

Okanagan Basin Monitoring and Evaluation Program (OBMEP) 2008 Annual Report for Sites in Canada



Prepared by:

Jamison Squakin, Certified Fisheries Technician
Skyeler Folks, BSc
Okanagan Nation Alliance Fisheries Department

Prepared for:

Colville Confederated Tribes Fish & Wildlife Department
Washington

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Okanagan Nation Alliance
3255 C Shannon Lake Road,
Westbank, BC V4T 1V4
Phone: (250) 707-0095 Fax: (250) 707-0166

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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) and 885,500 in 2008 (Kozlova *et al.* 2009).

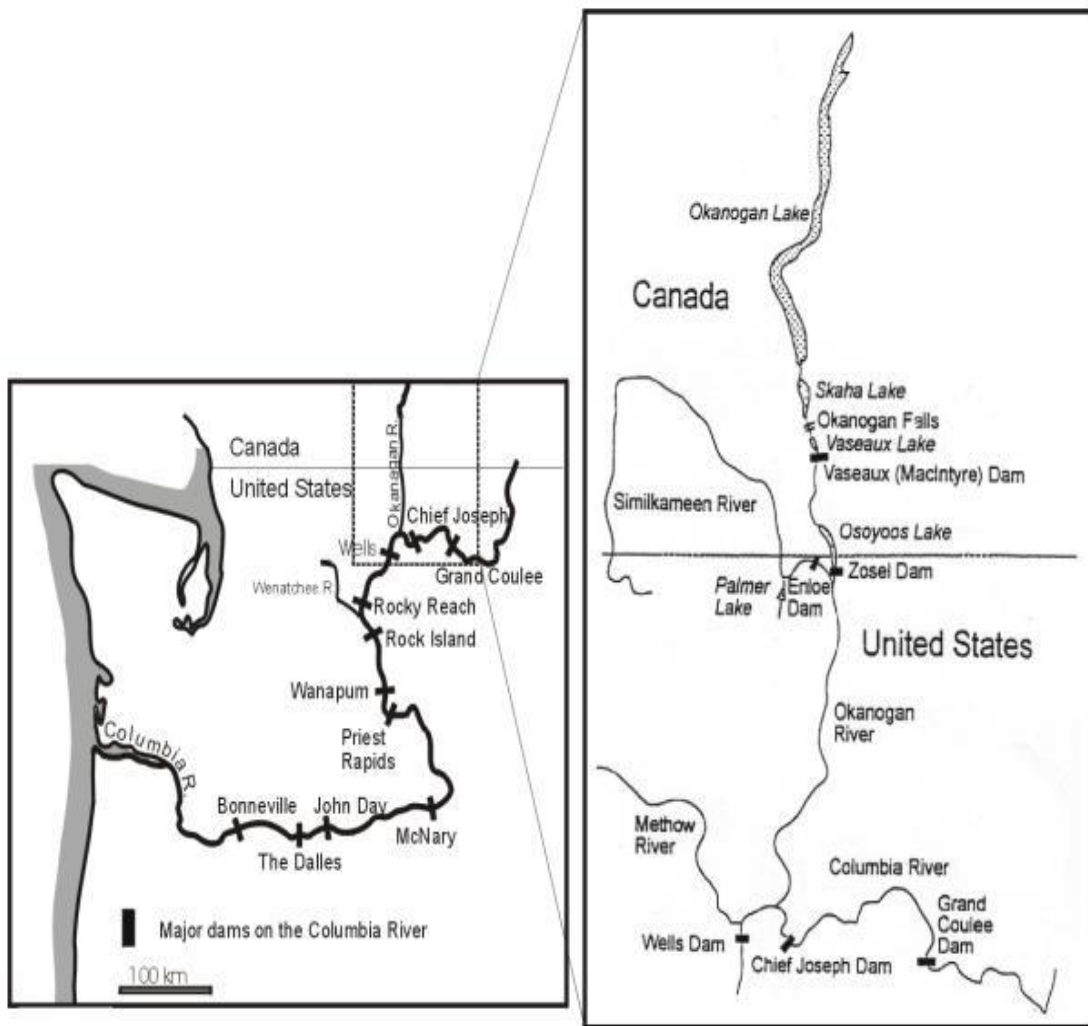


Figure 1: Core study area for the OBMEP program in Canada.

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 2008 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 4;
- survey the existing juvenile and adult fish production of sites from the Annual Panel and Panel 4 (following standard field protocols);
- establish Panel 5 sites at the end of 2008 OBMEP program in Canada; and
- continue on-going water temperature monitoring of the Annual Panel and begin temperature monitoring for Panel 5.

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 2007-2008 study period a total of 16 sites were evaluated from the annual panel and Panel 4 as displayed in Table 1. The sites for the 2008 study period include five Okanagan River mainstem sites and eleven tributary sites.

Table 1: EMAP sites for the OBMEP study in the Canadian Okanagan sub-basin surveyed in 2008. Panel 4 of the rotating panels will be surveyed once every five years, commencing in 2008.

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 4 Sites 2008:

Stream	Site No.
Okanagan River	339
Okanagan River	575
Shatford	507
Shuttleworth	582
Vaseux	367
Ellis	492
Shingle	541
Okanagan River	426

Canada OBMEP Survey Sites

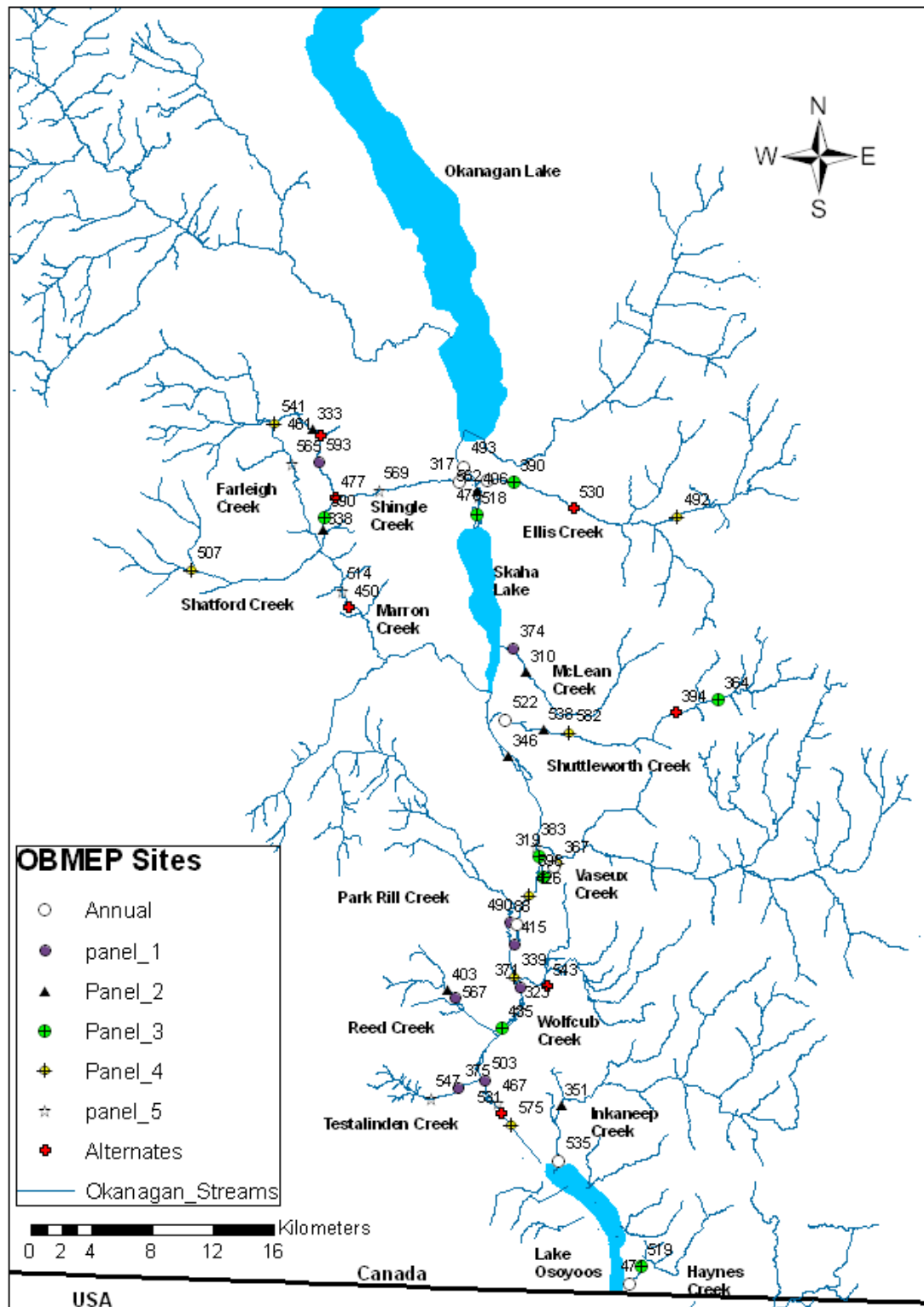


Figure 2: EMAP sites for the OBMEP program in the Canadian Okanagan sub-basin.

