# Okanagan Basin Monitoring and Evaluation Program (OBMEP) 2006 Annual Report for Sites in Canada

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# 1.0 INTRODUCTION

## *1.1 Project Background*

The Okanagan Basin Monitoring and Evaluation Program (OBMEP) is a status and trend monitoring program that extends over a 20 year period. The physical habitat, water, and fish production parameters have been collected in the Okanagan basin for the third year (CCTFWD 2005).

The purpose of the OBMEP program is to monitor the status and trends of components such as physical habitat condition, water quality and quantity, and juvenile and adult fish abundance in the Okanagan sub-basin over a 20 year period (CCTFWD 2005). The Colville Confederated Tribes initiated the OBMEP program in 2004[1]. In 2005, the Colville Tribes 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, for example, 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 (for example, did the stream restoration project result in a change in abundance of juvenile salmon?)

Thus, OBMEP will help to guide restoration and adaptive management strategies 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 and Vedan 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 (*Oncorhynchus 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

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

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

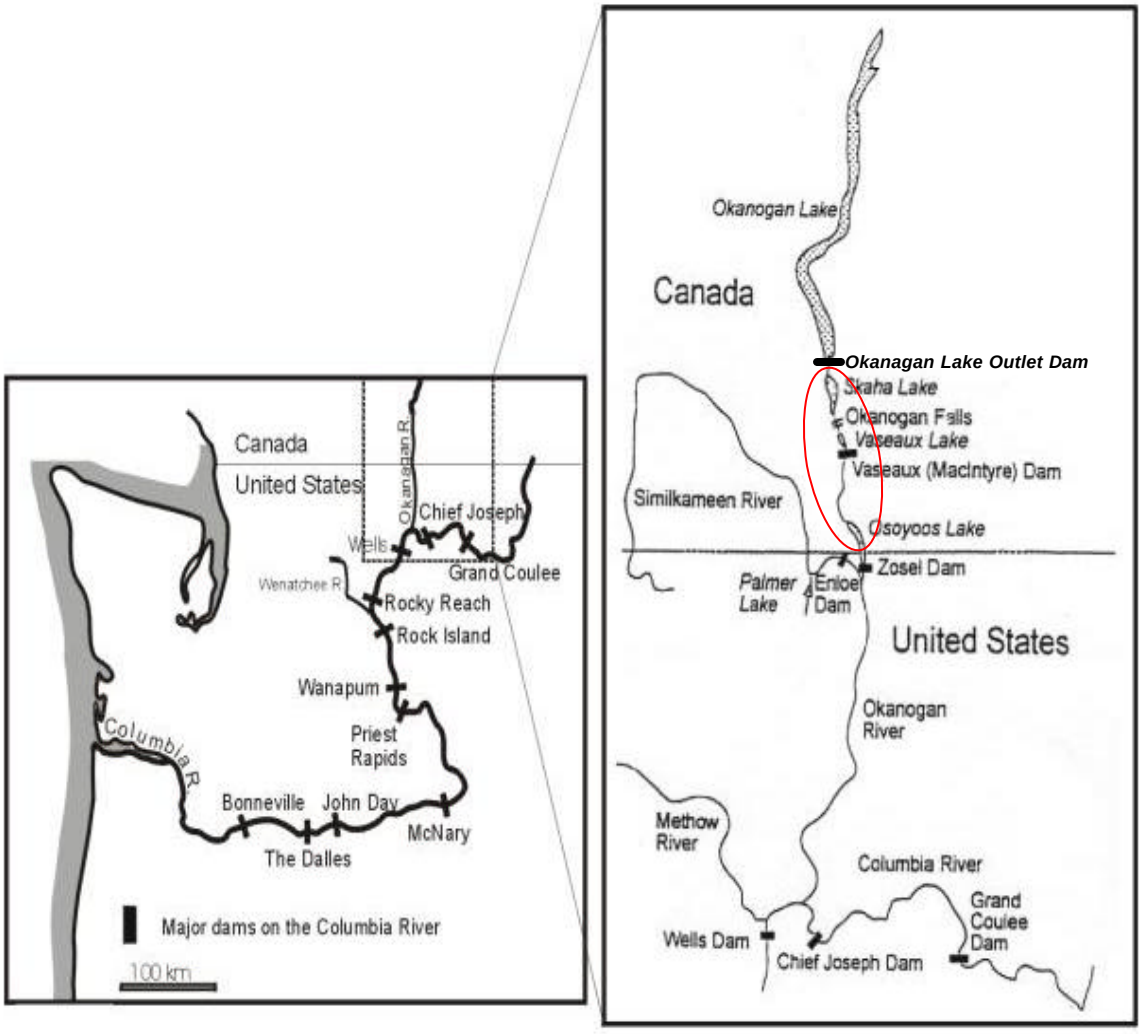


Figure 1. OBMEP study area in Canada.

## *1.2 Study Objectives*

The OBMEP program in Canada requires a total of 48 stream sites[3] to 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

[2] Re-introduction of sockeye salmon into Skaha Lake commenced in 2003 with the release of 352,000 fry. Recent releases include 1,205,500 in 2005 (Long et al. 2005) and 1,384,000 in 2006 (Long et al. 2007).
[3] As defined in Section 2.1.

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, quality and quantity of water, and biological components.

The primary objectives for the Canadian OBMEP program in 2006 were to:

- Monitor permanent water stations measuring water quantity and quality in Shuttleworth, Vaseux and Inkaneep creeks
- Survey physical habitat of the annual and panel 2 sites
- Survey the existing juvenile and adult fish production in annual and panel 2 sites following standard field protocols.
- Enumerate the rainbow/steelhead population on Inkaneep Creek below annual site 535 using a fish enumeration fence
- Obtain water quality information at annual and panel 2 sites using a Eureka water quality meter with predetermined parameters set
- Establish panel 3 sites at the end of 2006 OBMEP program
- Monitor water temperatures at annual and panel 2 sites

# 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 of stream reaches (Hillman 2004). 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 or river.

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). 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 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 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 Colville Tribes Fish and Wildlife Department developed two field-sampling protocol manuals employed in the Okanagan sub basin, based on 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 is included below.

In general, the OBMEP survey consists of documenting the study site, establishing transects within 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 2006.

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 Colville Tribes. Once the GPS coordinates of the site wer located, a rebar marker was placed to designate this location as the center point of the site. Each site consisted 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 were again divided in half to create mid-transect points. The mid-transect point was 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 permanent markers delineating the 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 providing a written description of the site (i.e. landmarks).

### 2.2.1 Physical Habitat Surveys

A crew of two collected and recorded the physical habitat data in 2006 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.

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

In streams too deep and deemed to be non-wadable, a zodiac equipped with a small outboard engine was used to obtain the cross-section information using a stadia rod for the thalweg depth of the cross-section, water depths, substrate compositions, and densiometer readings. Alternatively, cross-section data were collected using a two-person kayak.

### *2.2.2. Water Quality, Water Quantity, and Temperature Sampling*

Water quantity data (discharge) were obtained from the Water Survey of Canada (WSC) real-time hydrometric stations (WSC 2007). 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. A tributary station is located on Vaseux Creek above Solco Creek. 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. 2006a). Beginning in March 2006, WSC stations were installed near the mouths of Inkaneep, Shuttleworth, and Vaseux creeks with the support of OBMEP.

Temperature data were 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 for two hours. One temperature logger was installed at each of the 2006 OBMEP sites during the habitat survey. The data loggers were housed in aluminum piping to protect them from damage. The logger was then placed within the active channel representative of the site and secured to a 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 per site and plotted over time with sites from similar locations[5].

Water quality parameters were collected at each sample site at least three times a month from April to November 2006. Data collected at each sample site included turbidity, temperature, dissolved oxygen (DO) and pH. Each sample was processed and recorded with a Eureka Manta Water Quality Probe and Eureka iPAQ Data Logger.

### *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 two weeks of the physical habitat survey. 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 at the time of the survey were also recorded. A crew of five conducted the snorkel surveys on four Okanagan River mainstem sites. The number of crew members needed for the mainstem snorkel surveys was dependent upon the underwater visual distance. Crew members would snorkel downstream in a straight line across the wetted width of the stream and spaced

[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).

in intervals determined by the underwater visual distance. Snorkel surveys conducted on mainstem sites and streams with wider wetted widths required a crew of five. These surveys commenced at the upstream end of the study site and ended at the downstream end of the site. Snorkel surveys in smaller wadable streams that required only two observers began at the downstream end and ended at the upstream end of the site.

Table1. 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 |

To collect biological data in streams too shallow to snorkel, the crewmembers slowly walked side by side and observed fish with the aid of polarized glasses. Deeper pools in the reach were checked visually with a snorkel and mask.

### *2.2.4. Redd Surveys and Adult Enumeration*

Steelhead redd surveys were conducted between April 5$^{th}$ and June 26$^{th}$, 2006. Surveys were exploratory in nature and it was important in this preliminary year to survey the entire accessible stream, repeating reaches where redds were either suspected to occur or were located (Long et al. 2006a). A fish fence was installed and monitored 575 m upstream from the mouth of Inkaneep Creek (GPS co-ordinates: 49.074722, 119.501944) for 34 days (March 27$^{th}$ to April 29$^{th}$), and three days from May 15$^{th}$ to May 17$^{th}$. The purpose of the fence was to enumerate spawning steelhead trout migrating upstream.

## *2.3 Data Collection & Processing*

Data were recorded using electronic entry and data sheets. Data were entered electronically using a Trimble® GeoExplorer® Series GeoXM pocket PC. However, due to technical problems with the electronic device the majority of data were recorded on conventional paper 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 Colville Tribes and contained the same information as the field data sheets.

Electronic data wer 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 were sent to Colville Tribes where it was converted into Microsoft (MS) Excel format and returned to the ONA for further analysis. OBMEP data will be incorporated into a database in future years.

# 3.0 RESULTS

## *3.1 Study Sites*

The 48 OBMEP sites in the Canadian Okanagan sub-basin, in addition to eight extra sites, are presented (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 and include four Okanagan River main stem sites and twelve tributary sites.

Table 2. EMAP sites surveyed in 2006 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, and alternate sites have been modified for the 2007 sampling year and the next annual report will reflect these changes (Appendix 1a).

**Annual Panel Sites 2006:**

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

**Panel 2 Sites 2006:**

| Stream | Site No. |
|---|---|
| Shingle Creek | 333 |
| Shatford Creek | 338 |
| Okanagan River | 562 |
| Mclean Creek | 310 |
| Shuttleworth Creek | 538 |
| Okanagan River | 346 |
| Reed Creek | 403 |
| Inkaneep Creek | 351 |

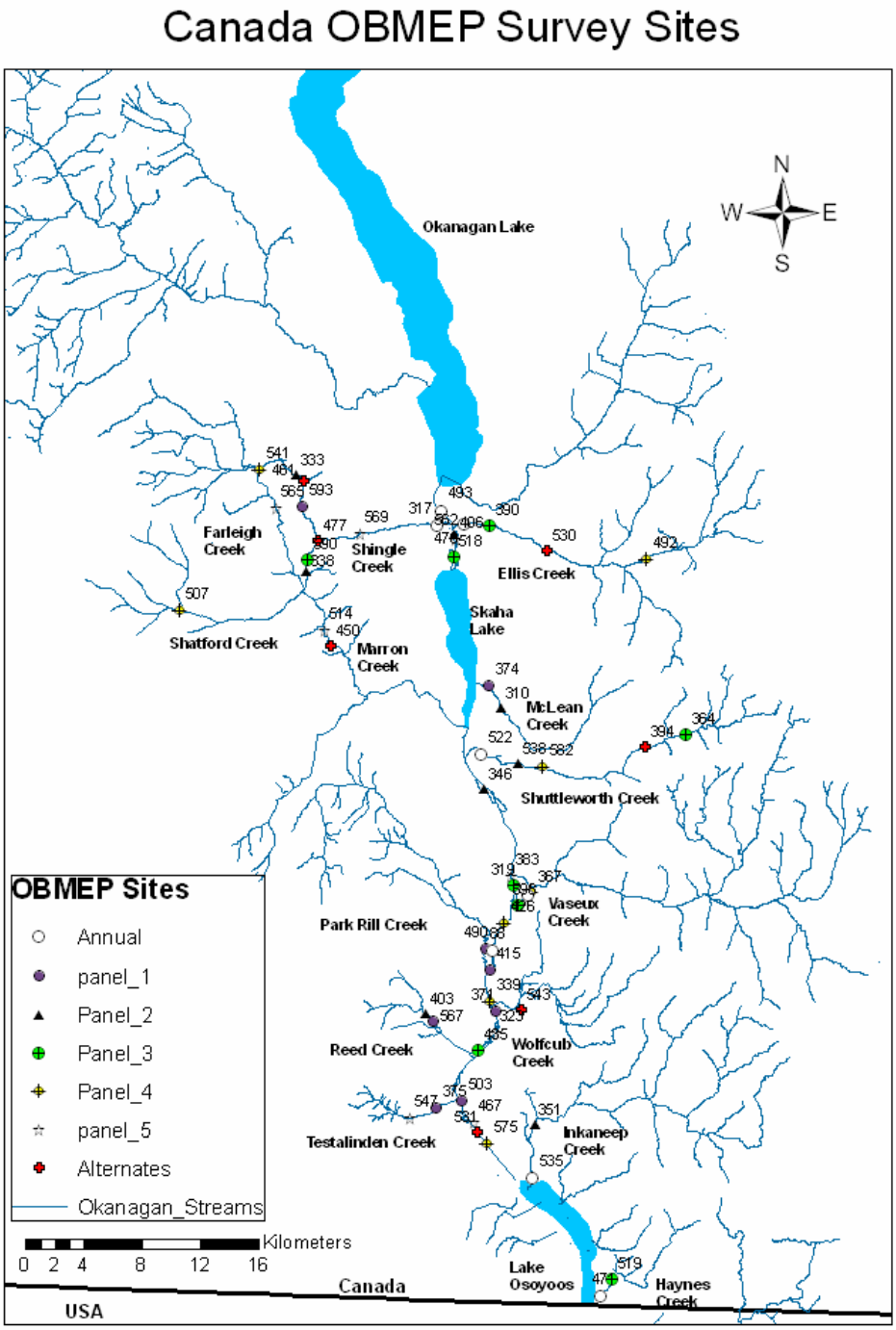


Figure 2. EMAP sites for the OBMEP program in the Canadian Okanagan sub-basin for the 20-year program. The map displays the annual and five rotating panel sites in addition to a sixth extra panel of alternate sites in case some sites are impractical to survey. In 2006, the annual and panel 2 sites were surveyed.

