

Okanagan Basin Monitoring and Evaluation Program (OBMEP) 2009 Annual Report for Sites in Canada



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1.0 INTRODUCTION

1.1 Project Background

The Okanagan Basin Monitoring and Evaluation Program (OBMEP) is a 20-year monitoring program of anadromous salmonids habitat and abundance within the Okanagan¹ sub-basin of the Upper Columbia River. Initiated in 2004 by the Colville Confederated Tribes Fish and Wildlife Department (CCTFWD), the program began collaborating with the Okanagan Nation Alliance Fisheries Department (ONAFD) in 2005 due to the trans-boundary nature of the sub-basin (Walsh and Long 2006a; Benson *et al.* 2007).

The OBMEP procedures and methodology are adapted from the Monitoring Strategy for the Upper Columbia Basin (Hillman 2004). Monitoring status and trends of anadromous salmonids and their habitat involves:

1. documenting present conditions of water quality, habitat characteristics, species presence and abundance; and
2. quantifying changes to these conditions over time.

Status and trend data will:

1. help identify issues that require further experimental research to understand cause and effect relationships; and
2. aid in effectively monitoring management actions performed on or around streams of interest (i.e., a stream restoration project resulting in a change of abundance or quality of habitat for juvenile salmonid populations).

Thus, OBMEP strives to guide restoration and adaptive management strategies within the study area with the collection of long-term data.

Structured barriers are major constraints to present salmonid migrations in the Okanagan sub-basin. Dams exist at the outlets of all Canadian bound Okanagan mainstem lakes (specifically, Osoyoos, Vaseux, Skaha, and Okanagan Lake). The outlet dam at Vaseux Lake (herein referred to as the McIntyre Dam) is predominately considered the upper migration limit for Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*) and steelhead trout (*O. mykiss*). Outlet dams upstream from the McIntyre Dam are the Skaha Lake (at Okanagan Falls) and Okanagan Lake outlet dams. It is the general thought that anadromous salmonids have previously occupied the entire Okanagan headwater system (Ernst and Vedan 2000).

Re-introduction of sockeye fry into the Skaha Lake² system presently extends the range of anadromous salmonids to just below the Okanagan Lake outlet dam in Penticton (British Columbia). Consequently, under the OBMEP mandate, the study area in Canada extends from the Okanagan Lake outlet dam south to the United States border (Figure. 1).

¹ Okanagan equals Okanogan in Washington State

² Re-introduction of sockeye salmon into Skaha Lake commenced in 2003 with the release of 352,500 fry. Recent releases include 1,205,500 in 2005 (Long *et al.* 2005), 1,384,000 in 2006 (Long *et al.* 2007), 1,479,000 in 2007 (Benson *et al.* 2008), 885,500 in 2008 (Kozlova *et al.* 2009), and 880,700 in 2009 (Wright *et al.* 2011).

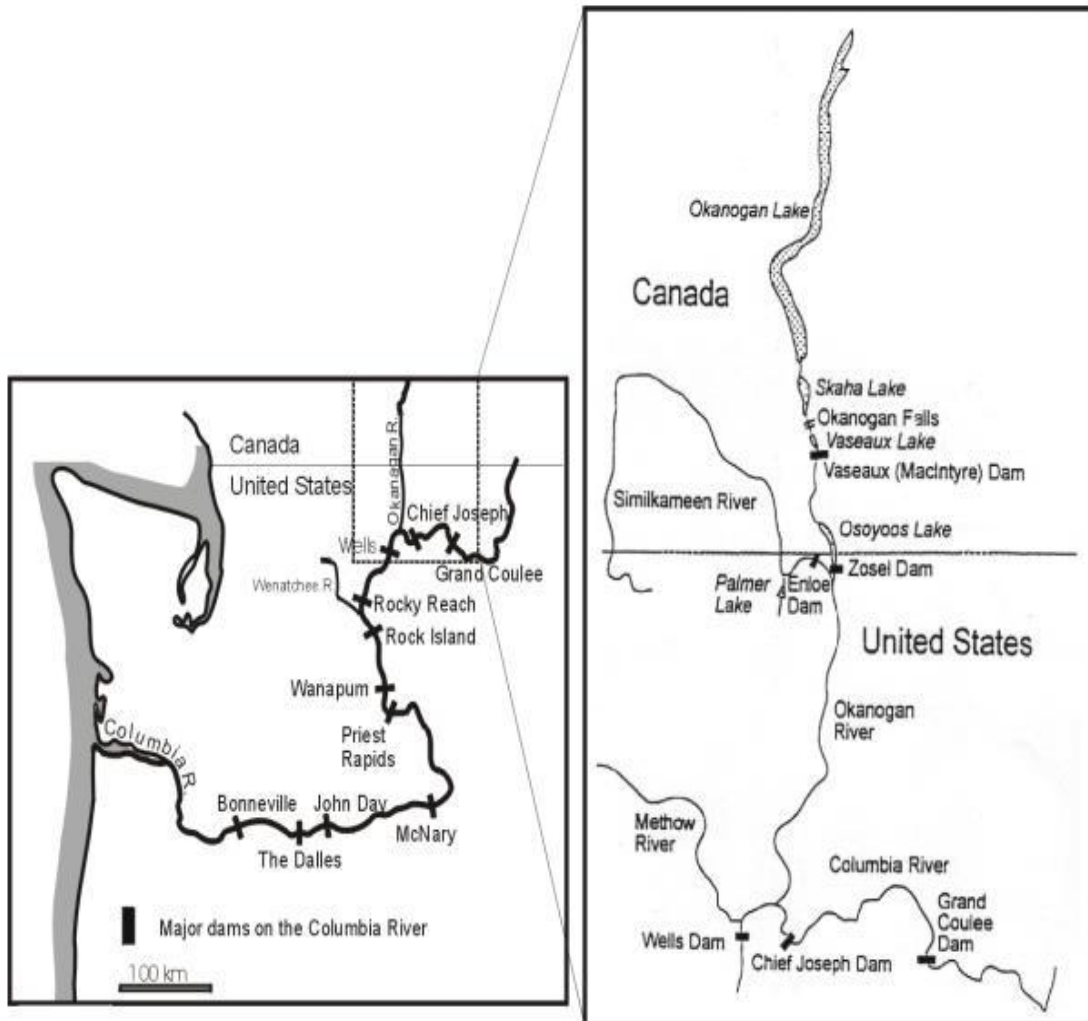


Figure 1: Core study area for the OBMEP program in Canada.

1.2 Study objectives

The OBMEP program in Canada requires a total of 48 sites³ to be surveyed over a 20-year study period. The 48 sites are divided into six panels each consisting of 8 sites. One constant panel is surveyed annually along with one of the remaining five panels surveyed in a five year rotation (initiated with Panel 1, in 2005). Status and trend data collected, thus far, primarily include physical habitat characteristics, biological conditions, and water quality components.

³As defined in Section 2.1.

The primary objectives for the Canadian OBMEP program in 2009 were to:

- observe six permanent hydrometric stations (three in Okanagan River mainstem sites and three at tributary sites - Inkaneep, Vaseux, and Shuttleworth Creeks) for water quality and quantity data;
- survey the physical habitat of sites from the Annual Panel and Panel 5;
- survey the existing juvenile and adult fish production of sites from the Annual Panel and Panel 5 (following standard field protocols);
- re-establish Panel 1 sites at the end of 2009 OBMEP program in Canada; and
- continue on-going water temperature monitoring of the Annual Panel and begin temperature monitoring for Panel 1.

2.0 METHODS

2.1 Site selection

Monitoring of fish and their habitats for status and trends involves both temporal and spatial replication and probabilistic sampling of stream reaches (Hillman 2004). Study sites in Canada were selected from a total of 600 possible sites randomly generated from the Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP). EMAP is a statistically based and spatially explicit site-selection process developed for aquatic systems. For the purpose of the OBMEP study, sites refer to the EMAP sites and consist of Okanagan sub-basin reaches of either stream or river.

Prior to selecting the OBMEP sites, barriers to anadromous fish migration were documented to determine current range (Walsh and Long 2006b). The 48 Canadian Okanagan EMAP sites were selected above and below fish migration barriers based on accessibility with preference toward sites downstream of barriers (Appendix 1). Reaches upstream of barriers were included as they are a source of water, nutrients, and substrate.

Prior to data collection, the sites were verified in the field to ensure they were practical and feasible to survey. If the sites could not be surveyed for these reasons, they could be replaced with sites not yet surveyed from an extra panel designated for this purpose.

The OBMEP sites in the Canadian Okanagan sub-basin are presented in Figure 2 and Appendix 1. The sites are grouped into one Annual Panel and five rotating panels. Each panel includes eight sites. An additional panel of alternate (extra) sites is included if any of the Panels 1 to 5 cannot be surveyed. The schedule of panel surveys to be performed over the 20-year OBMEP program is detailed in Appendix 2. For the 2008-2009 study period a total of 16 sites were evaluated from the Annual Panel and Panel 5 as displayed in Table 1. The sites for the 2009 study period include six Okanagan River mainstem sites and ten tributary sites.

Table 1: EMAP sites for the OBMEP study in the Canadian Okanagan sub-basin surveyed in 2009. Panel 5 of the rotating panels will be surveyed once every five years, commencing in 2009.

Annual Panel Sites:

Stream	Site No.
Okanagan River	490
Okanagan River	493
Inkaneep	535
Vaseux	177
Shuttleworth	522
Shingle	317
Ellis	470
McLean*	374

*replaced Haynes Creek 471 in 2007

Panel 5 Sites 2009:

Stream	Site No.
Shingle	569
Okanagan River	383
Okanagan River	323
Testalinden	547
Okanagan River	406
Okanagan River	467
Shingle	477
Farleigh Creek	565

Canada OBMEP Survey Sites

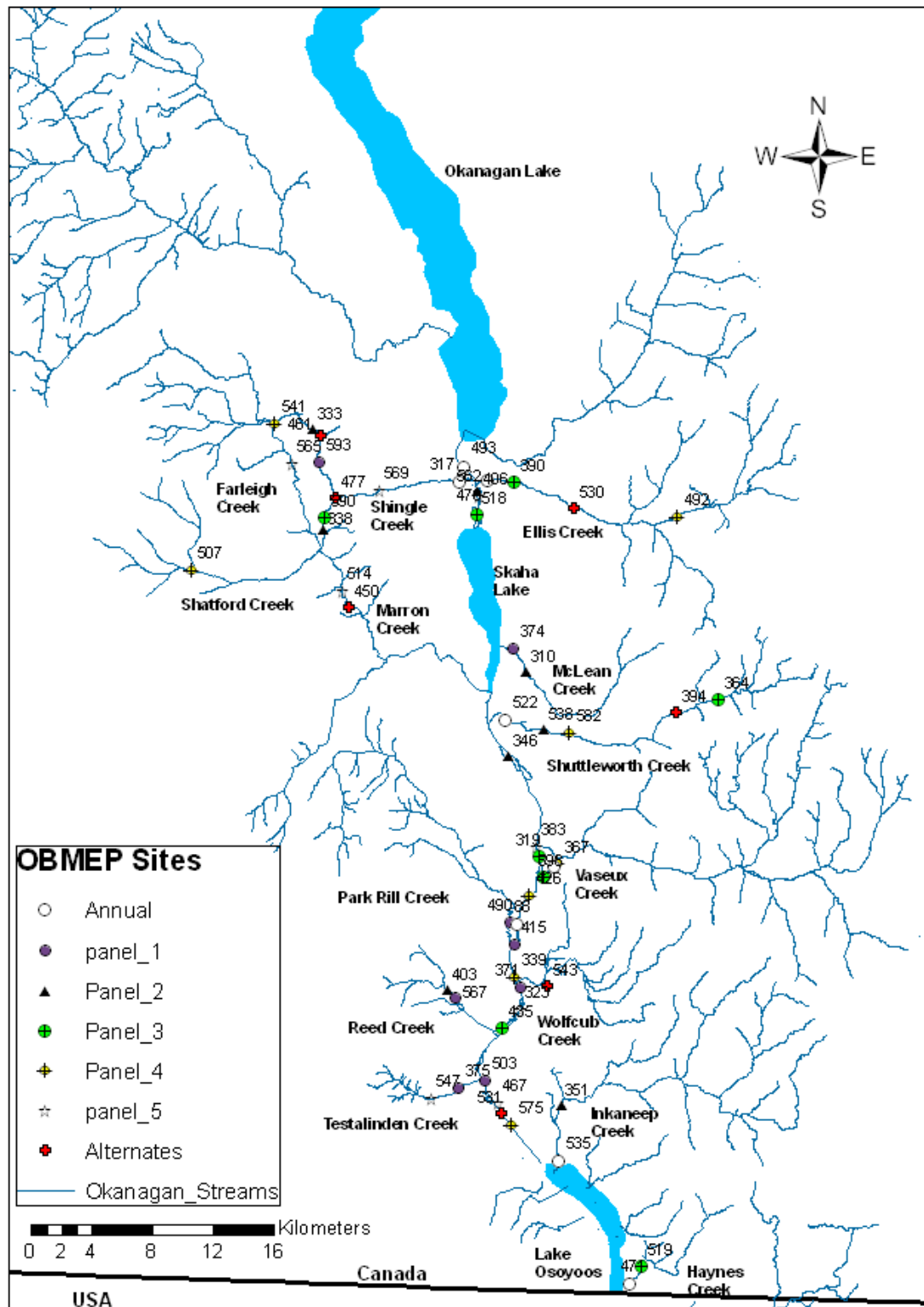


Figure 2: EMAP sites for the OBMEP program in the Canadian Okanagan sub-basin.