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.

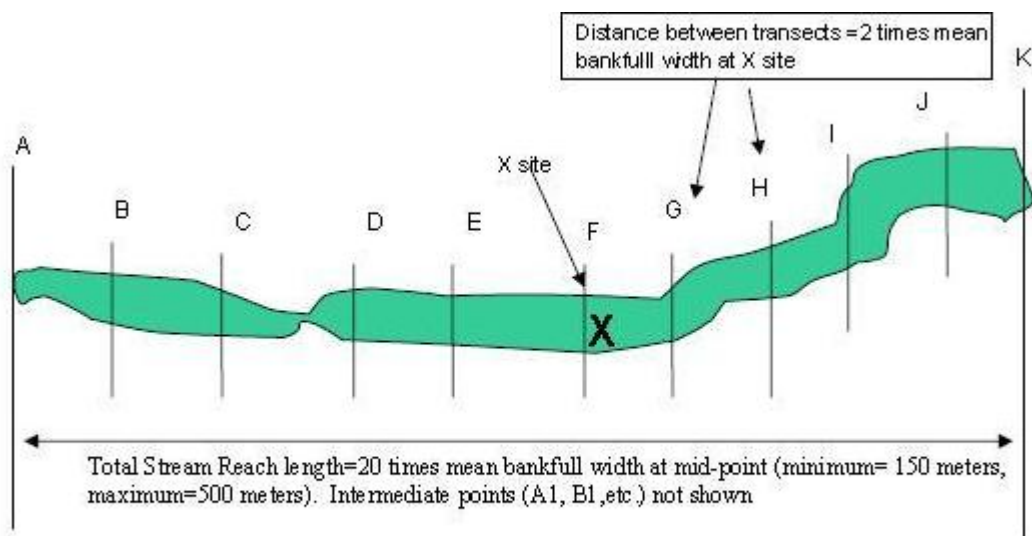


Figure 3: A typical EMAP habitat sampling site layout (from Arterburn *et al.* 2006).

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 2008. 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 2008 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 2008 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 2007-2008 water year were first collected from November 2007 to March 2008 followed then by March 2008 to October 2008. 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 2008. 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 2008 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 2008, two of the annual sites were not completely surveyed; one was considered too dry (522) and the other too turbid (374) 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 fourth year of a proposed 20-year monitoring program of anadromous salmonids 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 2008. 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 2005-2008. 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 2005-2008.

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	57.1	13	66	22.2	22	46
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	8.4	25.1	13	65	15.5	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	81.1	94.4	12	68	8.1	19	31
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	32.3	59.1	29	0	15.8	5	15
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	92.9	98.4	35	32	10.9	18	20
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	63.8	78.1	45	44	7.9	5	4
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	80.8	88.2	29	16	11.2	9	5
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	74.5	78.1	60	88	6.5	44	32

n/m – not measured

Table 3: Comparison of physical habitat parameters for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2008 (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	24.85	0.6	1.41	ME	40.2	1.6	3.2	27.8
	2008	0.78	0.3	24.97	0.4	1	E	26.9	1.2	2.3	32.2
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	E	32.8	2.6	5.2	21.6
	2007	0.92	0.1	26.88	0.9	1.41	ME	42.6	1.7	3.5	29.4
	2008	0.84	0.2	25.63	0.9	1	E	28.7	1.8	3.5	30.6
Inkaneep Creek 535	2005	0.18	0.5	3.75	0.6	2.14	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	4.03	0.6	1.8	ME	20.3	0.8	1.6	24.6
	2008	0.20	0.1	4.22	0.6	1.14	E	7.7	0.8	1.6	21.2
Vaseux Creek 177	2005	0.26	0.4	10.68	0.5	2.2	SE	32	0.8	1.5	43.8
	2006	0.2	2.3	5	1.1	1.8	ME	37.5	1.2	2.5	26
	2007	0.19	0.5	5.11	0.6	1.45	ME	21.5	0.8	1.5	29.8
	2008	0.23	0.4	8.12	0.7	1.60	ME	25.0	0.9	1.8	35.5
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	4.67	0.7	2.2	SE	21	0.7	1.5	57.3
	2008	0.13	0.2	5.01	0.6	1.41	ME	11.3	0.7	1.4	39.5
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	4.51	0.7	1.66	ME	13.4	1	2.1	12.9
	2008	0.22	0.2	3.41	0.6	1	E	7.0	0.8	1.7	15.2
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	5.65	0.6	1.41	ME	12.3	0.8	1.7	26.3
	2008	0.24	0.1	5.70	0.5	1	E	8.6	0.7	1.5	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	2.21	0.5	1	E	6.3	0.7	1.5	13.3
	2008	0.19	0.1	2.56	0.5	1.32	E	6.6	0.7	1.4	13.8

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 2005-2008.

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
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
Inkameep 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
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
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
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
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
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

n/m – not measured

Table 5: Comparison of physical habitat types for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2008.

EMAP Sites	Year	PARAMETER												
		Primary Pool (%)	Beaver Pool (%)	Pool Tail out (%)	Glide (%)	Large Cobble Riffle (%)	Small Cobble Riffle (%)	Rapids (%)	Side Channel (Y/N)	Back-water (Y/N)	Total Pools (%)	Total Riffles (%)	Cascade/Falls (%)	Mid-channel Bar width Average (m)
Okanagan River 490	2005	4	0	2	27	0	67	0	Y	Y	34	70	0	0.97
	2006	0	0	0	0	4	72	0	Y	N	0	76	0	0
	2007	0	0	0	1	0	99	0	Y	N	1	99	0	1.09
	2008	0	0	0	0	15	85	0	Y	Y	0	100	0	0.87
Okanagan River 493	2005	0	0	0	100	0	0	0	N	N	100	0	0	0
	2006	0	0	0	0	0	0	0	N	N	0	0	0	0
	2007	0	0	0	99	0	1	0	N	N	99	1	0	0
	2008	0	0	0	100	0	0	0	N	N	100	0	0	0
Inkaneep Creek 535	2005	6	0	13	17	46	19	0	N	N	23	77	0	0
	2006	0	0	1	0	3	6	0	N	N	0	10	0	0
	2007	10	0	2	0	7	8	0	N	N	10	90	0	0.14
	2008	5	0	2	0	4	89	0	N	N	5	95	0	0.02
Vaseux Creek 177	2005	0	0	0	2	60	22	16	Y	Y	3	98	16	2.65
	2006	0	0	0	0	56	38	0	Y	Y	0	94	0	0
	2007	2	0	2	0	30	66	0	Y	Y	2	98	0	0
	2008	0	0	0	0	99	1	0	N	N	0	100	0	0.71
Shuttleworth Creek 522	2005	0	0	0	19	58	23	0	N	N	19	81	0	0.89
	2006	1	0	1	0	35	58	0	N	N	1	0	0	0
	2007	0	0	0	0	0	100	0	N	N	0	100	0	0.51
	2008	0	0	0	0	2	98	0	N	N	0	100	0	0.46
Shingle Creek 317	2005	14	0	0	28	49	7	0	N	N	42	58	0	0
	2006	9	0	2	0	47	36	0	N	N	9	84	0	0
	2007	8	0	1	0	48	43	0	N	N	8	92	0	0
	2008	7	0	0	0	93	0	0	N	N	7	93	0	0.00
Ellis Creek 470	2005	0	0	0	4	65	31	0	N	N	4	96	0	0
	2006	0	0	0	0	61	38	0	N	N	0	99	0	0
	2007	0	0	0	0	21	79	0	N	N	0	100	0	0
	2008	0	0	0	0	69	31	0	N	N	0	100	0	0.00
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	N	N	47	42	0	0.03
	2008	20	0	3	0	0	1	0	N	N	96	4	0	0.01

n/m – not measured

Table 6: Comparison of riparian vegetation attributes for eight annual EMAP sites sampled in the Okanagan River Basin in 2005-2008.