## *3.2 Physical Data*

### *3.2.1 Physical Habitat Inventory*

Physical habitat data were collected for the 16 OBMEP sites in 2006. 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 (Appendices 7a, 7b, 7c, and 7d). For comparison, habitat data collected in 2006 were compared with data collected in 2005 for the eight annual sites. Data for 2005 and 2006 (Tables 3-8) are similar. Any difference in measured parameters is likely attributable to natural variation or differences in parameter estimation due to different field personnel each year. Long-term trends will only be apparent with a larger data set that includes multiple years.

Table 3. Comparison of physical habitat parameters for eight annual EMAP sites sampled in the Okanagan River Basin in 2005 and 2006.

| | | PARAMETER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **EMAP Sites** | **Site Numbers** | **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 (#)** |
| **Inkaneep Creek** | **535 2005** | 7.0 | 4.00 | 80 | 89 | 59 | 98 | 10.2 | 21 | 64 |
| | **535 2006** | 13.0 | 0.00 | 75 | 82 | 68 | 90 | 12.7 | 11 | 32 |
| **Okanagan River** | **493 2005** | 28.6 | 10.00 | 5 | 5 | 34 | 100 | 19.6 | 0 | 0 |
| | **493 2006** | 32.8 | 10.00 | 26 | 52 | 21 | 0 | 12.6 | 0 | 0 |
| **Okanagan River** | **490 2005** | 28.5 | 1.78 | 40 | 40 | 31 | 100 | 24.0 | 89 | 238 |
| | **490 2006** | 36.2 | 1.00 | 45 | 85 | 29 | 77 | 20.7 | 18 | 33 |
| **Ellis Creek** | **470 2005** | 8.5 | 0.05 | 69 | 80 | 30 | 98 | 11.8 | 3 | 13 |
| | **470 2006** | 9.6 | 0.00 | 88 | 91 | 40 | 42 | 8.5 | 21 | 59 |
| **Vaseux Creek** | **177 2005** | 14.6 | 0.03 | 17 | 33 | 23 | 51 | 20.0 | 16 | 46 |
| | **177 2006** | 22.8 | 0.00 | 41 | 48 | 37 | 8 | 19.5 | 2 | 15 |
| **Shuttleworth Cr** | **522 2005** | 7.8 | 0.45 | 80 | 87 | 35 | 90 | 14.6 | 5 | 22 |
| | **522 2006** | 11.0 | 0.01 | 84 | 91 | 43 | 80 | 11.0 | 9 | 19 |
| **Shingle Creek** | **317 2005** | 7.0 | 1.87 | 58 | 62 | 63 | 53 | 7.3 | 1 | 9 |
| | **317 2006** | 7.7 | 0.17 | 79 | 83 | 69 | 69 | 9.8 | 7 | 11 |
| **Haynes Creek** | **471 2005** | 2.5 | 10.00 | 81 | 84 | 99 | 100 | 19.6 | 4 | 2 |
| | **471 2006** | 4.1 | 0.00 | 97 | 99 | 60 | 99 | 3.3 | 21 | 64 |

Table 4. Comparison of physical habitat parameters for eight annual EMAP sites sampled in the Okanagan River Basin in 2005 and 2006.

| | | PARAMETER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAP Sites** | **Site Numbers** | **Thalweg depth (m)** | **Gradient (%)** | **Wetted width (m)** | **Bank full height (m)** | **Entrench-ment ratio (Bankful width/flood prone width)** | **Entrench-ment ratio (E,ME,SE)*** | **Flood prone width (m)** | **Bankfull depth (m)** | **Flood prone depth (m)** | **Wetted width/ Thalweg depth** |
| **Inkaneep Creek** | **535 2005** | 0.18 | 0.5 | 3.75 | 0.6 | 2.1 | ME | 15.1 | 0.7 | 1.4 | 27.0 |
| | **535 2006** | 0.02 | 0.2 | 4.70 | 0.8 | 2.1 | ME | 27.9 | 1.0 | 2.1 | 20.3 |
| **Okanagan River** | **493 2005** | 0.82 | 0.4 | 26.20 | 1.8 | 2.2 | E | 62.9 | 2.6 | 5.2 | 32.7 |
| | **493 2006** | 0.00 | 0.0 | 23.80 | 1.5 | 1.0 | E | 32.8 | 2.6 | 5.2 | 21.6 |
| **Okanagan River** | **490 2005** | 0.83 | NA | 26.30 | 0.4 | 2.2 | SE | 62.7 | 1.2 | 2.4 | 33.6 |
| | **490 2006** | 1.00 | 0.7 | 30.10 | 0.8 | 1.4 | E | 48.6 | 1.7 | 3.5 | 33.4 |
| **Ellis Creek** | **470 2005** | 0.22 | 1.1 | 5.80 | 0.5 | 1.4 | E | 12.0 | 0.7 | 1.4 | 28.4 |
| | **470 2006** | 0.25 | 0.0 | 6.10 | 0.9 | 1.5 | ME | 13.5 | 1.1 | 2.3 | 24.1 |
| **Vaseux Creek** | **177 2005** | 0.26 | 0.4 | 10.68 | 0.5 | 2.2 | SE | 32.0 | 0.8 | 1.5 | 43.8 |
| | **177 2006** | 0.20 | 2.3 | 5.00 | 1.1 | 1.8 | ME | 37.5 | 1.2 | 2.5 | 26.0 |
| **Shuttleworth Cr** | **522 2005** | 0.16 | 1.3 | 5.50 | 0.4 | 1.4 | E | 11.3 | 0.5 | 1.1 | 37.1 |
| | **522 2006** | 0.20 | 2.0 | 4.50 | 0.8 | NA | NA | NA | 0.9 | 1.8 | 27.4 |
| **Shingle Creek** | **317 2005** | 0.25 | 1.7 | 3.70 | 1.3 | 1.4 | E | 9.9 | 1.3 | 2.6 | 21.4 |
| | **317 2006** | 0.30 | 0.9 | 4.10 | 0.8 | 1.4 | E | 9.4 | 1.0 | 1.9 | 16.9 |
| **Haynes Creek** | **471 2005** | 0.14 | 1.0 | 1.60 | 0.6 | 2.2 | ME | 5.5 | 0.7 | 1.5 | 14.3 |
| | **471 2006** | 0.10 | 0.6 | 1.20 | 1.2 | 2.2 | ME | 8.7 | 1.2 | 2.4 | 16.1 |

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

Table 5. Comparison of substrate characteristics for eight annual EMAP sites sampled in the Okanagan Basin in 2005 and 2006.

| | | PARAMETER (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAP Sites** | **Site Numbers** | **Bedrock Smooth (RS)** | **Bedrock Rough (RR)** | **Boulder (BL)** | **Large Cobble (LCB)** | **Cobble (SCB)** | **Coarse Gravel (GC)** | **Fine Gravel (GF)** | **Sand (SA)** | **Silt/Clay/ Muck (FN)** | **Hardpan (HP)** | **Wood (WD)** | **Other (OT)** |
| **Inkaneep Creek** | **535 2005** | 0 | 0 | 0 | 17 | 26 | 8 | 3 | 20 | 19 | 6 | 0 | 0 |
| | **535 2006** | 0 | 0 | 0 | 0 | 8 | 11 | 3 | 1 | 23 | 0 | 0 | 2 |
| **Okanagan River** | **493 2005** | 0 | 0 | 7 | 16 | 30 | 17 | 7 | 11 | 2 | 1 | 0 | 0 |
| | **493 2006** | 0 | 0 | 4 | 19 | 50 | 0 | 0 | 0 | 1 | 0 | 0 | 26 |
| **Okanagan River** | **490 2005** | 0 | 0 | 7 | 4 | 36 | 22 | 7 | 8 | 13 | 0 | 2 | 0 |
| | **490 2006** | 0 | 0 | 4 | 1 | 64 | 7 | 0 | 0 | 1 | 0 | 0 | 13 |
| **Ellis Creek** | **470 2005** | 0 | 0 | 14 | 36 | 13 | 2 | 8 | 7 | 7 | 0 | 3 | 0 |
| | **470 2006** | 0 | 0 | 3 | 35 | 34 | 4 | 3 | 0 | 10 | 0 | 0 | 3 |
| **Vaseux Creek** | **177 2005** | 0 | 0 | 8 | 36 | 19 | 14 | 10 | 4 | 1 | 0 | 0 | 0 |
| | **177 2006** | 0 | 0 | 17 | 30 | 28 | 3 | 3 | 0 | 9 | 0 | 3 | 3 |
| **Shuttleworth Cr** | **522 2005** | 0 | 0 | 0 | 30 | 25 | 16 | 1 | 22 | 0 | 0 | 0 | 0 |
| | **522 2006** | 0 | 0 | 3 | 19 | 29 | 0 | 1 | 0 | 21 | 0 | 2 | 16 |
| **Shingle Creek** | **317 2005** | 0 | 0 | 9 | 39 | 8 | 4 | 3 | 38 | 0 | 0 | 0 | 0 |
| | **317 2006** | 0 | 0 | 3 | 28 | 10 | 4 | 7 | 0 | 32 | 2 | 1 | 4 |
| **Haynes Creek** | **471 2005** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 97 | 0 | 0 | 0 |
| | **471 2006** | 0 | 0 | 0 | 0 | 7 | 18 | 1 | 0 | 13 | 0 | 1 | 55 |

Table 6. Comparison of physical habitat types for eight annual EMAP sites sampled in the Okanagan River Basin in 2005 and 2006.

| | | PARAMETER | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAP Sites** | **Site Numbers** | **Primary Pool (%)** | **Beaver Pool (%)** | **Pool Tail out (%)** | **Glide (%)** | **Large Cobble Riffle (%)** | **Small Cobble Riffle (%)** | **Rapids (%)** | **Side Channel (%)** | **Back-water (%)** | **Total Pools (%)** | **Total Riffles (%)** | **Cascade/ Falls (%)** | **Mid-channel Bar width Average (m)** |
| **Inkaneep Creek** | **535 2005** | 6 | 0 | 13 | 17 | 46 | 19 | 0 | 0 | 0 | 23 | 77 | 0 | 0.00 |
| | **535 2006** | 0 | 0 | 1 | 0 | 3 | 6 | 0 | 0 | 0 | 0 | 10 | 0 | 0.00 |
| **Okanagan River** | **493 2005** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0.00 |
| | **493 2006** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| **Okanagan River** | **490 2005** | 4 | 0 | 2 | 27 | 0 | 67 | 0 | 26 | 4 | 34 | 70 | 0 | 0.97 |
| | **490 2006** | 0 | 0 | 0 | 0 | 4 | 72 | 0 | 0 | 0 | 0 | 76 | 0 | 0.00 |
| **Ellis Creek** | **470 2005** | 0 | 0 | 0 | 4 | 65 | 31 | 0 | 0 | 0 | 4 | 96 | 0 | 0.00 |
| | **470 2006** | 0 | 0 | 0 | 0 | 61 | 38 | 0 | 0 | 0 | 0 | 99 | 0 | 0.00 |
| **Vaseux Creek** | **177 2005** | 0 | 0 | 0 | 2 | 60 | 22 | 16 | 34 | 2 | 3 | 98 | 16 | 2.65 |
| | **177 2006** | 0 | 0 | 0 | 0 | 56 | 38 | 0 | 0 | 0 | 0 | 94 | 0 | 0.00 |
| **Shuttleworth Cr** | **522 2005** | 0 | 0 | 0 | 19 | 58 | 23 | 0 | 0 | 0 | 19 | 81 | 0 | 0.89 |
| | **522 2006** | 1 | 0 | 1 | 0 | 35 | 58 | 0 | 0 | 0 | 1 | 0 | 0 | 0.00 |
| **Shingle Creek** | **317 2005** | 14 | 0 | 0 | 28 | 49 | 7 | 0 | 0 | 0 | 42 | 58 | 0 | 0.00 |
| | **317 2006** | 9 | 0 | 2 | 0 | 47 | 36 | 0 | 0 | 0 | 9 | 84 | 0 | 0.00 |
| **Haynes Creek** | **471 2005** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0.00 |
| | **471 2006** | 0 | 0 | 0 | 0 | 0 | 99 | 0 | 0 | 0 | 0 | 99 | 0 | 0.00 |

Table 7. Comparison of riparian vegetation attributes for eight annual EMAP sites sampled in the Okanagan River Basin in 2005 and 2006.