2.2. Field protocol

With the implementation of scientifically rigorous protocols, randomly selected reaches located on a stream or river can be used to measure changes over time in the status and trends of habitat, water quality, and biota (Arterburn *et al.* 2006).

The CCTFWD developed two field-sampling protocol manuals employed throughout the Okanagan sub-basin (based on Hillman 2004). One is for the collection of physical habitat data (Arterburn *et al.* 2006) and the other for the collection of biological data (Arterburn *et al.* 2005). A brief description of the protocols is included below.

In general, the OBMEP survey consists of documenting the study site, establishing transects within the site, and collecting both physical habitat and biological data related to anadromous salmonids. Surveys of the sites are generally conducted from June to September.

Dividing the stream reach into transects creates defined increments for measuring habitat characteristics and changes (Arterburn *et al.* 2006). Initially, a study site is located with GPS coordinates provided for all the EMAP sites – supplied by the CCTFWD. Once the site is located, a rebar marker is placed to designate the center point of the site. The total length (or reach) of a site is determined based on an average of five bankfull width measurements (refer to Appendix 3) around the center point of the site, and then multiplied by ten. The reach of the site is then divided into ten equally spaced transects, flagged and consecutively labeled with letters 'A' through 'K' (with 'A' beginning at the downstream of the center point 'F' and 'K' ending upstream) (Figure 3). These ten transects are again divided in half to create mid-transect points. The mid-transect point is that point exactly halfway from transect line A to transect line B, for example, and would be flagged and labeled as 'A1'. Rebar placed at transects 'A' and 'K' also delineate the site as permanent markers.

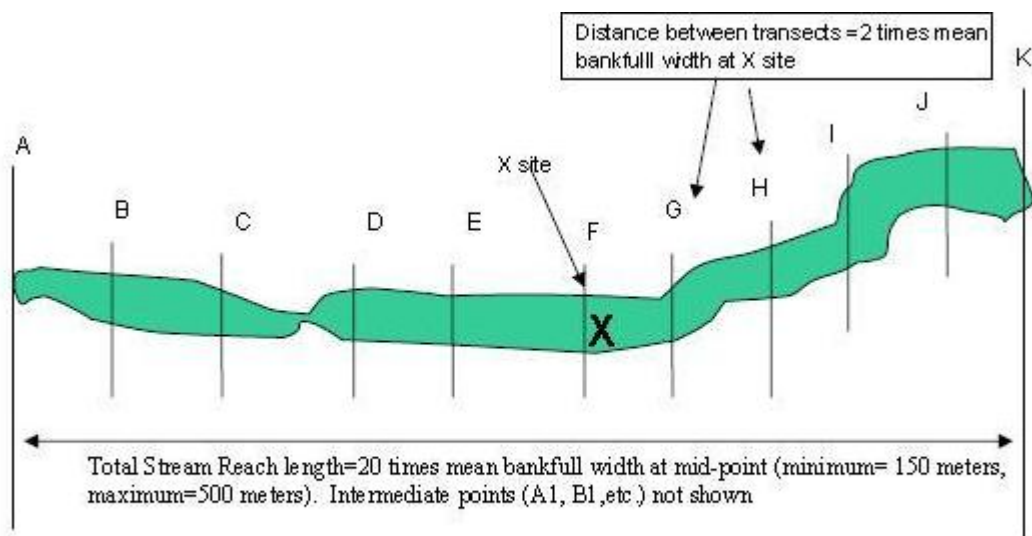


Figure 3: A typical EMAP habitat sampling site layout (from Arterburn *et al.* 2006).

Consistency in site location and data collection is important to the goals of the OBMEP study. Site documentation was recorded to assist in the accurate location of sites throughout the study period. GPS location of the center, upper- and lower-most transects⁴, photo-documentation, and written description of the site (i.e., landmarks) are all contained in the site documentation.

2.2.1 Physical habitat surveys

Alternating crews of three (one constant, all well versed in OBMEP methodology) collected and recorded the physical habitat data in 2009. Physical habitat measurements included stream depth characteristics, habitat type, substrate characteristics, riparian vegetation, and human influences. These measurements were collected along transects, mid-transects, and finer habitat increments. In addition, environmental conditions during the habitat survey were recorded. The physical habitat measurements, their units, and a short description are summarized in Appendix 3.

In streams too deep and deemed to be non-wadable, a zodiac equipped with a small outboard engine (or a two-person kayak) was used to obtain in-stream depth information. A stadia rod was used to acquire the thalweg and cross-section depths.

2.2.2 Water quality, quantity, and temperature sampling

Water quantity (or discharge) data for 2009 were obtained from the Water Survey of Canada (WSC) real-time hydrometric stations (<http://www.ec.gc.ca/rhc-wsc/>). Measurements include water velocity, water levels, discharge, and temperature from various stations operating within the OBMEP study area. Active WSC stations of interest are located on the Okanagan River at Penticton, Okanagan Falls, and Oliver and on the mouths of Shuttleworth, Vaseux, and Inkaneep Creeks (the latter three have involved assistance with OBMEP). A tributary station on Vaseux Creek is located above Solco Creek. It is important to note that the Solco drainage area (117 km²) comprises 40% of the total Vaseux drainage area (299 km²) (Long *et al.* 2006).

Temperature data were collected using Onset Computer Corporation Optic StowAway® temperature loggers. One temperature data logger was set for each of the 2009 OBMEP sites. The loggers were housed in aluminum piping (to protect from damage), secured to a land base anchor (tree stump, shrub bases, fence posts, etc), and placed within an active channel representative of the site. The installation date and a site description (i.e., transect and bank) were recorded. Loggers were retrieved after 8 to 14 weeks and the temperature data downloaded. Temperature data for the 2008-2009 water year were first collected from November 2008 to April 2009 followed then by April 2009 to October 2009. Data-recording intervals were set for two hours. Daily temperatures were averaged per site and plotted over time with sites from similar locations⁵.

⁴ Electronic data entry allowed for the collection of GPS locations of all transects (and mid-transects as explained in section 2.3).

⁵ Comparisons between site temperature data were made within 3 regions: Okanagan River main stem, northern tributaries (located between the Okanagan Lake Outlet Dam and Okanagan Falls), and southern tributaries (located between Okanagan Falls and the U.S. border).

2.2.3 Snorkel surveys

Snorkeling was conducted to identify, enumerate, and classify salmonids and non-salmonids into length categories. Snorkel surveys were performed within weeks of the physical habitat surveys. Data were recorded per transect (A to K) and included start and end times, species (for salmonids), family or species where possible (for non-salmonids), number of fish (for each species or family), and length category (<100 mm, 100-300 mm, or >300 mm) (Table 1). The underwater visual distance, average wetted width, stream temperature and environmental conditions (at the time of the survey) were also recorded.

The number of crew members for snorkeling mainstem sites (and stream sites with wider wetted widths) was dependent upon the visual distance under the water. A crew of five conducted the snorkel surveys on the five Okanagan River (mainstem) sites in 2009. Crew members spaced in intervals (determined by the underwater visual distance) snorkeled downstream (from Transect K) in a straight line across the wetted width of the site. Snorkel surveys in shallower streams generally required only two or three crew members who usually began downstream (at Transect A) and finished at the upstream end of the site.

Table 2: Description of the biological measurements collected during the 2009 snorkel surveys.

Measurement	General Description	Methods	Units
Fish species	Salmonids and non-salmonids are identified to species where possible	snorkel survey	species or family
Number of fish	The number of fish, of each species and family, are counted	snorkel survey	number
Length category	Counted fish are measured and classified into one of three fish length groups (<100mm, 100-300mm, or >300mm)	snorkel survey	millimeters

In streams too shallow to snorkel, crew members walked side by side and observed fish with the aid of polarized glasses and/ or snorkel masks for deeper pools. For 2009, three of the annual sites were not completely surveyed; one was considered too dry (Shuttleworth 522) and the others too turbid (Testalinden 547 and Farleigh 565) for fish observation.

2.3 Data collection and processing

Field data were recorded using both electronic data entry and data sheets. Most physical habitat data were collected with an electronic Trimble® GeoExplorer® Series GeoXM pocket PC. Snorkel data were primarily collected using OBMEP data field sheets or conventional field books (where necessary). Temperature data were collected using HOBO® Water Temp Pro v2 data loggers (Onset Computer Corporation) and devices with a Panasonic CF-30 TOUGHBOOK laptop.

The Trimble® device uses TerraSync™ Version 2.50 software to collect and record GPS positions. GPS coordinates were recorded with the Trimble® during the site documentation and physical habitat survey. Collection templates for the habitat survey were programmed into the Trimble® unit by the CCTFWD (containing the same information as the data field sheets).

The electronic Trimble® data were transferred and processed using GPS Pathfinder® Office 3.0 software. The GPS data collected by GPS receivers in the Trimble® unit were subject to errors (satellite clock errors, orbit errors, and atmospheric noise) and adjusted using differential correction. Snorkel field data were transferred from field notes to an OBMEP snorkel data sheet with Microsoft Excel. The temperature loggers' data were launched and read out using HOBOWare® Pro Version 2.x software (Onset Computer Corporation).

All Canadian OBMEP field data from the ONAFD are forwarded to Summit Environmental Consulting where it is quality assured and quality controlled through a Microsoft Access database program to be returned to both ONAFD and CCTFWD for further analysis. Direct access to the OBMEP database is still in progress.

3.0 RESULTS

This is the fifth year of a proposed 20-year monitoring program of anadromous salmonid habitat and abundance within the Okanagan sub-basin of the Upper Columbia. The methods used in this study will be repeated annually for the purpose of comparing results.

3.2 Physical data

3.2.1 Physical habitat inventory

Physical habitat data were collected for all 16 OBMEP sites in 2009. The data has been categorized into stream depth characteristics (Appendix 4), habitat type (Appendix 5), substrate characteristics (Appendix 6), riparian vegetation (Appendix 7), and human influence characteristics (Appendix 8).

Habitat data for the eight annual sites are tabled for comparison with data collected from 2005-2009. Similarly, all categories mentioned above are tabled for comparison (Tables 3-7). Difference in the measured parameters can be attributed to natural variation or differences in parameter estimation due to new field personnel each year. Long-term trends will only be apparent with a larger data set that includes multiple water year types.

Table 3: Comparison of physical habitat parameters for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2009.

EMAP Sites	Year	PARAMETER								
		Bankfull Width (m)	Pool/Riffle Ratio	Canopy Cover Reach Average (%)	Canopy Cover Bank Average (%)	% Embedded	Small Sediment (%)	Bankfull Width/ Depth	Small LWD >10 cm and >1m in length (#)	Large LWD >10 cm and >2m in length (#)
Okanagan River 490	2005	28.5	1.78	40	40	31	100	24	89	238
	2006	36.2	1	45	85	29	77	20.7	18	33
	2007	28.5	0	31	84	26	100	20.3	23	58
	2008	25.9	0	19	57	13	66	22.2	22	46
	2009	28.0	0.01	2	62	30	42	19.7	85	81
Okanagan River 493	2005	28.6	10	5	5	34	100	19.6	0	0
	2006	32.8	10	26	52	21	0	12.6	0	0
	2007	30.2	10	23	69	24	99	18.2	0	0
	2008	27.4	10	8	25	13	65	15.5	0	0
	2009	27.9	0	1	4	22	48	15.8	0	0
Inkaneep Creek 535	2005	7	4	80	89	59	98	10.2	21	64
	2006	13	0	75	82	68	90	12.7	11	32
	2007	10.9	0.17	70	85	56	96	14.4	12	17
	2008	6.5	0.05	81	94	12	68	8.1	19	31
	2009	5.1	0.06	79	88	39	86	14.0	13	21
Vaseux Creek 177	2005	14.6	0.03	17	33	23	51	20	16	46
	2006	22.8	0	41	48	37	8	19.5	2	15
	2007	14.8	0.02	25	34	28	25	20	8	39
	2008	14.4	0	32	59	29	0	15.8	5	15
	2009	13.4	0.01	31	46	36	11	15.1	8	29
Shuttleworth Creek 522	2005	7.8	0.45	80	87	35	90	14.6	5	22
	2006	11	0.01	84	91	43	80	11	9	19
	2007	9.5	0	92	96	34	95	13	3	26
	2008	7.6	0	93	98	35	32	10.9	18	20
	2009	5.7	0.03	70	79	36	21	12.3	26	30
Shingle Creek 317	2005	7	1.87	58	62	63	53	7.3	1	9
	2006	7.7	0.17	79	83	69	69	9.8	7	11
	2007	8.1	0.15	74	81	51	55	8	1	16
	2008	6.7	0.08	64	78	45	44	7.9	5	4
	2009	6.7	0.1	77	80	55	41	8.6	35	14
Ellis Creek 470	2005	8.5	0.05	69	80	30	98	11.8	3	13
	2006	9.6	0	88	91	40	42	8.5	21	59
	2007	8.7	0	79	91	34	60	10.5	2	9
	2008	8.2	0	81	88	29	16	11.2	9	5
	2009	8.1	0.01	73	80	35	31	12.4	0	7
McLean Creek 374	2005	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	2007	6.3	1.65	86	83	66	98	8.7	25	47
	2008	4.4	24.0	75	78	60	88	6.5	44	32
	2009	3.2	2	70	64	56	79	7.0	39	50

n/m – not measured

Table 3: Comparison of physical habitat parameters for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2009 (continued).