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	■	■	■	■	■	■
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	■	■	■	■	■	■
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	■	■	■	■	■	■
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	■	■	■	■	■	■
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	■	■	■	■	■	■
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	■	■	■	■	■	■
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	■	■	■	■	■	■
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	■	■	■	■	■	■

*- Data will be provided in the 2009 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 2005-2008.

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
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
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
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
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
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
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
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

n/m – not measured

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 2006 for OK River at OK Falls. Peak discharges typically occur from May to July.

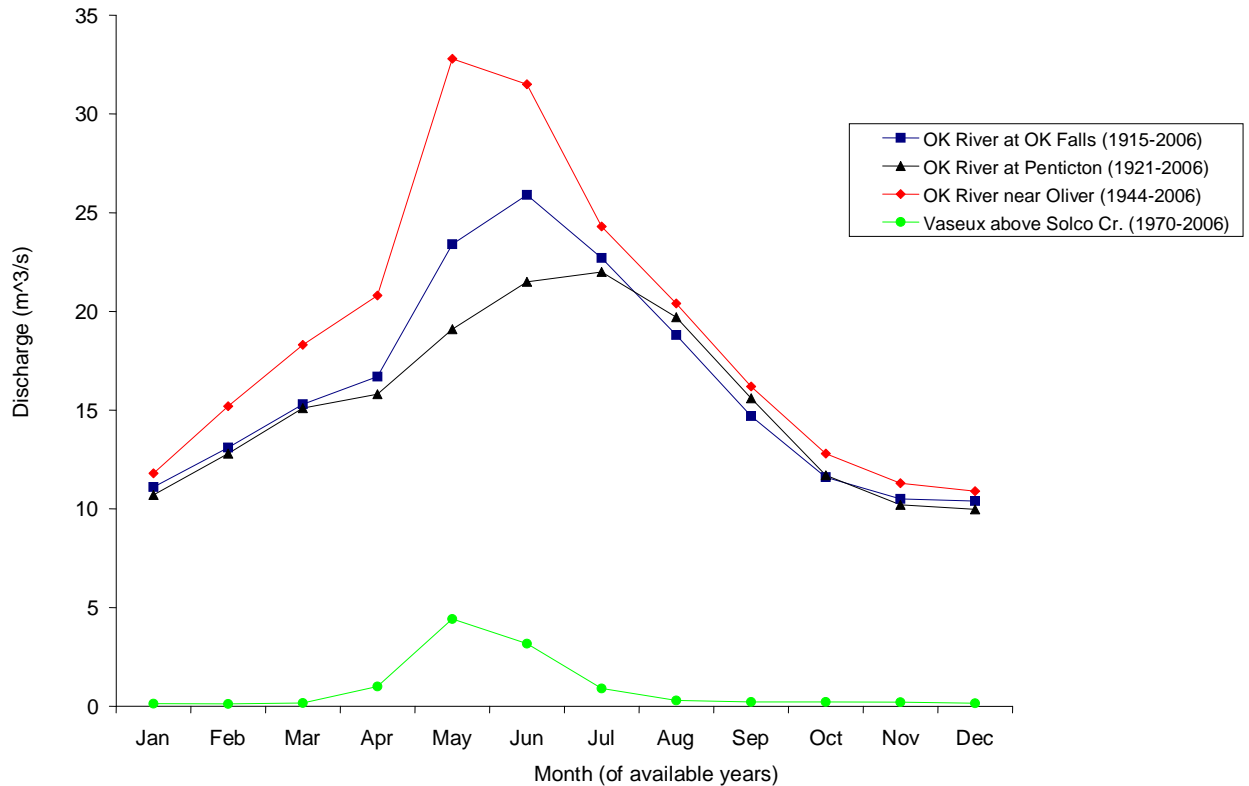


Figure 4: Historic mean monthly discharges (m^3/s) from four real-time hydrometric stations in the Okanagan sub-basin (WSC).

Mean daily discharge rates for the Okanagan river mainstem are depicted in Figures 5 to 7 for the 2008 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 2008 water year (November 2007 to November 2008).

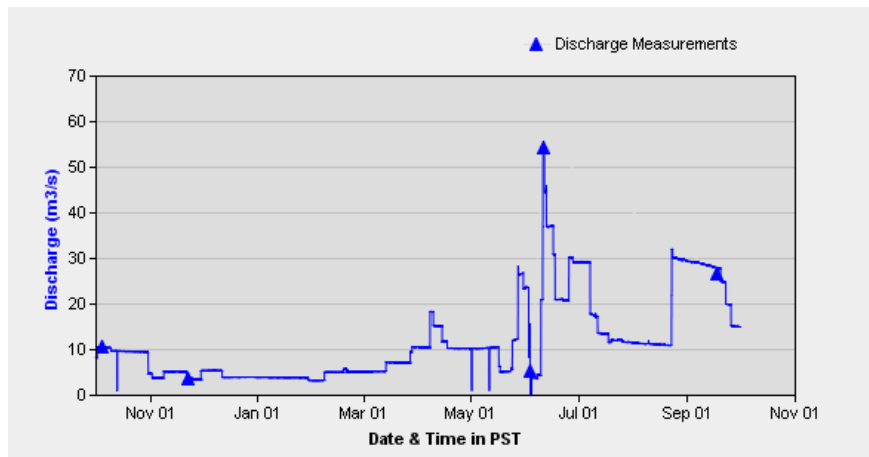


Figure 5: Mean daily discharge (m³/s) in the Okanagan River at Penticton (08NM050) during the 2008 water year (WSC).

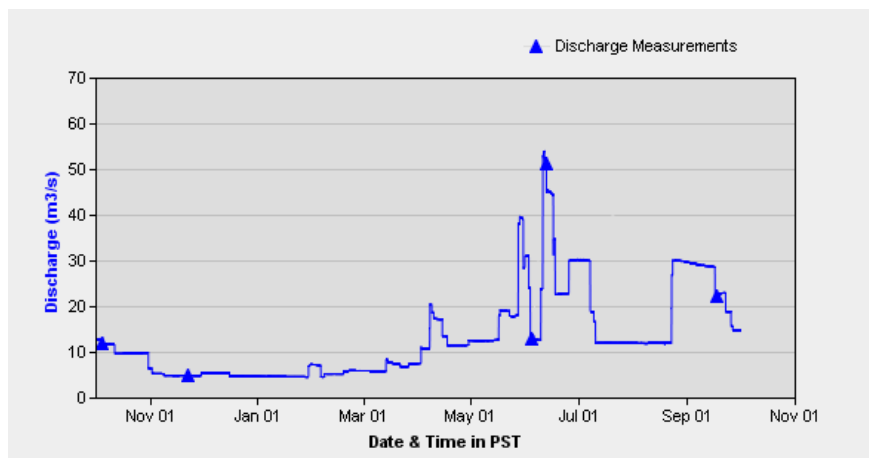


Figure 6: Mean daily discharge (m³/s) in the Okanagan River at Okanagan Falls (08NM002) during the 2008 water year (WSC).