| | | PARAMETER (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAP Sites** | **Site Numbers** | **Overstory Deciduous** | **Overstory Big trees** | **Overstory Small trees** | **Understory Deciduous** | **Understory Woody shrubs/ saplings** | **Understory Non-woody** | **Ground cover Woody shrubs/ saplings** | **Ground cover Non-woody** | **Ground cover Barren dirt/duff** | **Ground cover LWD** |
| **Inkaneep Creek** | **535 2005** | 90.0 | 35.6 | 34.2 | 100.0 | 43.6 | 5.5 | 18.1 | 40.2 | 27.1 | 40.7 |
| | **535 2006** | 100.0 | 28.0 | 22.0 | 100.0 | 43.8 | 1.5 | 34.0 | 40.3 | 19.0 | 17.5 |
| **Okanagan River** | **493 2005** | 100.0 | 3.6 | 3.2 | 100.0 | 21.4 | 22.3 | 9.1 | 48.0 | 48.0 | 1.8 |
| | **493 2006** | 100.0 | 5.8 | 5.8 | 75.0 | 10.0 | 0.0 | 30.5 | 91.5 | 4.1 | 0.0 |
| **Okanagan River** | **490 2005** | 100.0 | 6.8 | 51.1 | 100.0 | 65.5 | 46.9 | 12.7 | 25.0 | 27.7 | 9.1 |
| | **490 2006** | 100.0 | 6.5 | 47.8 | 100.0 | 31.7 | 1.3 | 22.3 | 40.5 | 7.7 | 4.5 |
| **Ellis Creek** | **470 2005** | 86.4 | 27.2 | 40.8 | 81.8 | 30.8 | 21.7 | 11.4 | 27.7 | 49.5 | 0.9 |
| | **470 2006** | 94.4 | 33.2 | 28.1 | 94.4 | 29.5 | 3.4 | 32.9 | 32.6 | 37.2 | 1.9 |
| **Vaseux Creek** | **177 2005** | 36.4 | 2.0 | 30.0 | 40.9 | 30.3 | 8.0 | 15.5 | 28.0 | 33.2 | 9.5 |
| | **177 2006** | 16.7 | 20.0 | 0.0 | 8.3 | 20.0 | 0.0 | 67.0 | 27.7 | 5.9 | 20.9 |
| **Shuttleworth Cr** | **522 2005** | 90.9 | 50.8 | 40.5 | 77.3 | 66.3 | 40.0 | 29.1 | 88.6 | 5.9 | 7.7 |
| | **522 2006** | 95.0 | 36.6 | 9.1 | 73.3 | 42.9 | 0.0 | 61.5 | 32.5 | 8.1 | 10.7 |
| **Shingle Creek** | **317 2005** | 59.1 | 59.1 | 45.4 | 77.3 | 36.0 | 32.7 | 13.6 | 29.1 | 29.1 | 8.6 |
| | **317 2006** | 77.3 | 25.7 | 10.7 | 43.9 | 25.0 | 0.0 | 37.3 | 36.4 | 19.5 | 6.8 |
| **Haynes Creek** | **471 2005** | 31.8 | 22.5 | 6.7 | 100.0 | 46.8 | 22.3 | 27.7 | 44.8 | 0.0 | 19.5 |
| | **471 2006** | 100.0 | 1.0 | 33.8 | 100.0 | 49.0 | 0.0 | 20.0 | 59.7 | 9.0 | 0.0 |

Table 8. Comparison of human influence for eight annual EMAP sites sampled in the Okanagan River Basin in 2005 and 2006.

| | | Not Present (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAP Sites** | **Site Numbers** | **Wall/ Dike/ Revetment /Riprap /Dam** | **Building** | **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** |
| **Inkaneep Creek** | **535 2005** | 100 | 100 | 100 | 90 | 100 | 100 | 100 | 100 | 20 | 100 | 100 | 100 |
| | **535 2006** | 90 | 100 | 70 | 55 | 100 | 95 | 95 | 100 | 50 | 100 | 100 | 100 |
| **Okanagan River** | **493 2005** | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | **493 2006** | 100 | 95 | 0 | 5 | 95 | 100 | 30 | 100 | 100 | 100 | 100 | 100 |
| **Okanagan River** | **490 2005** | 50 | 80 | 30 | 30 | 85 | 100 | 75 | 70 | 100 | 100 | 100 | 100 |
| | **490 2006** | 60 | 90 | 90 | 55 | 100 | 100 | 100 | 90 | 100 | 100 | 100 | 100 |
| **Ellis Creek** | **470 2005** | 45 | 60 | 35 | 25 | 25 | 100 | 60 | 100 | 100 | 100 | 100 | 100 |
| | **470 2006** | 80 | 60 | 60 | 25 | 85 | 95 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Vaseux Creek** | **177 2005** | 60 | 100 | 100 | 70 | 100 | 100 | 100 | 100 | 90 | 30 | 100 | 100 |
| | **177 2006** | 80 | 100 | 100 | 80 | 100 | 100 | 40 | 100 | 100 | 100 | 100 | 100 |
| **Shuttleworth Cr** | **522 2005** | 70 | 100 | 100 | 100 | 100 | 100 | 50 | 100 | 35 | 90 | 100 | 100 |
| | **522 2006** | 70 | 100 | 70 | 100 | 100 | 95 | 95 | 100 | 20 | 100 | 100 | 100 |
| **Shingle Creek** | **317 2005** | 45 | 90 | 75 | 90 | 100 | 85 | 85 | 100 | 70 | 100 | 100 | 100 |
| | **317 2006** | 45 | 80 | 70 | 50 | 100 | 80 | 90 | 100 | 100 | 100 | 100 | 100 |
| **Haynes Creek** | **471 2005** | 100 | 100 | 100 | 90 | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 100 |
| | **471 2006** | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 5 | 100 | 100 | 100 | 100 |

### *3.2.2 Water Quantity: Discharge*

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

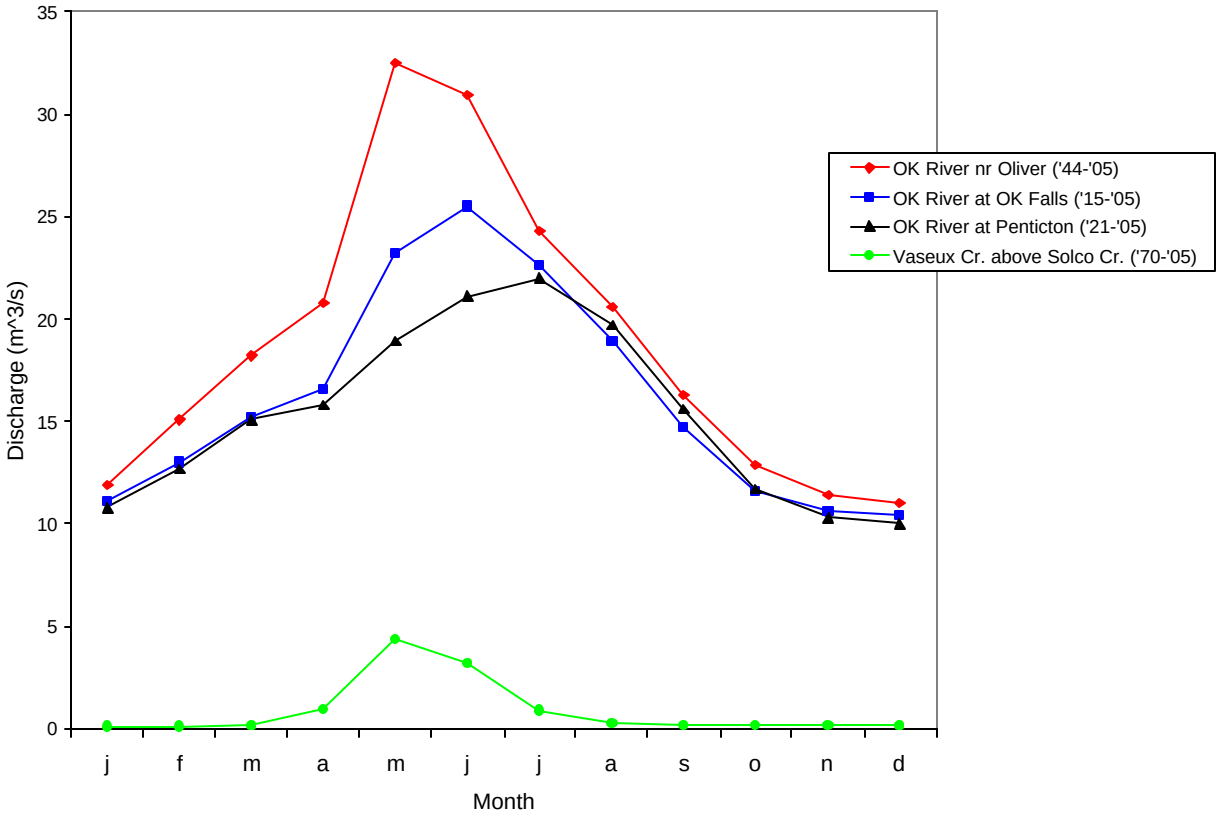


Figure 3. Historic mean monthly discharges ($m^3/s$) from four real-time hydrometric stations in the Okanagan sub-basin. The longest data set is from 1915 to 2005. Data provided by the Water Survey of Canada (WSC).

Mean monthly discharge rates for 2006 are depicted in Figures 4a-c. Water levels depicted are not the natural hydrograph. 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). The Vaseux Creek average discharge for 2006 was almost identical to previous years, peaking in May and maintaining very low discharge rates throughout the remainder of the year.

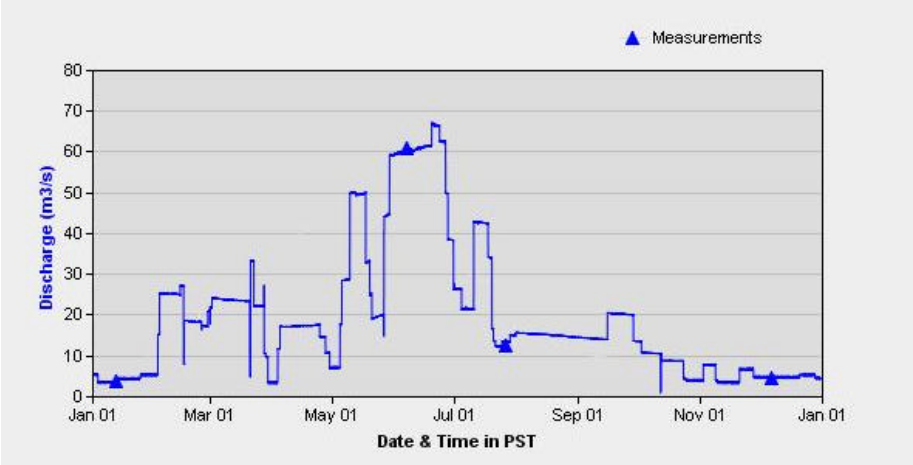


Fig. 4a. Okanagan River at Penticton

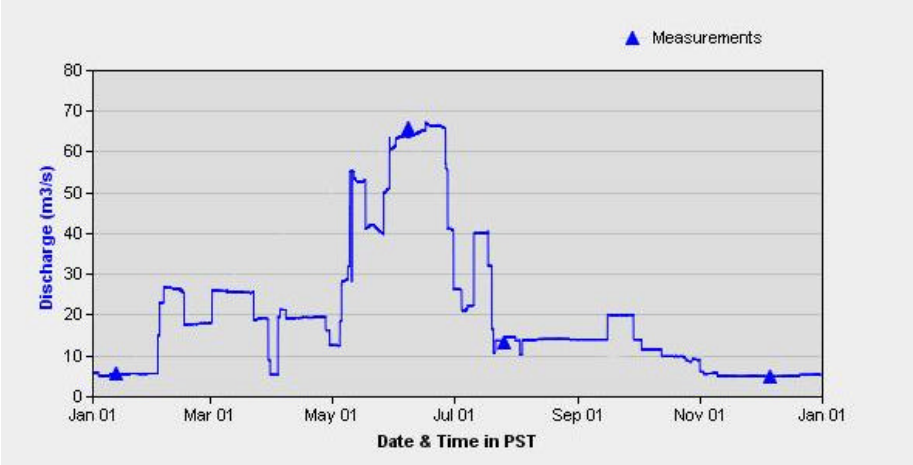


Fig. 4b. Okanagan River at Okanagan Falls.

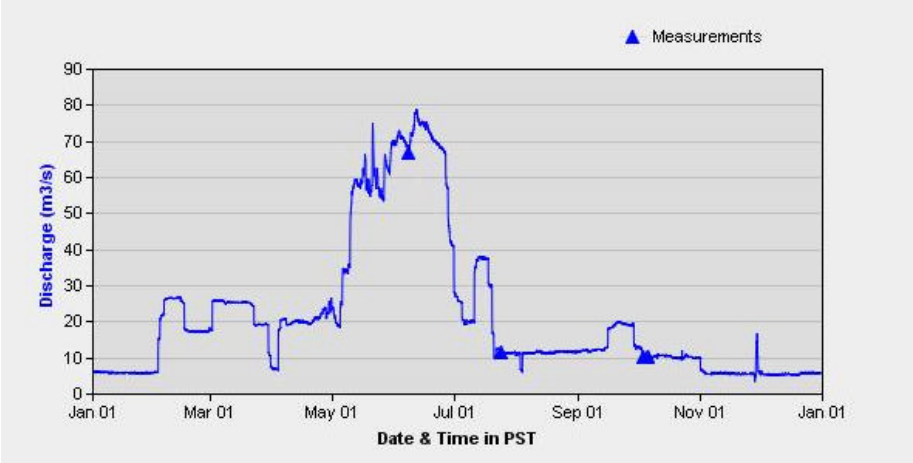


Fig. 4c. Okanagan River at Oliver

Figures 4a-c. Mean monthly discharge ($m^3/s$) in 2006 for three real-time hydrometric stations in the Okanagan sub-basin. Data is provided by Environment Canada, Water Survey Branch (WSC). Data presented are provisional and are not endorsed by Environment Canada until quality control and assurance protocols have been conducted.

WSC hydrometric stations at the mouths of Vaseux, Shuttleworth, and Inkaneep creeks are currently collecting real time data on temperature and water levels. Archived data for 2006 are currently unavailable. Real-time station data are available online at: http://www.wsc.ec.gc.ca.

### *3.2.3 Water Quality: Temperatures*

Temperature data loggers were deployed at the 16 study sites in 2006 during the habitat surveys and were downloaded in the fall. Loggers were re-installed for annual sites and removed from panel 2 sites.

Stream temperatures documented for the five Okanagan River main stem sites show very similar warming and cooling trends, starting with high temperatures of 19-26°C during early July to early September, and decreasing to lows between 8-11°C in October (Figure 5). The overall mainstem temperatures do not fluctuate significantly, however, a significant decrease occurs for site number 490 in mid-July where the temperature fluctuates 8°C during a 1 week period and for site 562, which fluctuates from 15-23°C in mid-July to early August. Temperatures equal to or greater than 20°C occurred in all four Okanagan River main stem sites from approximately July 17th to early September.