EMAP Sites	Year	PARAMETER									
		Thalweg Depth (m)	Gradient (%)	Wetted Width (m)	Bankfull Height (m)	Entrenchment Ratio (Bankfull width/flood prone width)	Entrenchment (E,ME,SE)	Flood Prone Width (m)	Bankfull Depth (m)	Flood Prone Depth (m)	Wetted Width/Thalweg Depth
Okanagan River 490	2005	0.83	NA	26.3	0.4	2.2	SE	62.7	1.2	2.4	33.6
	2006	1	0.7	30.1	0.8	1.4	E	48.6	1.7	3.5	33.4
	2007	0.98	0.4	24.9	0.6	1.4	ME	40.2	1.6	3.2	27.8
	2008	0.78	0.3	25.0	0.4	1.0	E	26.9	1.2	2.3	32.2
	2009	0.8	0.6	25.7	0.5	1.0	E	28.0	1.4	2.8	30.3
Okanagan River 493	2005	0.82	0.4	26.2	1.8	2.2	SE	62.9	2.6	5.2	32.7
	2006	0	0	23.8	1.5	1.0	E	32.8	2.6	5.2	21.6
	2007	0.92	0.1	26.9	0.9	1.4	ME	42.6	1.7	3.5	29.4
	2008	0.84	0.2	25.6	0.9	1.0	E	28.7	1.8	3.5	30.6
	2009	0.9	0.5	26.3	0.9	1.0	E	27.8	1.8	3.5	30.1
Inkaneep Creek 535	2005	0.18	0.5	3.8	0.6	2.1	ME	15.1	0.7	1.4	27
	2006	0.02	0.2	4.7	0.8	2.1	ME	27.9	1	2.1	20.3
	2007	0.19	2.2	4.0	0.6	1.8	ME	20.3	0.8	1.6	24.6
	2008	0.20	0.1	4.2	0.6	1.1	E	7.7	0.8	1.6	21.2
	2009	0.2	0.8	3.8	0.2	1.0	E	5.1	0.4	0.7	24.6
Vaseux Creek 177	2005	0.26	0.4	10.7	0.5	2.2	SE	32	0.8	1.5	43.8
	2006	0.2	2.3	5.0	1.1	1.8	ME	37.5	1.2	2.5	26
	2007	0.19	0.5	5.1	0.6	1.5	ME	21.5	0.8	1.5	29.8
	2008	0.23	0.4	8.1	0.7	1.6	ME	25.0	0.9	1.8	35.5
	2009	0.3	1.5	5.7	0.6	0.5	ME	28.6	0.9	1.8	22.6
Shuttleworth Creek 522	2005	0.16	1.3	5.5	0.4	1.4	E	11.3	0.5	1.1	37.1
	2006	0.2	2	4.5	0.8	NA	NA	NA	0.9	1.8	27.4
	2007	0.09	0.2	4.7	0.7	2.2	SE	21	0.7	1.5	57.3
	2008	0.13	0.2	5.0	0.6	1.4	ME	11.3	0.7	1.4	39.5
	2009	0.0	2.0	1.8	0.4	1.0	E	5.7	0.5	0.9	43.9
Shingle Creek 317	2005	0.25	1.7	3.7	1.3	1.4	E	9.9	1.3	2.6	21.4
	2006	0.3	0.9	4.1	0.8	1.4	E	9.4	1	1.9	16.9
	2007	0.36	0.7	4.5	0.7	1.7	ME	13.4	1	2.1	12.9
	2008	0.22	0.2	3.4	0.6	1.0	E	7.0	0.8	1.7	15.2
	2009	0.3	0.4	4.0	0.5	1.0	E	6.9	0.8	1.6	15.3
Ellis Creek 470	2005	0.22	1.1	5.8	0.5	1.4	E	12	0.7	1.4	28.4
	2006	0.25	0	6.1	0.9	1.5	ME	13.5	1.1	2.3	24.1
	2007	0.23	0.5	5.7	0.6	1.4	ME	12.3	0.8	1.7	26.3
	2008	0.24	0.1	5.7	0.5	1.0	E	8.6	0.7	1.5	23.6
	2009	0.2	1.2	5.4	0.4	1.0	E	8.1	0.7	1.3	23.6
McLean Creek 374	2005	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	2007	0.23	0.9	2.2	0.5	1.0	E	6.3	0.7	1.5	13.3
	2008	0.19	0.1	2.6	0.5	1.3	E	6.6	0.7	1.4	13.8
	2009	0.2	0.9	1.3	0.3	0.7	ME	4.7	0.5	0.9	8.7

n/m – not measured

NA= Not Applicable, E=Entrenched, ME=Moderately Entrenched, SE=Slightly Entrenched

Table 4: Comparison of substrate characteristics for eight annual EMAP sites sampled in the Okanagan Basin in 2005-2009.

EMAP Sites	Year	PARAMETER (%)											
		Bedrock Smooth (RS)	Bedrock Rough (RR)	Boulder (BL)	Large Cobble (LCB)	Small Cobble (SCB)	Coarse Gravel (GC)	Fine Gravel (GF)	Sand (SA)	Silt/Clay/Muck (FN)	Hardpan (HP)	Wood (WD)	Other (OT)
Okanagan River 490	2005	0	0	7	4	36	22	7	8	13	0	2	0
	2006	0	0	4	1	64	7	0	0	1	0	0	13
	2007	0	0	6	1	69	10	0	0	1	0	0	13
	2008	0	0	2	1	80	5	0	3	2	0	0	7
	2009	0	0	6	5	62	15	0	4	6	0	1	2
Okanagan River 493	2005	0	0	7	16	30	17	7	11	2	1	0	0
	2006	0	0	4	19	50	0	0	0	1	0	0	26
	2007	0	0	0	6	73	0	0	0	0	0	0	21
	2008	0	0	14	13	55	8	0	0	0	0	0	10
	2009	0	0	4	20	60	9	0	1	0	0	0	6
Inkaneep Creek 535	2005	0	0	0	17	26	8	3	20	19	6	0	0
	2006	0	0	0	0	8	11	3	1	23	0	0	2
	2007	0	0	0	0	42	6	5	23	3	0	0	22
	2008	0	0	0	13	37	17	1	11	9	0	4	8
	2009	0	0	0	16	49	14	0	4	14	0	2	2
Vaseux Creek 177	2005	0	0	8	36	19	14	10	4	1	0	0	0
	2006	0	0	17	30	28	3	3	0	9	0	3	3
	2007	0	0	21	16	50	3	0	3	2	0	2	4
	2008	0	0	10	32	45	5	0	5	1	0	0	2
	2009	0	0	20	29	31	9	0	3	6	0	0	1
Shuttleworth Creek 522	2005	0	0	0	30	25	16	1	22	0	0	0	0
	2006	0	0	3	19	29	0	1	0	21	0	2	16
	2007	0	0	0	5	54	7	1	4	3	0	0	27
	2008	0	0	2	10	53	10	0	0	11	0	3	11
	2009	0	0	2	26	36	4	1	6	16	0	4	5
Shingle Creek 317	2005	0	0	9	39	8	4	3	38	0	0	0	0
	2006	0	0	3	28	10	4	7	0	32	2	1	4
	2007	0	0	5	10	30	6	1	0	33	0	0	14
	2008	0	0	4	40	18	1	0	8	16	0	3	10
	2009	0	0	5	26	24	2	2	7	20	0	3	10
Ellis Creek 470	2005	0	0	14	36	13	2	8	7	7	0	3	0
	2006	0	0	3	35	34	4	3	0	10	0	0	3
	2007	0	0	5	8	62	5	0	2	7	0	0	11
	2008	0	0	7	40	32	2	1	1	4	0	5	6
	2009	0	0	7	38	34	5	0	2	11	0	1	1
McLean Creek 374	2005	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	2007	0	0	0	0	6	5	1	0	52	0	2	34
	2008	0	0	0	0	15	7	1	7	46	0	7	17
	2009	0	0	0	1	19	10	2	15	32	0	10	11

n/m – not measured

Table 5: Comparison of physical habitat types for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2009.

EMAP Sites	Year	PARAMETER												
		Primary Pool (%)	Beaver Pool (%)	Pool Tail out (%)	Glide (%)	Large Cobble Riffle (%)	Small Cobble Riffle (%)	Rapids (%)	Cascade/Falls (%)	Side Channel (Y/N)	Back-water (Y/N)	Total Pools (%)	Total Riffles (%)	Mid-channel Bar width Average (m)
Okanagan River 490	2005	4	0	2	27	0	67	0	0	Y	Y	34	70	0.97
	2006	0	0	0	0	4	72	0	0	Y	N	0	76	0
	2007	0	0	0	1	0	99	0	0	Y	N	1	99	1.09
	2008	0	0	0	0	15	85	0	0	Y	Y	0	100	0.87
	2009	0	0	0	1	25	67	0	0	Y	Y	1	92	1.03
Okanagan River 493	2005	0	0	0	100	0	0	0	0	N	N	100	0	0
	2006	0	0	0	0	0	0	0	0	N	N	0	0	0
	2007	0	0	0	99	0	1	0	0	N	N	99	1	0
	2008	0	0	0	100	0	0	0	0	N	N	100	0	0
	2009	0	0	0	91	0	0	0	0	N	N	91	0	0
Inkaneep Creek 535	2005	6	0	13	17	46	19	0	0	N	N	23	77	0
	2006	0	0	1	0	3	6	0	0	N	N	0	10	0
	2007	10	0	2	0	7	8	0	0	N	N	10	90	0.14
	2008	5	0	2	0	4	89	0	0	N	N	5	95	0.02
	2009	5	0	0	1	0	85	0	0	N	N	5	85	0.09
Vaseux Creek 177	2005	0	0	0	2	60	22	16	16	Y	Y	3	98	2.65
	2006	0	0	0	0	56	38	0	0	Y	Y	0	94	0
	2007	2	0	2	0	30	66	0	0	Y	Y	2	98	0
	2008	0	0	0	0	99	1	0	0	N	N	0	100	0.71
	2009	1	0	0	0	81	0	0	7	Y	N	1	88	0.24
Shuttleworth Creek 522	2005	0	0	0	19	58	23	0	0	N	N	19	81	0.89
	2006	1	0	1	0	35	58	0	0	N	N	1	0	0
	2007	0	0	0	0	0	100	0	0	N	N	0	100	0.51
	2008	0	0	0	0	2	98	0	0	N	N	0	100	0.46
	2009	0	0	0	3	5	81	0	0	N	N	3	86	0.1
Shingle Creek 317	2005	14	0	0	28	49	7	0	0	N	N	42	58	0
	2006	9	0	2	0	47	36	0	0	N	N	9	84	0
	2007	8	0	1	0	48	43	0	0	N	N	8	92	0
	2008	7	0	0	0	93	0	0	0	N	N	7	93	0
	2009	0	0	0	8	5	78	0	0	N	N	8	83	0
Ellis Creek 470	2005	0	0	0	4	65	31	0	0	N	N	4	96	0
	2006	0	0	0	0	61	38	0	0	N	N	0	99	0
	2007	0	0	0	0	21	79	0	0	N	N	0	100	0
	2008	0	0	0	0	69	31	0	0	N	N	0	100	0
	2009	30	0	4	30	0	26	0	0	N	N	1	90	0
McLean Creek 374	2005	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	2007	34	14	6	0	0	35	0	0	N	N	47	42	0.03
	2008	20	0	3	0	0	1	0	0	N	N	96	4	0.01
	2009	1	0	0	0	0	89	0	0	N	N	6	30	0

n/m – not measured

Table 6: Comparison of riparian vegetation attributes for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2009.

