Okanagan Basin Monitoring and Evaluation Program (OBMEP) 2005 Annual Report for Sites in Canada

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Project Background

The purpose of the Okanagan Basin Monitoring and Evaluation Program (OBMEP) is to monitor over 20 years the status and trends of components such as physical habitat condition, water quality and quantity, and juvenile and adult fish production in the Okanagan sub basin (CCTFWD 2005). The Colville Confederated Tribes (CCT) initiated the OBMEP program in 2004[1]. In 2005, the CCT coordinated with the Okanagan Nation Alliance (ONA) to begin collecting data in the Canadian Okanagan sub basin.

The OBMEP study structure and methods were adapted from the Monitoring Strategy for the Upper Columbia Basin (Hillman 2004). Monitoring the status and trends of fish and their habitat involves,

- Documenting existing conditions i.e. current status of populations and/or environmental conditions and,
- Quantifying changes over time i.e. is there a statistically significant difference over time in abundance, survival, timing, and life history characteristics of summer/fall, spring chinook, sockeye and steelhead or a statistically significant difference over time in the selected physical habitat parameters and characteristics?

Status and trend data will,

- Help identify issues that require further experimental research to understand cause and effect relationships,
- Aid in effectiveness monitoring of management actions performed on streams i.e. did the stream restoration project result in a change in abundance of juvenile salmon?

Thus OBMEP will help to guide restoration and adaptive management with the long-term collection of data.

The Canadian Okanagan sub basin study area was determined based on the current presence of anadromous salmon species, which traditionally occupied the entire Okanagan valley (Ernst 2000). Dams exist at the outlet of all main stem lakes in the Okanagan basin including Okanagan, Skaha, Vaseux and Osoyoos lakes. The Vaseux Lake Outlet Dam, herein referred to as McIntyre dam, is considered the upper migration limit for chinook (*O. tshawytscha*), steelhead (*O. mykiss*) and sockeye (*O. nerka)* salmon. Two other dams - the Skaha Lake Outlet Dam and the Okanagan Lake Outlet Dam - exist further upstream on the Okanagan River. With the experimental re-introduction of sockeye salmon into Skaha Lake[2] their range has been extended to below the Okanagan Lake Outlet Dam in Penticton, BC. Therefore, under the mandate

[1] In 2004, the CCT performed site documentation on Canadian sites Inkaneep (535) and Vaseux (177) creeks, however no status data was collected.

[2] Re-introduction of sockeye salmon into Skaha Lake commenced in 2003 with the release of 352,000 fry.

of OBMEP, the study area in Canada extends from the Okanagan Lake Outlet Dam, south to the US border (Fig. 1).

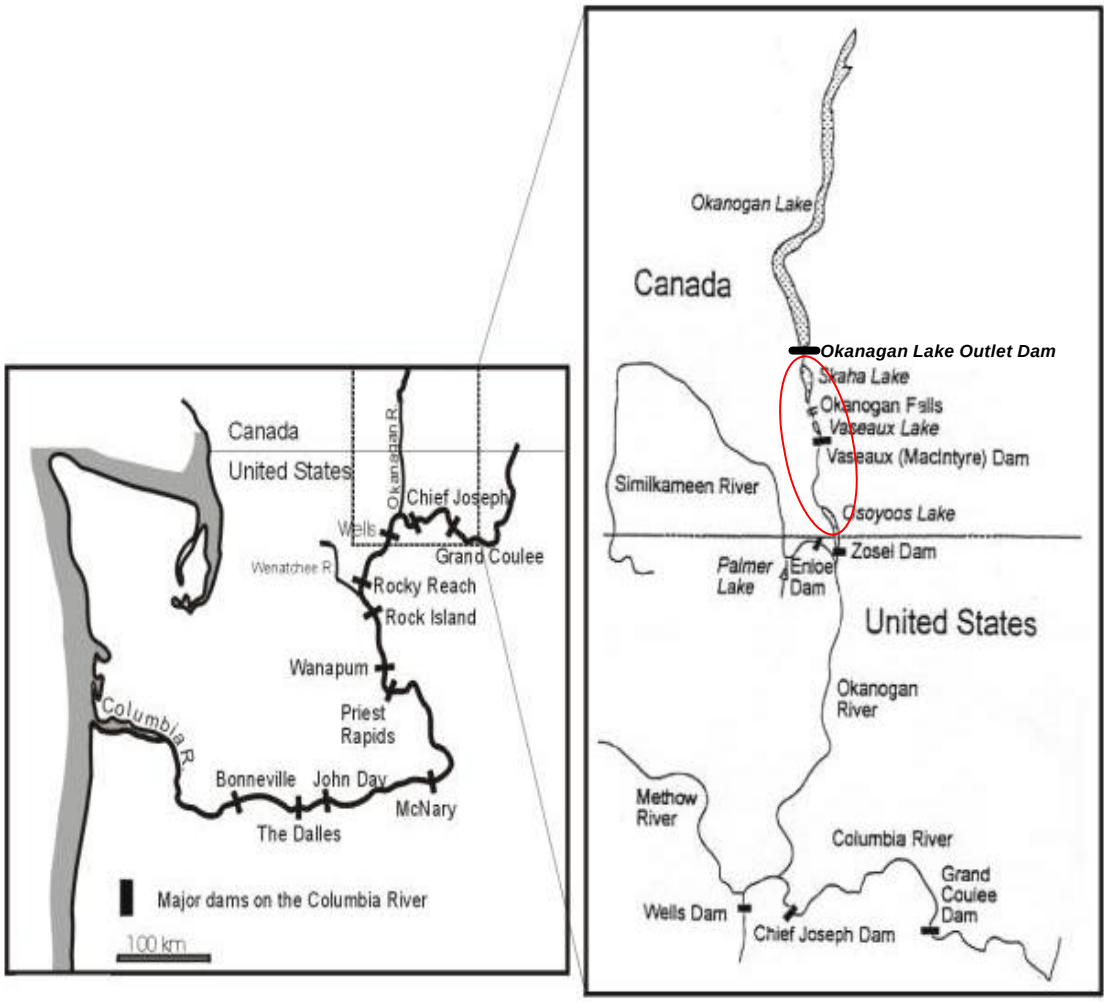

Figure 1. OBMEP study area in Canada.

1.2 Study Objectives

The OBMEP program in Canada requires a total of 48 stream sites[3] be surveyed over 20 years. The 48 sites are divided into one annual panel and five rotating panels, each panel consisting of eight sites. The annual panel is surveyed yearly and one rotating panel is surveyed every five years commencing in 2005. Each year, 16 sites will be surveyed, consisting of one annual and one rotating panel.

Status and trend data collection will include physical habitat, water quality and quantity, and biological components.

[3]As defined in Section 2.1

The primary objectives for the Canadian OBMEP program in 2005 were to,

- Select the 48 sites for the OBMEP program in Canada (and eight extra sites) and group into one annual and six rotating panels consisting of eight sites each,
- Produce the 20-year site survey schedule for the OBMEP study,
- Survey the physical habitat conditions in the annual and rotating panel sites following standard field protocols,
- Set up permanent water stations measuring water quantity and quality in Shuttleworth, Vaseux and Inkaneep creeks and,
- Survey the existing juvenile and adult fish production in the annual and rotating panel sites following standard field protocols.