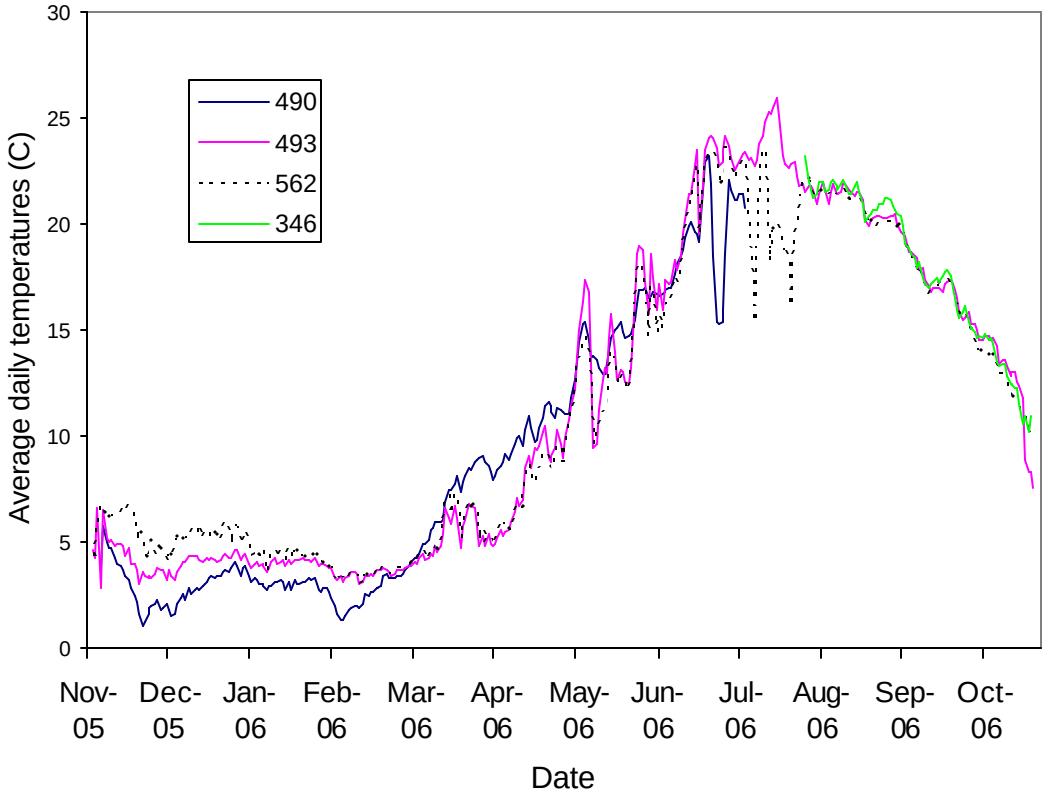


Figure 5. Mainstem Okanagan River mean daily temperatures for 2005-2006.

Chinook salmon parr display optimum growth and feeding at 19°C (Groot and 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). In 2006, mainstem site 493 reached lethal temperatures of around 26°C for approximately 1 week whereas the remaining 3 main stream temperatures in the Okanagan River did not exceed lethal temperatures for Chinook salmon or rainbow trout.

Kokanee generally spawn from September to October when temperatures reach from 10.5°C to 5.0°C (Scott and Crossman 1973). Anadromous sockeye can spawn from July to December at 3°C to 7°C (Scott and Crossman 1973). In 2006, peak of spawning in the Okanagan River was October 22th for sockeye (Wodchyc et al. in prep.) and October 23th for kokanee (Wodchyc and Wiens in prep). Mean temperatures in the Okanagan River[6] for these dates were 12.4°C and 12.5°C, respectively.

One northern tributary, McLean Creek (310) demonstrates very similar daily mean temperatures, commencing at 17-18°C in late August and reaching lows of 1-5°C in late October (Figure 6). In contrast to the mainstem sites, these tributaries experience more fluctuations in temperatures throughout the study, up to 4°C difference in a matter of 3-4 days. Tributaries may provide cold water refugia for salmon during the months of August and September when the Okanagan River mainstem temperatures reach near lethal levels

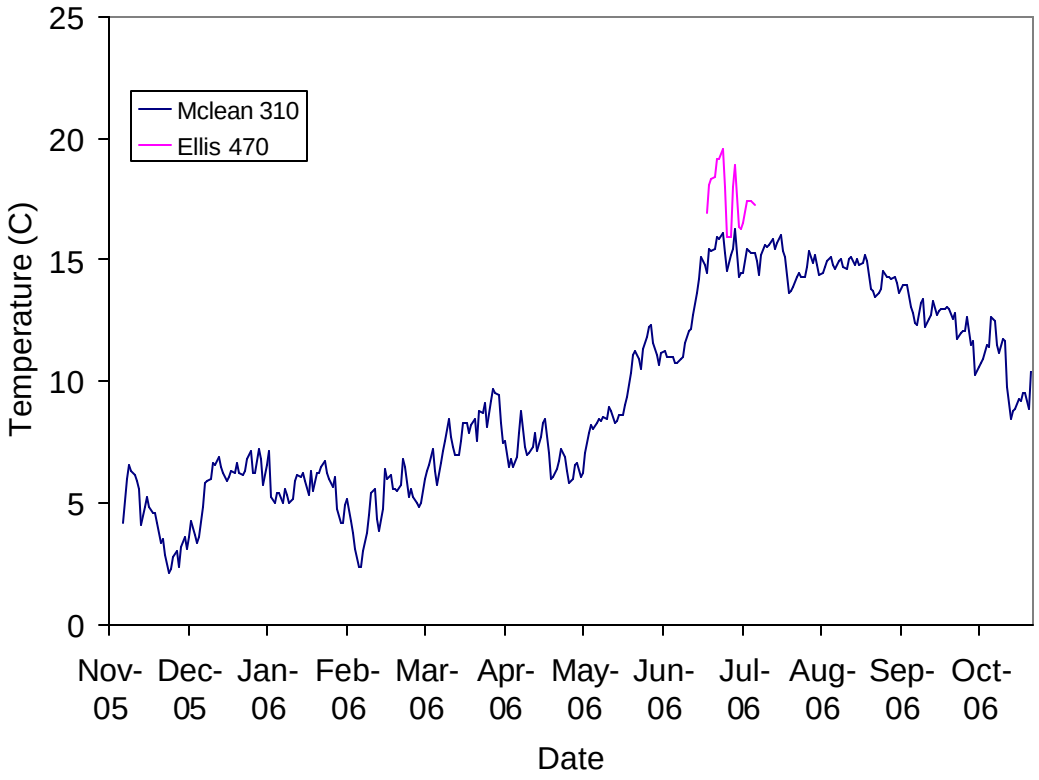


Figure 6. Mean daily stream temperatures (°C) for two tributaries of the Okanagan River located in the northern region of the habitat study area, 2005-2006.

[6] Averaged for the Okanagan River OBMEP sites.

Shingle Creek (317) had no comparable data this year because the temperature logger was lost during spring freshets. Ellis Creek 470 shows a significantly high temperature in late June with a cooling trend in the early part of August. Mclean Creek 310 has a rise in temperature from mid May and peaking around late June.

Three southern tributaries also display fluctuations in daily mean temperatures for 3-4 days, compared to the main stem sites (Figure 7). Seasonal high temperatures of approximately 22°C occurred in late July, slightly lower than mainstem temperatures during the same time. Again, these tributaries may offer preferred water temperature refugia for salmonids in the Okanagan River during August and September when the temperatures are greater than optimal for salmon.

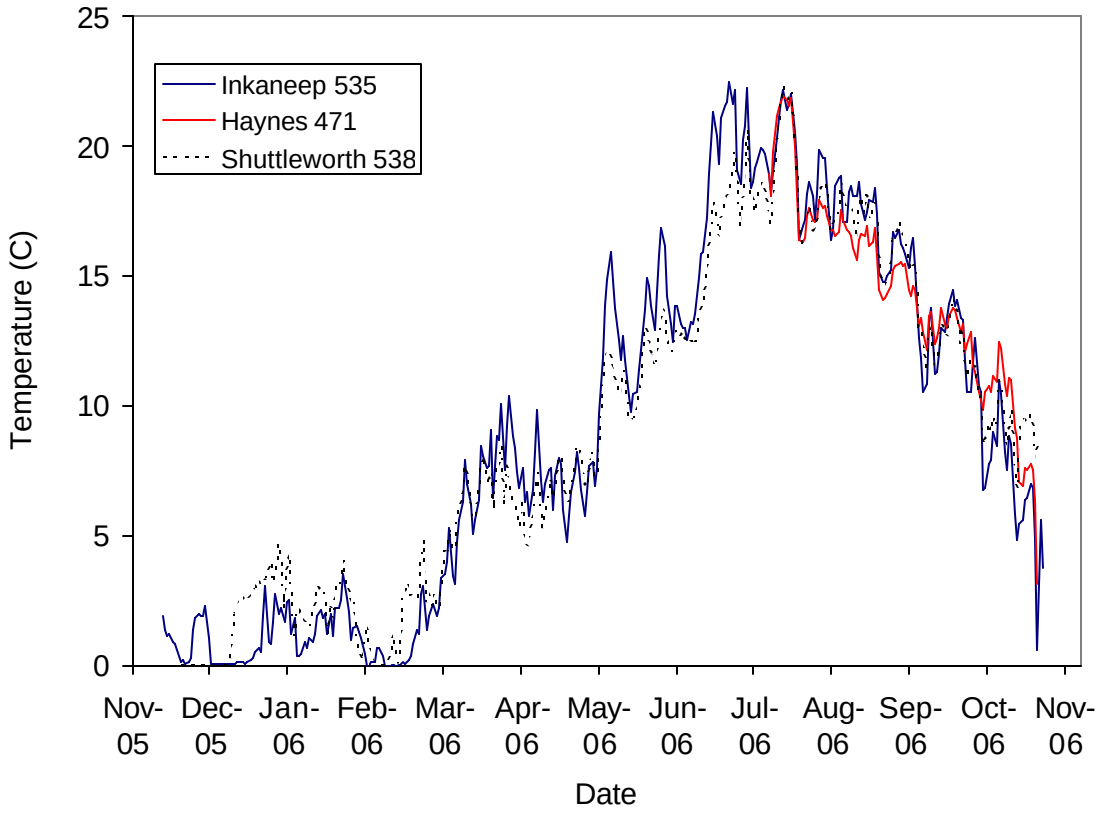


Figure 7. Mean daily stream temperatures (°C) for three tributaries of the Okanagan River located in the southern region of the habitat study area, 2005-2006.

### *3.2.4 Water Quality*

Water quality data including turbidity, temperature, dissolved oxygen (DO) and pH were highly variable throughout the study (Appendix 8). DO, an important metric for salmonid health, ranged 4.37 to 20.97 mg/L for all sites during the sampling period. Generally, low DO levels were recorded in the summer months (June-August). Low DO concentrations corresponded with high water temperatures. Measurements of pH remained stable throughout the period, ranging from 7.4 to 9.2 and a relatively low

standard deviation (Appendix 8). Turbidity measurements were highly variable depending on the watercourse, sample site, and time of year. The mainstem Okanagan River turbidity was consistently lower than tributary turbidities. Otherwise, no clear patterns in turbidity were observed.

## *3.3. Biological Data*

Snorkel surveys were conducted from July 31st to September 7th, 2006 to document the presence and abundance of juvenile and adult salmonids as well as non-salmonids. All mainstem surveys were conducted on August 25th. The wetted width averaged 25m on mainstem sites. Visibility conditions were excellent due to clear weather and low turbidity. The wetted width of tributary sites ranged from 1.5 to 5 m. Overall visibilities of the tributary sites were excellent with the exception of Ellis 470, Shingle 317 and Mclean 310 due to shade from overstory vegetation.

Salmonid species present included rainbow trout/ steelhead, sockeye salmon, Chinook salmon, brook trout (*Salvelinus fontinalis*) 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 9a and 9b.

A total of 22 *O. mykiss* redds were observed in the streams surveyed in the spring of 2006. Ten redds were observed in both Vaseux and Inkaneep Creeks. No redds were observed in Shuttleworth Creek and only two redds were observed in the Okanagan River mainstem. (Long et al. 2006b). Between March 27th and May 17th the fish enumeration fence was operational for a total of 37 days. The fence was non-operational from April 30th to May 14th due to high spring flows. During the operational phase of the fish fence, a total of 64 steelhead/rainbow trout migrated upstream. Over the three days in May when the fish fence was replaced no upstream migrating fish were caught. The daily peaks in migration correspond with days of high water flows and high water turbidity (Long et al. 2006b)

# 4.0 DISCUSSION AND RECOMMENDATIONS

The 2006 OBMEP objectives were successfully completed for this year's anadromous salmon physical habitat and biological study in the Canadian Okanagan sub-basin. Data collection and recording was conducted 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 were relatively minor.

A detailed discussion of changes in physical habitat parameters and trends between 2005 and 2006 is currently not applicable because only two years of data were collected. Comparisons will be warranted after several years of sampling are completed. Ideally, long-term monitoring will incorporate different water year types and the natural variation of the system.

Recommendations for future years include:

- Continue to have a consistent crew of at least three, two for data collection and one for recording. This would increase the efficiency of data collection.
- 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 in 2007.
- 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 Colville Tribes Fish and Wildlife Department.