EMAP Sites	Year	PARAMETER (%)									
		Overstory Deciduous	Over-story Big trees	Over-story Small trees	Understory Deciduous	Under-story Woody shrubs/saplings	Under-story Non-woody	Ground cover Woody shrubs/saplings	Ground cover Non-woody	Ground cover Barren dirt/duff	Ground cover LWD
Okanagan River 490	2005	100	6.8	51.1	100	65.5	46.9	12.7	25	27.7	9.1
	2006	100	6.5	47.8	100	31.7	1.3	22.3	40.5	7.7	4.5
	2007	100	9.5	6.2	100	18.4	4.2	23.6	43.6	8.2	5.9
	2008	64.3	*	*	78.6	*	*	*	*	*	*
	2009	95.4	*	*	84.6	*	*	*	*	*	*
Okanagan River 493	2005	100	3.6	3.2	100	21.4	22.3	9.1	48	48	1.8
	2006	100	5.8	5.8	75	10	0	30.5	91.5	4.1	0
	2007	100	1.3	10	75	10	0	25	97.7	0	0.5
	2008	50	*	*	31.8	*	*	*	*	*	*
	2009	31.8	*	*	90.9	*	*	*	*	*	*
Inkameep Creek 535	2005	90	35.6	34.2	100	43.6	5.5	18.1	40.2	27.1	40.7
	2006	100	28	22	100	43.8	1.5	34	40.3	19	17.5
	2007	100	23.5	4	100	25	1.4	20.9	25	9.1	22.3
	2008	95.5	*	*	86.4	*	*	*	*	*	*
	2009	100	*	*	100	*	*	*	*	*	*
Vaseux Creek 177	2005	36.4	2	30	40.9	30.3	8	15.5	28	33.2	9.5
	2006	16.7	20	0	8.3	20	0	67	27.7	5.9	20.9
	2007	26.3	2.5	7.5	51.3	13	0	23.6	4.1	5.9	12.7
	2008	31.8	*	*	59.1	*	*	*	*	*	*
	2009	22.7	*	*	41.7	*	*	*	*	*	*
Shuttleworth Creek 522	2005	90.9	50.8	40.5	77.3	66.3	40	29.1	88.6	5.9	7.7
	2006	95	36.6	9.1	73.3	42.9	0	61.5	32.5	8.1	10.7
	2007	90.9	8.4	15.7	77.3	17.5	0	92	7.7	1.4	9.1
	2008	90.9	*	*	77.3	*	*	*	*	*	*
	2009	77.3	*	*	85.5	*	*	*	*	*	*
Shingle Creek 317	2005	59.1	59.1	45.4	77.3	36	32.7	13.6	29.1	29.1	8.6
	2006	77.3	25.7	10.7	43.9	25	0	37.3	36.4	19.5	6.8
	2007	67.7	16	0.6	38.4	15	0	48	19.5	5	8.2
	2008	63.6	*	*	40.9	*	*	*	*	*	*
	2009	77.3	*	*	54.5	*	*	*	*	*	*
Ellis Creek 470	2005	86.4	27.2	40.8	81.8	30.8	21.7	11.4	27.7	49.5	0.9
	2006	94.4	33.2	28.1	94.4	29.5	3.4	32.9	32.6	37.2	1.9
	2007	95.5	5.2	7.4	86.4	10	0	12.7	15.5	0.9	8.2
	2008	86.4	*	*	86.4	*	*	*	*	*	*
	2009	86.4	*	*	40.9	*	*	*	*	*	*
McLean Creek 374	2005	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	2007	86.4	6.7	6.3	100	36.3	8.2	43	46.1	0	5.5
	2008	54.5	*	*	86.4	*	*	*	*	*	*
	2009	59.1	*	*	95.5	*	*	*	*	*	*

*- Data will be provided in the 2010 Annual Report for Sites in Canada

n/m – not measured

Table 7: Comparison of human influence for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2009.

EMAP Sites	Year	Not Present (%)											
		Wall/ Dike/ /Riprap /Dam	Buildings	River access site	Pavement/ Road/ Railroad	Pipes (inlet/ outlet)	Garbage pile	Cleared lot/ Lawn	Orchard/ Row Crops	Pasture/ Range/ Hay Field	Logging Operations	Mining Activity	Diversion
Okanagan River 490	2005	50	80	30	30	85	100	75	70	100	100	100	100
	2006	60	90	90	55	100	100	100	90	100	100	100	100
	2007	100	86	68	91	91	100	86	95	100	100	100	100
	2008	86	95	73	59	95	100	86	91	100	100	100	100
	2009	50	82	64	59	86	14	82	91	100	*	*	*
Okanagan River 493	2005	100	100	0	100	100	100	100	100	100	100	100	100
	2006	100	95	0	5	95	100	30	100	100	100	100	100
	2007	91	100	50	86	86	91	27	100	100	100	100	100
	2008	14	73	0	45	86	55	0	100	100	100	100	100
	2009	0	91	77	14	91	14	32	100	100	*	*	*
Inkaneep Creek 535	2005	100	100	100	90	100	100	100	100	20	100	100	100
	2006	90	100	70	55	100	95	95	100	50	100	100	100
	2007	95	100	75	100	100	100	100	100	55	100	100	100
	2008	86	100	86	82	100	100	100	100	68	100	100	100
	2009	86	95	50	91	95	100	100	100	41	*	*	*
Vaseux Creek 177	2005	60	100	100	70	100	100	100	100	90	30	100	100
	2006	80	100	100	80	100	100	40	100	100	100	100	100
	2007	100	100	100	100	100	100	100	100	100	100	100	100
	2008	91	100	91	77	100	100	86	100	100	100	100	100
	2009	73	100	95	64	100	100	100	100	100	*	*	*
Shuttleworth Creek 522	2005	70	100	100	100	100	100	50	100	35	90	100	100
	2006	70	100	70	100	100	95	95	100	20	100	100	100
	2007	100	73	86	100	100	100	73	100	18	100	100	100
	2008	50	77	91	45	100	100	91	100	18	100	100	100
	2009	95	82	100	86	100	95	50	100	77	*	*	*
Shingle Creek 317	2005	45	90	75	90	100	85	85	100	70	100	100	100
	2006	45	80	70	50	100	80	90	100	100	100	100	100
	2007	100	82	64	100	100	41	68	100	95	100	100	100
	2008	100	95	64	95	95	91	100	100	100	100	100	100
	2009	5	64	77	68	100	14	82	100	100	*	*	*
Ellis Creek 470	2005	45	60	35	25	25	100	60	100	100	100	100	100
	2006	80	60	60	25	85	95	100	100	100	100	100	100
	2007	64	55	9	91	91	14	27	100	100	100	100	100
	2008	91	32	36	36	100	27	86	100	100	100	100	100
	2009	100	45	95	36	82	14	55	100	100	*	*	*
McLean Creek 374	2005	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	2007	100	91	82	100	100	95	86	100	91	100	100	100
	2008	100	91	91	100	100	95	95	100	95	100	100	100
	2009	100	100	91	100	100	91	95	100	95	*	*	*

n/m – not measured

*- Data will be provided in the 2010 Annual Report for Sites in Canada

3.2.2 Water quantity: discharge

The mean monthly discharges (m^3/s) for four hydrometric stations are summarized in Figure 4. The longest data set is from 1915 to 2009 for OK River at OK Falls. Peak discharges typically occur from May to July.

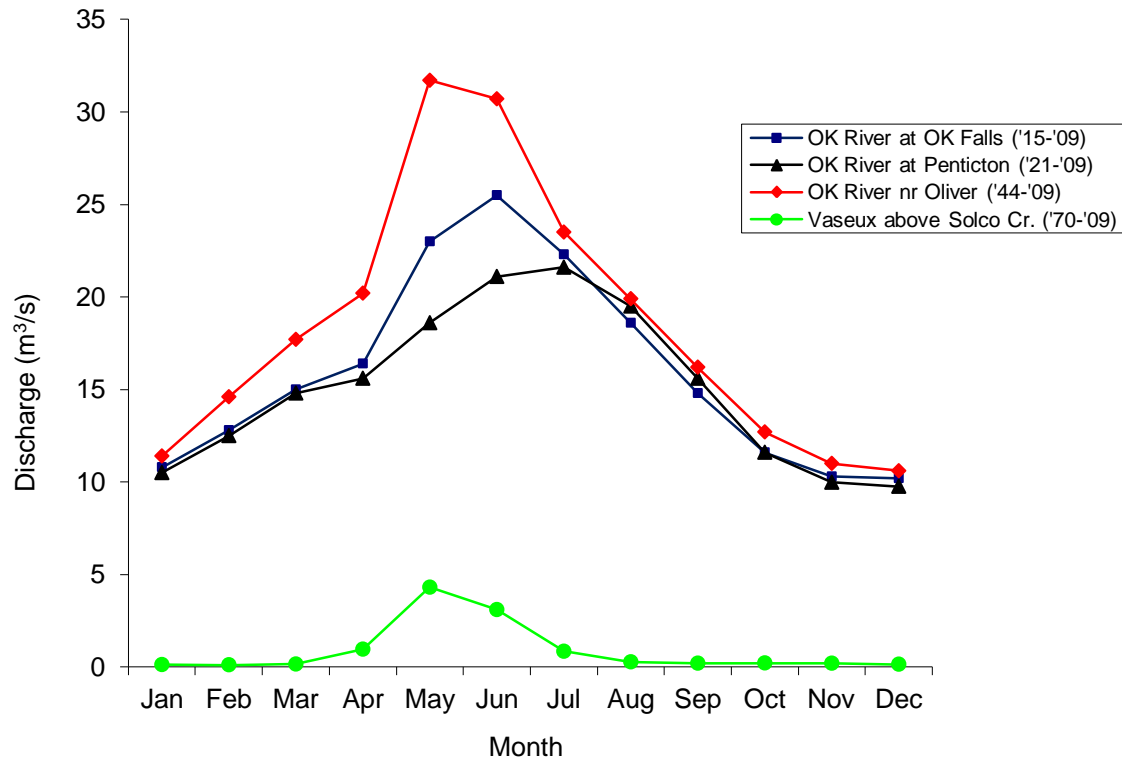


Figure 4: Historic mean monthly discharges (m^3/s) from four real-time hydrometric stations in the Okanagan sub-basin (WSC).

Mean daily discharge rates for the Okanagan river mainstem are depicted in Figures 5 to 7 for the 2009 water year. Data presented are provisional and not endorsed by Environment Canada until further quality control and assurance protocols have been conducted. Discharges depicted are not the natural hydrograph as discharge is controlled at the Okanagan Lake Outlet Dam in Penticton, the Skaha Lake Outlet dam in Okanagan Falls, and McIntyre Dam at the outlet of Vaseux Lake (Symonds 2000).

Mean daily discharge rates of three hydrometric stations located at the mouths of Shuttleworth, Vaseux, and Inkaneep creeks are depicted in Figures 8 to 10 for the 2009 water year (November 2008 to November 2009).

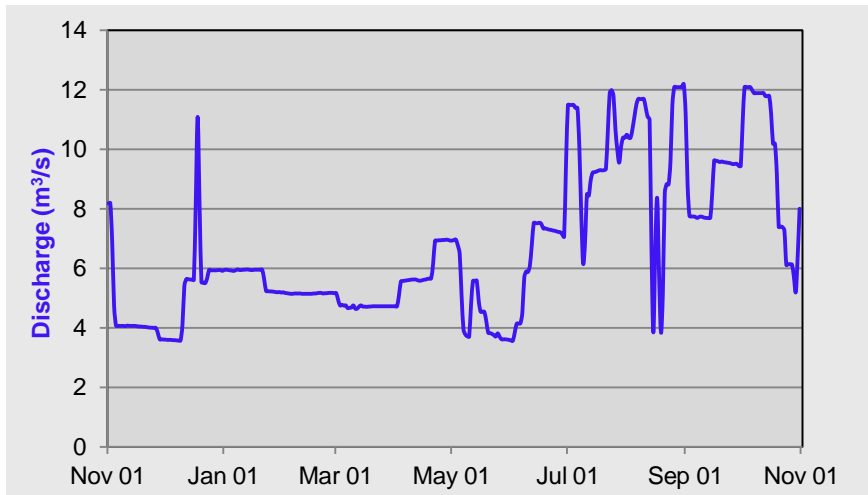


Figure 5: Mean daily discharge (m³/s) in the Okanagan River at Penticton (08NM050) during the 2009 water year (WSC).

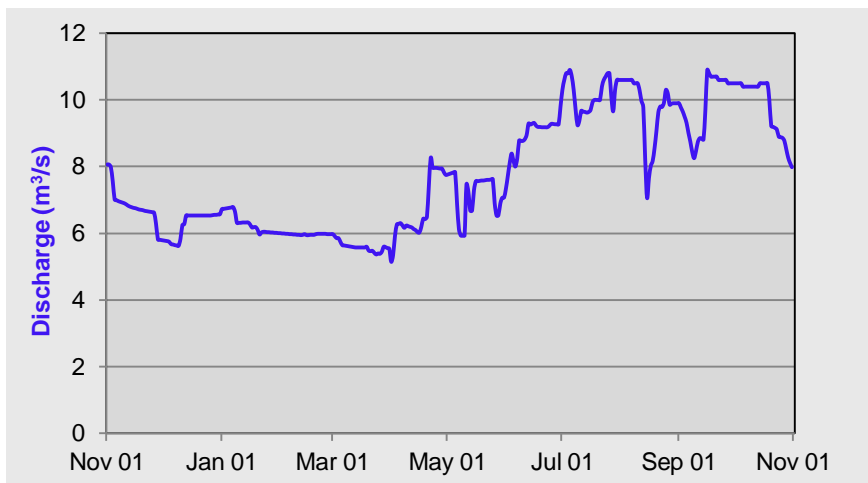


Figure 6: Mean daily discharge (m³/s) in the Okanagan River at Okanagan Falls (08NM002) during the 2009 water year (WSC).

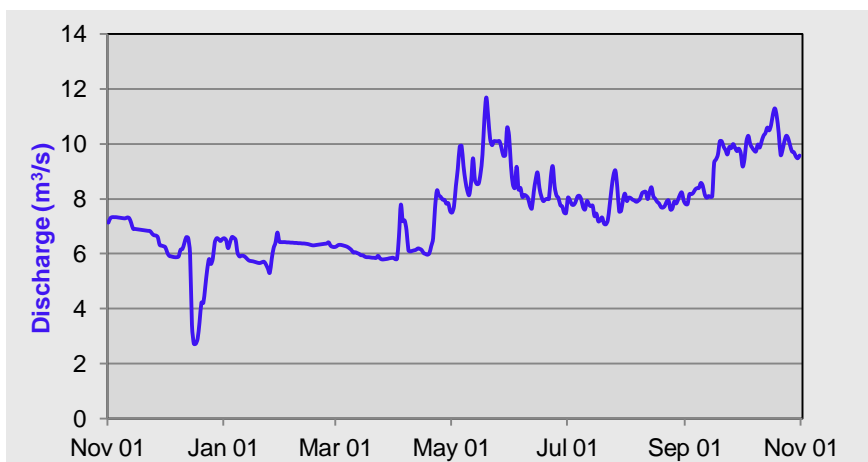


Figure 7: Mean daily discharge (m³/s) in the Okanagan River at Oliver (08NM085) during the 2009 water year (WSC).