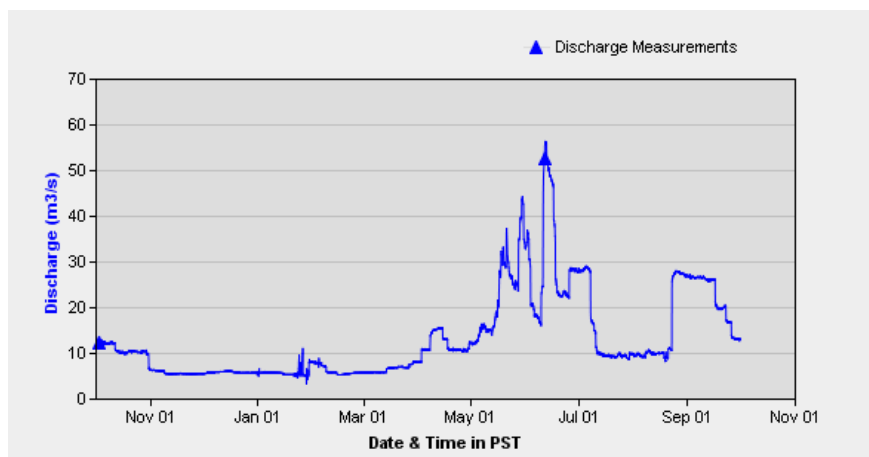


Figure 7: Mean daily discharge (m³/s) in the Okanagan River at Oliver (08NM085) during the 2008 water year (WSC).

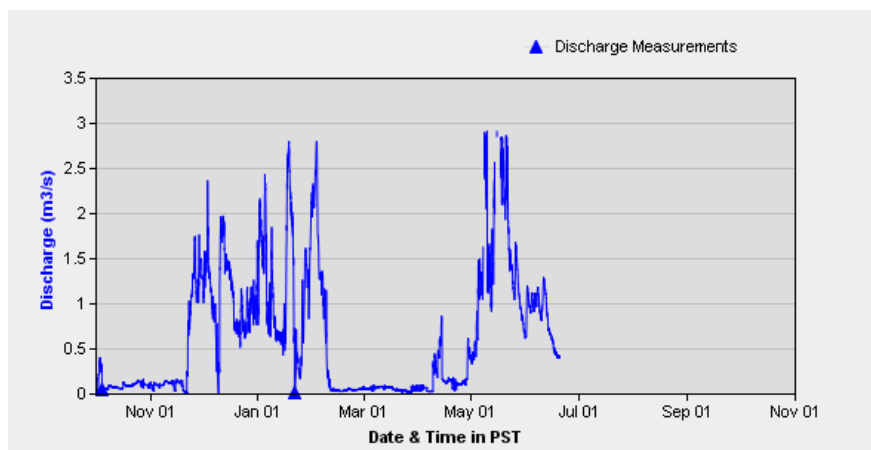


Figure 8: Mean daily discharge (m^3/s) at the mouth of Shuttleworth Creek (08NM149) during the 2008 water year (WSC).

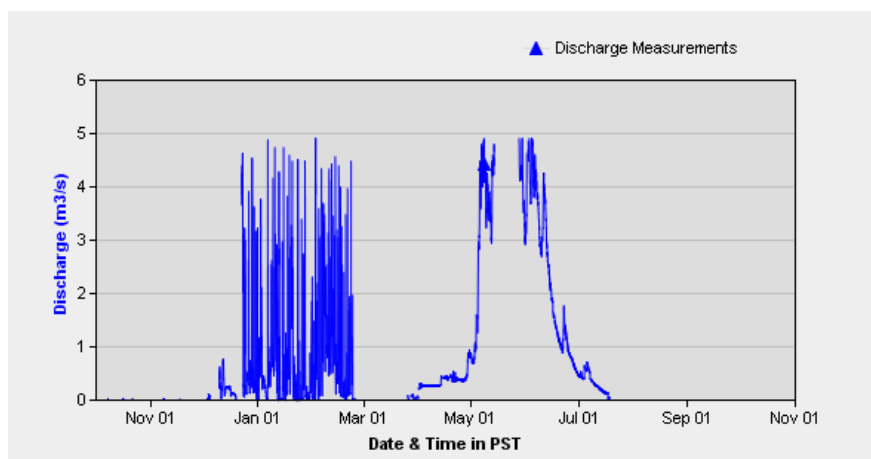


Figure 9: Mean daily discharge (m^3/s) at the mouth of Vaseux Creek (08NM246) during the 2008 water year (WSC).

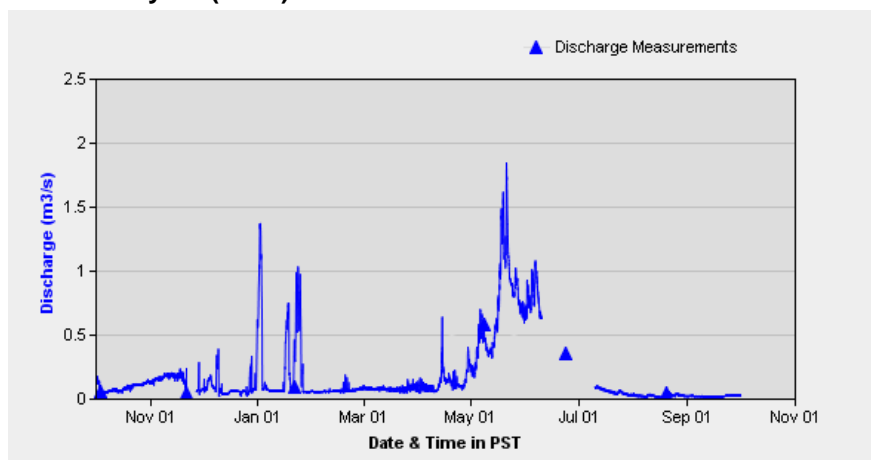


Figure 10: Mean daily discharge (m^3/s) at the mouth of Inkaneep Creek at the Mouth (08NM200) during the 2008 water year (WSC).

3.2.3 Water quality: temperatures

Water temperature loggers were deployed at all sites for this study year late in 2007. Downloads occurred in the spring and fall of 2008 (and or as necessary) to capture the 2007-2008 water year (Figures 11-14).

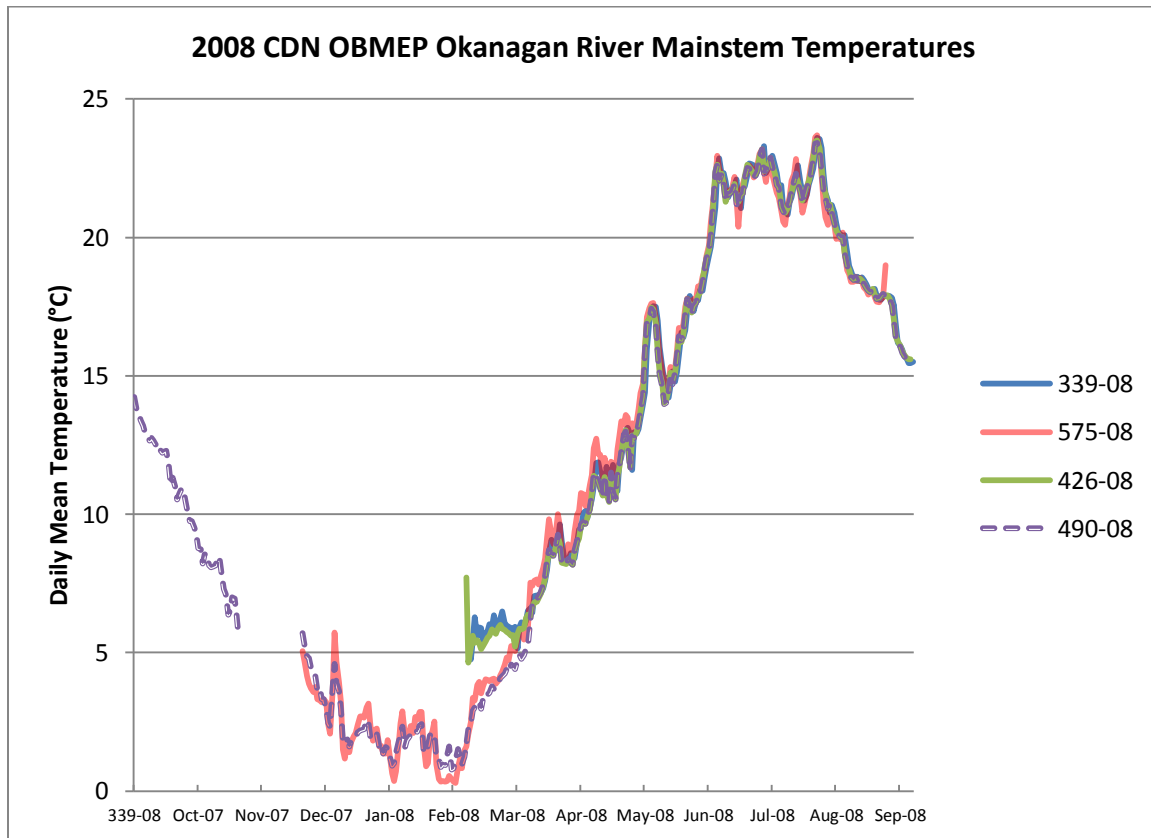


Figure 11: Mean daily river temperatures for the Okanagan mainstem sites 339, 575, 426, and 490 for the 2008 water year (493 has no recorded temperature data for this study period).