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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 |
| McLean 374 | Okanagan River415 | Okanagan River 474 | Okanagan River 319 |
| Inkaneep 535 | Testalinden 375 | Okanagan River 346 | Haynes 471 |
| Vaseux 177 | Reed 567 | Reed 403 | Ellis 390 |
| Shuttleworth 522 | Wolfcub 543 | 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 | Okanagan River 467 | Ellis 530 |
| Ellis 492 | Marron creek 514 | Shuttleworth 394 |
| Shingle 541 | Okanagan River 406 | Haynes 519 |
| 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 0.01m 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 2006, averaged over each site.

| 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/Bankfull Depth ratio | Average Flood prone Width (m) | Average Flood prone Depth (m) | Entrenchment Ratio (Bankfull width/Flood prone width) | Average Gradient (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ellis **470** | 6.10 | 0.25 | 9.6 | 0.0 | 0.0 | 22.9 | 8.5 | 13.5 | 1.1 | 1.5 | 0.0 |
| Haynes **471** | 1.20 | 0.08 | 4.1 | 1.2 | 1.2 | 16.1 | 3.3 | 8.7 | 2.4 | 2.2 | 0.6 |
| Inkaneep **351** | 2.90 | 0.25 | 6.3 | 1.3 | 1.1 | 10.9 | 4.6 | 8.2 | 2.6 | 1.3 | 2.7 |
| Inkaneep **535** | 4.70 | 0.02 | 13.2 | 1.0 | 0.8 | 20.3 | 12.7 | 27.9 | 2.1 | 2.1 | 0.2 |
| McLean **310** | 2.40 | 0.15 | 6.8 | 1.1 | 1.0 | 17.8 | 6.4 | 6.2 | 2.2 | 2.0 | 2.4 |
| Okanagan **346** | Non wadable | | | | | | | | | | |
| Okanagan **490** | 30.10 | 1.01 | 36.2 | 1.7 | 0.8 | 33.4 | 20.7 | 48.6 | 3.5 | 1.4 | 0.7 |
| Okanagan (SC) **490** | 10.20 | 0.13 | 12.7 | 0.4 | 0.6 | 4.6 | 2.8 | 3.4 | 0.6 | 1.4 | 0.6 |
| Okanagan **493** | 23.75 | 0.00 | 33.0 | 2.6 | 1.5 | 21.6 | 12.6 | 32.8 | 5.2 | 1.0 | N/A |
| Okanagan **562** | 0.40 | 0.40 | 33.7 | 1.9 | 0.0 | 0.0 | 17.4 | 33.7 | 1.9 | 1.0 | 0.0 |
| Reed **403** | 1.40 | 0.12 | 5.5 | 0.9 | 0.8 | 14.0 | 6.3 | 7.5 | 1.9 | 1.5 | 6.0 |
| Shingle **317** | 4.10 | 0.26 | 7.7 | 1.0 | 0.8 | 16.9 | 9.8 | 9.4 | 1.9 | 1.4 | 0.9 |
| Shingle **333** | 3.13 | 0.24 | 9.9 | 1.1 | 0.9 | 48.9 | 9.3 | 16.0 | 2.2 | 1.5 | N/A |
| Shuttleworth **522** | 4.50 | 0.15 | 11.0 | 0.9 | 0.8 | 27.4 | 11.0 | 20.1 | 2.0 | 1.8 | 2.0 |
| Shuttleworth **538** | 4.00 | 0.15 | 21.4 | 1.2 | 1.1 | 27.8 | 18.2 | 39.4 | 1.2 | 1.8 | 2.5 |
| Vaseux **177** | 5.00 | 0.20 | 22.8 | 1.2 | 1.1 | 26.0 | 19.5 | 37.5 | 2.5 | 1.8 | 2.3 |
| Shatford **338** | 4.70 | 0.16 | 9.0 | 1.1 | 0.9 | 31.0 | 8.3 | 16.6 | 2.1 | 1.9 | 1.5 |

**Appendix 4a.** Summary of habitat data collected in 2006, averaged over each site.

| EMAP Site Name and 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 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ellis **470** | 0 | 0 | 0 | 0 | 61 | 38 | 0 | 0 | 0 | 0.00 | 0 |
| Haynes **471** | 0 | 0 | 0 | 0 | 0 | 99 | 0 | 0 | 0 | 0.00 | 0 |
| Inkaneep **351** | 12 | 0 | 6 | 0 | 50 | 27 | 0 | 0 | 0 | 0.00 | 0 |
| Inkaneep **535** | 0 | 0 | 1 | 0 | 3 | 6 | 0 | 0 | 0 | 0.00 | 0 |
| McLean **310** | 12 | 0 | 10 | 0 | 16 | 61 | 0 | 0 | 0 | 0.00 | 0 |
| Okanagan **346** | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 |
| Okanagan **490** | 0 | 0 | 0 | 0 | 4 | 72 | 0 | 0 | 0 | 0.00 | 0 |
| Okanagan (SC) **490** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 |
| Okanagan **493** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 |
| Okanagan **562** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 |
| Reed **403** | 9 | 0 | 4 | 0 | 5 | 68 | 0 | 0 | 0 | 0.00 | 0 |
| Shingle **317** | 9 | 0 | 2 | 0 | 47 | 36 | 0 | 0 | 0 | 0.00 | 0 |
| Shingle **333** | 33 | 0 | 18 | 0 | 2 | 47 | 0 | 0 | 3 | 0.69 | 0 |
| Shuttleworth **522** | 1 | 0 | 1 | 0 | 35 | 58 | 0 | 0 | 0 | 0.00 | 0 |
| Shuttleworth **538** | 0 | 1 | 2 | 0 | 34 | 51 | 0 | 0 | 0 | 0.00 | 0 |
| Shuttleworth(SC)**538** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 |
| Vaseux **177** | 0 | 0 | 0 | 0 | 56 | 38 | 0 | 0 | 0 | 0.00 | 0 |
| Shatford **338** | 8 | 0 | 7 | 0 | 18 | 66 | 0 | 0 | 0 | 0.00 | 0 |

**Appendix 4b.** Summary of habitat data collected in 2006, averaged over each site

| EMAP Site Name & Number | Average Total Pools (%) | Average Total Riffles (%) | Pool/Riffle Ratio | Small LWD >10cm & >1m in length (#) | Large LWD >10cm & >2m in length (#) | Average Small Sediment (%) |
|---|---|---|---|---|---|---|
| Ellis **470** | 0 | 99 | 0.00 | 20 | 20 | 42 |
| Haynes **471** | 0 | 99 | 0.00 | 0 | 0 | 99 |
| Inkaneep **351** | 12 | 83 | 0.15 | 0 | 20 | 36 |
| Inkaneep **535** | 0 | 10 | 0.00 | 11 | 32 | 90 |
| McLean **310** | 12 | 87 | 0.16 | 17 | 45 | 82 |
| Okanagan **346** | 21 | 0 | 10.00 | 4 | 3 | 0 |
| Okanagan **490** | 0 | 76 | 10.00 | 18 | 33 | 1 |
| Okanagan (SC) **490** | 0 | 0 | 10.00 | 0 | 0 | 0 |
| Okanagan **493** | 0 | 0 | 10.00 | 0 | 0 | 0 |
| Okanagan **562** | 0 | 0 | 10.00 | 0 | 0 | 0 |
| Reed **403** | 9 | 77 | 0.16 | 23 | 66 | 72 |
| Shingle **317** | 9 | 84 | 0.17 | 7 | 11 | 69 |
| Shingle **333** | 33 | 66 | 0.69 | 0 | 0 | 79 |
| Shuttleworth **522** | 1 | 0 | 0.01 | 9 | 19 | 80 |
| Shuttleworth **538** | 1 | 87 | 1.01 | 13 | 31 | 59 |
| Shuttleworth(SC)**538** | 0 | 0 | 9.23 | 0 | 0 | 0 |
| Vaseux **177** | 0 | 1 | 0.00 | 2 | 15 | 0 |
| Shatford **338** | 8 | 91 | 0.13 | 8 | 16 | 75 |

**Appendix 5**. Summary of substrate characteristics collected in 2006, averaged for each site.

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ellis **470** | 0 | 0 | 3 | 35 | 34 | 4 | 3 | 0 | 10 | 0 | 0 | 3 | 40 |
| Haynes **471** | 0 | 0 | 0 | 0 | 7 | 18 | 1 | 0 | 13 | 0 | 1 | 55 | 60 |
| Inkaneep **351** | 0 | 0 | 16 | 34 | 28 | 4 | 3 | 0 | 8 | 1 | 1 | 1 | 60 |
| Inkaneep **535** | 0 | 0 | 0 | 0 | 8 | 11 | 3 | 1 | 23 | 0 | 0 | 2 | 68 |
| McLean **310** | 0 | 0 | 3 | 15 | 16 | 2 | 1 | 1 | 24 | 0 | 11 | 16 | 41 |
| Okanagan **346** | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 81 | 0 | 0 | 0 | 17 | 80 |
| Okanagan **490** | 0 | 0 | 4 | 1 | 64 | 7 | 0 | 0 | 1 | 0 | 0 | 13 | 29 |
| Okanagan (SC)**490** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Okanagan **493** | 0 | 0 | 4 | 19 | 50 | 0 | 0 | 0 | 1 | 0 | 0 | 26 | 21 |
| Okanagan **562** | 0 | 0 | 0 | 0 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Reed **403** | 0 | 0 | 1 | 3 | 7 | 4 | 4 | 0 | 33 | 0 | 9 | 35 | 50 |
| Shingle **317** | 0 | 0 | 3 | 28 | 10 | 4 | 7 | 0 | 32 | 2 | 1 | 4 | 69 |
| Shingle **333** | 0 | 0 | 1 | 5 | 26 | 5 | 4 | 10 | 12 | 1 | 6 | 27 | 49 |
| Shuttleworth **522** | 0 | 0 | 3 | 19 | 29 | 0 | 1 | 0 | 21 | 0 | 2 | 16 | 43 |
| Shuttleworth **538** | 0 | 0 | 10 | 29 | 33 | 6 | 4 | 0 | 10 | 0 | 2 | 2 | 50 |
| Shuttleworth(SC)**538** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vaseux **177** | 0 | 0 | 17 | 30 | 28 | 3 | 3 | 0 | 9 | 0 | 3 | 3 | 37 |
| Shatford **338** | 0 | 0 | 1 | 22 | 23 | 0 | 0 | 0 | 4 | 0 | 2 | 15 | 30 |

**Appendix 6.** Summary of riparian vegetation collected in 2006, averaged for each site.

| 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 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ellis **470** | 87.7 | 90.9 | 94.4 | 33.2 | 28.1 | 94.4 | 29.5 | 3.4 | 32.9 | 32.6 | 37.2 | 1.9 |
| Haynes **471** | 97.2 | 98.9 | 100.0 | 1.0 | 33.8 | 100.0 | 49.0 | 0.0 | 20.0 | 59.7 | 9.0 | 0.0 |
| Inkaneep **351** | 89.0 | 97.6 | 10.0 | 20.0 | 1.0 | 63.6 | 38.9 | 0.0 | 57.5 | 15.9 | 14.1 | 11.0 |
| Inkaneep **535** | 75.0 | 82.0 | 100.0 | 28.0 | 22.0 | 100.0 | 43.8 | 1.5 | 34.0 | 40.3 | 19.0 | 17.5 |
| McLean **310** | 96.8 | 98.1 | 18.2 | 5.0 | 12.5 | 95.5 | 44.9 | 0.0 | 60.7 | 15.5 | 9.1 | 20.9 |
| Okanagan **346** | 44.3 | 88.5 | 0.0 | 0.0 | 0.0 | 100.0 | 17.5 | 10.0 | 21.6 | 61.3 | 26.9 | 0.5 |
| Okanagan **490** | 44.7 | 85.3 | 100.0 | 6.5 | 47.8 | 100.0 | 31.7 | 1.3 | 22.3 | 40.5 | 7.7 | 4.5 |
| Okanagan **493** | 25.9 | 51.9 | 100.0 | 5.8 | 5.8 | 75.0 | 10.0 | 0.0 | 30.5 | 91.5 | 4.1 | 0.0 |
| Okanagan **562** | 43.0 | 86.1 | 0.0 | 0.0 | 0.0 | 75.0 | 10.0 | 0.0 | 27.7 | 55.9 | 42.3 | 0.0 |
| Reed **403** | 100.0 | 100.0 | 48.6 | 37.9 | 9.3 | 90.9 | 63.9 | 0.0 | 67.0 | 5.0 | 26.4 | 33.2 |
| Shingle **317** | 78.7 | 82.9 | 77.3 | 25.7 | 10.7 | 43.9 | 25.0 | 0.0 | 37.3 | 36.4 | 19.5 | 6.8 |
| Shingle **333** | 65.0 | 67.0 | 94.4 | 33.3 | 19.8 | 95.0 | 30.2 | 1.5 | 41.8 | 45.8 | 7.5 | 17.5 |
| Shuttleworth **522** | 83.7 | 90.6 | 95.0 | 36.6 | 9.1 | 73.3 | 42.9 | 0.0 | 61.5 | 32.5 | 8.1 | 10.7 |
| Shuttleworth **538** | 67.2 | 86.9 | 0.0 | 0.0 | 0.0 | 28.2 | 45.0 | 0.0 | 52.7 | 16.4 | 23.6 | 12.3 |
| Vaseux **177** | 41.0 | 48.4 | 16.7 | 20.0 | 0.0 | 8.3 | 20.0 | 0.0 | 67.0 | 27.7 | 5.9 | 20.9 |
| Shatford **338** | 65.2 | 81.8 | 100.0 | 13.0 | 24.6 | 100.0 | 36.4 | 0.0 | 30.5 | 44.8 | 2.7 | 3.2 |