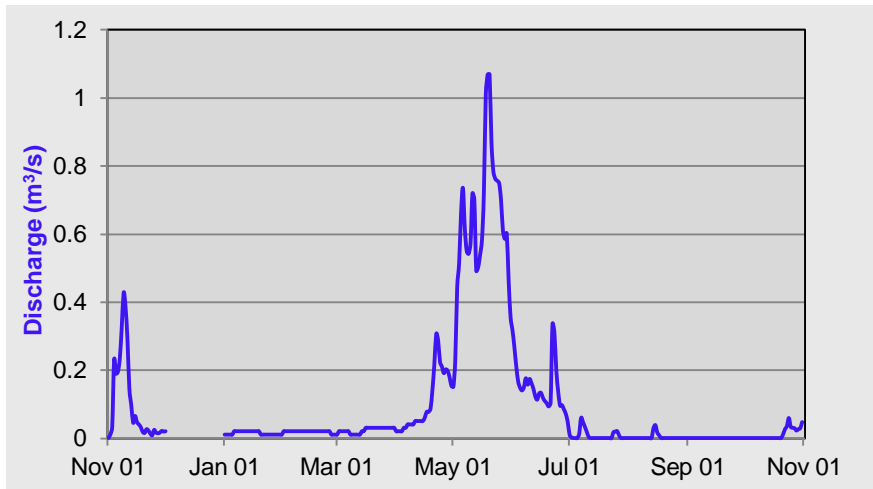


Figure 8: Mean daily discharge (m^3/s) at the mouth of Shuttleworth Creek (08NM149) during the 2009 water year (WSC).

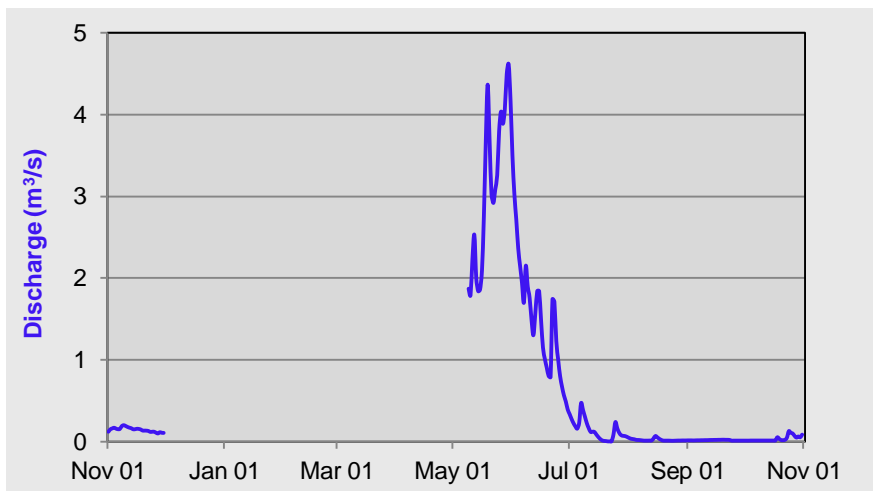


Figure 9: Mean daily discharge (m^3/s) at the mouth of Vaseux Creek (08NM246) during the 2009 water year (WSC).

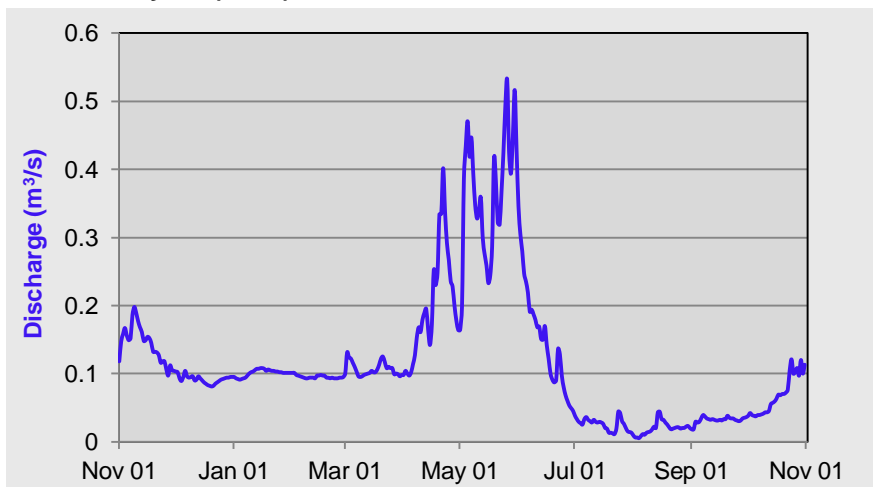


Figure 10: Mean daily discharge (m^3/s) at the mouth of Inkaneep Creek at the Mouth (08NM200) during the 2009 water year (WSC).

3.2.3 Water quality: temperatures

Water temperature loggers were deployed at all sites for this study year late in 2008. Downloads occurred in the spring and fall of 2009 (and or as necessary) to capture the 2008-2009 water year (Figures 11-15).

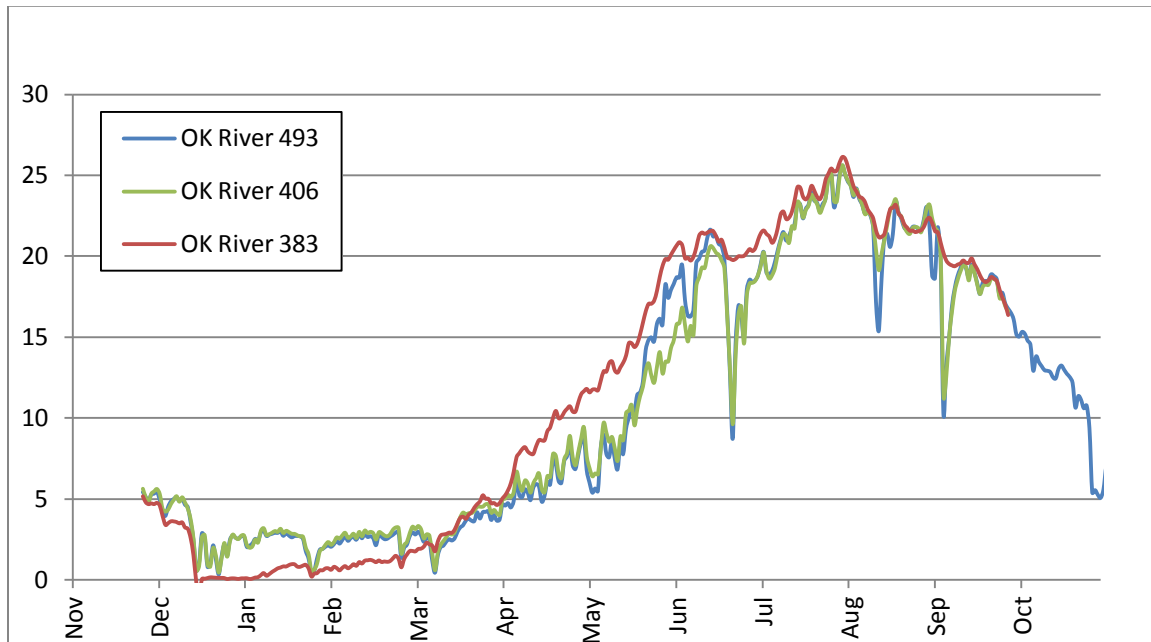


Figure 11: Mean daily river temperatures for the Okanagan mainstem sites 383, 493, and 406 for the 2009 water year.

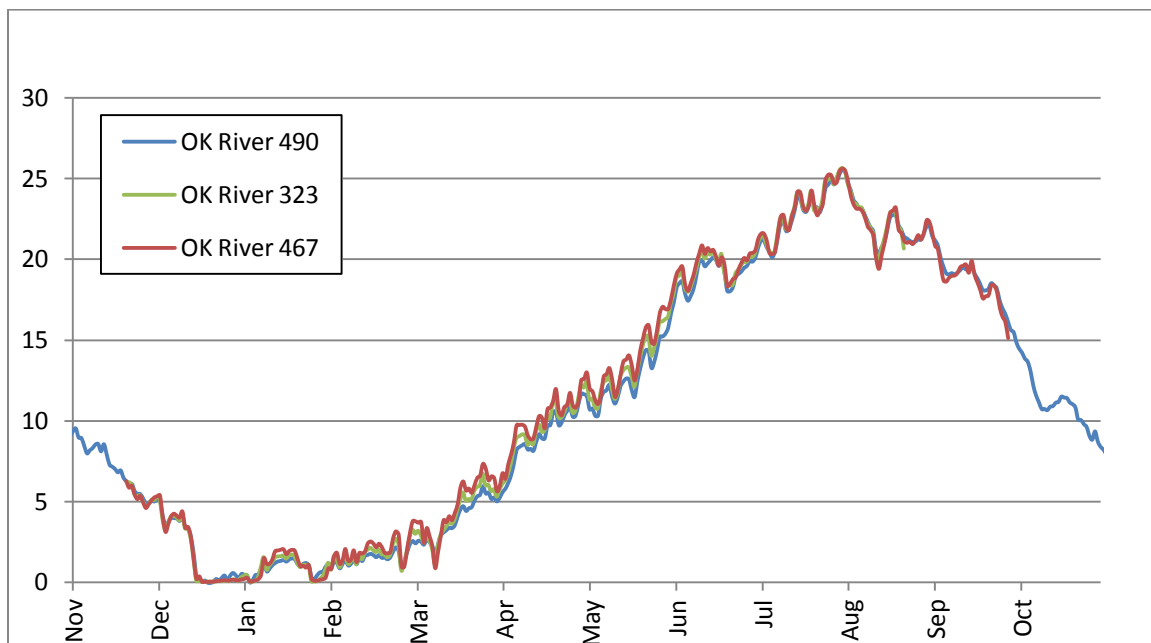


Figure 12: Mean daily river temperatures for the Okanagan mainstem sites 490, 323, and 467 for the 2009 water year.

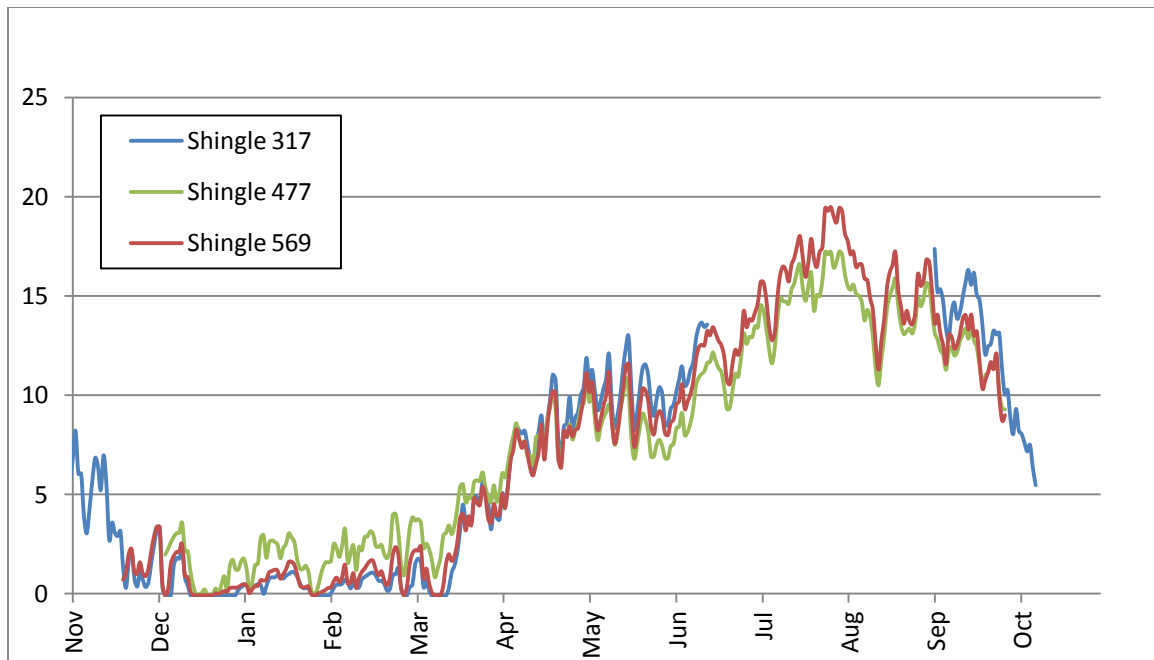


Figure 13: Mean daily stream temperatures for Shingle 317, 477, and 569 sites for the 2009 water year.