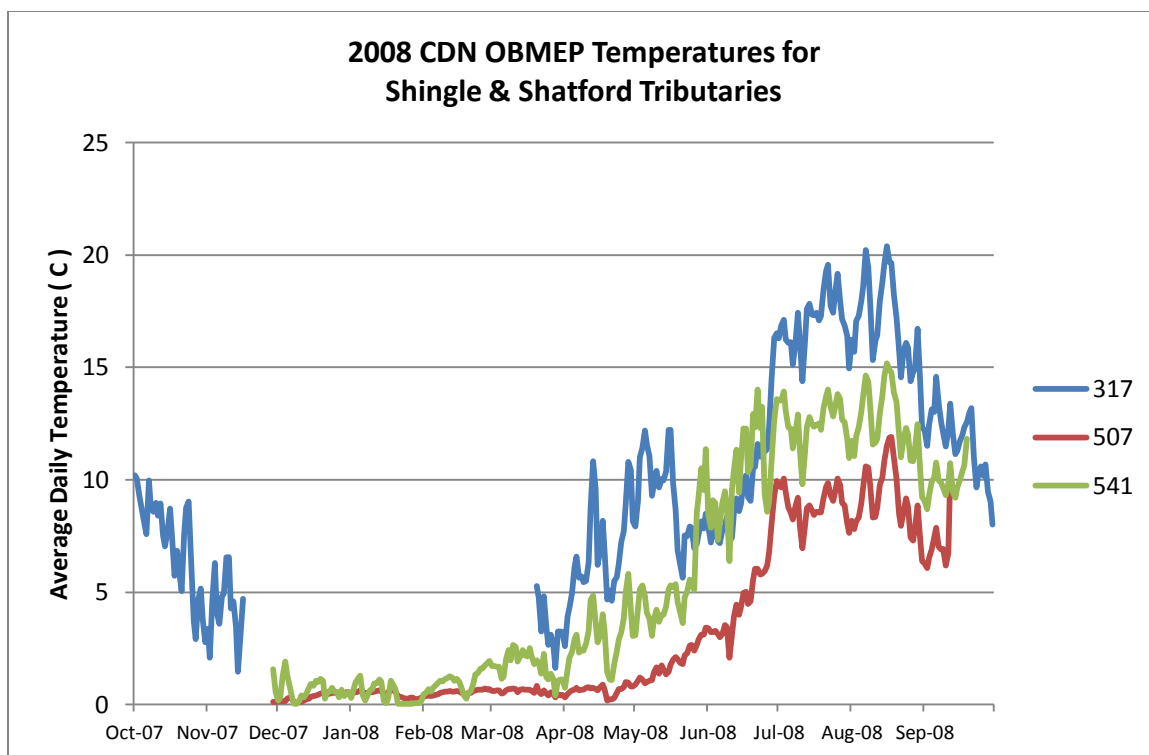


Figure 12: Mean daily stream temperatures for Shingle 317, 541, and Shatford 507 sites for the 2008 water year.

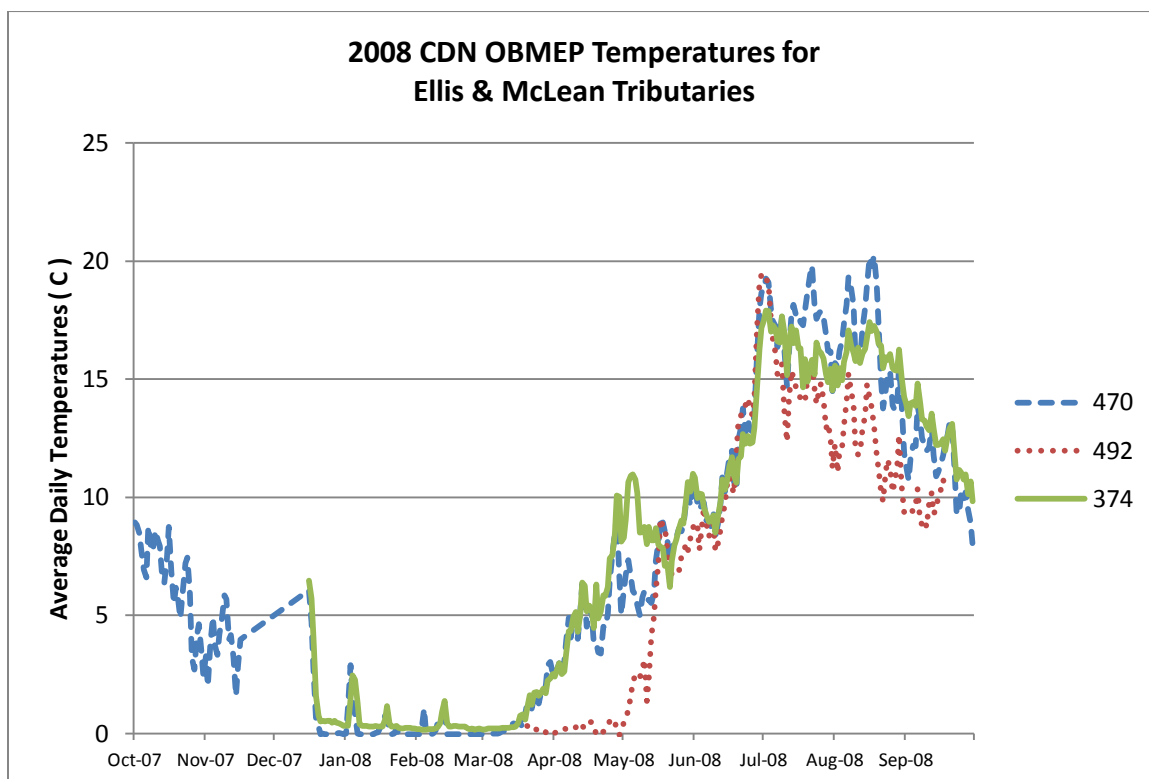


Figure 13: Mean daily stream temperatures for Ellis 470, 492, and McLean 374 sites for the 2008 water year.