**Appendix 7a.** Summary of human influence characteristics collected in 2006, 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** |
| Ellis **470** | 20 | 0 | 0 | 80 | 0 | 5 | 35 | 60 | 40 | 0 | 0 | 60 |
| Haynes **471** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Inkaneep **351** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 25 | 15 | 25 | 35 |
| Inkaneep **535** | 10 | 0 | 0 | 90 | 0 | 0 | 0 | 100 | 15 | 0 | 15 | 70 |
| McLean **310** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 5 | 0 | 95 |
| Okanagan **346** | 0 | 100 | 0 | 0 | 0 | 5 | 20 | 75 | 5 | 50 | 0 | 45 |
| Okanagan **490** | 40 | 0 | 0 | 60 | 0 | 10 | 0 | 90 | 10 | 0 | 0 | 90 |
| Okanagan (SC) **490** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **493** | 0 | 0 | 0 | 100 | 0 | 0 | 5 | 95 | 100 | 0 | 0 | 0 |
| Okanagan **562** | 20 | 0 | 0 | 80 | 0 | 0 | 0 | 100 | 50 | 0 | 0 | 50 |
| Reed **403** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 10 | 0 | 0 | 90 |
| Shingle **317** | 0 | 55 | 0 | 45 | 0 | 0 | 20 | 80 | 30 | 0 | 0 | 70 |
| Shingle **333** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 15 | 10 | 5 | 70 |
| Shuttleworth **522** | 25 | 5 | 0 | 70 | 0 | 0 | 0 | 100 | 15 | 5 | 0 | 70 |
| Shuttleworth **538** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 5 | 0 | 95 |
| Shuttleworth(SC)**538** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Vaseux **177** | 5 | 0 | 15 | 80 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shatford **338** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 45 | 0 | 0 | 55 |

**Appendix 7b.** Summary of human influence characteristics collected in 2006, 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 |
| Ellis **470** | 0 | 10 | 60 | 25 | 15 | 0 | 0 | 85 | 5 | 0 | 0 | 95 |
| Haynes **471** | 0 | 90 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Inkaneep **351** | 0 | 5 | 5 | 85 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Inkaneep **535** | 5 | 5 | 35 | 55 | 0 | 0 | 0 | 100 | 5 | 0 | 0 | 95 |
| McLean **310** | 0 | 0 | 30 | 70 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **346** | 0 | 0 | 0 | 100 | 5 | 0 | 0 | 95 | 0 | 0 | 0 | 100 |
| Okanagan **490** | 0 | 5 | 40 | 55 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan (SC)**490** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **493** | 5 | 0 | 85 | 5 | 5 | 0 | 0 | 95 | 0 | 0 | 0 | 100 |
| Okanagan **562** | 0 | 50 | 50 | 0 | 10 | 0 | 0 | 90 | 0 | 0 | 0 | 100 |
| Reed **403** | 0 | 20 | 25 | 50 | 55 | 0 | 0 | 45 | 40 | 20 | 0 | 40 |
| Shingle **317** | 0 | 0 | 45 | 50 | 0 | 0 | 0 | 100 | 5 | 10 | 5 | 80 |
| Shingle **333** | 0 | 5 | 10 | 85 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shuttleworth **522** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 95 |
| Shuttleworth **538** | 0 | 10 | 30 | 55 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shuttleworth(SC)**538** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Vaseux **177** | 0 | 5 | 15 | 80 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shatford **338** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |

**Appendix 7c.** Summary of human influence characteristics collected in 2006, averaged for each site.

| | 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** |
| Ellis **470** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Haynes **471** | 0 | 0 | 0 | 100 | 0 | 90 | 5 | 5 | 0 | 0 | 0 | 100 |
| Inkaneep **351** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 25 | 40 | 35 | 0 |
| Inkaneep **535** | 0 | 0 | 5 | 95 | 0 | 0 | 0 | 100 | 0 | 0 | 50 | 50 |
| McLean **310** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **346** | 0 | 5 | 5 | 90 | 0 | 0 | 0 | 100 | 0 | 0 | 5 | 95 |
| Okanagan **490** | 0 | 0 | 0 | 100 | 0 | 0 | 10 | 90 | 0 | 0 | 0 | 100 |
| Okanagan (SC) **490** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **493** | 0 | 0 | 70 | 30 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **562** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Reed **403** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 15 | 10 | 75 |
| Shingle **317** | 0 | 0 | 10 | 90 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shingle **333** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 20 | 80 |
| Shuttleworth **522** | 0 | 0 | 5 | 95 | 0 | 0 | 0 | 100 | 10 | 20 | 45 | 20 |
| Shuttleworth **538** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shuttleworth(SC)**538** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Vaseux **177** | 55 | 0 | 5 | 40 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shatford **338** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 5 | 5 | 40 | 50 |

**Appendix 7d.** Summary of human influence characteristics collected in 2006, 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** |
| Ellis **470** | 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 **351** | 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 |
| McLean **310** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **346** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **490** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan (SC) **490** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **493** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Okanagan **562** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Reed **403** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 5 | 0 | 0 | 95 |
| Shingle **317** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shingle **333** | 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 |
| Shuttleworth **538** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |
| Shuttleworth(SC)**538** | 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 |
| Shatford **338** | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 |

**Appendix 8.** Summary of water quality parameters measured at annual and panel habitat sites, April to September, 2006.

| Ellis-470 | | | | | |
|---|---|---|---|---|---|
| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
| 11-Apr-06 | 8.03 | 13.88 | 8.16 | 45.9 | 117.58 |
| 17-Apr-06 | 4.86 | 15.94 | 8.11 | 28.2 | 124.63 |
| 24-Apr-06 | 6.97 | 14.95 | 7.65 | 37.0 | 123.31 |
| 27-Apr-06 | 5.45 | 15.82 | 7.8 | 13.8 | 125.6 |
| 3-May-06 | 6.91 | 14.93 | 7.79 | 46.8 | 122.99 |
| 9-May-06 | 5.62 | 15.6 | 7.58 | 48.5 | 124.41 |
| 10-May-06 | 14.13 | 10.99 | 7.53 | 7.4 | 107.18 |
| 16-Jun-06 | 11.98 | 13.35 | 7.44 | 21.0 | 124.06 |
| 27-Jun-06 | 20.36 | 8.42 | 7.95 | 6.4 | 93.51 |
| 4-Jul-06 | 17.56 | 7.94 | 8.1 | 1.3 | 83.33 |
| 18-Jul-06 | 16.09 | 7.09 | 8.38 | 1.0 | 72.18 |
| 27-Jul-06 | 22.73 | 6.56 | 8.43 | 2.6 | 76.29 |
| 10-Aug-06 | 18.63 | 5.72 | 8.21 | 3.9 | 61.36 |
| 19-Aug-06 | 18.17 | 7.21 | 8.55 | 2.5 | 76.57 |
| 30-Aug-06 | 14.59 | 10.58 | 8.07 | 63.6 | 105.6 |
| 9-Sep-06 | 18.08 | 10.15 | 8.6 | 2.0 | 109.13 |
| 14-Sep-06 | 13.59 | 11.51 | 8.42 | 7.4 | 112.47 |
| 26-Sep-06 | 13.26 | 12.72 | 8.67 | 0.9 | 123.32 |
| **Average** | 13.17 | 11.30 | 8.08 | 18.90 | 104.64 |
| **Min** | 4.86 | 5.72 | 7.44 | 0.90 | 61.36 |
| **Max** | 22.73 | 15.94 | 8.67 | 63.60 | 125.60 |
| **Stdev.** | 5.66 | 3.51 | 0.38 | 20.65 | 21.68 |

| McLean-310 | | | | | |
|---|---|---|---|---|---|
| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
| 11-Apr-06 | 9.31 | 11.9 | 8.39 | 17.8 | 104.05 |
| 17-Apr-06 | 7.88 | 14.09 | 8.4 | 4.7 | 118.96 |
| 24-Apr-06 | 9.64 | 12.59 | 8.3 | 17.7 | 110.94 |
| 25-Apr-06 | 10.28 | 12.79 | 8.28 | 9.9 | 114.35 |
| 27-Apr-06 | 10.29 | 13.29 | 8.33 | 7.1 | 118.84 |
| 3-May-06 | 8.29 | 14.17 | 8.18 | 86.6 | 120.79 |
| 8-May-06 | 6.96 | 14.44 | 8.06 | 19.6 | 119.13 |
| 16-May-06 | 8.76 | 13.62 | 7.88 | 35.11 | 117.37 |
| 8-Jun-06 | 12.17 | 11.28 | 7.98 | 16.6 | 105.33 |
| 15-Jun-06 | 11.72 | 11.4 | 8 | 37.4 | 105.31 |
| 27-Jun-06 | 14.35 | 10.69 | 8.16 | 4 | 104.83 |
| 5-Jul-06 | 17.95 | 7.87 | 8.33 | 3 | 83.26 |
| 17-Jul-06 | 16.44 | 7.35 | 8.44 | 1.2 | 75.42 |
| 27-Jul-06 | 16.72 | 7.11 | 8.57 | 1.2 | 73.42 |
| 11-Aug-06 | 13.65 | 7.29 | 8.56 | 0.4 | 70.41 |
| 30-Aug-06 | 11.56 | 11.96 | 8.65 | -0.6 | 111.72 |
| 8-Sep-06 | 14.05 | 11.51 | 8.66 | -0.2 | 113.7 |
| 26-Sep-06 | 12.05 | 12.38 | 8.69 | -0.7 | 116.96 |
| **Average** | 11.78 | 11.43 | 8.33 | 14.49 | 104.71 |
| **Min** | 6.96 | 7.11 | 7.88 | -0.70 | 70.41 |
| **Max** | 17.95 | 14.44 | 8.69 | 86.60 | 120.79 |
| **Stdev.** | 3.20 | 2.45 | 0.25 | 21.48 | 17.01 |

**Appendix 8.** (Continued)

Haynes-471

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 13-Apr-06 | 11.07 | 11.61 | 8.46 | 15.5 | 105.87 |
| 24-Apr-06 | 6.46 | 14.19 | 8.11 | 162.1 | 115.6 |
| 25-Apr-06 | 7.45 | 15.36 | 8.11 | 159.5 | 128.26 |
| 2-May-06 | 8.4 | 14.23 | 8.13 | 77.6 | 121.61 |
| 8-May-06 | 8.38 | 12.32 | 8.22 | 88.0 | 105.22 |
| 12-May-06 | 8.45 | 11.02 | 8.08 | 16.7 | 94.33 |
| 6-Jun-06 | 15.58 | 9.93 | 8.55 | 1.7 | 100.06 |
| 15-Jun-06 | 12.67 | 10.42 | 8.31 | 32.8 | 98.38 |
| 23-Jun-06 | 14.31 | 10.87 | 8.61 | 7.4 | 106.53 |
| 7-Jul-06 | 15.93 | 9.02 | 8.71 | 36.2 | 91.61 |
| 17-Jul-06 | 17.17 | 7.68 | 8.9 | 1.7 | 80.11 |
| 27-Jul-06 | 18.18 | 8.28 | 8.88 | 1.1 | 88.1 |
| 10-Aug-06 | 16.89 | 6.43 | 9.07 | 0.1 | 66.7 |
| 15-Aug-06 | 18.0 | 6.55 | 9.1 | 0.1 | 69.49 |
| 28-Aug-06 | 16.56 | 7.58 | 8.99 | 0.4 | 78.07 |
| 9-Sep-06 | 16.55 | 10.26 | 9.04 | 0.3 | 106.98 |
| 14-Sep-06 | 12.84 | 11.22 | 8.95 | -0.4 | 108.01 |
| 26-Sep-06 | 12.55 | 12.06 | 8.95 | 2.7 | 115.31 |
| **Average** | 13.19 | 10.50 | 8.62 | 33.53 | 98.90 |
| **Min** | 6.46 | 6.43 | 8.08 | -0.40 | 66.70 |
| **Max** | 18.18 | 15.36 | 9.10 | 162.10 | 128.26 |
| **Stdev.** | 3.96 | 2.60 | 0.38 | 53.26 | 17.32 |

Okanagan-346

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 10-Apr-06 | 6.8 | 13.32 | 8.62 | 5.4 | 109.46 |
| 13-Apr-06 | 6.47 | 15.04 | 8.67 | 7.2 | 122.61 |
| 24-Apr-06 | 8.91 | 14.4 | 8.56 | 17 | 124.62 |
| 25-Apr-06 | 9.85 | 13.68 | 8.56 | 16.3 | 121.13 |
| 3-May-06 | 11.99 | 13.31 | 8.56 | 8.1 | 123.76 |
| 8-May-06 | 10.08 | 13.35 | 8.56 | 6.2 | 118.86 |
| 12-May-06 | 10.83 | 11.62 | 8.6 | 2.1 | 105.27 |
| 16-May-06 | 14.92 | 10.17 | 8.62 | 9.5 | 100.96 |
| 6-Jun-06 | 16.43 | 10.12 | 8.76 | 1.7 | 103.75 |
| 15-Jun-06 | 17.42 | 9.07 | 8.75 | 3.8 | 94.91 |
| 23-Jun-06 | 19.58 | 9.52 | 8.86 | 1.3 | 104.14 |
| 5-Jul-06 | 25.86 | 7.42 | 9.08 | 2.9 | 91.51 |
| 17-Jul-06 | 23.17 | 6.9 | 9 | 1.4 | 80.96 |
| 27-Jul-06 | 25.47 | 6.74 | 9.02 | 0.4 | 82.48 |
| 10-Aug-06 | 22.54 | 5.71 | 9.04 | 0.2 | 66.18 |
| 19-Aug-06 | 23 | 6.21 | 9.18 | 0.7 | 72.61 |
| 30-Aug-06 | 20.36 | 9.7 | 9.14 | 0.8 | 109.25 |
| 8-Sep-06 | 22.27 | 9.51 | 9.24 | 0.8 | 111.08 |
| 14-Sep-06 | 18.71 | 8.93 | 8.91 | 1.2 | 97.23 |
| 26-Sep-06 | 16.59 | 11.17 | 8.92 | 0.6 | 116.5 |
| **Average** | 16.56 | 10.29 | 8.83 | 4.38 | 102.86 |
| **Min** | 6.47 | 5.71 | 8.56 | 0.20 | 66.18 |
| **Max** | 25.86 | 15.04 | 9.24 | 17.00 | 124.62 |
| **Stdev.** | 6.27 | 2.87 | 0.23 | 5.05 | 17.20 |