2.0 METHODS

2.1 Site Selection

The monitoring of status and trends of fish and their habitat in OBMEP requires temporal and spatial replication, and probabilistic sampling (Hillman 2004) of stream reaches. Stream 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) design, as adapted from Hillman (2004). 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 site and consist of a reach of creek.

Prior to selecting the OBMEP sites, barriers to anadromous fish migration were documented to determine the current range of anadromous fish (Walsh and Long 2006, unpubl.). 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 1a). Reaches upstream of barriers were included as they are a source of water, nutrients, and substrate.

Prior to data collection, the sites will be verified in the field to ensure they are practical and feasible to survey. If the sites cannot be surveyed for these reasons they can be replaced with sites in the extra panel.

2.2 Field Protocol

Randomly selected reaches located on a stream can be used to measure changes in the status and trends of habitat, water quality, and biota over time if implemented in a scientifically rigorous manner per specific protocols (Arterburn et al. 2004).

The CCT Fish and Wildlife Department developed two field-sampling protocol manuals employed in the Okanagan sub basin, based upon Hillman (2004). The manuals include one for the collection of physical habitat data (Arterburn et al. 2004) and one for the biological collection of data (Arterburn et al. 2005). A brief description of the protocols are included below.

In general, the OBMEP survey consists of laying out transects within the study site, documenting the study site, and collecting both physical habitat and biological data related to anadromous salmon. Habitat and biological surveys of sites were conducted from July to September of 2005.

Dividing the stream reach into transects creates defined increments for measuring habitat characteristics and changes (Arterburn et al. 2004). The site was first located with GPS coordinates provided for all of the EMAP sites supplied by CCT. Once the GPS coordinate of the site was located, a rebar marker was placed to designate this location as the center point of the site. Each site consists of a reach of the stream whose total length was determined based on the average of five bankfull width measurements multiplied by ten. The reach was then divided into ten equally spaced transects, flagged and labeled consecutively with letters 'A' through 'K', with the center point as the middle transect 'F'. 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 was also placed at transects 'A', and 'K' as a permanent marker of the site reach.

Consistency in site locations (and data collection) is important to the goals of the OBMEP study. To assist in accurately locating the sites in the future, site documentation was performed. Site documentation consisted of recording the GPS location of the center, upper- and lower-most transects[4], photo-documenting the stream, and a description of the site (i.e. landmarks).

2.21 Physical Habitat Surveys

A crew of two collected and recorded the physical habitat data in 2005 in order to maintain consistency. 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 even finer scaled transects. In addition, environmental conditions during the habitat survey were recorded. The physical habitat measurements, their units, and a short description are summarized in Appendix 1b.

In streams too deep to wade safely, a small, inflatable boat was used to retrieve thalweg depths, water depths, substrate compositions, and densitometer readings. A climbing

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

rope was strung across the width of the river, and anchored to landscape entities (trees) or held by crew members on each bank[5]. A pulley connecting the boat to the rope allowed movement of the dinghy across the water.

Water quantity data (discharge) was obtained from the Water Survey of Canada (WSC) real-time hydrometric stations website accessible by the public (WSC 2005). Water quantity measurements include water velocity, water levels, discharge, and temperature from three stations operating within the OBMEP study area. Active WSC stations are located on the Okanagan River at Okanagan Falls, Penticton, and Oliver; only one tributary, Vaseux Creek above Solco Creek, has an active station. It is important to note that the Solco drainage area (117 km^2) comprises 40% of the total Vaseux drainage area (299 km^2) (Long et al. 2006). Mean monthly discharge data for 2004 are reported to initiate baseline data collection. Background information will include mean monthly discharge data available from year 1915 to present. Real-time water discharge and temperature stations are being installed on Inkaneep, Shuttleworth, and Vaseux creeks, and data collection will commence in February of 2006.

Water quality data (temperature) was collected using Onset Computer Corporation Optic StowAway® temperature loggers. Loggers were launched using Onset Computer Corporation BoxCar® Pro 4.0 software and the data-recording interval was set at two hours. One temperature logger was installed at each of the 2005 OBMEP sites during the habitat survey. The loggers were housed in aluminum piping to protect it from damage. The logger was then placed within the active channel representative of the site and secured to a landscape entity (tree) with aircraft cable. The installation date and a site description (i.e. transect and bank) was recorded. Loggers were retrieved after 8 to 14 weeks and the temperature data downloaded. Daily temperatures were averaged (to the first decimal) per site and plotted over time with sites from similar locations[6].

2.2.2. Biological Surveys

Biological surveys, using snorkeling methods, were conducted to identify, enumerate, and classify salmonids and non-salmonids into length categories. Biological surveys were to be performed within two weeks of the site physical habitat survey. Equipment included snorkel and mask, timer, wet suits, and rubber soled boots. Snorkel surveys commenced at the upstream end of the study site and ended at the downstream end of the site. Data collection was recorded per transect (A to K) and included the start and end times, species (for salmonids), family (for non-salmonids), the number of fish of each species or family, and the length category (<100mm, 100-300mm, or >300mm) (Table 1). The underwater visual distance, average wetted width, stream temperature and environmental conditions were also recorded. The crew numbers for the snorkel surveys were dependent on the underwater visual distance. Crew members would snorkel downstream in a straight line across the wetted width of the stream and spaced apart by the underwater visual distance.

[5] A third crew member is required in the latter situation

[6] 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).

Table 1. Description of the biological measurements collected.

Measurement	General Description	Methods	Units
Fish species	Salmonids are identified to species and non-salmonids are identified to family	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 2005, all of the five Okanagan River site snorkel surveys were conducted on one day with the same crew of five. A crew of two conducted the remaining 11 sites.

To collect biological data in streams too shallow to snorkel, crew members modified the protocols to slowly walking side by side and using sticks to disturb pools and rock crevices in the stream to startle any fish into visible range. The modified survey method was employed in Haynes (471), Park Rill (88), Testalinden (375), and Shuttleworth (522) creeks[7].

Steelhead/rainbow trout enumeration data for 2005 is also included as background information

2.3 Data Collection & Processing

Two methods of data recording were utilized, data sheets and electronic entry. Electronic data entry was performed using a Trimble® GeoExplorer® Series GeoXM pocket PC. However due to technical problems with the electronic software, the majority of data was recorded on data sheets.

The Trimble® device uses TerraSync™ Version 2.50 software to collect and record GPS positions. The Trimble was used to record GPS coordinates during the site documentation and physical habitat data. Habitat data collection templates were programmed onto the Trimble® unit by CCT and contained the same information as the field data sheets.

Electronic data was transferred and processed using GPS Pathfinder® Office 3.0 software. The GPS data collected by the Trimble® device's GPS receivers is subject to errors (satellite clock errors, orbit errors, and atmospheric noise) and was corrected using differential correction. After GPS correction, the electronic data was sent to CCT where it was converted into Microsoft (MS) Excel format and returned to the ONA for further processing using MS Excel.

OBMEP data will be incorporated into a database in future years.

[7] Bracketed numbers represent the EMAP site number.