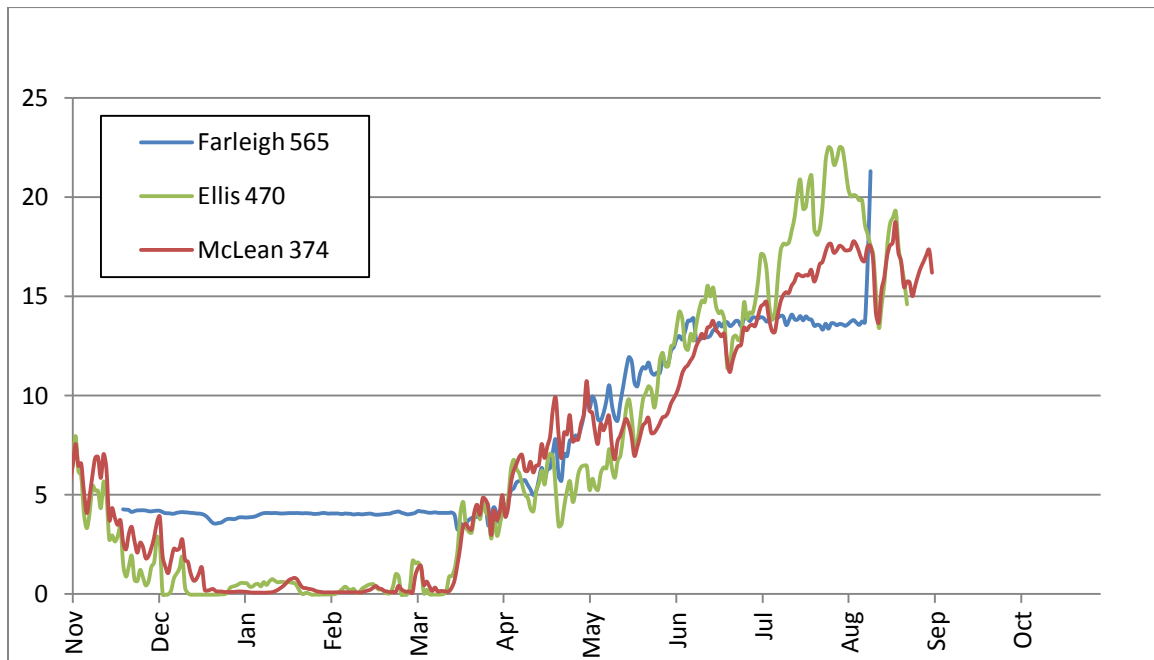


Figure 14: Mean daily stream temperatures for Ellis 470, McLean 374, and Farleigh 565 sites for the 2009 water year.

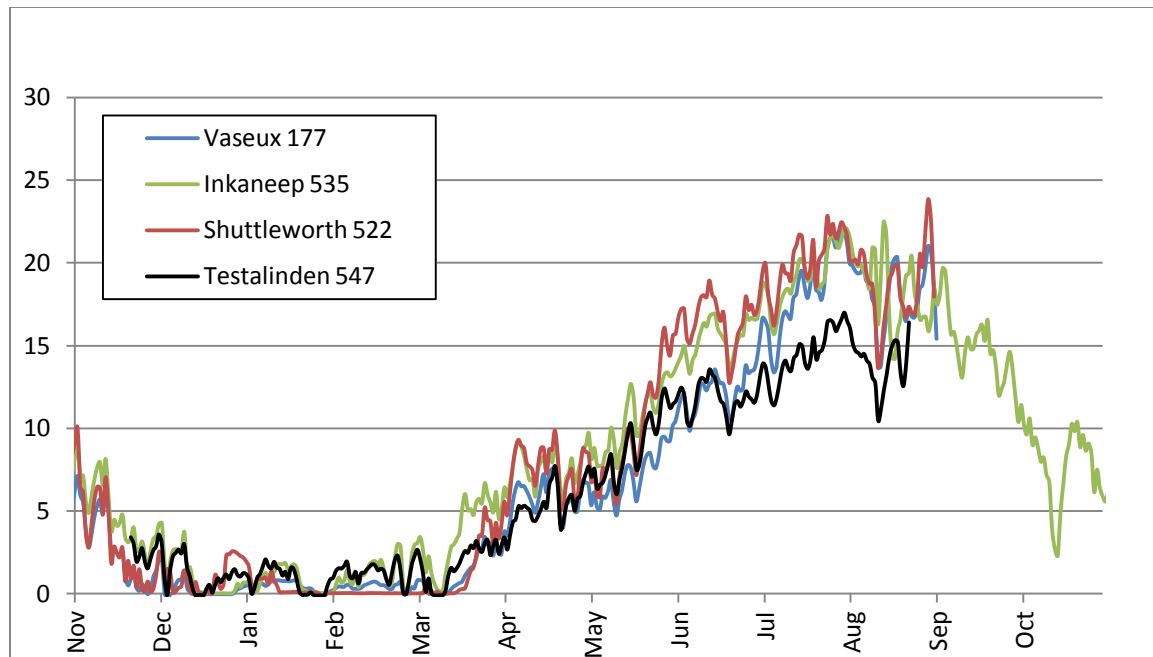


Figure 15: Mean daily stream temperatures for Vaseux 177, Shuttleworth 522, Inkaneep 535, and Testalinden 547 sites for the 2009 water year.

Brett (1952) determined that the preferred temperature of Chinook salmon fingerlings ranges from 12.2°C to 13.9°C, with an upper lethal temperature for Chinook fry at 25°C. The upper lethal temperature for Kamloops trout fingerlings was 24°C after being acclimated down to 11°C in laboratory studies (Black 1953).

In mid-August, mean daily temperatures for all the mainstem river sites approached 26°C, with maximum daily temperatures reaching 28.5°C at 323, 26.8°C at 383 and 406, 27.1°C at 467, 27.4°C at 490 and 26.7°C at 493. These temperatures are above the upper lethal limits for Chinook and trout fry.

According to Scott and Crossman (1973), kokanee generally spawn from September to October when temperatures drop from 10.5°C to 5.0°C and sockeye spawn from July to December when temperatures drop from 7°C to 3°C. In 2009, peak spawning in the Okanagan River was October 19th for sockeye (Audy and Kozlova 2011) and November 4th for kokanee (Louie and Benson 2011). Mean temperatures in the Okanagan River⁶ for these dates were 11.9°C and 7.7°C, respectively.

3.3 Biological data

Snorkel surveys were conducted from August to September 2009 to document the presence and abundance of juvenile and adult salmonids as well as non-salmonids. All of the mainstem surveys were conducted on August 20th, 2009 with five snorkelers.

Most of the tributary surveys were conducted on August 26th and 27th, with two snorkelers.

⁶ Averaged for the Okanagan River OBMEP sites.

Salmonid species present included rainbow trout/steelhead (*Oncorhynchus mykiss*), sockeye salmon (*O. nerka*), and mountain whitefish (*Prosopium williamsoni*). Non-salmonid families present included bass, bluegill and pumpkinseed (Centrarchidae), minnows (Cyprinidae), sculpins (Cottidae), and (Catostomidae), perch (Percidae), and channel catfish (*Ictalurus punctatus*). Snorkel survey results are summarized in Appendices 9 and 10.

4.0 DISCUSSION AND RECOMMENDATIONS

The 2009 OBMEP objectives were effectively completed for this year's anadromous salmonid physical habitat and biological study in the Canadian Okanagan sub-basin. A detailed discussion of changes in physical habitat parameters and trends from 2005 to 2009 is currently not applicable because only five years of data have been collected. Comparisons will be warranted after several years of sampling are completed. Ideally, long-term monitoring will incorporate different water year types and thus capture the natural variation of the system.

Recommendations for future years include:

- Continue providing land owners with information sheets detailing the study and survey schedule.
- Test the Trimble® GPS unit and its software prior to and during the OBMEP study.
- Check and download temperature data loggers pre- and post-freshet.
- Continue the present methodology for snorkel surveys in streams too shallow to snorkel.
- Continue on-going communications with the CCTFWD and Summit Environmental Consulting Ltd.

5.0 REFERENCES

- Armantrout, N.B., Compiler. 1998. Glossary of Aquatic Habitat Inventory Terminology. American Fisheries Society, Bethesda, Maryland
- Arterburn, J., Wagner, P. and R. Dasher. 2005. Field Manual: Okanogan Monitoring and Evaluation Program Biological Protocols Draft. Colville Confederated Tribes, OMAK, WA & KWA Ecological Sciences, Inc., Duvall, Washington.
- Arterburn, J., Kistler, K., Wagner, P., Nugent, J. and R. Dasher. 2006. Field Manual: Okanogan Monitoring and Evaluation Program Physical Habitat Protocols. Colville Confederated Tribes, OMAK, WA & KWA Ecological Sciences, Inc., Duvall, Washington.
- Audy, N., T. Kozlova. 2010. Okanogan River Sockeye Spawner Enumeration and Biological Sampling 2009. Prepared by Okanogan Nation Alliance – Fisheries Department, Westbank, BC.
- Benson, R., M. Squakin, and K. Wodchyc. 2007. Okanogan Basin Monitoring and Evaluation Program (OBMEP) 2006 Annual Report for Sites in Canada. Prepared by the Okanogan Nation Alliance Fisheries Department, Westbank, B.C.
- Benson, R., G. Traxler and S. Wolski. 2008. Collection and rearing of Okanogan sockeye for the Skaha Reintroduction 2006 Brood Year. Prepared by Okanogan Nation Alliance Fisheries Department, Westbank, BC. 34pp.
- Black, E.C. 1953. Upper Lethal Temperatures of some British Columbia Freshwater Fishes. J. Fish. Res. Board Canada 10(4): 196-210. Cited in: Groot, C, L. Margolis (Editors). 1991. Pacific Salmon Life Histories. UBC Press, Vancouver, BC. Page 189.
- Brett, J.R. 1952. Temperature Tolerance in Young Pacific Salmon, Genus *Oncorhynchus*. J. Fish. Res. Board Canada 9(6): 265-323.
- Ernst, A., and A. Vedan, Editors. 2000. Aboriginal Fisheries Information within the Okanogan Basin. Okanogan Nation Fisheries Commission, Westbank, BC.
- Hillman, T.W. 2004. Monitoring Strategy for the Upper Columbia Basin Draft Report. 2004. Cited in J. Arterburn, and K. Kistler. 2005. Colville Tribe Okanogan Basin Monitoring and Evaluation Program Annual Report for 2004. Prepared by Colville Confederated Tribes Fish and Wildlife Department Anadromous Fish Division. Prepared for U.S. Department of Energy Bonneville Power Administration Division of Fish and Wildlife.
- Kozlova, T., G. Traxler, K. Garver, and S. Wolski. 2009. Collection and rearing of Okanogan sockeye for the Skaha Reintroduction 2007 brood year. Prepared by Okanogan Nation Fisheries Department, Westbank, BC.

- Long, K., S. Wolski and G. Traxler. 2005. Collection and rearing of Okanagan sockeye for Skaha reintroduction 2004 brood year. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC. 13 pp.
- Long, K., R. Newbury and C. Bull. 2006. Fish Habitat Assessment of Vaseux Creek to Determine Restoration Potential. Okanagan Nation Alliance Fisheries Department, Westbank, BC.
- Long, K., G. Traxler and S. Wolski. 2007. Collection and rearing of Okanagan sockeye for the Skaha reintroduction 2005 Brood Year. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC.
- Louie, C, and R. Benson. 2011. Skaha Lake kokanee spawner enumeration and biological sampling 2009. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC.
- Scott, W.B, and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bull. Fish. Res. Bd. Can. 184. 966 pp.
- Symonds, B.J. 2000. Background and History of Water Management of Okanagan Lake and River. Prepared by Ministry of Environment, Lands, and Parks (Water Management), Penticton, BC.
- Walsh, M. and K. Long. 2006a. Okanagan Basin Monitoring and Evaluation Program (OBMEP) 2005 Annual Report for Sites in Canada. Prepared by the Okanagan Nation Alliance Fisheries Department, Westbank, B.C.
- Walsh, M. and K. Long. 2006b. Survey of barriers to anadromous fish migration in the Canadian Okanagan sub-basin. Prepared by the Okanagan Nation Alliance Fisheries Department, Westbank, BC.
- Wright, H., K. Alex, R. Bussanich, D.McQueen, K.D. Hyatt, D.P. Rankin, S. Lawrence, N. Audy, R. Benson, C. Mathieu, J. Pizzey, A. Warman, L.Wiens, K. Garver, S.Wolski, C. Louie. 2011. Experimental Re-introduction of sockeye salmon (*Oncorhynchus nerka*) in Skaha Lake: 2009 Brood Year Report, Year 6 of 12. Okanagan Nation Alliance, Westbank, BC. 427 pp.
- WSC (Water Survey of Canada). Archived hydrometric data-query [2009] for Okanagan River (near Oliver, OK Falls, and Penticton) and Vaseux Creek above Solco Creek. [www.wsc.ec.gc.ca].