**Appendix 8.** (Continued)

| Inkaneep-351 | | | | | |
|---|---|---|---|---|---|
| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
| 6-Apr-06 | 8.64 | 11.21 | 8.47 | 19.6 | 96.33 |
| 13-Apr-06 | 5.06 | 13.22 | 7.97 | 74.8 | 103.93 |
| 24-Apr-06 | 3.34 | 16.72 | 7.69 | 164.9 | 125.64 |
| 25-Apr-06 | 4.26 | 17.64 | 7.58 | 205.8 | 135.81 |
| 2-May-06 | 5.03 | 15.87 | 7.58 | 131.2 | 124.63 |
| 8-May-06 | 5.26 | 14.14 | 7.71 | 158.8 | 111.72 |
| 12-May-06 | 6.68 | 14.0 | 7.58 | 281.3 | 114.66 |
| 6-Jun-06 | 10.24 | 10.71 | 7.6 | 33.9 | 95.64 |
| 15-Jun-06 | 10.83 | 11.11 | 7.76 | 48.3 | 100.59 |
| 23-Jun-06 | 10.43 | 11.69 | 7.96 | 219 | 104.9 |
| 5-Jul-06 | 20.07 | 7.7 | 8.2 | 12.3 | 85.02 |
| 17-Jul-06 | 14.36 | 9.6 | 8.3 | 0.6 | 94.07 |
| 27-Jul-06 | 17.39 | 8.54 | 8.42 | 0.1 | 89.23 |
| 11-Aug-06 | 16.55 | 5.73 | 8.57 | 0.5 | 58.91 |
| 30-Aug-06 | 15.19 | 10.21 | 8.76 | -0.6 | 103.31 |
| 10-Sep-06 | 15.77 | 10.01 | 8.75 | 0.1 | 102.49 |
| 14-Sep-06 | 11.27 | 11.92 | 8.71 | 0.2 | 110.51 |
| 26-Sep-06 | 10.91 | 12.81 | 8.7 | 0 | 117.74 |
| **Average** | 10.63 | 11.82 | 8.13 | 75.04 | 104.17 |
| **Min** | 3.34 | 5.73 | 7.58 | -0.60 | 58.91 |
| **Max** | 20.07 | 17.64 | 8.76 | 281.30 | 135.81 |
| **Stdev.** | 5.07 | 3.12 | 0.46 | 93.09 | 17.43 |

| Okanagan-474 | | | | | |
|---|---|---|---|---|---|
| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
| 11-Apr-06 | 6.35 | 12.99 | 8.67 | -0.2 | 105.56 |
| 13-Apr-06 | 5.96 | 13.1 | 8.39 | 0.3 | 105.42 |
| 24-Apr-06 | 8.1 | 13.88 | 8.55 | 0 | 117.83 |
| 25-Apr-06 | 8.94 | 13.75 | 8.57 | 0.6 | 119.14 |
| 27-Apr-06 | 9.01 | 13.56 | 8.59 | -0.6 | 117.66 |
| 3-May-06 | 10.82 | 13.02 | 8.68 | -1.1 | 117.92 |
| 8-May-06 | 9.93 | 13.2 | 8.58 | 0.4 | 117.05 |
| 16-May-06 | 14.2 | 11.38 | 8.68 | 0.4 | 111.25 |
| 6-Jun-06 | 16.26 | 9.92 | 8.74 | 1.4 | 101.3 |
| 15-Jun-06 | 17.45 | 9.18 | 8.76 | 0.4 | 96.13 |
| 23-Jun-06 | 19.34 | 8.38 | 8.85 | 1.1 | 91.15 |
| 4-Jul-06 | 24.04 | 7.38 | 8.86 | 0.7 | 87.98 |
| 17-Jul-06 | 22.75 | 6.61 | 8.94 | 0.4 | 76.92 |
| 27-Jul-06 | 25.35 | 6.38 | 8.95 | -0.1 | 77.96 |
| 10-Aug-06 | 22.54 | 5.71 | 9.04 | 0.2 | 66.18 |
| 19-Aug-06 | 22.58 | 5.92 | 9.05 | 0.7 | 68.65 |
| **Average** | 15.23 | 10.27 | 8.74 | 0.29 | 98.63 |
| **Min** | 5.96 | 5.71 | 8.39 | -1.10 | 66.18 |
| **Max** | 25.35 | 13.88 | 9.05 | 1.40 | 119.14 |
| **Stdev.** | 6.88 | 3.16 | 0.19 | 0.61 | 18.53 |

**Appendix 8.** (continued)

Inkaneep-535

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 3-Apr-06 | 5.63 | 11.95 | 8.26 | 13.0 | 95.34 |
| 6-Apr-06 | 6.74 | 10.89 | 8.17 | 35.0 | 89.39 |
| 24-Apr-06 | 4.82 | 15.44 | 7.7 | 23.6 | 120.6 |
| 25-Apr-06 | 5.69 | 16.24 | 7.71 | 34.6 | 129.74 |
| 26-Apr-06 | 9.01 | 13.96 | 7.8 | 64.0 | 121.1 |
| 2-May-06 | 6.54 | 15.64 | 7.69 | 33.3 | 127.62 |
| 8-May-06 | 6.17 | 14.92 | 7.69 | 47.8 | 120.62 |
| 12-May-06 | 7.53 | 11.85 | 7.65 | 26.5 | 99.16 |
| 6-Jun-06 | 11.32 | 11.03 | 7.64 | 14.6 | 101.04 |
| 15-Jun-06 | 11.71 | 11.48 | 7.75 | 13.7 | 106.06 |
| 23-Jun-06 | 11.7 | 13.13 | 7.93 | 12.6 | 121.29 |
| 5-Jul-06 | 22.47 | 7.16 | 8.19 | 3.6 | 82.87 |
| 17-Jul-06 | 15.74 | 8.29 | 8.28 | 0.8 | 83.72 |
| 27-Jul-06 | 19.24 | 8.15 | 8.35 | 0.5 | 88.46 |
| 11-Aug-06 | 17.53 | 6.54 | 8.55 | 0 | 68.61 |
| 30-Aug-06 | 16.15 | 10.84 | 8.76 | 0.1 | 111.93 |
| 10-Sep-06 | 17.4 | 9.83 | 8.78 | 0.3 | 104.17 |
| 14-Sep-06 | 12.49 | 11.45 | 8.73 | -0.1 | 109.18 |
| 26-Sep-06 | 11.87 | 12.78 | 8.71 | -0.1 | 120.09 |
| **Average** | 11.57 | 11.66 | 8.12 | 17.04 | 105.32 |
| **Min** | 4.82 | 6.54 | 7.64 | -0.10 | 68.61 |
| **Max** | 22.47 | 16.24 | 8.78 | 64.00 | 129.74 |
| **Stdev.** | 5.28 | 2.85 | 0.43 | 18.85 | 17.25 |

Okanagan-490

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 10-Apr-06 | 9.15 | 11.81 | 8.63 | 1 | 102.83 |
| 11-Apr-06 | 6.1 | 12.38 | 8.56 | -1.3 | 100.02 |
| 13-Apr-06 | 9.09 | 12.9 | 8.63 | 1.3 | 112.17 |
| 25-Apr-06 | 10.81 | 13.42 | 8.48 | 4.3 | 121.45 |
| 2-May-06 | 11.75 | 12.63 | 8.45 | 7.4 | 116.84 |
| 8-May-06 | 11.39 | 12.86 | 8.48 | 8.3 | 118.03 |
| 12-May-06 | 10.98 | 11.2 | 8.53 | 2.2 | 101.85 |
| 16-May-06 | 14.16 | 11.3 | 8.59 | -0.4 | 110.33 |
| 6-Jun-06 | 16.62 | 9.77 | 8.67 | 6.4 | 100.5 |
| 15-Jun-06 | 17.03 | 9.86 | 8.62 | 4.5 | 102.35 |
| 23-Jun-06 | 19.77 | 9 | 8.83 | 1.7 | 98.83 |
| 5-Jul-06 | 25.26 | 6.77 | 8.91 | 0 | 82.54 |
| 17-Jul-06 | 23.08 | 6.88 | 8.92 | -0.2 | 80.55 |
| 27-Jul-06 | 26.79 | 6.22 | 8.98 | 0.3 | 78.02 |
| 11-Aug-06 | 22.55 | 5.77 | 9.03 | 0.1 | 66.94 |
| 30-Aug-06 | 20.88 | 9.41 | 9.12 | 0.3 | 107.07 |
| 14-Sep-06 | 18.84 | 9.32 | 8.92 | -0.3 | 101.75 |
| 26-Sep-06 | 16.48 | 10.62 | 8.9 | 0 | 110.42 |
| **Average** | 16.15 | 10.12 | 8.74 | 1.98 | 100.69 |
| **Min** | 6.10 | 5.77 | 8.45 | -1.30 | 66.94 |
| **Max** | 26.79 | 13.42 | 9.12 | 8.30 | 121.45 |
| **Stdev.** | 6.09 | 2.45 | 0.21 | 2.93 | 14.86 |

**Appendix 8.** (continued)

Okanagan-493

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 17-Apr-06 | 5.34 | 15.84 | 8.64 | -1.4 | 125.48 |
| 24-Apr-06 | 8.16 | 14.68 | 8.56 | -0.7 | 124.83 |
| 27-Apr-06 | 8.18 | 15.52 | 8.61 | -0.8 | 132.01 |
| 3-May-06 | 10.48 | 13.84 | 8.66 | 0.1 | 124.38 |
| 9-May-06 | 9.92 | 11.79 | 8.62 | -1.3 | 104.56 |
| 8-Jun-06 | 18.33 | 9.53 | 8.75 | 0.6 | 101.59 |
| 16-Jun-06 | 16.42 | 9.54 | 8.82 | -0.3 | 97.8 |
| 27-Jun-06 | 22.92 | 8.63 | 8.83 | 0.7 | 100.74 |
| 4-Jul-06 | 23.88 | 7.45 | 8.79 | 0.5 | 88.57 |
| 18-Jul-06 | 22.9 | 6.62 | 8.86 | -1.1 | 77.2 |
| 27-Jul-06 | 25.43 | 7 | 9.02 | -0.1 | 85.6 |
| 10-Aug-06 | 21.87 | 4.37 | 9.03 | 0.3 | 50.04 |
| 19-Aug-06 | 22.7 | 6.42 | 9.07 | 0.3 | 74.65 |
| 30-Aug-06 | 20.69 | 9.12 | 9.05 | 0.2 | 103.36 |
| 8-Sep-06 | 21.87 | 9.68 | 9.09 | 0.3 | 112.22 |
| 10-Sep-06 | 20.86 | 9.68 | 9.09 | 0.4 | 110.04 |
| 14-Sep-06 | 20.03 | 10.57 | 9.11 | 0.6 | 118.18 |
| 26-Sep-06 | 17.96 | 10.95 | 9.08 | -0.4 | 117.46 |
| **Average** | 17.66 | 10.07 | 8.87 | -0.12 | 102.71 |
| **Min** | 5.34 | 4.37 | 8.56 | -1.40 | 50.04 |
| **Max** | 25.43 | 15.84 | 9.11 | 0.70 | 132.01 |
| **Stdev.** | 6.35 | 3.26 | 0.20 | 0.68 | 21.25 |

Okanagan-562

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 11-Apr-06 | 6.94 | 14.31 | 8.55 | 4.6 | 118.02 |
| 17-Apr-06 | 5.72 | 15.42 | 8.52 | 0.8 | 123.32 |
| 24-Apr-06 | 8.7 | 13.63 | 8.21 | 3.4 | 117.41 |
| 27-Apr-06 | 8.5 | 13.42 | 8.33 | 14.1 | 115.03 |
| 3-May-06 | 9.71 | 14.15 | 8.38 | 2.2 | 124.87 |
| 9-May-06 | 8.96 | 12.56 | 8.46 | 9.5 | 108.86 |
| 8-Jun-06 | 17.99 | 9.62 | 8.73 | 1.7 | 101.83 |
| 16-Jun-06 | 15.45 | 9.78 | 8.72 | 1.3 | 98.18 |
| 27-Jun-06 | 22.27 | 8.71 | 8.74 | 0.9 | 100.41 |
| 4-Jul-06 | 23.9 | 7.27 | 8.79 | 0.6 | 86.43 |
| 18-Jul-06 | 22.54 | 7.42 | 8.92 | 0.8 | 85.92 |
| 27-Jul-06 | 26.45 | 6.74 | 8.97 | -0.1 | 84.04 |
| 19-Aug-06 | 22.54 | 6.41 | 9.06 | 0.8 | 74.32 |
| 30-Aug-06 | 20.68 | 9.34 | 9 | 0.9 | 105.85 |
| 8-Sep-06 | 21.72 | 9.27 | 9.08 | -0.2 | 107.17 |
| 14-Sep-06 | 19.94 | 10.14 | 9.12 | 0.1 | 113.27 |
| 26-Sep-06 | 17.78 | 10.14 | 9.08 | -0.1 | 108.4 |
| **Average** | 16.46 | 10.49 | 8.74 | 2.43 | 104.31 |
| **Min** | 5.72 | 6.41 | 8.21 | -0.20 | 74.32 |
| **Max** | 26.45 | 15.42 | 9.12 | 14.10 | 124.87 |
| **Stdev.** | 6.88 | 2.88 | 0.29 | 3.83 | 14.61 |