3.0 RESULTS

3.1 Study Sites & Map

The 48 OBMEP sites in the Canadian Okanagan sub basin, in addition to eight extra sites, are selected and mapped (Figure 2). The sites were grouped into one annual and five rotating panels (plus an extra panel) each consisting of eight sites. The OBMEP sites in rotating panels two to five were not verified in the field. The schedule of site surveys to be performed over the 20-year OBMEP program is detailed in Appendix 2.

A total of 16 sites were selected and evaluated (Table 2). The sites and their location are mapped in Figure 2; they include five Okanagan River main stem sites, and nine tributary sites.

Table 2. EMAP sites surveyed in 2005 for the OBMEP study in the Canadian Okanagan sub basin. The rotating panel will be surveyed once every five years, commencing in 2005.

Annual Panel 2005:

Stream	Site No.
Okanagan River	490
Okanagan River	493
Haynes Creek	471
Inkaneep Creek	535
Vaseux Creek	177
Shuttleworth Creek	522
Shingle Creek	317
Ellis Creek	470

Rotating Panel Sites 2005:

Stream	Site No.
Okanagan River	371
Okanagan River	503
Okanagan River	415
Testalinden Creek	375
Reed Creek	567
McLean Creek	374
Park Rill Creek	88
Shingle Creek	593

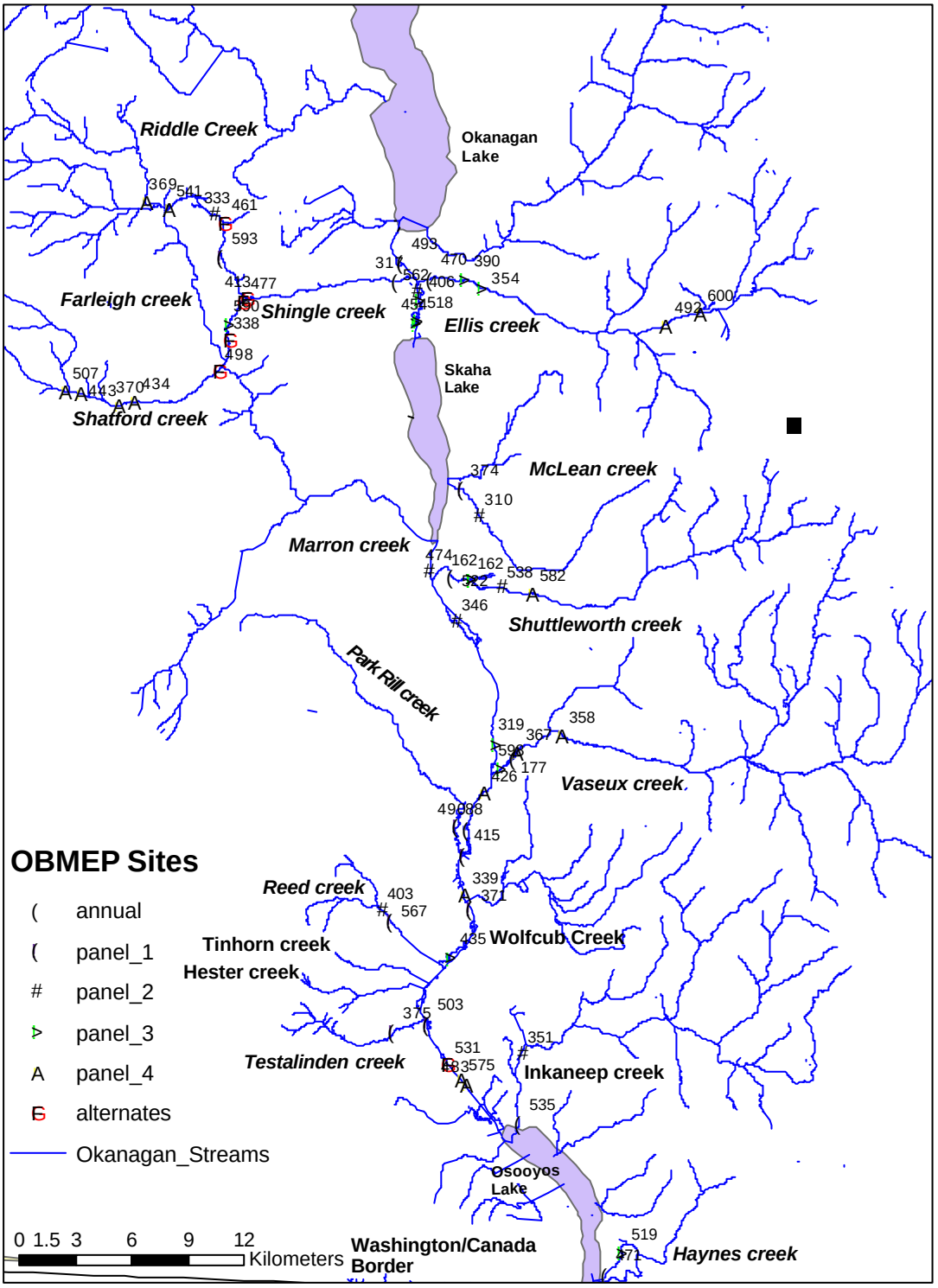

Figure 2. EMAP sites for the OBMEP program in the Canadian Okanagan sub basin for the 20-year program. The map displays the annual and five rotating panel sites in addition to a sixth extra panel of alternate sites lest some sites are impractical to survey. In 2005, the annual and panel 1 sites were surveyed.

3.3 Physical Data

3.3.1 Physical Habitat Inventory

Physical fish habitat data was collected for the 16 OBMEP sites for 2005. The data has been categorized into stream depth characteristics (Appendix 3), habitat type (Appendix 4a, 4b), substrate characteristics (Appendix 5), riparian vegetation (Appendix 6), and human influence characteristics (Appendix 7a, 7b, 7c, and 7d).

3.3.2 Water Quantity: Discharge

The mean monthly discharge (m^3/s) for the four hydrometric since 1915 is summarized in Figure 3. Peak discharges typically occur from May to July.

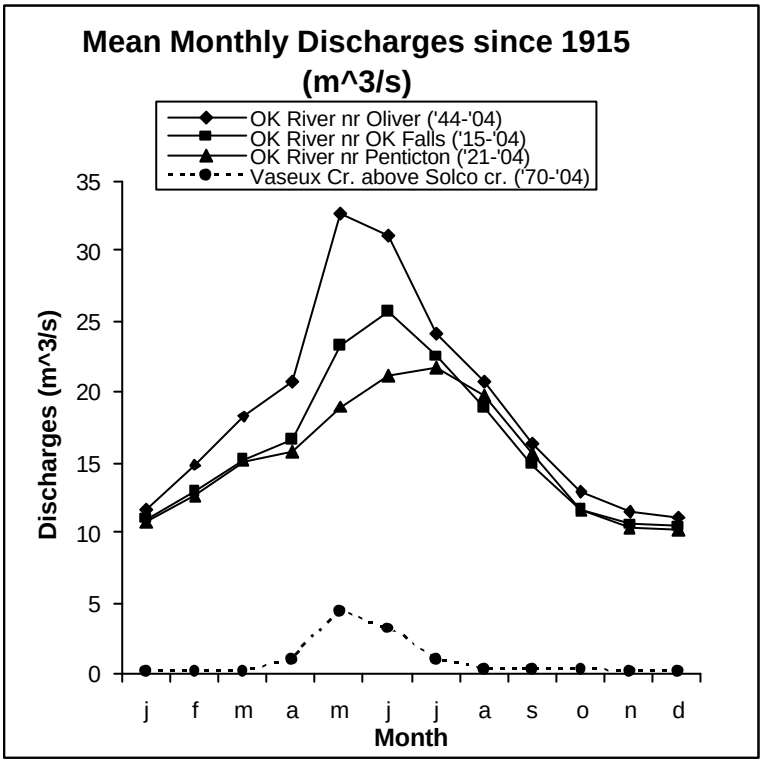

Figure 3. Mean monthly discharges (m^3/s) for four real-time hydrometric stations in the Okanagan sub basin. The longest data set is from 1915 to 2004. Data provided by the Water Survey of Canada (WSC).

Discharge rates for 2005 are not yet available. However mean monthly discharge rates for 2004 are depicted in Figure 4. Water levels are not the natural hydrograph as the discharges are controlled at the Okanagan Lake Outlet Dam in Penticton with lake level modification made at the Skaha Lake Outlet dam in OK Falls and McIntyre Dam at the outlet of Vaseux Lake (Symonds 2000). The Vaseux Creek average discharge for 2004 was almost identical to previous years, peaking in May and maintaining very low discharge rates throughout the rest of the year.

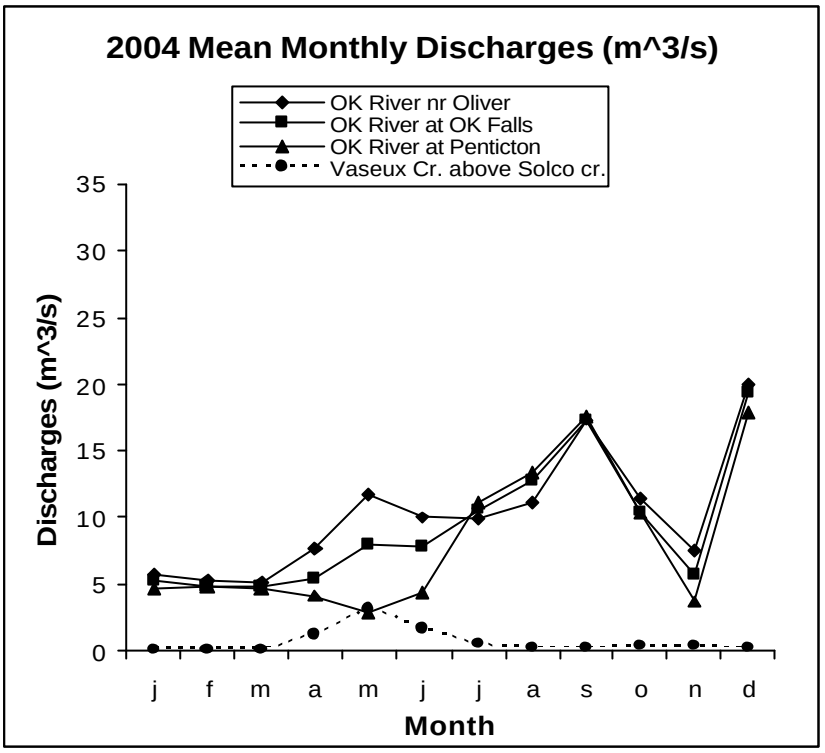

Figure 4. Mean monthly discharge (m^3/s) for 2004 for four real-time hydrometric stations in the Okanagan sub basin. Data is provided by the Water Survey of Canada (WSC).

3.3.3 Water Quality: Temperatures

Temperature loggers were installed at 15 of the 16 study sites between August 11th and November 17th, 2005. Loggers were installed during the habitat survey and downloaded (and re-installed for annual sites only) in the fall. Temperature data is not available from the Shingle Creek site (593) or the Shuttleworth Creek site (522). A temperature logger was installed in Reed Creek (567); however the creek remained dry the entire time so no stream temperatures are available.

Stream temperatures documented for the five Okanagan River main stem sites show very similar warming and cooling trends, starting off at high temperatures (19-23°C) during mid August to early September, and decreasing to lows between 5-8°C in November (Figure 5). The temperatures do not fluctuate significantly, however a significant decrease occurs twice for site number 493 from mid to late October.

Temperatures equal to or greater than 20°C occurred in Okanagan River main stem site numbers 493 and 490 for 23 and 22 days, respectively. For site 493 these high temperatures occurred from August 17th to September 8th, 2005 and for site 490 they occurred from August 13th to September 3rd, 2005.

Chinook salmon parr display optimum growth and feeding at 19°C (Groot & Margolis 1991) and prefer temperatures from 12°C to 14°C (Brett 1952). The upper lethal temperature for chinook fry is 25.1°C (Brett 1952). After Kamloops trout fingerlings were

acclimated at 11°C in laboratory studies, their upper lethal temperature was 24°C (Black 1953). For 2005, stream temperatures in the Okanagan River did not exceed lethal temperatures for chinook salmon or rainbow trout.

Kokanee generally spawn from September to October over temperatures from 10.5°C to 5.0°C (Scott & Crossman 1998). Anadromous sockeye can spawn from July to December at 3°C to 7°C (Scott & Crossman 1998). In 2005, peak of spawn in the Okanagan River was October 19th for sockeye (Audy & Long 2006, unpubl.) and October 24th for kokanee (Walsh and Long 2006, unpubl.). Mean temperatures in the Okanagan River[8] for these dates were 12.3°C and 12.0°C, respectively.

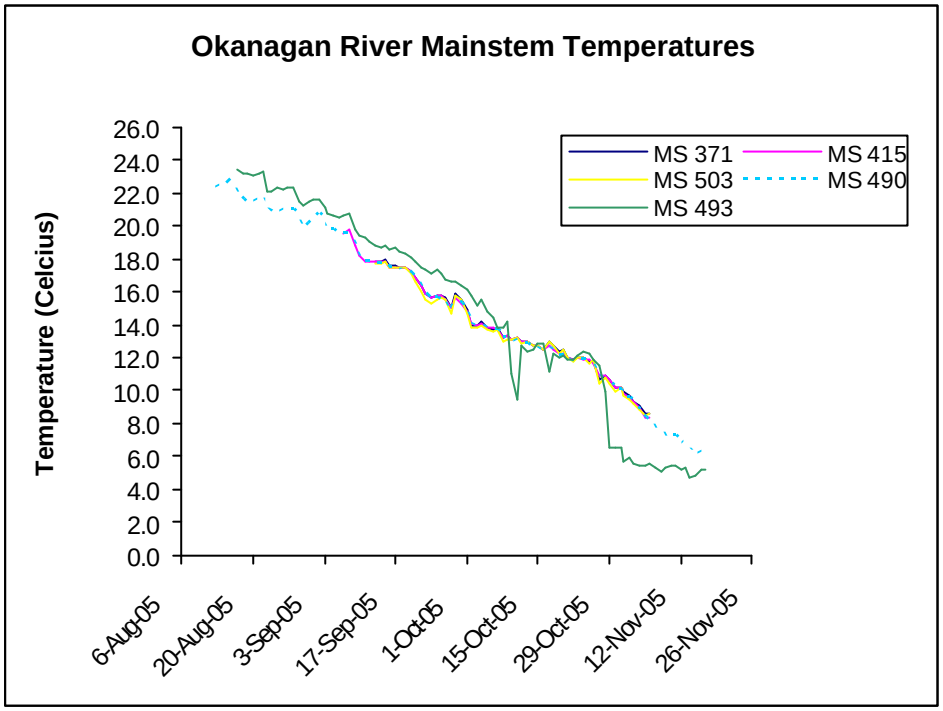

Figure 5. Daily average stream temperatures (°Celcius) for five Okanagan River main stem sites over various periods of time.

The three northern tributaries, Ellis (470), Shingle (317), and McLean (374) demonstrate very similar daily mean temperatures, commencing at 17-18°C in late August and reaching lows of 1-5°C in late November (Figure 6). In contrast to the main stem sites, these tributaries experience more fluctuations in temperatures throughout the study, up to 4°C difference in a matter of 3-4 days. These tributaries may offer preferred water temperature refugia for salmon during the months of August and September when the Okanagan River main stem temperatures reach near lethal levels.

[8] Averaged for the five Okanagan River OBMEP sites.

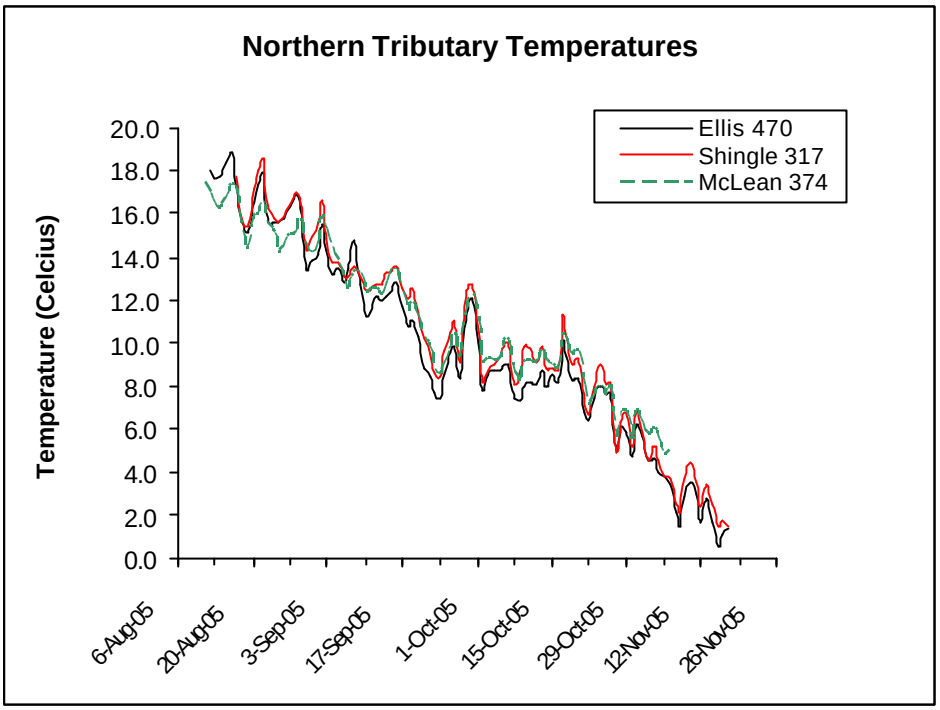

Figure 6. Daily average stream temperatures (^{o}Celcius) for three tributaries of the Okanagan River in the northern region of the habitat study area. The temperature data vary in duration.

The four southern tributaries also display fluctuations in daily mean temperatures, per 3-4 days, compared to the main stem sites (Figure 7). Initial temperatures are 14.3-15.6^{o}C during mid August and reached lows of 0.7 - 5.9^{o}C during mid November. Again, these tributaries may offer preferred water temperature refugia to salmon in the Okanagan River during August and September where the temperatures are greater than optimum for salmon.

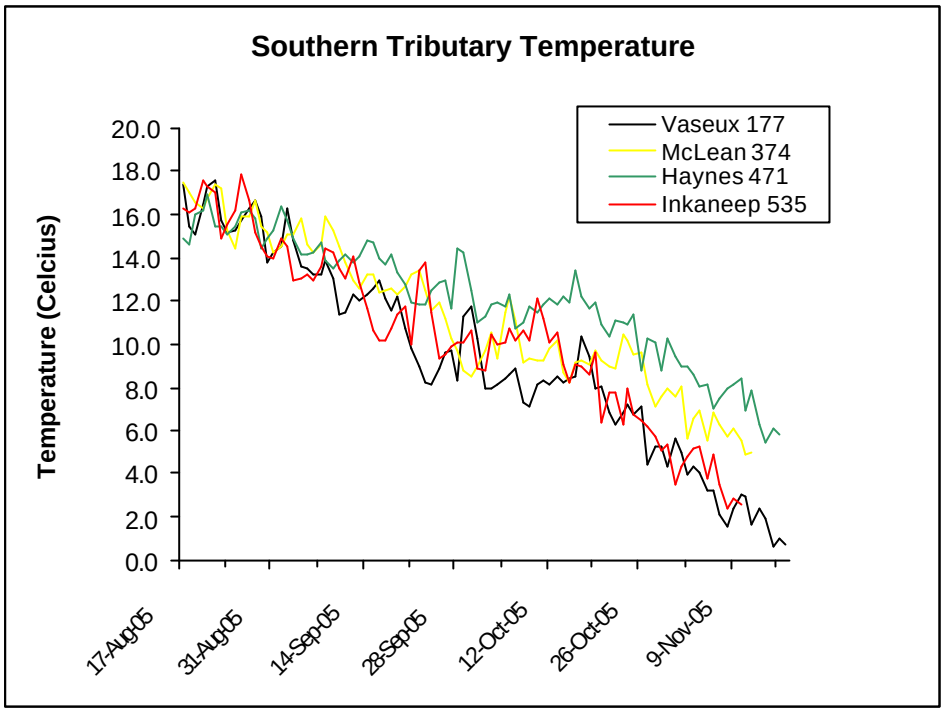

Figure 7. Average daily stream temperatures (°Celcius) for four tributaries of the Okanagan River located in the southern region of the habitat study area. The temperature data vary in duration.

3.4. Biological Data

Biological surveys for the 16 study sites were conducted to estimate the density of juvenile and adult salmonids as well as non-salmonids between August 18th and September 29th, 2005. The biological survey results are summarized in Appendices 8a and 8b. A snorkel survey for the Okanagan River main stem (415) was performed however the data is not available. Reed Creek (567) was dry and therefore no fish were present.

A steelhead/rainbow trout redd survey and enumeration was also conducted in 2005 (Long 2005) (Appendix 9). No steelhead/rainbow trout were observed in the Okanagan River or Vaseux Creek; but two redds were observed in the latter. In Inkaneep Creek, 38 steelhead/rainbow trout were observed.

4.0 DISCUSSION AND RECOMMENDATIONS

Overall, this year's anadromous salmon physical habitat and biological study in the Canadian Okanagan sub basin was a success. The objectives identified were achieved. The field crew was kept consistent and able to quickly master field protocol techniques.

Data collection and recording was mostly complete with only a few incidents in which data was either, not collected in the field due to environmental conditions, or compromised by technical difficulties. These problems are relatively minor.

Recommendations for future years include,

- Test the Trimble® data collection unit prior to the OBMEP study,
- Waterproof the field equipment (i.e. Trimble, laser ranging instrument)
- Verify OBMEP sites in panels two to six are practical and feasible,
- Perform biological survey of Okanagan River main stem sites in one day if possible,
- Continue to have a consistent crew of at least 2,
- Include standardized protocol for biological surveys in streams too shallow to snorkel,
- Use hand-counters during the biological survey and,
- Continue to provide land owners with information sheets detailing the study and survey schedule.

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Appendix 1a. Summary of the OBMEP sites in the Canadian portion of the Okanagan sub-basin to be monitored and evaluated over the 20-year study. An additional panel of alternate (extra) sites is included if any of the Panels 1 to 5 cannot be surveyed.

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
Haynes 471	Okanagan River415	Okanagan River 474	Okanagan River 319
Inkaneep 535	Testalinden 375	Okanagan River 346	Haynes 519
Vaseux 177	Reed 567	Reed 403	Ellis 390
Shuttleworth 522	McLean 374	Inkaneep 351	Okanagan River 518
Shingle 317	Park rill 88	Shuttleworth 538	Shuttleworth 364
Ellis 470	Shingle 593	McLean 310	Vaseux 598

Panel 4 (2008)	Panel 5 (2009)	Extra Panel
Okanagan River 339	Shingle 569	Shingle 461
Okanagan River 575	Okanagan River 383	Shatford 338
Shatford 507	Okanagan River 323	Shingle 477
Shuttleworth 582	Testalinden 547	Okanagan River 531
Vaseux 367 Ellis 492	Okanangan River 467 Marron creek 514	Ellis 530 Shuttleworth 394
Shingle 541	Okanagan River 406	Wolfcub 543
Okanagan River 426	Farleigh creek 565	Marron Creek 450

Appendix 1b. OBMEP physical habitat measurements collected and recorded in the field. Units are measured to the nearest 0.1m where applicable.

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	Depth of water measured from the surface to the channel bottom when the water surface is even with the top of the streambank *	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 <16mm 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 >0.1m in the active channel or spanning the channel	n/a	no. of pieces of each length category (>1m or >2m)
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

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

Appendix 2. The schedule of OBMEP survey events for the 20-year program. Sites are located in the Canadian Okanagan sub basin. 'X' denotes a physical and biological survey will be performed.

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

Appendix 3. Summary of stream depth measurements collected in 2005, averaged over each site[9].

EMAP Site Name & Number	Average Wetted Width (m)	Average Thalweg Depth (m)	Average Bankfull Width (m)	Average Bankfull Depth (m)	Average Bankfull Height (m)	Average Wetted Width/ Thalweg Depth	Average Bankfull Width/Bank-full Depth Ratio	Average Flood prone Width (m)	Average Flood prone Depth (m)	Entrenchment Ratio (Bankfull width/Flood prone width)	Average Gradient (%)
Okanagan River 490	26.3	0.83	28.5	1.2	0.4	33.6	24	62.7	2.4	2.2	N/A
Okanagan River 493	26.2	0.82	28.6	2.6	1.8	32.7	19.6	62.9	5.2	2.2	0.4
Haynes 471	1.6	0.14	2.5	0.7	0.6	14.3	3.5	5.5	1.5	2.2	1
Inkaneep 535	3.7	0.18	7	0.7	0.6	27	10.2	15.1	1.4	2.1	0.5
Vaseux 177	10.68	0.26	14.57	0.8	0.52	43.8	20	32	1.5	2.2	0.35
Shuttleworth 522	5.5	0.16	7.8	0.5	0.4	37.1	14.6	11.3	1.1	1.4	1.3
Shingle 317	3.7	0.25	7	1.3	1.1	21.4	7.3	9.9	2.6	1.4	1.7
Ellis 470	5.8	0.22	8.5	0.7	0.5	28.4	11.8	12	1.4	1.4	1.1
Okanagan River 371	29.6	1.66	31.3	2	0.4	19	16.1	68.9	4.1	2.2	N/A
Okanagan River 503	27.6	1.37	28.8	1.8	0.3	19.7	16.6	63.4	3.5	2.2	1.9
Okanagan River 415	27.3	0.81	28.2	1.1	0.3	37.7	26.6	62.1	2.2	2.2	0.5
Testalinden 375	1	0.09	2.1	0.4	0.3	12.4	5.4	2.5	0.8	1.2	6.1
Reed 567	0	0	1.05	0.11	0.24	0	0	2.32	0.21	2.2	7.31
McLean 374	2.8	0.33	3.9	0.6	0.3	20.5	6.9	5.6	1.1	1.4	1.2
Park Rill 88	11.8	0.4	13.6	0.5	0.2	39.1	25.6	30	1	2.2	N/A
Shingle 593	2.5	0.2	4.6	0.5	0.3	15.5	12.2	10	1	2.2	0.9

[9]Gradients unavailable for Parkrill (88) and for Okanagan River (371) due to crew safety concerns. Gradient data incomplete for Okanagan River (490). Side channel bankfull heights are unavailable for Reed (567).

Appendix 4a. Summary of habitat type data collected in 2005, averaged over each site.

EMAP Site Name & Number	Average Primary Pool (%)	Average Beaver Pool (%)	Average Pool Tail out (%)	Average Glide (%)	Average Large Cobble Riffle (%)	Average Small Cobble Riffle (%)	Average Rapids (%)	Average Cascade/Falls (%)	Average Side Channel (%)	Average Mid-channel Bar width (m)	Average Backwater (%)
Okanagan River 490	4	0	2	27	0	67	0	0	26	0.97	4
Okanagan River 493	0	0	0	100	0	0	0	0	0	0	0
Haynes 471	0	0	0	100	0	0	0	0	0	0	0
Inkaneep 535	6	0	13	17	46	19	0	0	0	0	0
Vaseux 177	0	0	0	2	60	22	16	30	34	2.65	2
Shuttleworth 522	0	0	0	19	58	23	0	0	0	0.89	0
Shingle 317	14	0	0	28	49	7	0	0	0	0	0
Ellis 470	0	0	0	4	65	31	0	0	0	0	0
Okanagan River 371	0	0	0	86	14	0	0	0	0	0	0
Okanagan River 503	0	0	0	93	4	3	0	0	0	0	0
Okanagan River 415	0	0	0	100	0	0	0	0	0	0	0
Testalinden 375	0	0	0	0	6	93	0	0	60	0	0
Reed 567	0	0	0	0	0	0	0	0	95	0	0
McLean 374	7	49	1	19	0	21	0	0	0	0	2
Park Rill 88	76	13	2	8	0	0	0	0	27	0	92
Shingle 593	19	0	7	52	0	22	0	0	8	1.33	1

Appendix 4b. Summary of habitat type data collected in 2005, averaged over each site.

EMAP Site Name & Number	Average Total Pools (%)	Average Total Riffles (%)	Pool/Riffle Ratio (%) (Average)	Average Small LWD >10 cm and >1m in length (%)	Average Large LWD >10 cm and >2m in length (%)	Average Small Sediment (%)
Okanagan River 490	34	70	1.78	89	238	100
Okanagan River 493	100	0	10	0	0	100
Haynes 471	100	0	10	4	2	100
Inkaneep 535	23	77	0.4	21	64	98
Vaseux 177	3	98	0.03	16	46	51
Shuttleworth 522	19	81	0.45	5	22	90
Shingle 317	42	58	1.87	1	9	53
Ellis 470	4	96	0.05	3	13	98
Okanagan River 371	86	14	8.15	16	10	91
Okanagan River 503	93	7	8.55	14	17	99
Okanagan River 415	100	0	10	95	218	100
Testalinden 375	0	99	0	13	26	100
Reed 567	25	0	10	3	28	87
McLean 374	74	22	6.34	17	52	100
Park Rill 88	100	2	9.92	23	57	99
Shingle 593	72	29	3.88	28	18	100

Appendix 5. Summary of substrate characteristics collected in 2005, averaged for each site[10].

EMAP Site Name & Number	Average Bedrock Smooth (%)	Average Bedrock Rough (%)	Average Boulder (%)	Average Large Cobble (%)	Average Cobble (%)	Average Coarse Gravel (%)	Average Fine Gravel (%)	Average Sand (%)	Average Fines (%)	Average Hardpan (%)	Average Wood (%)	Average Other (%)	Average % Embedded
Okanagan River 490	0	0	7	4	36	22	7	8	13	0	2	0	30.9
Okanagan River 493	0	0	7	16	30	17	7	11	2	1	0	0	33.89
Haynes 471	0	0	0	0	0	0	0	3	97	0	0	0	99.05
Inkaneep 535	0	0	0	17	26	8	3	20	19	6	0	0	59.19
Vaseux 177	0	0	8	36	19	14	10	4	1	0	0	0	22.78
Shuttleworth 522	0	0	0	30	25	16	1	22	0	0	0	0	35.45
Shingle 317	0	0	9	39	8	4	3	38	0	0	0	0	63.1
Ellis 470	0	0	14	36	24	2	8	7	7	0	3	0	30.14
Okanagan River 371	0	0	2	5	13	11	18	50	0	0	0	0	64.76
Okanagan River 503	0	0	11	9	10	11	25	31	1	0	0	0	46.62
Okanagan River 415	0	0	9	0	8	28	36	11	3	4	2	0	26.7
Testalinden 375	0	0	10	10	10	22	17	1	10	18	2	0	48.24
Reed 567	0	0	8	16	11	5	3	0	92	0	2	0	82.8
McLean 374	0	0	0	0	7	13	11	27	42	0	0	0	74.23
Park Rill 88	0	0	0	0	1	2	0	0	97	0	0	0	93.9
Shingle 593	0	0	0	0	0	11	39	40	7	1	2	0	66.86

[10] Embededness (%) data for Okanagan River (490) incomplete

Appendix 6. Summary of riparian vegetation collected in 2005, averaged for each site[11].

EMAP Site Name & Number	Average Canopy Cover-Reach (%)	Average Canopy Cover-Bank (%)	Average Overstory-Deciduous (%)	Average Overstory-Big trees (%)	Average Overstory-Small trees (%)	Average Understory-Deciduous (%)	Average Understory-Woody shrubs/saplings (%)	Average Understory-Non-woody (%)	Average Ground cover-Woody shrubs/saplings (%)	Average Ground cover-Non-woody (%)	Average Ground cover-Barren dirt/duff (%)	Average Ground cover-LWD (%)
Okanagan River 490	40	78	100	6.8	51.1	100	65.5	46.8	12.7	25	27.7	9.1
Okanagan River 493	5	11	100	3.6	3.2	100	21.4	22.3	9.1	48	48	1.8
Haynes 471	81	84	31.8	22.5	6.7	100	46.8	6.2	27.7	44.8	0	19.5
Inkaneep 535	80	89	90.9	35.6	34.2	100	43.6	5.5	18.2	40.2	27.2	40.7
Vaseux 177	17	33	36.4	2	30	40.9	30.3	8	15.5	27.7	33.2	9.5
Shuttleworth 522	80	87	90.9	50.8	40.5	77.3	66.3	40	29.1	88.6	5.9	7.7
Shingle 317	58	62	59.1	17.1	45.4	77.3	36	32.7	13.6	29.1	29.1	8.6
Ellis 470	69	80	86.4	27.2	40.8	81.8	30.8	21.7	11.4	27.7	49.5	0.9
Okanagan River 371	16	31	100	8.2	9.1	100	65.5	34.5	19.5	32	52.7	0
Okanagan River 503	18	36	100	35.9	9.1	100	54.3	52.7	9.1	11.4	60.7	1.8
Okanagan River 415	43	85	100	25	22.5	100	60.7	27.7	11.4	10.9	43.4	11.4
Testalinden 375	93	94	9.1	100	20	18.2	25	17.5	7.7	0.5	94.3	37.3
Reed 567	87	87	100	0	33.2	100	46.4	19.1	27.7	26.4	71.4	2.3
McLean 374	69	67	90.9	5.2	27.7	100	65.5	46.8	37.5	60.7	8.6	4.5
Park Rill 88	100	100	100	26.6	54.3	100	62.3	22.3	22.3	37.3	22.3	10.5
Shingle 593	33	38	77.3	4.1	2.9	100	79.1	51.1	16.8	54.3	11.8	4.5

[11] Riparian vegetation data for reach G for Okanagan River (490) unavailable

Appendix 7a. Summary of human influence characteristics collected in 2005, averaged for each site.

	Average Wall/ Dike/ Revetment /Riprap /Dam (%)				Average Buildings (%)				Average River access sites (%)			
EMAP Site Name & Number	**Bank**	**<10m**	**10-30m**	**none**	**Bank**	**<10m**	**10-30m**	**none**	**Bank**	**<10m**	**10-30m**	**none**
Okanagan River 490	45	5	0	50	0	10	10	80	30	25	15	30
Okanagan River 493	0	0	0	100	0	0	0	100	0	0	0	100
Haynes 471	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	40	0	0	60	0	0	0	100	0	0	0	100
Shuttleworth 522	30	0	0	70	0	0	0	100	0	0	0	100
Shingle 317	45	10	0	45	0	0	10	90	25	0	0	75
Ellis 470	55	0	0	45	0	0	40	60	35	5	25	35
Okanagan River 371	0	100	0	0	0	0	100	0	5	0	0	95
Okanagan River 503	0	100	0	0	0	0	5	95	0	0	0	100
Okanagan River 415	75	5	5	15	0	0	0	100	0	100	0	
Testalinden 375	0	0	0	100	0	0	0	100	0	0	0	100
Reed 567	0	0	0	100	0	0	0	100	0	0	0	100
McLean 374	0	0	0	100	0	0	5	95	0	0	0	100
Park Rill 88	0	0	0	100	0	0	30	70	0	0	0	100
Shingle 593	0	0	0	100	0	0		100	0	0	0	100

Appendix 7b. Summary of human influence characteristics collected in 2005, averaged for each site.

	Average Pavement/ Road/ Railroad (%)				Average Pipes (inlet/outlet) (%)				Average Garbage Piles (%)			
EMAP Site Name & Number	Bank	<10m	10-30m	none	Bank	<10m	10-30m	none	Bank	<10m	10-30m	none
Okanagan River 490	20	30	20	30	0	5	10	85	0	0	0	100
Okanagan River 493	0	0	0	100	0	0	0	100	0	0	0	100
Haynes 471	0	0	10	90	0	0	0	100	0	0	0	100
Inkaneep 535	0	10	0	90	0	0	0	100	0	0	0	100
Vaseux 177	0	0	30	70	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	10	90	0	0	0	100	10	5	0	85
Ellis 470	0	50	25	25	5	0	25	70	0	0	0	100
Okanagan River 371	0	100	0	0	5	0	0	95	0	0	0	100
Okanagan River 503	0	100	0	0	5	0	0	95	0	0	0	100
Okanagan River 415	0	100	0	0	0	0	30	70	0	0	0	100
Testalinden 375	0	0	0	100	0	0	0	100	0	0	0	100
Reed 567	0	30	25	45	0	0	0	100	0	0	0	100
McLean 374	0	0	5	95	0	0	0	100	0	0	0	100
Park Rill 88	0	0	0	100	15	5	0	85	5	0	0	95
Shingle 593	0	0	0	100	0	0	0	100	0	0	0	100

Appendix 7c. Summary of human influence characteristics collected in 2005, averaged for each site[12].

	Average Cleared lot/lawn (%)				Average Orchard/Row Crops (%)				Average Pasture/ Range/ Hay Field (%)			
EMAP Site Name & Number	**Bank**	**<10m**	**10-30m**	**none**	**Bank**	**<10m**	**10-30m**	**none**	**Bank**	**<10m**	**10-30m**	**none**
Okanagan River 490	0	10	15	75	0	5	25	70	0	0	0	100
Okanagan River 493	0	0	0	100	0	0	0	100	0	0	0	100
Haynes 471	0	0	0	100	0	100	0	0	0	0	0	100
Inkaneep 535	0	0	0	100	0	0	0	100	25	40	15	20
Vaseux 177	0	0	0	100	0	0	0	100	0	0	10	90
Shuttleworth 522	0	40	10	50	0	0	0	100	0	35	30	35
Shingle 317	0	0	15	85	0	0	0	100	0	30	0	70
Ellis 470	5	30	5	60	0	0	0	100	0	0	0	100
Okanagan River 371	0	0	5	95	0	0	30	70	0	0	35	65
Okanagan River 503	0	0	0	100	0	0	15	85	0	0	45	55
Okanagan River 415	0	0	90	10	0	0	0	100	0	0	80	20
Testalinden 375	0	0	0	100	0	0	0	100	0	0	0	100
Reed 567	0	0	5	95	0	0	0	100	70	0	0	30
McLean 374	0	0	10	90	0	0	0	100	0	0	10	90
Park Rill 88	20	10	5	65	10	10	5	75	0	0	0	100
Shingle 593	0	0	0	100	0	0	0	100	0	100	0	0

[12] McLean (374), human influence data unavailable for transect 'E'

Appendix 7d. Summary of human influence characteristics collected in 2005, averaged for each site.

	Average Logging Operations (%)				Average Mining Activities (%)				Average Diversions (%)			
EMAP Site Name & Number	Bank	<10m	10-30m	none	Bank	<10m	10-30m	none	Bank	<10m	10-30m	none
Okanagan River 490	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan River 493	0	0	0	100	0	0	0	100	0	0	0	100
Haynes 471	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	20	50	30	0	0	0	100	0	0	0	100
Shuttleworth 522	10	0	0	90	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
Okanagan River 371	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan River 503	0	0	0	100	0	0	0	100	0	0	0	100
Okanagan River 415	0	0	0	100	0	0	0	100	0	0	0	100
Testalinden 375	0	0	0	100	0	0	0	100	0	0	0	100
Reed 567	0	0	0	100	0	0	0	100	0	0	0	100
McLean 374	0	15	25	60	0	0	0	100	0	0	0	100
Park Rill 88	0	0	0	100	0	0	0	100	0	0	0	100
Shingle 593	0	0	0	100	0	0	0	100	0	0	0	100

Appendix 8a. Summary of biological survey data for salmonids collected in 2005.

	Total Salmonids			Total *O. mykiss*			Total *O. nerka*			Total *O. tshawytscha*			Total Whitefish			Density of Salmonids per km^2		
Site Name & Number	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L
Okanagan River 490	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	5.3	0
Okanagan River 493	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haynes 471	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inkaneep 535	38	1	0	37	1	0	0	0	0	0	0	0	0	0	0	153	4	0
Vaseux 177	16	0	0	16	0	0	0	0	0	0	0	0	0	0	0	13	0	0
Shuttleworth 522	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shingle 317	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ellis 470	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Okanagan River 371	1	85	20	0	0	0	0	0	18	0	0	0	1	85	2	0.3	28	6.7
Okanagan River 503	1	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	3.6	0
Okanagan River 415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Testalinden 375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reed 567	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
McLean 374	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3.3	0	0
Park Rill 88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shingle 593	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 8b. Summary of biological survey data for non-salmonids collected in 2005. Bullheads, sunfish, and percids were not observed during any of the biological surveys.

	Total Non-Salmonids			Total Bass			Total Suckers			Total Minnows			Total Sculpins			Density of Non-Salmonids per km^2	Total Unidentified		
Site Name & Number	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L		S	M	L
Okanagan River 490	0	0	3	0	0	0	0	0	1	0	0	2	0	0	0	38.0	0	0	0
Okanagan River 493	0	30	34	0	0	0	0	26	0	0	4	15	0	0	0	533.3	0	0	0
Haynes 471	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0
Inkaneep 535	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0	24.0	3	0	0
Vaseux 177	23	0	0	0	0	0	0	0	0	23	0	0	0	0	0	238.0	99	0	0
Shuttleworth 522	66	0	0	0	0	0	0	0	0	66	0	0	0	0	0	605.0	29	0	0
Shingle 317	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		18	0	0
Ellis 470	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	15.0	0	0	0
Okanagan River 371	5	30	54	5	4	0	0	6	64	0	10	5	0	0	0	1075.0	0	0	0
Okanagan River 503	3	44	4	3	7	1	0	36	0	0	1	3	0	0	0	563.0	0	0	0
Okanagan River 415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0
Testalinden 375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0
Reed 567	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0
McLean 374	10	0	0	0	0	0	0	0	0	10	0	0	0	0	0	93.3	65	2	0
Park Rill 88	0	0	7	0	0	0	0	0	0	0	0	7	0	0	0	375.0	171	0	0
Shingle 593	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5	0	0

Appendix 9. 2005 Steelhead/Rainbow trout spawner counts in Vaseux Creek. No fish were observed in the Okanagan River.

Date	*Live*	*Dead*	*Redds*	*Fish Visibility*
May 12th	0	0	1	Poor: Vaseux Creek adding much turbidity and very high water levels making the visibility poor
June 2nd	0	0	1	High: Vaseux Creek less turbid and more moderate water levels