMW2	1	0
		ESMW3	5	0
		ESMW4	29	0
		ESMW5	55	0
		ESMW6	29	0
		ESMW7	8	0
Subtotals			**127**	**0**
Middle	10-Sep-08	ESMW8	3	0
		ESMW9	3	0
		ESMW10	35	0
		ESMW11	11	0
		ESMW12	0	0
		ESMW13	5	0
		ESMW14	3	0
Subtotals			**60**	**0**
Lower	11-Sep-08	ESMW15	6	0
		ESMW16	1	0
		ESMW17	2	0
		ESMW18	0	0
		ESMW19	1	0
		ESMW20	1	0
		ESMW21	0	0
Subtotals			**11**	**0**
Upper	12-Sep-08	ESMW4	15	2
		ESMW5	57	1
		ESMW6	10	0
		ESMW23	48	0
		ESMWKR	5	0
		ESMWKL	5	0
Subtotals			**140**	**3**
Session 1 Grand Totals			**338**	**3**
Upper	16-Sep-08	ESMW4	21	2
		ESMW5	47	3
		ESMW6	25	1
		ESMW22	1	0
		ESMW23	23	0
		ESMW24	2	0
Subtotals			**119**	**6**
Middle	18-Sep-08	ESMW8	3	0
		ESMW9	2	0
		ESMW10	11	0
		ESMW11	4	0
		ESMW25	0	0
		ESMW26	7	0
		ESMW27	1	0
		ESMW28	5	0
Subtotals			**33**	**0**
Lower	19-Sep-08	ESMW15	7	0
		ESMW29	4	0
		ESMW30	6	0
		ESMW31	0	0
Subtotals			**17**	**0**
Upper	20-Sep-08	ESMW4	22	2
		ESMW5	54	4
		ESMW6	22	7
		ESMW23	24	0
		ESMWKL	7	0
		ESMW32	14	0
Subtotals			**143**	**13**
Session 2 Grand Totals			**312**	**19**

[a] See Figures A1 to A3 for site locations.

Table E6: Catches and recaptures of juvenile mountain whitefish captured by site in the CLBMON-48 study area, September 10 to 21, 2009 (Year 2).

Reach	Date	Site[a]	Captures	Recaptures
Upper	10-Sep-09	ESMW4	29	0
		ESMW5	34	0
		ESMW6	45	0
		ESMW7	6	0
		ESMW23	22	0
Subtotals			**136**	**0**
Middle	11-Sep-09	ESMW8	20	0
		ESMW9	17	0
		ESMW10	7	0
		ESMW11	2	0
		ESMW14	3	0
		ESMW25	2	0
		ESMW26	4	0
		ESMW28	2	0
Subtotals			**57**	**0**
Lower	12-Sep-09	ESMW15	11	0
		ESMW16	1	0
		ESMW17	23	0
		ESMW18	8	0
		ESMW19	3	0
		ESMW20	2	0
		ESMW29	1	0
		ESMW30	5	0
Subtotals			**54**	**0**
Upper	13-Sep-09	ESMW4	17	0
		ESMW5	34	0
		ESMW6	51	2
		ESMW7	14	1
		ESMW23	57	0
		ESMWKL	4	0
		ESMW32	6	0
Subtotals			**183**	**3**
Session 1 Grand Totals			**430**	**3**
Upper	16-Sep-09	ESMW4	26	2
		ESMW5	18	0
		ESMW6	37	7
		ESMW7	7	1
		ESMW23	63	1
Subtotals			**151**	**11**
Middle	17-Sep-09	ESMW8	7	0
		ESMW9	13	0
		ESMW10	10	0
		ESMW11	10	0
		ESMW14	4	0
		ESMW25	2	0
		ESMW26	3	0
		ESMW28	6	0
Subtotals			**55**	**0**
Lower	18-Sep-09	ESMW15	7	0
		ESMW16	2	0
		ESMW17	8	1
		ESMW18	1	0
		ESMW29	0	0
		ESMW30	5	0
Subtotals			**23**	**1**
Upper	21-Sep-09	ESMW4	18	1
		ESMW5	14	1
		ESMW6	28	2
		ESMW7	13	0
		ESMW23	25	1
		ESMWKL	2	0
		ESMW32	2	0
Subtotals			**102**	**5**
Session 2 Grand Totals			**331**	**17**

[a] See Figures A1 to A3 for site locations.

Table E7: Catches and recaptures of juvenile mountain whitefish captured at sites in the CLBMON-48 study area, September 7 to 23, 2010 (Year 3).

Reach	Date	Site[a]	Captures	Recaptures
Upper	7-Sep-10	ESMW4	14	0
	9-Sep-10	ESMW5	53	0
	10-Sep-10	ESMW6	25	0
		ESMW7	6	0
		ESMW23	41	0
Subtotals			**139**	**0**
Upper	13-Sep-10	ESMW4	16	0
		ESMW5	18	0
		ESMW6	8	0
		ESMW7	3	0
		ESMW23	19	0
Subtotals			**64**	**0**
Session 1 Grand Totals			**203**	**0**
Upper	17-Sep-10	ESMW4	19	0
		ESMW5	15	0
		ESMW6	9	0
		ESMW7	4	0
		ESMW23	14	0
Subtotals			**61**	**0**
Upper	23-Sep-10	ESMW4	21	1
		ESMW5	16	0
		ESMW6	13	2
		ESMW7	3	1
		ESMW23	2	0
Subtotals			**55**	**4**
Session 2 Grand Totals			**116**	**4**

[a] See Figure A1 for site locations.

Table E8: Descriptions of categories used in the Lower Columbia River Bank Habitat Types Classification System.

Category	Code	Description
Armoured/Stable	A1	Banks generally stable and at repose with cobble/small boulder/gravel substrates predominating; uniform shoreline configuration with few/minor bank irregularities; velocities adjacent to bank generally low-moderate, instream cover limited to substrate roughness (i.e., cobble/small boulder interstices).
	A2	Banks generally stable and at repose with cobble/small boulder and large boulder substrates predominating; irregular shoreline configuration generally consisting of a series of armoured cobble/boulder outcrops that produce Backwater habitats; velocities adjacent to bank generally moderate with low velocities provided in BW habitats: instream cover provided by BW areas and substrate roughness; overhead cover provided by depth and woody debris; occasionally associated with C2, E4, and E5 banks.
	A3	Similar to A2 in terms of bank configuration and composition although generally with higher composition of large boulders/bedrock fractures; very irregular shoreline produced by large boulders and bed rock outcrops; velocities adjacent to bank generally moderate to high; instream cover provided by numerous small BW areas, eddy pools behind submerged boulders, and substrate interstices; overhead cover provided by depth; exhibits greater depths offshore than found in A1 or A2 banks; often associated with C1 banks.
	A4	Gently sloping banks with predominantly small and large boulders (boulder garden) often embedded in finer materials; shallow depths offshore, generally exhibits moderate to high velocities; instream cover provided by “pocket eddies” behind boulders; overhead cover provided by surface turbulence.
	A5	Bedrock banks, generally steep in profile resulting in deep water immediately offshore; often with large bedrock fractures in channel that provide instream cover; usually associated with moderate to high current velocities; overhead cover provided by depth.
	A6	Man-made banks usually armoured with large boulder or concrete rip-rap; depths offshore generally deep and usually found in areas with moderate to high velocities; instream cover provided by rip-rap interstices; overhead cover provided by depth and turbulence.
Depositional	D1	Low relief, gently sloping bank type with shallow water depths offshore; substrate consists predominantly of fines (i.e., sand/silt); low current velocities offshore; instream cover generally absent or, if present, consisting of shallow depressions produced by dune formation (i.e., in sand substrates) or embedded cobble/boulders and vegetative debris; this bank type was generally associated with bar formations or large backwater areas.
	D2	Low relief, gently sloping bank type with shallow water depths offshore; substrate consists of coarse materials (i.e., gravels/cobbles); low-moderate current velocities offshore; areas with higher velocities usually producing riffle areas; overhead cover provided by surface turbulence in riffle areas; instream cover provided by substrate roughness; often associated with bar formations and shoal habitat.
	D3	Similar to D2 but with coarser substrates (i.e., large cobble/small boulder) more dominant; boulders often embedded in cobble/gravel matrix; generally found in areas with higher average flow velocities than D1 or D2 banks; instream cover abundantly available in form of substrate roughness; overhead cover provided by surface turbulence; often associated with fast riffle transitional bank type that exhibits characteristics of both Armoured and Depositional bank types.
SPECIAL HABITAT FEATURES		
BACKWATER POOLS	-	These areas represent discrete areas along the channel margin where backwater irregularities produce localized areas of counter-current flows or areas with reduced flow velocities relative to the mainstem; can be quite variable in size and are often an integral component of Armoured and erosional bank types. The availability and suitability of Backwater pools are determined by flow level. To warrant separate identification as a discrete unit, must be a minimum of 10 m in length; widths highly variable depending on bank irregularity that produces the pool. Three classes are identified:
	BW-P1	Highest quality pool habitat type for adult and subadult cohorts for feeding/holding functions. Maximum depth exceeding 2.5 m, average depth 2.0 m or greater; high availability of instream cover types (e.g., submerged boulders, bedrock fractures, depth, woody debris); usually with Moderate to High countercurrent flows that provide overhead cover in the form of surface turbulence.
	BW-P2	Moderate quality pool type for adult and subadult cohorts for feeding/holding; also provides moderate quality habitat for smaller juveniles for rearing. Maximum depths between 2.0 to 2.5 m, average depths generally in order of 1.5 m. Moderate availability of instream cover types; usually with Low to Moderate countercurrent flow velocities that provide limited overhead cover.

Continued.

Table E8: Concluded.

	BW-P3	Low quality pool type for adult/subadult classes; moderate-high quality habitat for y-o-y and small juveniles for rearing. Maximum depth <1.0 m. Low availability of instream cover types; usually with Low-Nil current velocities.
EDDY POOL	EDDY	Represent large (<30 m in diameter) areas of counter current flows with depths generally >5 m; produced by major bank irregularities and are available at all flow stages although current velocities within eddy are dependent on flow levels. High quality areas for adult and subadult life stages. High availability of instream cover.
SNYE	SN	A side channel area that is separated from the mainstem at the upstream end but retains a connection at the lower end. SN habitats generally present only at lower flow stages since area is a flowing side channel at higher flows: characterized by low-nil velocity, variable depths (generally <3 m) and predominantly depositional substrates (i.e., sand/silt/gravel); often supports growths of aquatic vegetation; very important areas for rearing and feeding.

Table E9: Summary of data collected during the surgical impantation of dummy tags in juvenile Mountain Whitefish (MW), October, 2009 (Year 2).

Sample No.	Capture Location[a]	Water temp (ºC)	Species	Fork Length (mm)	Weight (g)	Surgery Date	Surgeon Initials	Anaesthetic Start Time	Anaesthetic End Time	Surgery Start Time	Surgery End Time	Survived Tagging Process	Release Date	Release Time	Release Location	Total Post Surgery Holding Time (hrs)
1	ESMW15	8.0	MW	149	n/r[b]	28-Oct	DS	18:59	19:04	19:08	19:12	Y	29-Oct	10:56	ESMW16	15:44
Comments																
2	ESMW15	8.0	MW	146	36.2	28-Oct	DS	19:17	19:27	19:32	19:35	N	N/A	N/A	N/A	15:21
Comments	stomach burst during surgery, inserted tag in fish as others in holding tank were smaller in size, fish did not survive extended holding period															
3	ESMW15	8.0	MW	142	28.3	28-Oct	DS	19:39	19:44	19:45	19:52	N	N/A	N/A	N/A	15:04
Comments	fish did not survive extended holding period															
4	ESMW15	8.0	MW	134	21.6	28-Oct	BH	20:01	20:10	20:10	20:13	N	N/A	N/A	N/A	14:43
Comments	fish did not survive extended holding period															
5	ESMW15	8.0	MW	135	22.8	28-Oct	BH	20:16	20:25	20:27	20:31	N	N/A	N/A	N/A	14:24
Comments	stomach burst during surgery, inserted tag in fish as others in holding tank were smaller in size, fish did not survive extended holding period															
6	ESMW5	8.5	MW	158	41.3	30-Oct	DS	19:45	19:47	19:48	19:53	Y	31-Oct	0:53	RKm 6.0	5:00
Comments																

[a] See Figures A1 and A2 for site locations.

[b] Not recorded due to scale malfunction.

Table E10: Data collected from Mountain Whitefish juveniles used in the tagging survivability experiment, September, 2010 (Year 3).

Sample No.	Capture Location[a]	Water temp (°C)	Species	Fork Length (mm)	Weight (g)	Experimental Treatment	Surgery Date	Surgeon Initials	Anesthetic Start Time	Anesthetic End Time	Surgery Start Time	Surgery End Time	PIT Tag Number	Fate After Holding Period
1	ESMW4	13.0	MW	230	131.5	V5	23-Sep	BH	21:04	21:09	21:11	21:17	N/A	Live
Comments	Sacrificed to retrieve V5 tag													
2	ESMW4	13.0	MW	190	76.5	V5 and PIT	23-Sep	BH	21:18	21:23	21:23	21:27	900118001364841	Live
Comments	Sacrificed to retrieve V5 tag													
3	ESMW4	13.0	MW	124	19.0	V5 and PIT	23-Sep	BH	21:28	21:34	21:34	21:37	900118001363273	Mortality
Comments														
4	ESMW4	13.0	MW	138	26.5	V5 and PIT	23-Sep	BH	21:40	21:44	21:46	21:49	900118001364141	Mortality
Comments	Killed by heron during holding period													
5	ESMW4	13.0	MW	110	15.5	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001366452	Mortality
Comments														
6	ESMW4	13.0	MW	85	6.0	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001366009	Mortality
Comments	Killed by heron during holding period													
7	ESMW4	13.0	MW	92	8.5	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001364236	Mortality
Comments														
8	ESMW4	13.0	MW	106	12.0	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001367402	Mortality
Comments														
9	ESMW4	13.0	MW	99	9.5	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001367437	Mortality
Comments	Small wound on right side, only implanted with PIT tag													
10	ESMW4	13.0	MW	70	3.5	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Mortality
Comments	Killed by heron during holding period													
11	ESMW4	13.0	MW	205	99.5	V5 and PIT	23-Sep	DF	22:09	22:14	22:15	22:19	900118001363927	Mortality
Comments														
12	ESMW4	13.0	MW	201	81.5	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001366607	Mortality
Comments														
13	ESMW4	13.0	MW	94	9.0	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001367080	Mortality
Comments														
14	ESMW4	13.0	MW	101	10.5	V5 and PIT	23-Sep	DF	22:24	22:28	22:29	22:31	900118001362730	Mortality
Comments														
15	ESMW4	13.0	MW	110	13.0	V5 and PIT	23-Sep	DF	22:32	22:37	22:37	22:40	900118001364294	Mortality
Comments														

[a] See Figure A1 for site locations.

Table E10: Continued.

Sample No.	Capture Location[a]	Water temp (°C)	Species	Fork Length (mm)	Weight (g)	Experimental Treatment	Surgery Date	Surgeon Initials	Anesthetic Start Time	Anesthetic End Time	Surgery Start Time	Surgery End Time	PIT Tag Number	Fate After Holding Period
16	ESMW4	13.0	MW	118	14.5	V5 and PIT	23-Sep	DF	22:40	22:44	22:45	22:49	900118001367261	Mortality
Comments														
17	ESMW4	13.0	MW	110	13.0	V5 and PIT	23-Sep	DF	22:54	22:58	22:59	23:02	900118001367223	Mortality
Comments														
18	ESMW4	13.0	MW	107	11.0	V5 and PIT	23-Sep	DF	23:00	23:04	23:05	23:09	900118001363108	Mortality
Comments														
19	ESMW4	13.0	MW	108	13.0	V5	23-Sep	DF	23:08	23:11	23:11	23:16	N/A	Live
Comments		Sacrificed to retrieve V5 tag												
20	ESMW5	13.0	MW	125	21.0	V5 and PIT	23-Sep	BH	23:19	23:25	23:26	23:29	900118001364432	Mortality
Comments														
21	ESMW5	13.0	MW	126	20.5	V5	23-Sep	BH	23:29	23:34	23:35	23:38	N/A	Live
Comments		Sacrificed to retrieve V5 tag												
22	ESMW5	13.0	MW	119	17.0	V5	23-Sep	BH	23:38	23:42	23:42	23:45	N/A	Live
Comments		Sacrificed to retrieve V5 tag												
23	ESMW5	13.0	MW	220	145.0	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Live
Comments														
24	ESMW5	13.0	MW	120	18.0	V5	BH	23:46	23:50	23:50	23:52	N/A	N/A	Mortality
Comments														
25	ESMW5	13.0	MW	100	9.0	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001366375	Mortality
Comments														
26	ESMW5	13.0	MW	100	9.5	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001362884	Mortality
Comments														
27	ESMW5	13.0	MW	101	11.0	PIT	N/A	N/A	N/A	N/A	N/A	N/A	900118001363100	Mortality
Comments														
28	ESMW5	13.0	MW	210	96.0	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Live
Comments														
29	ESMW5	13.0	MW	199	101.0	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Live
Comments														
30	ESMW5	13.0	MW	200	94.0	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Live
Comments														

[a] See Figure A1 for site locations.

Table E10: Concluded.

Sample No.	Capture Location[a]	Water temp (ºC)	Species	Fork Length (mm)	Weight (g)	Experimental Treatment	Surgery Date	Surgeon Initials	Anesthetic Start Time	Anesthetic End Time	Surgery Start Time	Surgery End Time	PIT Tag Number	Fate After Holding Period
31	ESMW5	13.0	MW	190	83.5	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Live
Comments														
32	ESMW5	13.0	MW	201	104.5	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Live
Comments														
33	ESMW6	13.0	MW	110	13.0	V5	24-Sep	BH	0:07	00:12	00:13	00:14	N/A	Mortality
Comments														
34	ESMW6	13.0	MW	105	10.0	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Mortality
Comments														
35	ESMW6	13.0	MW	110	13.0	V5	24-Sep	BH	00:19	00:24	00:24	00:26	N/A	Mortality
Comments														
36	ESMW6	13.0	MW	109	13.0	V5	24-Sep	BH	00:26	00:30	00:30	00:34	N/A	Mortality
Comments														
37	ESMW5	13.0	MW	105	11.5	V5	24-Sep	BH	00:30	00:35	00:35	00:38	N/A	Live
Comments	Sacrificed to retrieve V5 tag													
38	ESMW5	13.0	MW	110	13.5	V5	24-Sep	BH	00:36	00:40	00:41	00:44	N/A	Mortality
Comments														
39	ESMW5	13.0	MW	107	12.0	Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Live
Comments														

[a] See Figure A1 for site locations.

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