Appendices

Appendix 1. Summary of the OBMEP sites in the Canadian portion of the Okanagan sub-basin

Annual Panel	Panel 1 (2005)	Panel 2 (2006)	Panel 3 (2007)
Okanagan River 490	Okanagan River 371	Okanagan River 562	Okanagan River 435
Okanagan River 493	Okanagan River 503	Shingle Upper 333	Shatford 590
Inkaneep 535	Okanagan River 415	Shatford 338	Shingle 461 (extra p)
Vaseux 177	Testalinden 375	Okanagan River 346	Haynes 471
Shuttleworth 522	Reed 567	Reed 403	Ellis 390
Shingle 317	Wolfcub 543	Inkaneep 351	Okanagan River 518
Ellis 470	Park rill 88	Shuttleworth 538	Shuttleworth 364
McLean 374^a	Shingle 593	McLean 310	Vaseux 598

Panel 4 (2008)	Panel 5 (2009)	Extra Panel
Okanagan River 339	Shingle 569	Okanagan River 319
Okanagan River 575	Okanagan River 383	Shatford 338
Shatford 507	Okanagan River 323	Shingle 477
Shuttleworth 582	Testalinden 547	Okanagan River 531
Vaseux 367	Okanagan River 467	Ellis 530
Ellis 492	Shingle 477 ^b	Shuttleworth 394
Shingle 541	Okanagan River 406	Haynes 519
Okanagan River 426	Farleigh creek 565	Marron Creek 450

^aprior to 2007 Haynes 471 was an annual site, replaced later by McLean 374

^bShingle 477, in Panel 5, is actually within the Shatford tributary

Appendix 2. Monitoring schedule for the 20-year OBMEP project.

Panel	Year									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Annual	x	x	x	x	x	x	x	x	x	x
Panel 1	x					x				
Panel 2		x					x			
Panel 3			x					x		
Panel 4				x					x	
Panel 5					x					x

Panel	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Annual	x	x	x	x	x	x	x	x	x	x
Panel 1	x					x				
Panel 2		x					x			
Panel 3			x					x		
Panel 4				x					x	
Panel 5					x					x

Note: X' denotes a physical and biological survey will be performed.

Appendix 3. OBMEP physical habitat measurements collected and recorded in the field.

Measurement	General Description	Equipment	Units
Thalweg depth	Deepest depth of a channel cross-section	stadia rod	meters
Entrenchment ratio	Entrenched, moderately entrenched, or slightly entrenched	n/a	no units
Wetted width	Width of water surface measured perpendicular to the direction of flow at a specific discharge*	stadia rod or laser ranging instrument	meters
Bankfull width	Channel width between the tops of the most pronounced banks on either side of a stream reach*	stadia rod or laser ranging instrument	meters
Bankfull heights	Vertical distance from the water surface at the wetted edge to the point of maximum flow elevation occurring on a 1.5 year cycle	stadia rod and a level	meters
Sediment	Unconsolidated, loose deposits with diameter <16 mm i.e. fine gravel, sand, silt, clay or muck	n/a	presence or absence
Habitat types	Glide, primary pool, dry, falls, small cobble riffle, large cobble riffle, pool tailout, beaver pond, rapid, or cascade	n/a	habitat type code
Mid channel bar	Width of mid channel bar if present	stadia rod or laser ranging instrument	meters
Substrate	Classify particle by its median diameter i.e. coarse gravel, boulder, bedrock. Estimate embeddedness as the average % that substrate are surrounded by fine sediments	n/a	substrate size class and embeddedness (%)
Large Woody Debris	Dead trees with diameter >0.1 m in the active channel or spanning the channel	n/a	no. of pieces of each length category (>1 m or >2 m)
Human influence	Pipes, buildings, dikes, pasture, river access site, pavement, garbage piles, cleared lots, orchards, logging or mining operations, diversion structures	n/a	presence or absence, proximity to channel
Canopy cover	Measure riparian vegetation structure in mid-channel, and facing the left and right bank	concave spherical densitometer	number of grid intersection points
Riparian vegetation	Dominant vegetation type and aerial coverage for: canopy layer, understory, and ground cover layer	n/a	vegetation type, % aerial coverage
Side channel	LWD, Thalweg, and substrate	stadia rod	units for each described above
Backwaters	Quiescent off-channel aquatic habitats i.e. sloughs, alcoves, backwater ponds, or oxbows	n/a	presence or absence
Gradients	Gradients between the transects and mid-transects (i.e. A to A1, J1 to K) collected while standing in the thalweg of the stream	Laser Technology, Inc Impulse 200™ laser ranging instrument	percentage

Note: Units are measured to the nearest 0.01m where applicable.

*Armantrout, N.B., Compiler. 1998. Glossary of Aquatic Habitat Inventory Terminology. American Fisheries Society, Bethesda, Maryland.

Appendix 4. Summary of average stream depth measurements collected for sites surveyed in 2009.

EMAP Site Name & Number	Wetted Width (m)	Thalweg Depth (m)	Bankfull Width (m)	Bankfull Depth (m)	Bankfull Height (m)	Wetted Width/ Thalweg Depth	Bankfull Width/ Bankfull Depth Ratio	Flood Prone Width (m)	Flood Prone Depth (m)	Entrenchment Ratio (Exactly)	Entrenchment Value (as previous reports)	Gradient (%)
Okanagan 490	25.7	0.8	28.0	1.4	0.5	30.3	19.7	28.0	2.8	1.0	1.0	0.6
Okanagan 493	26.3	0.9	27.9	1.8	0.9	30.1	15.8	27.8	3.5	1.0	1.0	0.5
Inkaneep 535	3.8	0.2	5.1	0.4	0.2	24.6	14.0	5.1	0.7	1.0	1.0	0.8
Vaseux 177	5.7	0.3	13.4	0.9	0.6	22.6	15.1	28.6	1.8	0.5	2.1	1.5
Shuttleworth 522	1.8	0.0	5.7	0.5	0.4	43.9	12.3	5.7	0.9	1.0	1.0	2.0
Shingle 317	4.0	0.3	6.7	0.8	0.5	15.3	8.6	6.9	1.6	1.0	1.0	0.4
Ellis 470	5.4	0.2	8.1	0.7	0.4	23.6	12.4	8.1	1.3	1.0	1.0	1.2
McLean 374	1.3	0.2	3.2	0.5	0.3	8.7	7.0	4.7	0.9	0.7	1.4	0.9
Shingle 569	5.3	0.4	8.4	0.9	0.5	14.7	9.7	11.7	1.7	0.7	1.4	2.1
Okanagan 383	21.7	0.9	23.0	1.4	0.5	24.6	16.9	23.0	2.7	1.0	1.0	0.3
Okanagan 323	28.0	1.3	29.6	2.0	0.6	20.8	15.2	29.6	3.9	1.0	1.0	0.5
Testalinden 547	2.0	0.2	3.7	0.6	0.5	11.4	5.9	3.7	1.3	1.0	1.0	3.1
Okanagan 467	29.4	1.7	30.0	2.3	0.7	16.9	12.9	30.0	4.7	1.0	1.0	0.4
Okanagan 406	30.3	1.7	31.2	2.4	0.6	17.8	13.2	37.8	4.7	0.8	1.2	0.4
Shingle 477	3.9	0.3	5.5	0.6	0.3	13.9	9.3	5.5	1.2	1.0	1.0	0.9
Farleigh 565	0.9	0.1	1.5	0.3	0.2	11.4	4.9	1.5	0.6	1.0	1.0	1.4

*Need one or other Column for Entrenchment (last yellow column is representative of how previous reports have averaged Entrenchment Values)

Appendix 5. Summary of habitat data collected for sites surveyed in 2009 (averaged for each site).

EMAP Site Name & Number	Primary Pool (%)	Beaver Pool (%)	Pool Tail Out (%)	Glide (%)	Large Cobble Riffle (%)	Small Cobble Riffle (%)	Standing Water (%)	Cascade Falls (%)	Side Channel (%)*	Mid-Channel Bar Width (m)*
Okanagan 490	0	0	0	1	25	67	0	0	3	1.03
Okanagan 493	0	0	0	91	0	0	0	0	1	0.00
Inkaneep 535	5	0	0	1	0	85	0	0	1	0.09
Vaseux 177	1	0	0	0	81	0	0	7	1	0.24
Shuttleworth 522	0	0	0	3	5	81	0	0	0	0.10
Shingle 317	0	0	0	8	5	78	0	0	1	0.00
Ellis 470	1	0	0	0	0	89	0	0	1	0.00
McLean 374	30	0	4	30	0	26	0	0	0	0.00
Shingle 569	13	0	4	0	70	4	0	1	0	0.25
Okanagan 383	0	0	0	0	91	0	0	0	0	0.63
Okanagan 323	0	0	0	91	0	0	0	0	0	0.00
Testalinden 547	0	0	0	0	29	58	0	4	1	0.42
Okanagan 467	0	0	0	100	0	0	0	0	0	0.02
Okanagan 406	0	0	0	90	0	0	0	0	0	0.00
Shingle 477	0	0	0	0	0	91	0	0	0	0.00
Farleigh 565	7	0	0	29	0	55	0	0	0	0.08

*Last two columns not included in the overall habitat percentage

Appendix 5. Summary of habitat data collected from sites surveyed in 2009 (averaged for each site)
continued.Table 3

EMAP Site Name & Number	Average Total Pools (%)	Average Total Riffles (%)	Pool/Riffle Ratio	Small LWD >0.1 m diameter & > 1 m length	Large LWD >0.1 m diameter & >2 m length	Average Fine Sediment (%)
Okanagan 490	1	92	0.01	85	81	42
Okanagan 493	91	0	0	0	0	48
Inkaneep 535	5	85	0.06	13	21	86
Vaseux 177	1	88	0.01	8	29	11
Shuttleworth 522	3	86	0.03	26	30	21
Shingle 317	8	83	0.10	35	14	41
Ellis 470	1	90	0.01	0	7	31
McLean 374	6	30	2	39	50	79
Shingle 569	13	79	0.16	41	42	38
Okanagan 383	0	91	0	3	7	11
Okanagan 323	91	0	0	23	6	85
Testalinden 547	0	91	0	19	16	45
Okanagan 467	100	0	0	14	13	87
Okanagan 406	90	0	0	107	56	75
Shingle 477	0	91	0	35	22	52
Farleigh 565	36	55	0.67	20	57	83

Appendix 6. Summary of substrate data collected from sites surveyed in 2009 (averaged for each site).

EMAP Site Name & Number	Boulder (%)	Large Cobble (%)	Small Cobble (%)	Coarse Gravel (%)	Fine Gravel (%)	Sand (%)	Fines (%)	Wood (%)	Other (%)	% Embedded
Okanagan 490*	6	5	62	15	0	4	6	1	2	30
Okanagan 493	4	20	60	9	0	1	0	0	6	22
Inkaneep 535	0	16	49	14	0	4	14	2	2	39
Vaseux 177	20	29	31	9	0	3	6	0	1	36
Shuttleworth 522	2	26	36	4	1	6	16	4	5	36
Shingle 317	5	26	24	2	2	7	20	3	10	55
Ellis 470	7	38	34	5	0	2	11	1	1	35
McLean 374	0	1	19	10	2	15	32	10	11	56
Shingle 569	12	21	26	9	0	14	10	7	1	47
Okanagan 383	26	48	12	8	0	0	1	1	3	30
Okanagan 323	0	0	21	2	18	44	8	0	7	48
Testalinden 547	2	15	33	14	4	1	26	0	4	45
Okanagan 467	3	11	27	36	1	12	3	0	9	40
Okanagan 406	0	8	5	0	0	56	0	0	31	54
Shingle 477	0	4	38	18	6	18	9	4	4	44
Farleigh 565	0	3	11	14	13	3	45	8	3	68

*490 includes side channel substrates

Appendix 7. Summary of riparian vegetation from sites surveyed in 2009 (averaged for each site).

EMAP Site Name & Number	Canopy Cover Reach (%)	Canopy Cover Bank (%)	Overstory Deciduous (%)	Overstory Coniferous (%)	Overstory Mixed (%)	Overstory None (%)	Understory Deciduous (%)	Understory Coniferous (%)	Understory Mixed (%)	Understory None (%)
Okanagan 490	21.9	62.4	95.5	0.0	0.0	4.5	84.6	15.4	0.0	0.0
Okanagan 493	1.2	3.7	31.8	0.0	0.0	68.2	90.9	0.0	0.0	9.1
Inkaneeep 535	79.1	88.2	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Vaseux 177	30.8	46.1	22.7	13.6	45.5	18.2	41.7	8.3	37.5	12.5
Shuttleworth 522	70.1	78.6	77.3	0.0	4.5	18.2	85.5	0.0	14.5	0.0
Shingle 317	77.8	79.9	40.9	4.5	54.5	0.0	54.5	4.5	40.9	0.0
Ellis 470	72.7	79.7	86.4	0.0	9.1	4.5	40.9	0.0	27.3	31.8
McLean 374	70.1	63.9	59.1	0.0	22.7	18.2	95.5	0.0	4.5	0.0
Shingle 569	44.2	74.3	13.6	27.3	36.4	4.5	15.5	0.0	84.5	0.0
Okanagan 383	26.8	66.6	25.0	20.0	40.0	15.0	90.9	9.1	0.0	0.0
Okanagan 323	9.6	28.9	22.7	0.0	0.0	77.3	54.5	0.0	0.0	45.5
Testalinden 547	65.9	73.5	63.6	9.1	13.6	13.6	90.9	0.0	9.1	0.0
Okanagan 467	27.4	75.9	95.0	0.0	0.0	5.0	100.0	0.0	0.0	0.0
Okanagan 406	0.6	1.9	31.8	0.0	0.0	68.2	40.9	0.0	0.0	59.1
Shingle 477	40.9	54.3	22.7	0.0	0.0	77.3	81.8	0.0	0.0	18.2
Farleigh 565	72.7	72.7	54.5	4.5	18.2	22.7	74.2	0.0	25.8	0.0

Appendix 7. Summary of riparian vegetation from sites surveyed in 2009 (averaged for each site) continued.

EMAP Site Name & Number	Canopy Big Trees > 0.3 m DBH*					Canopy Small Trees <0.3 m DBH*					Understory Woody Shrubs/Saplings				
	0%	<10%	10-40%	40-75%	>75%	0%	<10%	10-40%	40-75%	>75%	0%	<10%	10-40%	40-75%	>75%
Okanagan 490	36	59	5	0	0	9	32	23	36	0	0	9	68	23	0
Okanagan 493	91	5	5	0	0	77	18	5	0	0	68	32	0	0	0
Inkaneep 535	18	59	23	0	0	5	68	27	0	0	0	41	41	18	0
Vaseux 177	64	32	5	0	0	32	59	9	0	0	14	82	5	0	0
Shuttleworth 522	45	45	9	0	0	45	41	14	0	0	0	32	45	23	0
Shingle 317	5	91	5	0	0	9	73	18	0	0	5	59	36	0	0
Ellis 470	18	27	41	14	0	45	45	5	5	0	32	59	9	0	0
McLean 374	27	59	14	0	0	27	68	5	0	0	0	55	32	14	0
Shingle 569	23	64	9	5	0	9	73	18	0	0	0	32	59	9	0
Okanagan 383	20	65	15	0	0	50	40	10	0	0	0	35	50	15	0
Okanagan 323	86	14	0	0	0	91	5	5	0	0	45	32	23	0	0
Testalinden 547	50	50	0	0	0	23	68	9	0	0	9	73	18	0	0
Okanagan 467	10	75	15	0	0	10	70	20	0	0	0	55	45	0	0
Okanagan 406	100	0	0	0	0	73	27	0	0	0	64	23	9	5	0
Shingle 477	86	14	0	0	0	86	14	0	0	0	18	14	36	18	14
Farleigh 565	64	32	0	5	0	36	64	0	0	0	0	91	5	5	0

* DBH = diameter at breast height

Appendix 7. Summary of riparian vegetation from sites surveyed in 2009 (averaged for each site) continued.

EMAP Site name & Number	Understory Non-Woody Herbs/Grasses/Forbs					Ground Cover Woody Shrubs/Saplings					Ground Cover Non-Woody Herbs/Grasses/Forbs				
	0%	<10%	10-40%	40-75%	>75%	0%	<10%	10-40%	40-75%	>75%	0%	<10%	10-40%	40-75%	>75%
Okanagan 490	0	27	55	18	0	9	68	18	5	0	0	55	45	0	0
Okanagan 493	5	0	82	14	0	82	18	0	0	0	0	9	86	5	0
Inkaneep 535	0	86	14	0	0	5	91	5	0	0	0	27	27	45	0
Vaseux 177	41	59	0	0	0	9	64	23	5	0	23	73	5	0	0
Shuttleworth 522	0	32	50	18	0	0	95	5	0	0	0	5	27	68	0
Shingle 317	9	82	9	0	0	0	100	0	0	0	5	45	45	5	0
Ellis 470	100	0	0	0	0	0	55	36	0	9	23	55	23	0	0
McLean 374	0	5	50	45	0	23	59	18	0	0	0	45	55	0	0
Shingle 569	14	55	27	5	0	0	32	55	14	0	0	55	27	18	0
Okanagan 383	40	10	45	5	0	5	60	25	10	0	0	75	25	0	0
Okanagan 323	73	18	0	9	0	14	45	32	9	0	0	5	41	50	5
Testalinden 547	27	68	5	0	0	23	77	0	0	0	5	18	50	27	0
Okanagan 467	5	60	30	5	0	0	85	10	5	0	0	30	45	25	0
Okanagan 406	0	86	14	0	0	59	18	23	0	0	0	68	32	0	0
Shingle 477	18	23	36	23	0	14	86	0	0	0	0	5	5	64	27
Farleigh 565	100	0	0	0	0	0	5	14	64	18	27	50	18	5	0

Appendix 7. Summary of riparian vegetation from sites surveyed in 2009 (averaged for each site) continued.

EMAP Site Name & Number	Ground Cover Barren Dirt/Duff					Ground Cover LWD				
	0%	<10%	10-40%	40-75%	>75%	0%	<10%	10-40%	40-75%	>75%
Okanagan 490	32	23	36	9	0	9	82	9	0	0
Okanagan 493	0	55	41	5	0	100	0	0	0	0
Inkaneep 535	9	59	5	27	0	0	50	45	5	0
Vaseux 177	0	23	27	45	5	14	64	14	9	0
Shuttleworth 522	32	64	5	0	0	18	68	14	0	0
Shingle 317	0	41	36	9	14	5	86	9	0	0
Ellis 470	0	14	45	32	9	73	27	0	0	0
McLean 374	73	23	5	0	0	9	77	14	0	0
Shingle 569	14	73	14	0	0	41	45	9	5	0
Okanagan 383	45	45	10	0	0	45	50	5	0	0
Okanagan 323	27	50	23	0	0	82	14	5	0	0
Testalinden 547	0	23	45	27	5	5	68	27	0	0
Okanagan 467	5	85	10	0	0	25	55	20	0	0
Okanagan 406	5	55	27	14	0	86	9	5	0	0
Shingle 477	36	55	9	0	0	27	59	14	0	0
Farleigh 565	73	18	9	0	0	27	64	9	0	0

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2009 (averaged for each site).

EMAP Site Name & Number	Wall/Dike/Revetment/Riprap/Dam (%)				Buildings (%)				River access sites (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	41	5	5	50	0	14	5	82	36	0	0	64
Okanagan 493	0	18	82	0	0	0	9	91	23	0	0	77
Inkaneeep 535	14	0	0	86	0	5	0	95	50	0	0	50
Vaseux 177	14	0	14	73	0	0	0	100	5	0	0	95
Shuttleworth 522	0	0	5	95	0	0	18	82	0	0	0	100
Shingle 317	95	0	0	5	0	9	27	64	23	0	0	77
Ellis 470	0	0	0	100	0	0	55	45	0	0	5	95
McLean 374	0	0	0	100	0	0	0	100	9	0	0	91
Shingle 569	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 383	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 323	0	0	0	100	0	0	5	95	14	0	0	86
Testalinden 547	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 467	50	0	0	50	0	0	10	90	0	0	0	100
Okanagan 406	50	50	0	0	0	0	32	68	14	5	0	82
Shingle 477	0	0	0	100	0	0	0	100	9	0	0	91
Farleigh 565	5	0	0	95	0	0	0	100	14	0	0	86

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2009 (averaged for each site) continued.

EMAP Site name & Number	Pavement/Road/railroad (%)				Pipes (inlet/outlet) (%)				Garbage Piles (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	5	5	32	59	9	5	0	86	55	18	14	14
Okanagan 493	5	0	82	14	9	0	0	91	27	50	9	14
Inkaneep 535	0	9	0	91	5	0	0	95	0	0	0	100
Vaseux 177	5	0	32	64	0	0	0	100	0	0	0	100
Shuttleworth 522	0	14	0	86	0	0	0	100	5	0	0	95
Shingle 317	0	0	32	68	0	0	0	100	82	5	0	14
Ellis 470	5	0	59	36	18	0	0	82	86	0	0	14
McLean 374	0	0	0	100	0	0	0	100	9	0	0	91
Shingle 569	0	0	18	82	0	0	0	100	0	0	0	100
Okanagan 383	0	0	0	100	0	0	0	100	10	0	0	90
Okanagan 323	0	0	55	45	5	0	0	95	0	0	0	100
Testalinden 547	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 467	0	45	35	20	5	5	0	90	20	0	0	80
Okanagan 406	50	50	0	0	18	0	0	82	45	0	0	55
Shingle 477	0	0	0	100	0	0	5	95	0	0	0	100
Farleigh 565	0	0	0	100	0	0	0	100	0	0	0	100

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2009 (averaged for each site) continued.

EMAP Site Name & Number	Cleared lot/lawn (%)				Orchard/Row Crops (%)				Pasture/Range/Hay Field (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	0	5	14	82	0	0	9	91	0	0	0	100
Okanagan 493	0	0	68	32	0	0	0	100	0	0	0	100
Inkaneep 535	0	0	0	100	0	0	0	100	0	5	55	41
Vaseux 177	0	0	0	100	0	0	0	100	0	0	0	100
Shuttleworth 522	5	9	36	50	0	0	0	100	0	23	0	77
Shingle 317	0	18	0	82	0	0	0	100	0	0	0	100
Ellis 470	0	5	41	55	0	0	0	100	0	0	0	100
McLean 374	0	0	5	95	0	0	0	100	5	0	0	95
Shingle 569	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 383	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 323	0	0	23	77	0	0	0	100	0	0	0	100
Testalinden 547	0	0	0	100	0	0	0	100	100	0	0	0
Okanagan 467	0	0	0	100	0	0	15	85	0	0	20	80
Okanagan 406	0	0	32	68	0	0	5	95	5	0	50	45
Shingle 477	0	0	0	100	0	0	0	100	5	27	68	0
Farleigh 565	0	14	23	64	0	0	0	100	0	14	18	68

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2009 (averaged for each site) continued.

EMAP Site Name & Number	Logging Operations (%)				Mining Activities (%)				Diversions (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 493	0	0	0	100	0	0	0	100	0	0	0	100
Inkaneep 535	0	0	0	100	0	0	0	100	0	0	0	100
Vaseux 177	0	0	0	100	0	0	0	100	0	0	0	100
Shuttleworth 522	0	0	0	100	0	0	0	100	0	0	0	100
Shingle 317	0	0	0	100	0	0	0	100	0	0	0	100
Ellis 470	0	0	0	100	0	0	0	100	0	0	0	100
McLean 374	0	0	0	100	0	0	0	100	0	0	0	100
Shingle 569	0	0	0	100	0	0	0	100	5	0	0	95
Okanagan 383	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 323	0	0	0	100	0	0	0	100	0	0	0	100
Testalinden 547	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 467	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 406	0	0	0	100	0	0	0	100	0	0	0	100
Shingle 477	0	0	0	100	0	0	0	100	0	0	0	100
Farleigh 565	0	0	0	100	0	0	0	100	0	0	0	100

Appendix 9. Summary of snorkel survey data for salmonids collected in 2009.

Site Name and Salmonid Fish Abundance 2009																
Size Class	Okanagan 490	Okanagan 493	McLean 374*	Inkaneep 535	Vaseux 177	Shuttle- worth 522	Shingle 317	Ellis 470	Testalinden 547	Farleigh 565	Shingle 569	Shingle 477	Okanagan 467	Okanagan 406	Okanagan 383	Okanagan 323
Salmonids	6	11	93	132	576	No data	8	27	No data	No data	119	159	4	10	104	0
<100 mm	1	0	83	117	524		6	20			38	138	0	0	0	0
100 - 300 mm	4	11	10	15	0		0	7			79	20	1	10	14	0
>300 mm	1	0	0	0	52		2	0			2	1	3	0	93	0
Rainbow/Steelhead																
<100 mm			83	117	524		6	20			38	138				
100 – 300 mm	2	9	10	15				7			79	20		10	10	
>300 mm					52		2				2	1			6	
Brook Trout																
<100 mm																
100 – 300 mm																
>300 mm																
Sockeye																
<100 mm																
100 – 300 mm	2															
>300 mm	1														71	
Chinook																
<100 mm																
100 – 300 mm																
>300 mm																
Whitefish																
<100 mm																
100 – 300 mm		2											1		4	
>300 mm													3		16	
Unknown salmonid																
<100 mm	1															
100 – 300 mm													1		4	
>300 mm													3		16	
Total Salmonids															1252	

Appendix 10. Summary of snorkel survey data for non-salmonids collected in 2009.

Site Name and Non-Salmonid Fish Abundance 2009																
Size Class	Okanagan 490	Okanagan 493	McLean 374*	Inkaneep 535	Vaseux 177	Shuttle- worth 522	Shingle 317	Ellis 470	Testalinden 547	Farleigh 565	Shingle 569	Shingle 477	Okanagan 467	Okanagan 406	Okanagan 383	Okanagan 323
Non-Salmonids	520	572	0	0	41	No data	384	274	No data	No data	25	0	279	292	248	416
<100 mm	432	528	0	0	19		379	273			25	0	125	210	96	306
100 – 300 mm	48	43	0	0	22		5	1			0	0	118	3	38	89
>300 mm	40	1	0	0	0		0	0			0	0	36	79	114	21
Bass																
<100 mm	427	518											125	149	95	306
100 – 300 mm	47	11											81	2	38	71
>300 mm	7												9	7	7	1
Suckers																
<100 mm	3							7								
100 – 300 mm	1												1			
>300 mm	4												4	15	36	1
Carp*																
<100 mm																
100 – 300 mm													3			
>300 mm	29												22	49	56	19
Dace*																
<100 mm					19		379	266			20					
100 – 300 mm					22		4	1								
>300 mm																
Minnows*																
<100 mm		4									5			60		
100 – 300 mm		25											28			
>300 mm													1	8	15	
Sculpins																
<100 mm		6												1	1	
100 – 300 mm		7														
>300 mm																
Perch																
<100 mm																
100 – 300 mm													3	1		17
>300 mm																
Unidentified/ other	pumpkinseed	catfish											bluegill, pumpkinseed			pumpkinseed
<100 mm	2															
100 – 300 mm													2			1
>300 mm		1														
*Carp, Dace, Minnow and Peamouth all part of the larger Minnow Family Cyprinidae													Total Non-Salmonids			3051