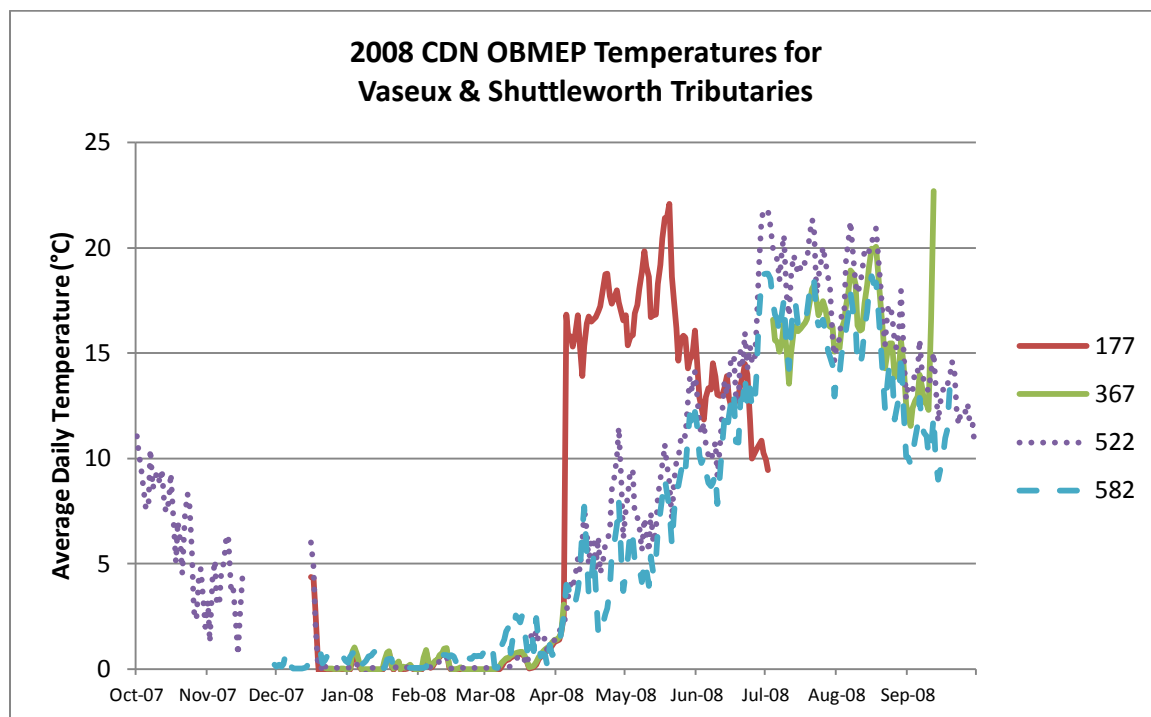


Figure 14. Mean daily stream temperatures for Vaseux 177, 367, Shuttleworth 522, and 582 sites for the 2008 water year.

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 24°C, with maximum daily temperatures reaching 23.6°C for 339, 23.7°C for 575, 23.5°C for 426, and 23.4°C for 490.

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 2008, peak spawning in the Okanagan River was October 14th for sockeye (Davis *et al.* 2010) and October 31st for kokanee (Mathieu *et al.* 2010). Mean temperatures in the Okanagan River⁶ for these dates were 12.6°C and 9.9°C, respectively.

3.3 Biological data

Snorkel surveys were conducted from August to September 2008 to document the presence and abundance of juvenile and adult salmonids as well as non-salmonids. Most of the mainstem surveys were conducted on August 11th, 2008 (with the exception of 575 done on August 13th), with five snorkelers. The average wetted width for all

⁶ Averaged for the Okanagan River OBMEP sites.

mainstem sites was 25 m with visibility conditions generally recorded between 2 and 3 m.

Most of the tributary surveys were conducted in September, with two to three snorkelers. The wetted width of the tributary sites ranged from 3.5 to 7.5 m with visibility conditions generally described as 1 to 2 m in distance.

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

4.0 DISCUSSION AND RECOMMENDATIONS

The 2008 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 2008 is currently not applicable because only four 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

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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 2008.

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	24.97	0.78	25.9	1.2	0.4	32.2	22.2	26.9	2.3	0.96	1.00	0.3
Okanagan 493	25.63	0.84	27.4	1.8	0.9	30.6	15.5	28.7	3.5	0.95	1.00	0.2
Inkaneep 535	4.22	0.20	6.5	0.8	0.6	21.2	8.1	7.7	1.6	0.84	1.14	0.1
Vaseux 177	8.12	0.23	14.4	0.9	0.7	35.5	15.8	25.0	1.8	0.57	1.60	0.4
Shuttleworth 522	5.01	0.13	7.6	0.7	0.6	39.5	10.9	11.3	1.4	0.68	1.41	0.2
Shingle 317	3.41	0.22	6.7	0.8	0.6	15.2	7.9	7.0	1.7	0.95	1.00	0.2
Ellis 470	5.70	0.24	8.2	0.7	0.5	23.6	11.2	8.6	1.5	0.95	1.00	0.1
McLean 374	2.56	0.19	4.4	0.7	0.5	13.8	6.5	6.6	1.4	0.67	1.32	0.1
Okanagan 339	23.33	1.35	25.1	1.9	0.5	17.2	13.2	26.3	3.8	0.95	1.00	0.1
Okanagan 575	29.21	1.42	30.7	2.1	0.6	20.6	14.6	32.1	4.2	0.95	1.00	0.1
Shatford 507	4.61	0.30	7.1	0.8	0.5	15.6	8.4	7.5	1.7	0.95	1.00	0.6
Shuttleworth 582	4.16	0.26	6.6	0.7	0.4	16.1	9.4	6.9	1.4	0.95	1.00	0.5
Vaseux 367	6.39	0.24	11.1	0.9	0.6	26.6	12.6	18.4	1.8	0.60	1.55	0.3
Ellis 492	3.70	0.26	4.9	0.7	0.4	14.1	6.6	5.1	1.5	0.95	1.00	0.2
Shingle 541	3.29	0.18	5.9	0.7	0.5	18.1	9.1	6.4	1.3	0.93	1.02	0.3
Okanagan 426	21.05	0.99	27.2	1.5	0.5	21.3	18.2	28.5	3.0	0.95	1.00	0.2

*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 2008 (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	0	15	85	0	0	2	0.87
Okanagan 493	0	0	0	100	0	0	0	0	0	0.00
Inkaneep 535	5	0	2	0	4	89	0	0	0	0.02
Vaseux 177	0	0	0	0	99	1	0	0	0	0.71
Shuttleworth 522	0	0	0	0	2	98	0	0	0	0.46
Shingle 317	7	0	0	0	93	0	0	0	0	0.00
Ellis 470	0	0	0	0	69	31	0	0	0	0.00
McLean 374	20	0	3	0	0	1	76	0	0	0.01
Okanagan 339	0	0	0	100	0	0	0	0	0	0.00
Okanagan 575	0	0	0	100	0	0	0	0	0	0.00
Shatford 507	0	4	0	0	55	3	0	38	0	0.00
Shuttleworth 582	9	0	5	0	79	7	0	0	1	0.03
Vaseux 367	0	0	0	0	99	1	0	0	3	6.60
Ellis 492	10	0	3	0	71	16	0	0	0	0.00
Shingle 541	12	0	5	0	48	34	0	1	0	0.00
Okanagan 426	0	0	0	0	3	97	0	0	1	2.04

*Last two columns not included in the overall habitat percentage

Appendix 5. Summary of habitat data collected from sites surveyed in 2008 (averaged for each site) continued.

EMAP Site Name & Number	Total Pools (%)	Total Riffles (%)	Pool/Riffle Ratio	Small LWD >0.1 m diameter & > 1 m length	Large LWD >0.1 m diameter & >2 m length	Fine Sediment (%)
Okanagan 490	0	100	0.00	22	46	66
Okanagan 493	100	0	0.00	0	0	65
Inkaneep 535	5	95	0.05	19	31	68
Vaseux 177	0	100	0.00	5	15	0
Shuttleworth 522	0	100	0.00	18	20	32
Shingle 317	7	93	0.08	5	4	44
Ellis 470	0	100	0.00	9	5	16
McLean 374	96	4	24.00	44	32	88
Okanagan 339	100	0	0.00	85	77	9
Okanagan 575	100	0	0.00	21	5	80
Shatford 507	4	96	0.04	36	75	19
Shuttleworth 582	9	91	0.10	4	10	20
Vaseux 367	0	100	0.00	1	9	10
Ellis 492	10	90	0.11	6	15	31
Shingle 541	12	88	0.14	17	36	55
Okanagan 426	0	100	0.00	10	60	84

Appendix 6. Summary of substrate data collected from sites surveyed in 2008 (averaged for each site).

EMAP Site Name & Number	Boulder (%)	Large Cobble (%)	Small Cobble (%)	Coarse Gravel (%)	Fine Gravel (%)	Sand (%)	Fines (%)	Wood (%)	Other (%)	% Embedded
Okanagan 490*	2	1	80	5	0	3	2	0	7	13
Okanagan 493	14	13	55	8	0	0	0	0	10	13
Inkaneep 535	0	13	37	17	1	11	9	4	8	12
Vaseux 177	10	32	45	5	0	5	1	0	2	29
Shuttleworth 522	2	10	53	10	0	0	11	3	11	35
Shingle 317	4	40	18	1	0	8	16	3	10	45
Ellis 470	7	40	32	2	1	1	4	5	6	29
McLean 374	0	0	15	7	1	7	46	7	17	60
Okanagan 339	2	0	26	20	0	42	1	7	1	43
Okanagan 575	1	0	23	47	0	10	0	0	19	1
Shatford 507	22	25	26	4	0	4	1	5	13	31
Shuttleworth 582	11	41	30	7	0	8	0	0	3	34
Vaseux 367*	19	46	25	6	0	4	0	0	1	26
Ellis 492	8	23	39	7	0	5	6	1	12	29
Shingle 541	13	18	37	6	0	3	10	6	6	30
Okanagan 426	7	22	54	6	0	5	1	0	3	15

*490 and 367 include side channel substrates

339 is missing one particle classification from the site data (very minimal error, could be data entry)

Appendix 7. Summary of riparian vegetation from sites surveyed in 2008 (averaged for each site).

EMAP Site Name & Number	Canopy Cover Reach (%)	Canopy Cover Bank (%)	Overstory Deciduous	Understory Deciduous	Overstory Coniferous	Understory Coniferous	Overstory Mixed	Understory Mixed	Overstory None	Understory None
Okanagan 490	19.0	57.1	64.3%	78.6%	0.0%	0.0%	0.0%	0.0%	14.3%	0.0%
Okanagan 493	8.4	25.1	50.0%	31.8%	0.0%	0.0%	0.0%	0.0%	50.0%	68.2%
Inkaneep 535	81.1	94.4	95.5%	86.4%	0.0%	0.0%	0.0%	0.0%	4.5%	13.6%
Vaseux 177	32.3	59.1	31.8%	59.1%	18.2%	9.1%	9.1%	22.7%	40.9%	9.1%
Shuttleworth 522	92.9	98.4	90.9%	77.3%	0.0%	0.0%	9.1%	22.7%	0.0%	0.0%
Shingle 317	63.8	78.1	63.6%	40.9%	0.0%	9.1%	36.4%	18.2%	0.0%	31.8%
Ellis 470	80.8	88.2	86.4%	86.4%	0.0%	0.0%	13.6%	0.0%	0.0%	13.6%
McLean 374	74.5	78.1	54.5%	86.4%	0.0%	0.0%	9.1%	4.5%	36.4%	9.1%
Okanagan 339	17.8	53.5	72.7%	100.0%	0.0%	0.0%	0.0%	0.0%	27.3%	0.0%
Okanagan 575	2.9	8.6	63.6%	100.0%	0.0%	0.0%	0.0%	0.0%	36.4%	0.0%
Shatford 507	92.3	98.1	9.1%	40.9%	0.0%	0.0%	90.9%	59.1%	0.0%	0.0%
Shuttleworth 582	65.1	80.5	36.4%	54.5%	4.5%	0.0%	50.0%	40.9%	9.1%	4.5%
Vaseux 367	22.8	52.4	13.3%	30.0%	6.7%	3.3%	30.0%	40.0%	23.3%	0.0%
Ellis 492	88.6	97.1	9.1%	45.5%	45.5%	0.0%	45.5%	54.5%	0.0%	0.0%
Shingle 541	99.5	99.2	40.9%	77.3%	9.1%	0.0%	45.5%	18.2%	4.5%	4.5%
Okanagan 426	29.4	69.5	31.8%	77.3%	0.0%	0.0%	0.0%	0.0%	68.2%	22.7%

Appendix 7. Summary of riparian vegetation from sites surveyed in 2008 (averaged for each site) continued.

EMAP Site Name & Number	Average Canopy Big Trees > 0.3 m DBH [*]					Average Canopy Small Trees <0.3 m DBH [*]					Average 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	50	36	14	0	0	41	32	18	9	0	0	55	36	9	0
Okanagan 493	77	18	0	5	0	68	32	0	0	0	68	32	0	0	0
Inkaneep 535	14	68	18	0	0	50	32	14	5	0	14	50	23	14	0
Vaseux 177	77	18	5	0	0	55	36	9	0	0	9	73	18	0	0
Shuttleworth 522	23	73	5	0	0	59	32	5	5	0	0	59	36	5	0
Shingle 317	5	59	36	0	0	18	55	27	0	0	32	64	5	0	0
Ellis 470	0	27	55	18	0	9	73	18	0	0	14	55	23	9	0
McLean 374	73	27	0	0	0	59	41	0	0	0	18	50	18	9	5
Okanagan 339	45	45	5	5	0	32	55	14	0	0	0	55	23	14	9
Okanagan 575	55	32	9	5	0	55	36	5	5	0	9	68	18	5	0
Shatford 507	0	27	55	18	0	0	45	50	5	0	0	95	5	0	0
Shuttleworth 582	36	32	27	5	0	45	50	5	0	0	5	59	27	9	0
Vaseux 367	59	41	0	0	0	50	50	0	0	0	0	45	45	9	0
Ellis 492	5	73	23	0	0	9	36	45	9	0	0	45	45	9	0
Shingle 541	27	64	9	0	0	23	68	9	0	0	5	91	5	0	0
Okanagan 426	68	32	0	0	0	100	0	0	0	0	23	32	27	14	5

* DBH = diameter at breast height

Appendix 7. Summary of riparian vegetation from sites surveyed in 2008 (averaged for each site) continued.

EMAP Site name & Number	Average Understory Non-Woody Herbs/Grasses/Forbs					Average Ground Cover Woody Shrubs/Saplings					Average 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	100	0	0	0	0	5	55	27	14	0	0	41	50	9	0
Okanagan 493	100	0	0	0	0	9	50	36	5	0	5	0	0	0	95
Inkaneep 535	100	0	0	0	0	5	68	23	5	0	14	55	27	5	0
Vaseux 177	100	0	0	0	0	9	36	27	23	5	41	55	5	0	0
Shuttleworth 522	95	0	5	0	0	0	5	14	64	18	0	55	36	9	0
Shingle 317	100	0	0	0	0	0	64	32	5	0	32	32	32	5	0
Ellis 470	95	5	0	0	0	0	59	32	9	0	27	59	14	0	0
McLean 374	64	27	0	9	0	5	18	14	41	23	5	14	27	45	9
Okanagan 339	9	50	41	0	0	5	82	14	0	0	0	64	36	0	0
Okanagan 575	0	41	59	0	0	9	91	0	0	0	0	59	32	9	0
Shatford 507	100	0	0	0	0	0	36	55	9	0	55	36	5	5	0
Shuttleworth 582	100	0	0	0	0	0	95	5	0	0	55	45	0	0	0
Vaseux 367	85	0	0	0	0	0	31	46	8	0	42	35	8	0	0
Ellis 492	100	0	0	0	0	0	27	59	9	5	5	64	27	5	0
Shingle 541	100	0	0	0	0	0	27	36	23	14	14	55	32	0	0
Okanagan 426	91	5	5	0	0	23	36	41	0	0	0	5	50	23	23

Appendix 7. Summary of riparian vegetation from sites surveyed in 2008 (averaged for each site) continued.

EMAP Site Name & Number	Average Ground Cover Barren Dirt/Duff					Average Ground Cover LWD				
	0%	<10%	10-40%	40-75%	>75%	0%	<10%	10-40%	40-75%	>75%
Okanagan 490	23	55	23	0	0	23	64	14	0	0
Okanagan 493	82	18	0	0	0	95	0	0	0	5
Inkaneep 535	5	68	9	0	18	9	50	41	0	0
Vaseux 177	14	18	14	23	32	50	32	14	5	0
Shuttleworth 522	95	5	0	0	0	32	45	18	5	0
Shingle 317	0	14	77	9	0	45	45	5	5	0
Ellis 470	0	27	41	23	9	50	45	5	0	0
McLean 374	59	36	0	5	0	18	59	14	9	0
Okanagan 339	9	50	32	5	5	32	36	18	14	0
Okanagan 575	14	45	41	0	0	86	14	0	0	0
Shatford 507	18	82	0	0	0	0	50	41	9	0
Shuttleworth 582	5	32	36	23	5	5	68	18	9	0
Vaseux 367	0	68	27	5	0	23	64	14	0	0
Ellis 492	27	55	14	5	0	5	73	18	5	0
Shingle 541	32	45	23	0	0	5	59	32	5	0
Okanagan 426	32	45	5	5	14	45	50	5	0	0

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2008 (averaged for each site).

EMAP Site Name & Number	Average Wall/Dike/Revetment/Riprap/Dam (%)				Average Buildings (%)				Average River access sites (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	14	0	0	86	0	5	0	95	23	0	5	73
Okanagan 493	86	0	0	14	0	5	23	73	59	41	0	0
Inkaneep 535	14	0	0	86	0	0	0	100	14	0	0	86
Vaseux 177	5	0	5	91	0	0	0	100	0	5	5	91
Shuttleworth 522	41	9	0	50	0	0	23	77	5	5	0	91
Shingle 317	0	0	0	100	0	5	0	95	36	0	0	64
Ellis 470	9	0	0	91	0	9	59	32	55	5	5	36
McLean 374	0	0	0	100	0	0	9	91	9	0	0	91
Okanagan 339	0	0	0	100	0	0	27	73	14	0	86	0
Okanagan 575	0	0	0	100	0	0	0	100	0	0	64	36
Shatford 507	0	0	0	100	0	0	0	100	0	0	0	100
Shuttleworth 582	0	0	0	100	0	0	0	100	0	0	0	100
Vaseux 367	0	0	0	100	0	0	0	100	0	0	0	100
Ellis 492	0	0	0	100	0	0	0	100	0	0	0	100
Shingle 541	0	0	0	100	0	0	0	100	50	0	0	50
Okanagan 426	14	0	0	86	0	0	0	100	0	0	0	100

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2008 (averaged for each site) continued.

EMAP Site name & Number	Average pavement/Road/railroad (%)				Average Pipes (inlet/outlet) (%)				Average Garbage Piles (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	0	5	36	59	5	0	0	95	0	0	0	100
Okanagan 493	0	36	18	45	14	0	0	86	27	14	5	55
Inkaneep 535	0	9	9	82	0	0	0	100	0	0	0	100
Vaseux 177	5	0	18	77	0	0	0	100	0	0	0	100
Shuttleworth 522	14	18	23	45	0	0	0	100	0	0	0	100
Shingle 317	0	0	5	95	0	0	0	100	9	0	0	91
Ellis 470	18	45	0	36	5	0	0	95	73	0	0	27
McLean 374	0	0	0	100	0	0	0	100	0	0	5	95
Okanagan 339	0	0	100	0	0	0	0	100	14	5	5	77
Okanagan 575	0	0	100	0	5	0	0	95	9	0	0	91
Shatford 507	0	0	0	100	0	0	0	100	0	0	0	100
Shuttleworth 582	0	0	0	100	0	0	0	100	9	0	0	91
Vaseux 367	0	0	0	100	0	0	0	100	0	0	0	100
Ellis 492	0	9	23	68	0	0	0	100	0	0	0	100
Shingle 541	0	9	18	73	0	0	0	100	5	0	0	95
Okanagan 426	0	0	36	64	0	0	0	100	0	0	0	100

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2008 (averaged for each site) continued.

EMAP Site Name & Number	Average Cleared lot/lawn (%)				Average Orchard/Row Crops (%)				Average pasture/range/Hay Field (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	0	14	0	86	0	5	5	91	0	0	0	100
Okanagan 493	0	14	86	0	0	0	0	100	0	0	0	100
Inkaneep 535	0	0	0	100	0	0	0	100	0	23	9	68
Vaseux 177	5	0	9	86	0	0	0	100	0	0	0	100
Shuttleworth 522	0	0	9	91	0	0	0	100	0	0	82	18
Shingle 317	0	0	0	100	0	0	0	100	0	0	0	100
Ellis 470	5	9	0	86	0	0	0	100	0	0	0	100
McLean 374	0	0	5	95	0	0	0	100	0	0	5	95
Okanagan 339	0	0	45	55	0	0	0	100	0	0	14	86
Okanagan 575	0	0	0	100	0	0	0	100	0	0	0	100
Shatford 507	0	0	0	100	0	0	0	100	0	0	0	100
Shuttleworth 582	0	0	0	100	0	0	0	100	0	0	0	100
Vaseux 367	0	0	0	100	0	0	0	100	0	0	0	100
Ellis 492	0	0	0	100	0	0	0	100	0	0	0	100
Shingle 541	0	0	0	100	0	0	0	100	100	0	0	0
Okanagan 426	0	0	0	100	0	0	0	100	0	0	0	100

Appendix 8. Summary of human influence characteristics collected from sites surveyed in 2008 (averaged for each site) continued.

EMAP Site Name & Number	Average Logging Operations (%)				Average Mining Activities (%)				Average Diversions (%)			
	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None	Bank	<10m	10-30m	None
Okanagan 490	0	0	0	100		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
Okanagan 339	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 575	0	0	0	100	0	0	0	100	0	0	0	100
Shatford 507	0	0	0	100	0	0	0	100	0	0	0	100
Shuttleworth 582	0	0	0	100	0	0	0	100	0	0	0	100
Vaseux 367	0	0	0	100	0	0	0	100	0	0	0	100
Ellis 492	0	0	0	100	0	0	0	100	0	0	0	100
Shingle 541	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan 426	0	0	0	100	0	0	0	100	0	0	0	100

Appendix 9. Summary of snorkel survey data for salmonids collected in 2008.

Site Name and Salmonid Fish Abundance 2008																
Size Class	Okanagan 490	Okanagan 493	McLean 374*	Inkaneep 535	Vaseux 177	Shuttle- worth 522	Shingle 317	Ellis 470	Okanagan 339	Okanagan 575	Shatford 507	Shuttle- worth 582	Vaseux 367	Ellis 492	Shingle 541	Okanagan 426
Salmonids	4	16	81	127	265	0	0	28	15	0	36	98	456	32	94	9
<100 mm	1	6	70	117	238	0	0	15	0	0	16	69	391	21	38	7
100 - 300 mm	3	8	11	10	27	0	0	13	15	0	18	25	65	9	9	0
>300 mm	0	2	0	0	0	0	0	0	0	0	2	4	0	2	47	2
Rainbow/Steelhead																
<100 mm	1		70	117	238			15			16	69	391	21	38	7
100 - 300 mm	3	6	11	10	27			13	1		18	25	65	9	9	
>300 mm											2	4		2		2
Brook Trout																
<100 mm																
100 - 300 mm																
>300 mm																
Sockeye																
<100 mm																
100 - 300 mm		2														
>300 mm		2														
Chinook																
<100 mm		6														
100 - 300 mm																
>300 mm																
Whitefish																
<100 mm																
100 - 300 mm									14							
>300 mm															47	
*McLean 374 snorkel data only available for the first half of the site													Total Salmonids			1261

Appendix 10. Summary of snorkel survey data for non-salmonids collected in 2008.

Site Name and Non-Salmonid Fish Abundance 2008																
Size Class	Okanagan 490	Okanagan 493	McLean 374*	Inkaneep 535	Vaseux 177	Shuttle- worth 522	Shingle 317	Ellis 470	Okanagan 339	Okanagan 575	Shatford 507	Shuttle- worth 582	Vaseux 367	Ellis 492	Shingle 541	Okanagan 426
Non-Salmonids	441	69	0	2	0	0	432	442	424	64	0	0	12	0	0	214
<100 mm	437	26	0	2	0	0	432	439	55	30	0	0	11	0	0	169
100 – 300 mm	3	32	0	0	0	0	0	3	285	23	0	0	1	0	0	37
>300 mm	1	11	0	0	0	0	0	0	84	11	0	0	0	0	0	8
Bass																
<100 mm	68	18							54	30						167
100 – 300 mm	2	26							32	21						34
>300 mm		1							9	1						
Suckers																
<100 mm		7														
100 – 300 mm		6							253							3
>300 mm		5							24	1						1
Carp*																
<100 mm																
100 – 300 mm																
>300 mm	1	5							51	2						7
Dace*																
<100 mm				2			430	439					11			
100 – 300 mm								3					1			
>300 mm																
Minnows*																
<100 mm	368						1									1
100 – 300 mm																
>300 mm										7						
Sculpins																
<100 mm	1	1					1									1
100 – 300 mm	1															
>300 mm																
Unidentified/Other																
									yellow perch	peamouth*						
<100 mm									1							
100 – 300 mm										2						
>300 mm																
*Carp, Dace, Minnow and Peamouth all part of the larger Minnow Family Cyprinidae															Total Non - Salmonids	
															2100	