**Appendix 8.** (Continued)

| Redd-403 | | | | | |
|---|---|---|---|---|---|
| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
| 6-Apr-06 | 6.87 | 10.62 | 8.56 | 25.3 | 87.48 |
| 13-Apr-06 | 6.86 | 11.04 | 8.55 | 23.7 | 90.98 |
| 24-Apr-06 | 7.07 | 14 | 8.48 | 10.9 | 115.89 |
| 25-Apr-06 | 7.5 | 14.16 | 8.54 | 7.8 | 118.54 |
| 2-May-06 | 7.69 | 13.56 | 8.54 | 15 | 114.05 |
| 8-May-06 | 6.45 | 14.08 | 8.43 | 17.6 | 114.84 |
| 12-May-06 | 6.88 | 12.38 | 8.47 | 36.6 | 102.04 |
| 6-Jun-06 | 9.33 | 12.22 | 8.53 | 7.5 | 106.96 |
| 15-Jun-06 | 9.21 | 11.91 | 8.57 | 7.7 | 103.92 |
| 23-Jun-06 | 9.96 | 10.14 | 8.61 | 5.9 | 90.07 |
| 10-Aug-06 | 11.6 | 7.15 | 8.65 | 2.7 | 66.04 |
| 30-Aug-06 | 11.28 | 11.33 | 8.67 | 0.1 | 105.25 |
| 10-Sep-06 | 11.6 | 10.6 | 8.66 | 1.8 | 99.16 |
| 14-Sep-06 | 9.96 | 11.92 | 8.64 | -0.3 | 107.38 |
| 26-Sep-06 | 9.88 | 12.82 | 8.65 | 0.1 | 115.21 |
| **Average** | 8.81 | 11.86 | 8.57 | 10.83 | 102.52 |
| **Min** | 6.45 | 7.15 | 8.43 | -0.30 | 66.04 |
| **Max** | 11.60 | 14.16 | 8.67 | 36.60 | 118.54 |
| **Stdev.** | 1.87 | 1.86 | 0.08 | 10.88 | 14.12 |

| Shingle-317 | | | | | |
|---|---|---|---|---|---|
| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
| 3-Apr-06 | 6.98 | 14.71 | 8.42 | 28.6 | 121.45 |
| 11-Apr-06 | 11.35 | 12 | 8.72 | 18.8 | 110.06 |
| 17-Apr-06 | 8.16 | 13.72 | 8.84 | 2 | 116.7 |
| 24-Apr-06 | 12.33 | 11.93 | 8.7 | 6.4 | 111.84 |
| 9-May-06 | 6.1 | 15.16 | 8.49 | 14.2 | 122.43 |
| 8-Jun-06 | 12.49 | 11.07 | 8.16 | 35.8 | 104.11 |
| 16-Jun-06 | 9.96 | 12.77 | 8.09 | 41 | 113.3 |
| 27-Jun-06 | 19.52 | 8.42 | 8.81 | 6.4 | 91.97 |
| 4-Jul-06 | 16.52 | 9.56 | 8.75 | 3.3 | 98.14 |
| 18-Jul-06 | 18.33 | 7.33 | 8.94 | 2.1 | 78.14 |
| 27-Jul-06 | 23.75 | 6.53 | 9.02 | 0.9 | 77.46 |
| 11-Aug-06 | 19.35 | 5.91 | 9.08 | 0.3 | 64.35 |
| 19-Aug-06 | 18.56 | 7.21 | 9.11 | 0.9 | 77.26 |
| 30-Aug-06 | 13.52 | 11.2 | 9.13 | 0.4 | 109.28 |
| 8-Sep-06 | 17.51 | 10.29 | 9.3 | 0.9 | 109.4 |
| 14-Sep-06 | 13.1 | 13.07 | 9.32 | 0.4 | 126.33 |
| 26-Sep-06 | 13.59 | 12.6 | 9.37 | 2 | 123.2 |
| **Average** | 14.18 | 10.79 | 8.84 | 9.67 | 103.26 |
| **Min** | 6.10 | 5.91 | 8.09 | 0.30 | 64.35 |
| **Max** | 23.75 | 15.16 | 9.37 | 41.00 | 126.33 |
| **Stdev.** | 4.92 | 2.88 | 0.38 | 13.36 | 18.95 |

**Appendix 8.** (Continued)

Shingle-333

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 11-Apr-06 | 8.72 | 12.51 | 8.67 | 5.4 | 107.84 |
| 17-Apr-06 | 6.83 | 13.72 | 8.58 | 0.1 | 112.93 |
| 24-Apr-06 | 12.08 | 11.32 | 8.42 | 5.3 | 105.5 |
| 27-Apr-06 | 6.59 | 13.8 | 8.2 | 16.3 | 112.84 |
| 3-May-06 | 5.17 | 15.81 | 7.76 | 6.3 | 124.68 |
| 9-May-06 | 5.08 | 16.24 | 7.85 | 7.2 | 127.68 |
| 8-Jun-06 | 10.41 | 16.32 | 7.79 | 28.7 | 146.33 |
| 16-Jun-06 | 8.21 | 13.75 | 7.67 | 42.4 | 116.97 |
| 28-Jun-06 | 15.41 | 7.84 | 8.3 | 3.2 | 78.6 |
| 4-Jul-06 | 15.25 | 9.74 | 8.15 | 1.8 | 97.37 |
| 18-Jul-06 | 17.33 | 7.7 | 8.64 | 1.9 | 80.39 |
| 27-Jul-06 | 21.71 | 6.95 | 7.9 | 0.7 | 79.27 |
| Aug-06 | Dry | Dry | Dry | Dry | Dry |
| Sep-06 | Dry | Dry | Dry | Dry | Dry |
| **Average** | 11.07 | 12.14 | 8.16 | 9.94 | 107.53 |
| **Min** | 5.08 | 6.95 | 7.67 | 0.10 | 78.60 |
| **Max** | 21.71 | 16.32 | 8.67 | 42.40 | 146.33 |
| **Stdev.** | 5.33 | 3.40 | 0.36 | 13.03 | 20.96 |

Shuttleworth-522

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 10-Apr-06 | 11.21 | 10.66 | 8.33 | 150.4 | 97.39 |
| 17-Apr-06 | 6.48 | 14.42 | 8.27 | 83.3 | 117.49 |
| 24-Apr-06 | 10.35 | 12.86 | 7.94 | 146.1 | 115.1 |
| 25-Apr-06 | 11.57 | 11.8 | 7.98 | 170.6 | 108.66 |
| 27-Apr-06 | 11.62 | 11.88 | 7.9 | 296.5 | 109.49 |
| 3-May-06 | 10.39 | 12.73 | 7.77 | 57.2 | 114.03 |
| 8-May-06 | 8.18 | 13.33 | 7.68 | 77.5 | 113.33 |
| 16-May-06 | 15.66 | 9.93 | 7.64 | 53.8 | 100.03 |
| 8-Jun-06 | 16.63 | 10.44 | 7.97 | 16.4 | 107.46 |
| 15-Jun-06 | 15.26 | 9.92 | 7.81 | 54.9 | 99.14 |
| 27-Jun-06 | 20.92 | 7.95 | 8.13 | 9 | 89.2 |
| 10-Aug-06 | 16.98 | 7.62 | 8.34 | 1.7 | 79.05 |
| 30-Aug-06 | 16.19 | 10.22 | 8.39 | 5.5 | 105.62 |
| 8-Sep-06 | 19.32 | 7.57 | 7.77 | 10.4 | 83.48 |
| 19-Sep-06 | 16.94 | 10.91 | 8.33 | 5.6 | 114.56 |
| 26-Sep-06 | 14.26 | 11.48 | 8.54 | 0.5 | 113.82 |
| **Average** | 13.87 | 10.86 | 8.05 | 71.21 | 104.24 |
| **Min** | 6.48 | 7.57 | 7.64 | 0.50 | 79.05 |
| **Max** | 20.92 | 14.42 | 8.54 | 296.50 | 117.49 |
| **Stdev.** | 4.05 | 2.01 | 0.28 | 82.66 | 11.87 |

**Appendix 8.** (Continued)

Shuttleworth-538

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 10-Apr-06 | 8.38 | 13.5 | 8.26 | 354.8 | 115.34 |
| 17-Apr-06 | 3.93 | 11.82 | 8.18 | 101.6 | 90.26 |
| 24-Apr-06 | 8.15 | 14.14 | 7.87 | 134.5 | 120.13 |
| 25-Apr-06 | 9.19 | 13.23 | 7.9 | 299.2 | 115.26 |
| 3-May-06 | 8.7 | 13.84 | 7.75 | 114.4 | 119.09 |
| 8-May-06 | 6.87 | 15.94 | 7.78 | 114 | 131.17 |
| 16-May-06 | 14.15 | 10.42 | 7.62 | 90.5 | 101.68 |
| 8-Jun-06 | 14.22 | 9.81 | 8.19 | 21 | 95.82 |
| 15-Jun-06 | 13.67 | 10.26 | 7.8 | 575 | 99.04 |
| 27-Jun-06 | 17.9 | 8.45 | 8.17 | -7.6 | 89.26 |
| 27-Jul-06 | 23.83 | 5.71 | 8.8 | 1.1 | 67.75 |
| 10-Aug-06 | 14.99 | 7.09 | 8.45 | 1.7 | 70.45 |
| 29-Aug-06 | 17.54 | 9.6 | 8.63 | 3.6 | 102.1 |
| 8-Sep-06 | 18.91 | 9.22 | 8.41 | 0.4 | 100.78 |
| 26-Sep-06 | 12.48 | 11.19 | 8.69 | -0.7 | 106.66 |
| **Average** | 12.86 | 10.95 | 8.17 | 120.23 | 101.65 |
| **Min** | 3.93 | 5.71 | 7.62 | -7.60 | 67.75 |
| **Max** | 23.83 | 15.94 | 8.80 | 575.00 | 131.17 |
| **Stdev.** | 5.36 | 2.82 | 0.37 | 167.42 | 17.65 |

Shatford-338

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 30-Aug-06 | 12.34 | 10.97 | 8.57 | 1.7 | 104.21 |
| 8-Sep-06 | 16.74 | 9.71 | 9.01 | 0.4 | 101.57 |
| 19-Sep-06 | 12.87 | 11.62 | 8.85 | 0.2 | 111.75 |
| 26-Sep-06 | 13.6 | 11.28 | 8.97 | 0.2 | 110.22 |
| **Average** | 13.89 | 10.90 | 8.85 | 0.63 | 106.94 |
| **Min** | 12.34 | 9.71 | 8.57 | 0.20 | 101.57 |
| **Max** | 16.74 | 11.62 | 9.01 | 1.70 | 111.75 |
| **Stdev.** | 1.97 | 0.83 | 0.20 | 0.72 | 4.84 |

Vaseux-177

| Date | Temp. | DO mg/L | PH | Turbid NTU | DO % |
|---|---|---|---|---|---|
| 10-Apr-06 | 6.29 | 12.34 | 8.41 | 26.2 | 100.12 |
| 13-Apr-06 | 5.13 | 14.99 | 8.44 | 22.2 | 118.01 |
| 24-Apr-06 | 4.94 | 16.7 | 7.98 | 43.4 | 130.86 |
| 25-Apr-06 | 6.16 | 17.33 | 7.92 | 34.9 | 140.08 |
| 8-May-06 | 3.67 | 13.78 | 7.76 | 290.1 | 104.46 |
| 12-May-06 | 5.79 | 13.31 | 7.64 | 32.5 | 106.62 |
| 6-Jun-06 | 11.86 | 13.69 | 7.63 | 186.8 | 126.9 |
| 15-Jun-06 | 11.03 | 11.82 | 7.75 | 734 | 107.5 |
| 23-Jun-06 | 13.68 | 12.37 | 8.01 | 21.66 | 119.45 |
| 19-Aug-06 | 20.97 | 6 | 9.17 | 0 | 67.4 |
| 26-Sep-06 | 14.45 | 12.5 | 9.09 | -1 | 124.43 |
| **Average** | 9.45 | 13.17 | 8.16 | 126.43 | 113.26 |
| **Min** | 3.67 | 6.00 | 7.63 | -1.00 | 67.40 |
| **Max** | 20.97 | 17.33 | 9.17 | 734.00 | 140.08 |
| **Stdev.** | 5.39 | 2.98 | 0.55 | 220.86 | 19.57 |

**Appendix 9a.** Summary of snorkel survey data for salmonids collected in 2006.

| | Site name and fish abundance | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species and size class | Shingle 317 | Vaseux 177 | Shingle 333 | McLean 310 | Shatford 338 | Okanagan 493 | Ellis 470 | Okanagan 562 | Okanagan 346 | Shuttle-worth 538 | Shuttle-worth 522 | Reed 403 | Okanagan 490 | Inkaneep 351 | Inkaneep 535 | Haynes 471 |
| Total Salmonids | | | | | | | | | | | | | | | | |
| <100mm | 1 | 70 | 102 | 24 | 53 | 2 | 0 | 4 | 0 | 31 | 0 | 0 | 15 | 14 | 81 | 0 |
| 100-300mm | 0 | 0 | 15 | 11 | 48 | 14 | 1 | 26 | 1 | 4 | 0 | 0 | 3 | 7 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| rainbow/ steelhead | | | | | | | | | | | | | | | | |
| <100mm | 1 | 70 | 102 | 24 | 53 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 2 | 13 | 81 | 0 |
| 100-300mm | 0 | 0 | 15 | 11 | 48 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 4 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| brook trout | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| sockeye | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chinook | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| whitefish | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 26 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Appendix 9b.** Summary of snorkel survey data for non-salmonids collected in 2006.

| | Site name and fish abundance | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species and size class | Shingle 317 | Vaseux 177 | Shingle 333 | McLean 310 | Shatford 338 | Okanagan 493 | Ellis 470 | Okanagan 562 | Okanagan 346 | Shuttle-worth 538 | Shuttle-worth 522 | Reed 403 | Okanagan 490 | Inkaneep 351 | Inkaneep 535 | Haynes 471 |
| Total Non-Salmonids | | | | | | | | | | | | | | | | |
| <100mm | 6 | 79 | 0 | 1 | 5 | 2 | 19 | 6 | 0 | 0 | 59 | 0 | 19 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 41 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| bass | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 19 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| minnows | | | | | | | | | | | | | | | | |
| <100mm | 6 | 79 | 0 | 1 | 0 | 0 | 19 | 2 | 0 | 0 | 59 | 0 | 2 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| sculpins | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| suckers | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| unidentified | | | | | | | | | | | | | | | | |
| <100mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100-300mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| >300mm | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |