2005 OKANOGAN BASIN SNORKEL SURVEYS

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Table of Contents

Abstract

The Colville Tribes Fish and Wildlife Department conducted snorkel surveys throughout the Okanogan basin as part of the Okanogan Basin Monitoring and Evaluation Project (OBMEP) in 2004 (U.S. tributaries only) and 2005 (throughout the basin). In 2005 we conducted snorkel surveys for the fist time along the main-stem Okanogan River and in many of the tributaries especially in the Canadian portion of the basin. River conditions in 2005 were atypical compared to the historic hydrograph because a warm winter contributed to early runoff and low peak flows with record low flows throughout the summer and fall. Fifteen different species of fish were identified with Whitefish (*Prosopium williamsoni*), Smallmouth Bass (*Micropterus dolomieu*), and Steelhead (*Oncorhynchus mykiss*) being the most abundant. The majority of the juvenile *O. mykiss* however, were found in the tributaries of the United States portion of the Okanogan River basin. Few juvenile *O. mykiss* were counted in main-stem sites throughout the U.S. and Canada. These surveys indicate that coldwater tributaries are vital to the survival of steelhead in the Okanogan River basin. Bonaparte Creek had the highest densities of juvenile *O. mykiss* in both years surveyed. United States tributaries: Omak Creek, Salmon Creek, Loup-Loup Creek and Nine-mile Creek have healthy *O. mykiss* populations and are the most likely tributaries to contribute to recovery of this listed species. We expect to see more juvenile *O. mykiss* in both upper and lower Omak Creek reaches due to enhanced passage starting in 2006 at Mission Falls which is designed to open up 26 additional miles of spawning and rearing habitat. In Canada, very little empirical data on anadromous fish exists. Inkaneep Creek and Vaseux Creek both had *O. mykiss* that are considered steelhead progeny. Opening access to tributaries above McIntyre Dam in Canada such as Shuttleworth, McLean, Shingle, and Ellis Creeks will likely enhance *O. mykiss* production in the future.

Introduction

The Okanogan River is the most northern watershed accessible to anadromous fish in the entire Columbia River basin. The confluence with the Columbia River is located in north

central Washington State, but 70% of the watershed is located in Canada. Due to an extremely low gradient, high summer water temperatures and turbid water, the habitat in the mainstem Okanogan River differs greatly from traditional conditions most people consider ideal for anadromous fish production. Returning fish must traverse nine major hydroelectric dams and several smaller impediments. Many tributary streams of the Okanogan basin have been diverted in part or whole to support the agrarian economy of the region. In spite of all this, a healthy stock of summer Chinook, and the most robust stock of sockeye salmon remaining in the Columbia River Basin call the Okanogan River home. The Okanogan River is like two rivers in one: the United States (US) portion of the river is strongly influenced by the Similkameen River, which provides most of the water and sediment from a flashy, snowmelt-driven watershed; while the Okanagan River above the Similkameen confluence provides a lessor quantity of water from a stable, clear, lake-drained watershed.

For many years, spawning and rearing information on anadromous fish in the Okanogan basin had more to do with professional opinion than actual data. Fulton (1970) noted use of Salmon Creek, Omak Creek and the upper Similkameen River by steelhead. In Canada, it is likely that historically Steelhead, Chinook, Sockeye, and Coho spawned in tributaries south of Okanogan Lake (Rae 2005). In fact, the Okanagan Nation's traditional name for Shingle Creek literally translates as "place where steelhead spawn" (Rae 2005). Two streams, Inkaneep and Vaseux, have suitable habitat for steelhead and Chinook salmon. WDW (1993) indicates spawning locations upstream from Lake Osoyoos. Shepard (1992) notes the presence of large rainbow trout in creel survey data from Okanogan Lake in the 1920's. However, distribution of steelhead and Chinook in the Canadian portion of the Okanagan River basin remains largely unknown (Rae 2005). The State of Washington considers steelhead from the Okanogan and Methow Rivers to be a composite stock, so little information specifically related to the Okanogan River basin was ever collected (WDF 1993).

Chapman et al 1994, clearly links spawning activity of summer steelhead with juvenile densities. Density independent factors related to habitat and water quality, climate and geology set the potential upper limit for juvenile production with density dependent functions such as predation, disease, and competition keeping the population from achieving this upper level (Poff and Ward 1989). Although snorkel surveys have occurred throughout the Wenatchee and Methow basins for the purposes of research studies over the years (Griffith and Hillman 1986, Hillman and Chapman 1989, Mullan et al. 1992), there has yet been no effort made to compile these data into a usable status and trend analysis for providing information about changes in juvenile steelhead densities over time.

> *"We believe that numbers of adult steelhead in the mid-Columbia basin increase as the abundance of juveniles (seeding levels) increase until an upper limit, i.e. carrying capacity, is reached".*
>
> Chapman et al 1994

Most literary references related to juvenile summer steelhead abundance and distribution throughout the Okanogan basin are personal opinions, such as *"In as much as riffle and cascade habitat is lacking in the Okanogan River, and because of warm summer temperatures and high sediment levels, we would expect to see few steelhead rearing in*

the main-stem. This is probably also true in the lower reaches of the Similkameen River" (Chapman et al 1994). No statements about rearing capacity or juvenile densities could be found for tributaries to the Okanogan River. Although these opinions may prove to be true, they are not currently supported by empirical evidence.

In an attempt to improve our understanding of the Okanogan River basin, the Okanogan Basin Monitoring and Evaluation Project (OBMEP) is collecting empirical data to address a number of questions, including:

- Is there is a statistically significant difference in biological parameters of summer/fall, spring Chinook, sockeye, and steelhead in the Okanogan basin within a 7-20+ year time frame?

The snorkeling part of the OBMEP program is designed to help address the juvenile rearing response to habitat changes overtime. Juvenile summer steelhead are the focal species because they require extended rearing time in freshwater habitats and are commonly found throughout the Okanogan basin. Information on both abundance and distribution are important to fishery managers, planners, and decision makers. Non-anadromous fish distribution, abundance, and species composition can also be collected as part of these efforts.

The Colville Tribes do have data from Omak Creek extending back to 2002 (Fisher and Arterburn 2003). No other references or documentation of snorkel surveys are known to exist within the Okanogan River basin prior to the 2004 OBMEP effort. Initial surveys were limited to only 6 tributary and 1 main-stem site to test and develop protocols. Results from 2004 were rolled into this report for discussion purposes. In 2005, snorkel surveys were conducted at 50 randomly selected sites within the Okanogan basin between 23 August and 26 October by the Colville Tribes and Okanagan Nation Alliance as part of the OBMEP program (Figure 1&2).

Methods

A probabilistic sampling design (EMAP) was used to randomly select panel sites from a sampling universe which included all accessible habitats for anadromous fish in the United States and Canadian portions of the Okanogan River watershed. Annual panel sites are sampled annually, while rotating panel sites are sampled once every 5 years (Figures 1 & 2).

In 2005, 50-randomly selected EMAP sites were surveyed. Thirty-four sites were surveyed in the United States by the Colville Tribes and 16 in Canada by the Okanagan Nation Alliance. Snorkel surveys occurred within two weeks of the physical habitat survey conducted at the same locations. Sites observed to be dewatered during the physical habitat surveys were not snorkeled.

Survey reaches were snorkeled using protocols developed from the Upper Columbia strategies (Hillman 2004) and methodologies refined for OBMEP (Arterburn et al. 2005a). Sampling reaches in the US included nineteen sites on small tributary streams and fifteen sites on the main-stem Okanogan and Similkameen Rivers. Survey sites in

Canada included ten sites on small tributary streams and six sites on the main-stem Okanagan. Fish were identified to species if possible, to family if needed and lastly into non-salmonids and salmonids when necessary to reduce the number of unidentified fish in the sample. Each fish was grouped into 1 of 3 size categories:

- less than 100mm
- between 100 and 300mm
- greater than 300mm

Sampling on small tributary streams in the United States started on 23 August and finished on 26 October. Snorkel surveys were performed by a single snorkeler moving upstream through the length of the reach. Fish were tallied by a technician following the snorkeler who recorded the data as fish were observed.

Sampling on the twenty-one main-stem Okanogan River and two Similkameen River sites in the United States were sampled starting on 7 September and finished on 26 September. Most sites were sampled using a single pass method using up to 9 snorkelers at a time moving in unison from the top of the reach to the bottom, one transect at a time. Snorkelers stopped at the completion of each transect to record sightings on individual wrist slates, and to allow the team to keep in alignment across the river.

Results and Discussion

Results from snorkel surveys are presented using the same reference reaches recommended by the OBMEP redd surveys for 2005 (Arterburn et al. 2005b). These reference reaches have only been established for the US portion of the basin to date (Table 2) The Canadian portion was divided into two reference reaches. More reaches in Canada may be established in 2006.

Table 1: Species observed during snorkel surveys in the Okanogan River Watershed in the summer of 2005.

Sockeye Salmon	*Oncorhynchus nerka*
Chinook Salmon	*Oncorhynchus tshawytscha*
Steelhead	*Oncorhynchus mykiss*
Brook Trout	*Salvelinus fontinalis*
Whitefish	*Prosopium williamsoni*
Bridgelip Sucker	*Catostomus columbianus*
Yellow Perch	*Perca flavescens*
Redside Shiner	*Richardsonius balteatus*
Northern Pikeminnow	*Ptychocheilus oregonensis*
Common Carp	*Cyprinus carpio*
Smallmouth Bass	*Micropterus dolomieu*
Largemouth Bass	*Micropterus salmoides*
Pumpkinseed	*Lepomis gibbosus*
Shorthead Sculpin	*Cottus confusus*
Black Bullhead	*Ictalurus melas*

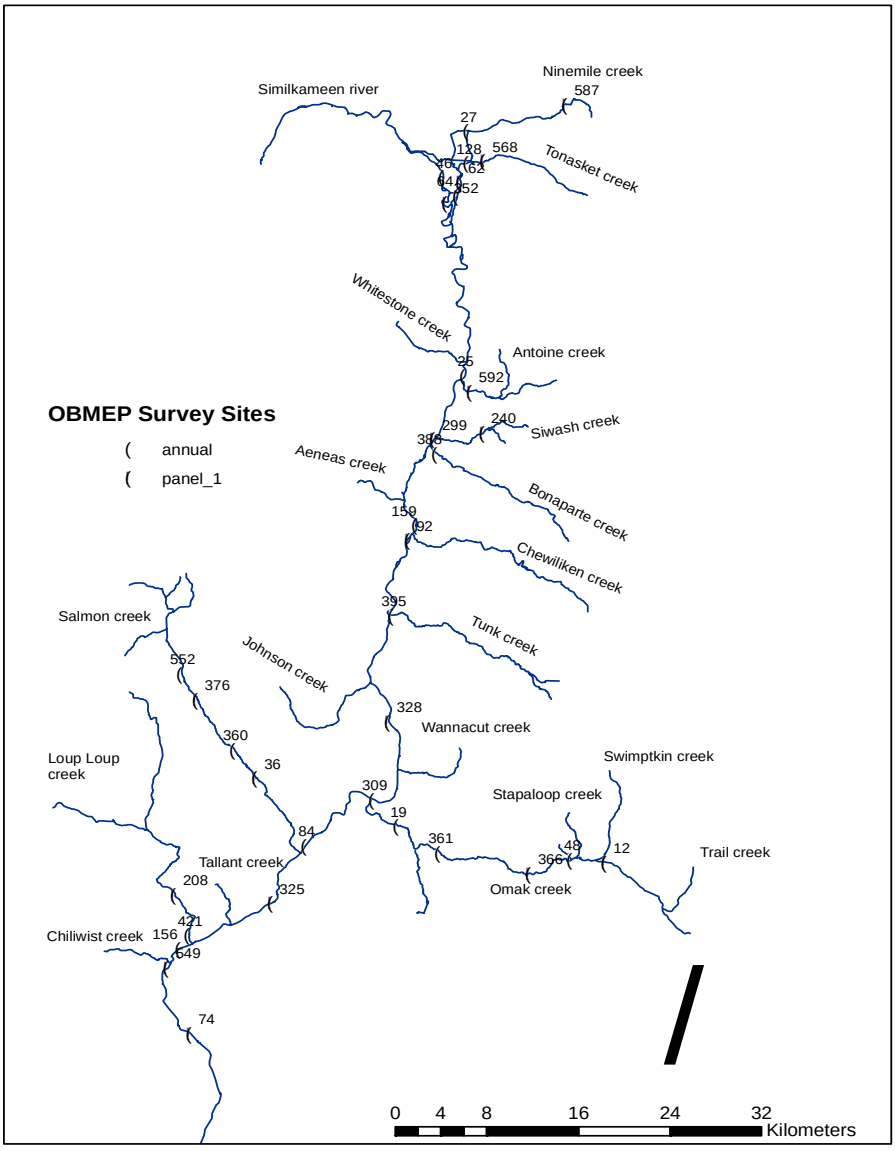

Figure 1: United States snorkel and physical habitat sample sites for 2005.

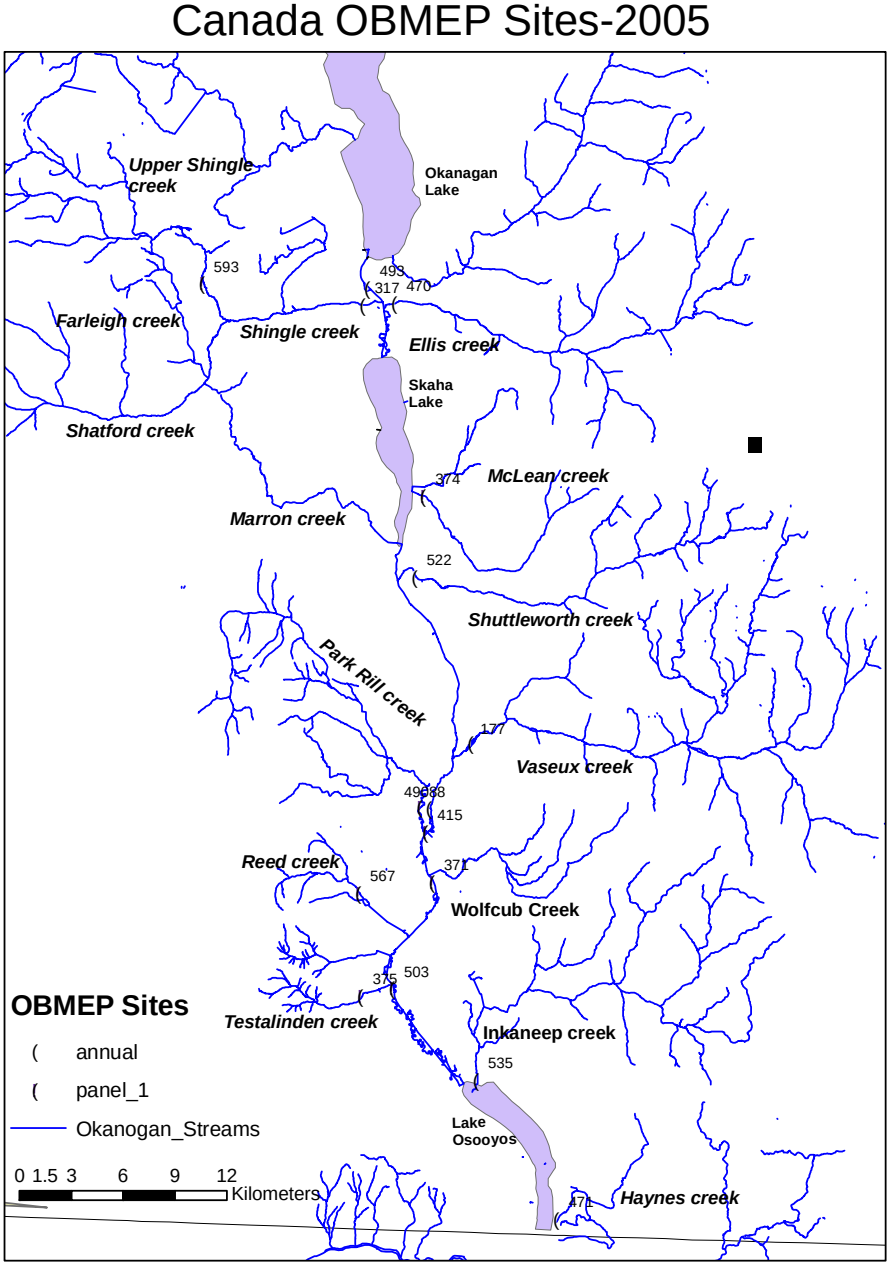

Figure 2: Canada snorkel and physical habitat sample sites 2005.

Table 2: Comparison of number of redds and number of juvenile *O. mykiss* observed during snorkel surveys in 2005 and the reference reach length, description, and designation for these observations.

Reference Reaches	Description (river-mile)	miles	kms	OBMEP sites surveyed	2005 # of Juvenile O. mykiss	2005 # of Redds
O1	Okanogan River south of Chiliwist Creek(24.4) to Salmon Creek(41.4)	17	27.4	74, 549, 156, 325	1	17
O2	Okanogan River @ Salmon Creek(41.4) to Riverside(66.1)	24.7	39.7	84, 309, 328	0	66
O3	Okanogan River @ Riverside(66.1) to Janis Bridge(84.6)	18.5	29.8	92, 159	1	58
O4	Okanogan River @ Janis Bridge(84.6) to Ellisforde(98.2)	13.6	21.9	299	3	63
O5	Ellisforde(98.2) to Similkameen confluence(119.5)	21.3	34.3	25	0	19
O6	Okanogan River @ Similkameen confluence(119.5) to Zosel Dam(127.0)	7.5	12.1	64, 62	0	141
S1	Similkameen River @ Okanogan confluence(0) to Enloe Dam (14.6)	14.6	23.5	352, 46	1	106
TU1	Tunk Creek @ Okanogan River confluence (0) to high water mark (0.2)	0.06	0.09	395	0	47
B1	Bonaparte Creek @ Okanogan River confluence (0) to waterfall barrier (1.6)	1.6	2.57	388	124	67
N1	Ninemile Creek @ Okanogan River confluence(0) to Eder land (1.72)	1.72	2.77	27, 587	107	9
TO1	Tonasket Creek @ Okanogan River confluence(0) to Tonasket Falls(3.5)	3.5	5.63	128, 568	0	0
Omak Lower	Omak Creek @ Okanogan River confluence(0) to Mission Falls(6.2)	6.2	10	19	4	77
Omak Upper	Mission Falls(6.2) to Trail Creek(21.5)	15.3	24.6	361, 366, 48, 12	266	0
Antoine	Panel 1 site	0.1	0.15	592	10	0
Siwash	Panel 1 site	0.1	0.15	240	0	0
Salmon	OID diversion(4.3) to Conconully Lake(22.3)	11.2	18	552, 376, 360, 36	271	0
Loup Loup	Annual and panel site	0.19	0.3	208, 421	32	0
Haynes	Annual site	0.1	0.15	471	0	NA
Johnson	Annual site	0.1	0.15	520	NA	NA
Canada 1	Inkaneep Creek(136.6) to McIntyre Dam(151.6)	15	24.1	535, 503, 375, 567, 371, 415, 490, 88, 177	54	NA
Canada 2	McIntyre Dam(151.6) to Okanagan Lake(170.2)	18.6	30	522,374,317,470,493, 593	17	NA

NA=Not Surveyed

United States

A total of 6 juvenile *Oncorhynchus mykiss* were counted in main-stem sites; 940 juvenile *O. mykiss* were observed in tributary sites in both the United States and Canada. A small number of adult *O. mykiss* were observed in nine Okanogan and Similkameen River main-stem sites and in ten of the tributary reaches.

In 2005, river conditions were atypical throughout the Okanogan River watershed. Low snow pack and a warm winter contributed to early runoff and low peak flows with record low flows throughout the summer and fall compared to historic conditions (Figure 3). Therefore, the low abundance of juvenile *O. mykiss*, and anadromous juvenile species in general within the main-stem Okanogan River sites was no surprise.

Salmonids exhibit avoidance behavior for waters that are warmer than 20°C. The Okanogan River typically has mean daily temperatures greater than 20°C from early July to mid-September in most years (Arterburn and Kistler 2005). Instantaneous mortality of *O. mykiss* occurs at mean daily water temperatures above 25°C (Jenkins and Burkhead 1993). In 2005, mean daily temperatures for the Okanogan River did not exceed 25°C (Figure 4).

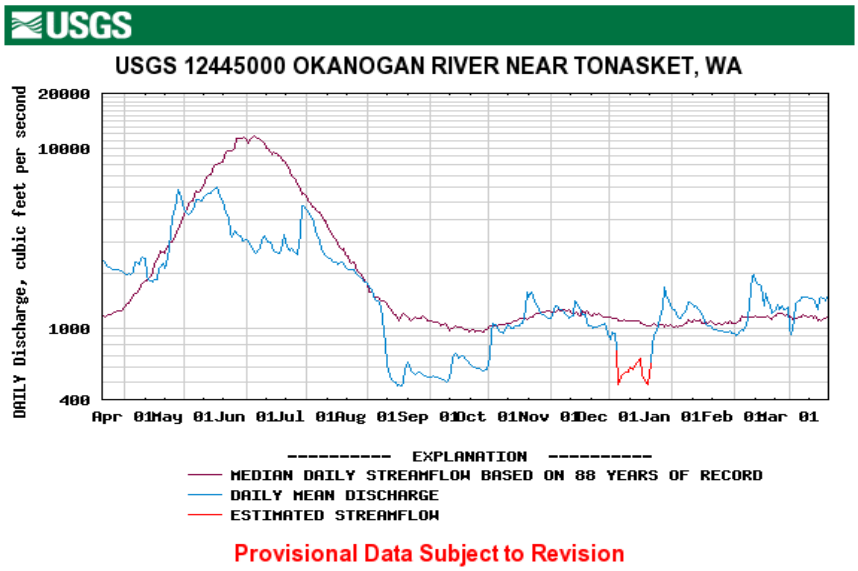

Figure 3: Discharge for the Okanogan River at Janis for the period from April 2005 to March of 2006. Summer low flows are period when most snorkel surveys occurred.

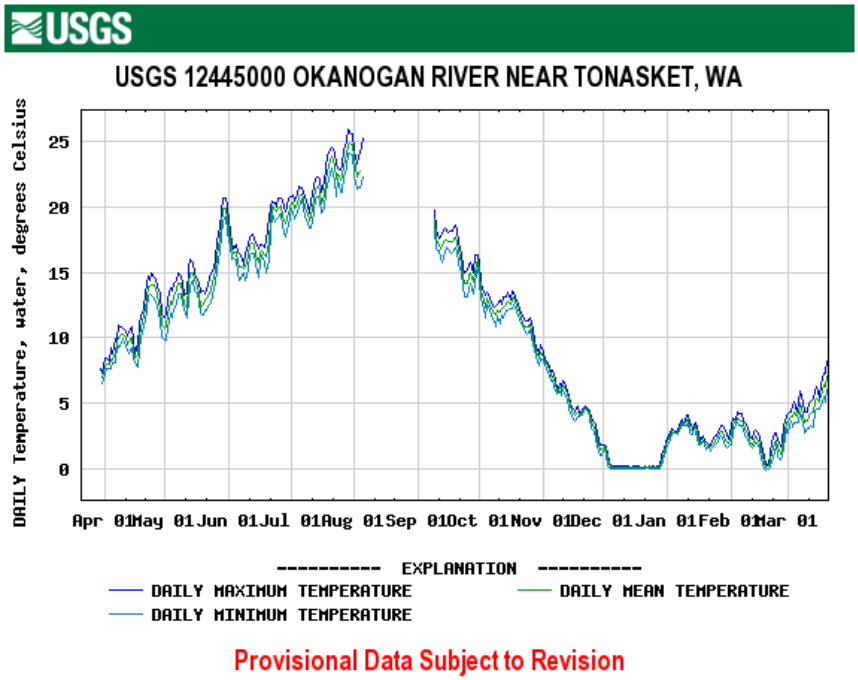

Figure 4: Temperature from the Okanogan River from April 2005 to March 2006. Main-stem snorkel surveys occurred after peak high temperatures but before temperatures had dropped to below 20 degrees Celsius.

The following maps (Figures 5-14) show spatial locations and results of snorkel surveys for both 2004 and 2005. The results shown are: total fish, juvenile *O. mykiss* and adult *O. mykiss* detected. Information is also provided on the number of fish per square kilometer as extrapolated from the number of fish observed divided by the visual distance or average wetted width times the reach length of each site surveyed.

Reach 01 (Figure 5: sites 74, 549, 156 & 325) the segment of the Okanogan River located downstream of Salmon Creek (1-juvenile *O. mykiss observed).* The dominant species were smallmouth bass (site 74), bridgelip sucker (site 549), and whitefish (sites 156 and 325). Densities of all fish were highest at site 156 (109-fish/km^2) and lowest at site 74 (8.6-fish/km^2) with an average fish density of (51-fish/km^2) and an average juvenile *O. mykiss* density of (0.1-fish/km^2) for this stream segment.

Loup-Loup Creek (Figure 5) included one site below the falls (421) that was dry and therefore had no fish. The site above the natural falls (208) was dominated by brook trout (139) for a density of (457-eastern brook trout/ km^2). We observed 37 resident *O. mykiss* for a density of (122- *O. mykiss*/km^2). Overall, Loup-Loup Creek contained an average juvenile *O. mykiss* density of (52.5-fish/km^2) in 2005 and we considered these to be resident fish because the site was located above an impassable barrier.

Reach 02 (Figure 6: sites 84, 309 & 328) the segment of the Okanogan River located from Salmon Creek to Riverside (0-juvenile *O. mykiss* observed). Five adult sockeye salmon, *Oncorhynchus nerka*, were observed in this reach at site 309. The dominant species observed were smallmouth bass (site 84) and bridgelip sucker (sites 309 and 328).

These fish comprised 64% of the fish observed. Densities for all fish ranged from (34 to 38- fish/km^2) with an average fish density of (36.5-fish/km^2) for the entire reach.

Johnson Creek (Figure 6: site 520) was surveyed in 2004. No fish were observed at this site.

Reach 03 (Figure 7: sites 92 & 159) the segment of the Okanogan River located from Riverside to Janis bridge (1-juvenile *O. mykiss observed).* Seven adult *O. nerka,* along with one adult *O. mykiss* were observed in this reach. The dominant species observed were smallmouth bass (Site 159) and both smallmouth bass and bridgelip suckers at site 92. These fish comprised 64% of the fish observed. Densities were highest at site 159 due more to the width of the channel at site 92 than because of a higher abundance of fish observed. The average fish density for this reach was (72-fish/km^2) and average juvenile *O. mykiss* density was (0.95-fish/km^2).

Tunk Creek (Figure 5: site 395) was surveyed in 2005. This site was dry at the time of snorkeling and thus no fish were observed at this site. Tunk Creek is normally considered a perennial water body and is a good example of how bad the drought conditions were in 2005.

Reach 04 (Figure 8: sites 299 & 25) the segment of the Okanogan River located from the Janis bridge to Whitestone Creek (3-juvenile *O. mykiss* observed*).* The dominant species observed were Common Carp (site 25) and whitefish (site 299) and they made up 54% of all fish observed. The densities for fish in these reaches varied widely. Site 299 was a cobble riffle with an abundance of fish at a density of (102-fish/km^2) and 3 juvenile *O. mykiss.* Site 25 on the other hand contained slow water and mostly sand substrate with a sparse density of non-salmonid fish (6.4- fish/km^2). The average density for this reach of juvenile *O. mykiss* was (0.7-fish/km^2).

Bonaparte Creek (Figure 8: site 388) was surveyed in 2004 and 2005. This site was dominated by *O. mykiss* with 210 juvenile *O. mykiss* observed in 2004 and 124 juvenile *O. mykiss* observed in 2005. However, average densities of juvenile *O. mykiss* remained stable, (579-juvenile *O. mykiss*/km^2) in 2004 compared to (551-juvenile *O. mykiss*/km^2) observed in 2005. Abundance was considerable lower for adult *O. mykiss* in 2005 compared to 2004 and more non-salmonids were observed in 2005 than in 2004 mostly consisting of sucker species. The densities of juvenile *O. mykiss* were higher in Bonaparte Creek during both years than any other stream observed in the Okanogan River watershed. In 2005, redd surveys detected 67 redds in 1.6km of accessible stream (Arterburn et al 2005) thus we expected a large number of juveniles to be observed during our snorkel surveys. However, in 2004, there were 61 more juveniles detected and 20 fewer non-salmonids detected than in 2005. We believe that because discharge was low, available rearing habitat was reduced and this resulted in increased competition for available resources. The narrowing of the creek channel allowed us to see more non-salmonids in 2005 than would normally occur.

Siwash Creek (Figure 8: site 240) is located above the anadromous fish zone and is cut-off from the Okanogan River in most years due to lack of flow. We observed no resident

O. mykiss. Two brook trout were observed and represents a density of (6.1-eastern brook trout/km^2) in 2005.

Antoine Creek (Figure 8: site 592) is located above a permanent barrier to fish migration. The dominant species observed was eastern brook trout with a density of (59.6-fish/km^2). Juvenile *O. mykiss* were observed at a density of (14.6-fish/km^2). All fish at this site were considered resident fish as they were found above a permanent passage barrier.

Reach 05 –No sites were snorkeled in this reach during 2005. However, habitats are generally poor for juvenile rearing. The substrate through this reach consists mostly of sand; sand substrates tend to be very low productivity environments. Therefore, we would anticipate finding low densities of mostly non-salmonid fishes in this reach.

Reach 06 (Figure 9: sites 64 & 62) the segment of the Okanogan River located near Oroville from the confluence with the Similkameen River to Zosel Dam (0-juvenile *O. Mykiss observed).* Two adult Chinook salmon were observed in 2004 at site 64. The dominant non-salmonid species were smallmouth bass (site 64 and 62) in 2005 and common carp (site 64) in 2004. Smallmouth bass made-up 81% of all fish observed. The number of fish observed were comparable between sites but the densities were higher at site 62 (163-fish/km^2) due to a narrower channel. 2004 data for site 64 was collected at a different time of year (October) and snorkel surveys were conducted with fewer and less qualified snorkelers to try to determine future protocols.

Reach S1 (Figure 9: sites 46 & 352) the segment of the Similkameen River located between the confluence of the Okanogan River and Enloe Dam (1-juvenile *O. mykiss observed).* Three adult sockeye and two adult Chinook salmon were observed at site 352. The average juvenile *O. mykiss* density was (0.35 -fish/km^2). The dominant species was bridgelip sucker and these fish made-up 53% of all fish observed. Densities were fairly consistent between sites (75.1-fish/km^2)at site 352 and (87.3-fish/km^2) at site 46.

Omak Creek (Figure 10: sites 19, 361, 366, 48 & 12) was divided into two reaches: Omak Lower, from the confluence with the Okanogan River upstream to Mission Falls; and Omak Upper, from Mission Falls upstream to Trail Creek. Omak Lower contained EMAP site 19 and Omak Upper contained EMAP sites 361, 366, 48 and 12.

Omak Lower (site 19) was surveyed in 2004 and 2005. In 2004, 31 juvenile *O. mykiss* were observed at this site. In 2005 only 4 juvenile and one adult *O. mykiss* were observed along with 29 sucker species. Densities for all fish observed were higher in 2005 (48.6 fish/km^2) than in 2004 (38.6 fish/km^2) mainly because the wetted width of the stream was much reduced in 2005. Prolonged drought conditions have resulted in low streamflows and contributed to low abundance of juvenile *O. mykiss.* A proliferation of beavers and beaver dams have contributed to reduced *O. mykiss* production because they blocked fish passage in 2005 and inundated much of the good steelhead spawning habitat near this site. A return to a more typical hydrograph would solve these problems by removing most beaver dams during the spring freshet.

Omak Upper contained EMAP sites 361, 366, 48 and 12. Mission Falls is considered to be a passage barrier, therefore fish observed above this point are considered resident. A

total of 266 juvenile *O. mykiss* and 33 adult *O. mykiss* were observed at these sites in 2005. The juvenile *O. mykiss* densities ranged from (116-fish/km^2) at site 48 to (24.7-fish/km^2) at site 12. The dominant species at all sites except for site 12 (eastern brook trout) was *O. mykiss*. *Oncorhynchus mykiss* made-up 81% of all fish observed in 2005. Site 48 was the only site surveyed in both 2004 and 2005. A comparison of these data shows that densities of juvenile *O. mykiss* increased from (84.7-fish/km$^{2)}$ in 2004 to (117-fish/km^2) in 2005. Eastern brook trout counts decreased from 91 in 2004 to 42 in 2005. All fish densities remained relatively stable at (140.4-fish/km^2) in 2004 to (164.6-fish/km^2) in 2005.

Salmon Creek (Figure 11: sites 36, 360, 376 & 552) A total of 271 juvenile *O. mykiss* were observed at these sites in 2005. The juvenile *O. mykiss* densities ranged from (196.4-fish/km^2) at site 360 to (11.9-fish/km^2) at site 552. The dominant species at all sites was *O. mykiss* and comprised 64% of all fish observed. Site 360 was the only site surveyed in both 2004 and 2005. A comparison of data at this site shows that densities of juvenile *O. mykiss* increased from (104-fish/km^2) in 2004 to (196.4-fish/km^2) in 2005. Eastern brook trout counts increased from 194 in 2004 to 314 in 2005. All fish densities increased from (201.6-fish/km^2) in 2004 to (393.5-fish/km^2) in 2005. Salmon Creek had steelhead spawning in 2003 when water was purchased by the Colville Tribes making the portion of the creek below the OID diversion accessible from the Okanogan River. Therefore, it is possible that some of the *O. mykiss* observed were considered resident fish but really were offspring of these steelhead. In 2004, no water was made available for adult passage due to drought conditions in the Salmon Creek basin. There are efforts underway to provide minimum flows in the future.

Reach TO1 (Figure 12) Tonasket Creek (sites 128 & 568). Site 128 was dry at the time of snorkeling, and thus had no fish observed while site 568 had water but no fish were observed. Tonasket Creek has been cut-off from the Okanogan River for many years due to lack of flow. In years with an abundance of snow this creek can connect to the Okanogan River for part of the year.

Reach N1 (Figure 12) Ninemile Creek (sites 27 & 587) no fish were observed at site 587, located above private property owned by Junior Edder. Site 27 was surveyed in 2004 and 2005 and is located downstream of Mr. Edder's property. A total of 136 juvenile *O. mykiss* and 2 adult *O. mykiss* were observed at this site. The average adult *O. mykiss* fish density was (1.5 -fish/km^2) and average juvenile *O. mykiss* density was (129-fish/km^2). There were no non-salmonid species observed. In 2005 there were 78 more juvenile *O. mykiss* detected than in 2004. The low flow and narrowing of the stream channel in 2005 may have contributed to more juvenile *O. mykiss* being detected. This stream has dense vegetation along its banks and at higher water flows fish would have more hiding cover than existed at the low flows in 2005.

Canada

Canadian sites were surveyed by the Okanagan Nation Alliance. There were no juvenile *O. mykiss* observed in the main-stem Okanagan River. This section of the river is lake drained but has lesser temperature limitations when compared to the portion located in the United States.

Many creeks lacked juvenile *O. mykiss*, such as Ellis (site 470), Haynes (471), Testalinden (375), Reed (567), and Shingle (593 & 317). The presence of barriers low in the drainage (Walsh and Long 2006) correlated closely with the lack of *O. mykiss* observed during snorkel surveys (Figure 13).

Several tributaries, including Inkaneep, Vaseux, Shuttleworth, Shingle, McLean and Park Rill Creeks had many unidentified fish. The unidentified fish were a result of a change in accepted protocols by the Okanagan Nation Alliance (ONA). Identification issues were further impacted by ONA's inability to retain specimens for later identification and the small size of fish observed.

Inkaneep (site 535), Vaseux (177), and McLean Creeks (374) had juvenile *O. mykiss* present. Sites 535 and 177 were surveyed in both 2004 and 2005 and are both accessible to anadromous fish. Therefore juvenile *O. mykiss* detected in these systems are considered steelhead progeny. There were 33 more juvenile *O. mykiss* detected in 2005 than 2004 at site 535 and was likely due to the timing of surveys. In 2004, Inkaneep Creek was surveyed after a rainfall and Vaseux Creek was unable to be surveyed due high and turbid waters. In 2005, these streams were visited during the low flow summer period.

Canada Reach 1 (Figure 14: sites 503, 371, 415 & 490) the segment of the Okanagan River in Canada from The United States/Canadian border to McIntyre Dam (0-juvenile *O. mykiss* observed*)*. Eighteen adult sockeye were observed at site 371. The dominant fish species were common carp, whitefish and bridgelip sucker. These fish comprised 74% of all fish observed. Total fish densities were highest at site 371 and lowest at site 490 with an average fish density for this reach of (27.7-fish/km^2).

Haynes Creek (Figure 12: site 471) was surveyed in 2005. No fish were observed at this site.

Inkaneep Creek (Figure 14: site 535) was surveyed in 2004 and 2005. In 2004 five juvenile *O. mykiss* were observed compared to 38 juvenile *O. mykiss* observed in 2005. A comparison of data at this site shows that densities of juvenile *O. mykiss* increased from (30.1-fish/km^2) in 2004 to (152.6-fish/km^2) in 2005. All fish densities increasing from (30.1-fish/km^2) in 2004 to (172.3-fish/km^2) in 2005. In 2004, the site was surveyed by the Colville Tribes after a rain event and the visibility at this site was very poor making it difficult to draw conclusions from between year comparisons.

Testalinden Creek (Figure 14: site 375) was surveyed in 2005. No fish observed at this site.

Reed Creek (Figure 14: site 567) was surveyed in 2005. No fish were observed at this site.

Park Rill Creek (Figure 14: site 88) was surveyed in 2005 (0-juvenile *O. mykiss* observed*)*. The dominant fish species were unidentified. These fish made-up 92% of the fish observed. Fish Density was (496-fish/km^2).

Vaseux Creek (Figure 14: site 177) was surveyed in 2005 and was included in Reach Canada 1 (16-juvenile *O. mykiss* were observed). This site was dominated by *O. mykiss* and unidentified fish. Juvenile *O. mykiss* densities were (12.6-fish/km^2). Unidentified fish made-up 91% of the fish observed with total fish density being (143.6-fish/km^2).

Reach Canada 2 (Figure 15: site 493), the segment of the Okanagan River in Canada from McIntyre dam to Okanagan Lake (0-juvenile *O. mykiss observed).* Sixteen adult sockeye were observed. The dominant fish species was bridgelip sucker. These fish made-up 32.5% of the fish observed with a total fish density of (66.6-fish/km^2).

Shuttleworth Creek (Figure 15: site 522) was surveyed in 2005 (0-juvenile *O. mykiss observed).* This site was dominated by minnows and unidentified fish. The total fish density was (158.3-fish/km^2).

McLean Creek (Figure 15: site 374) was surveyed in 2005 (1-juvenile *O. mykiss observed).* Juvenile *O. mykiss* density was (3-fish/km^2). This site was dominated by unidentified fish thought to be longnose dace but no voucher specimens were collected. Total fish densities were (257-fish/km^2).

Ellis Creek (Figure 15: site 470) was surveyed in 2005 (0-juvenile *O. mykiss* observed). Only one fish was observed at this site and was classified by ONA field crews as a minnow but no voucher specimens were collected.

Shingle Creek (Figure 15: site 317 & 593) These sires were surveyed in 2005; no fish were observed at these sites.

Okanogan River O1 and Loup Loup Creek

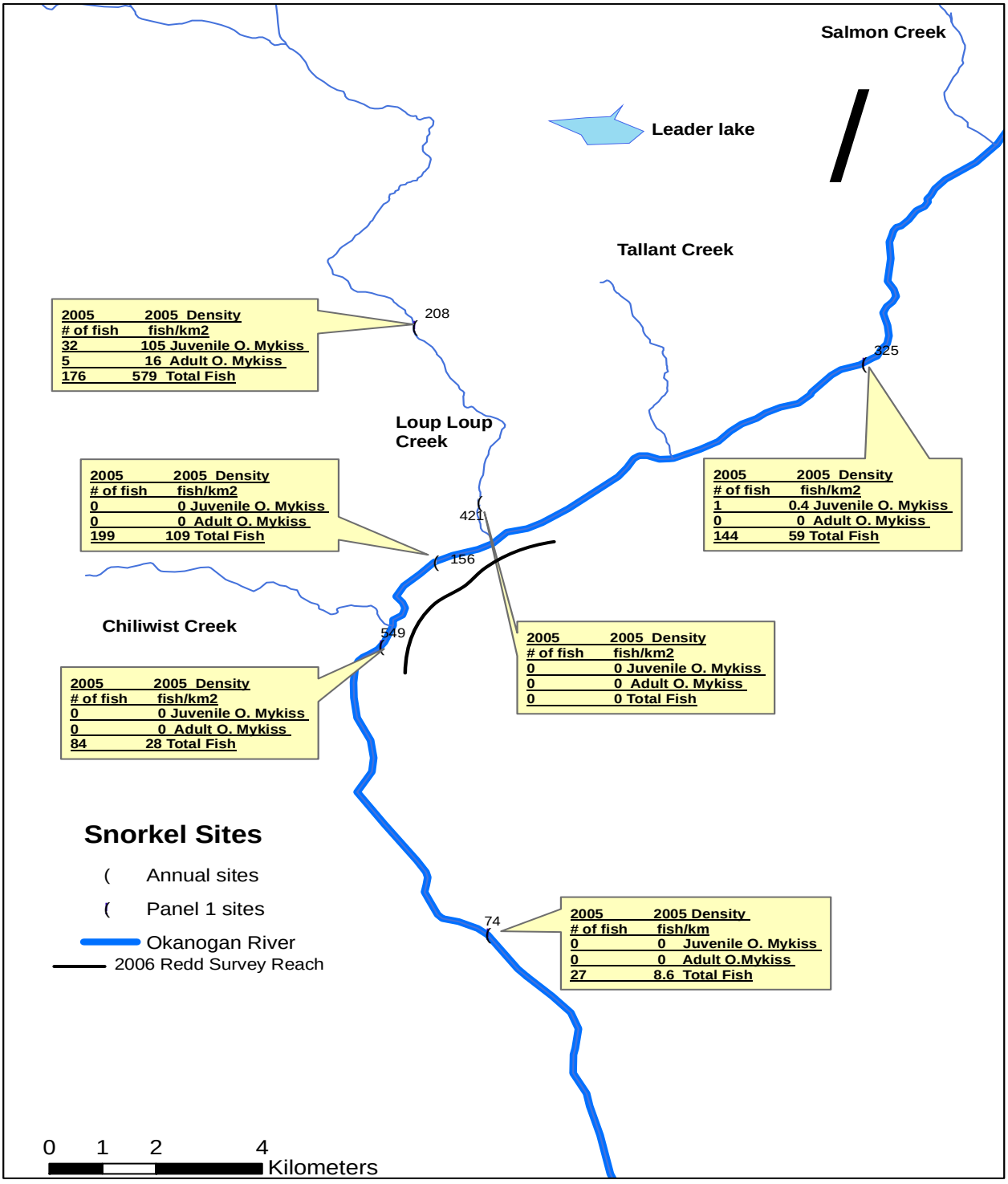

Figure 5: Snorkel survey reaches O1 and Loup Loup Creek.

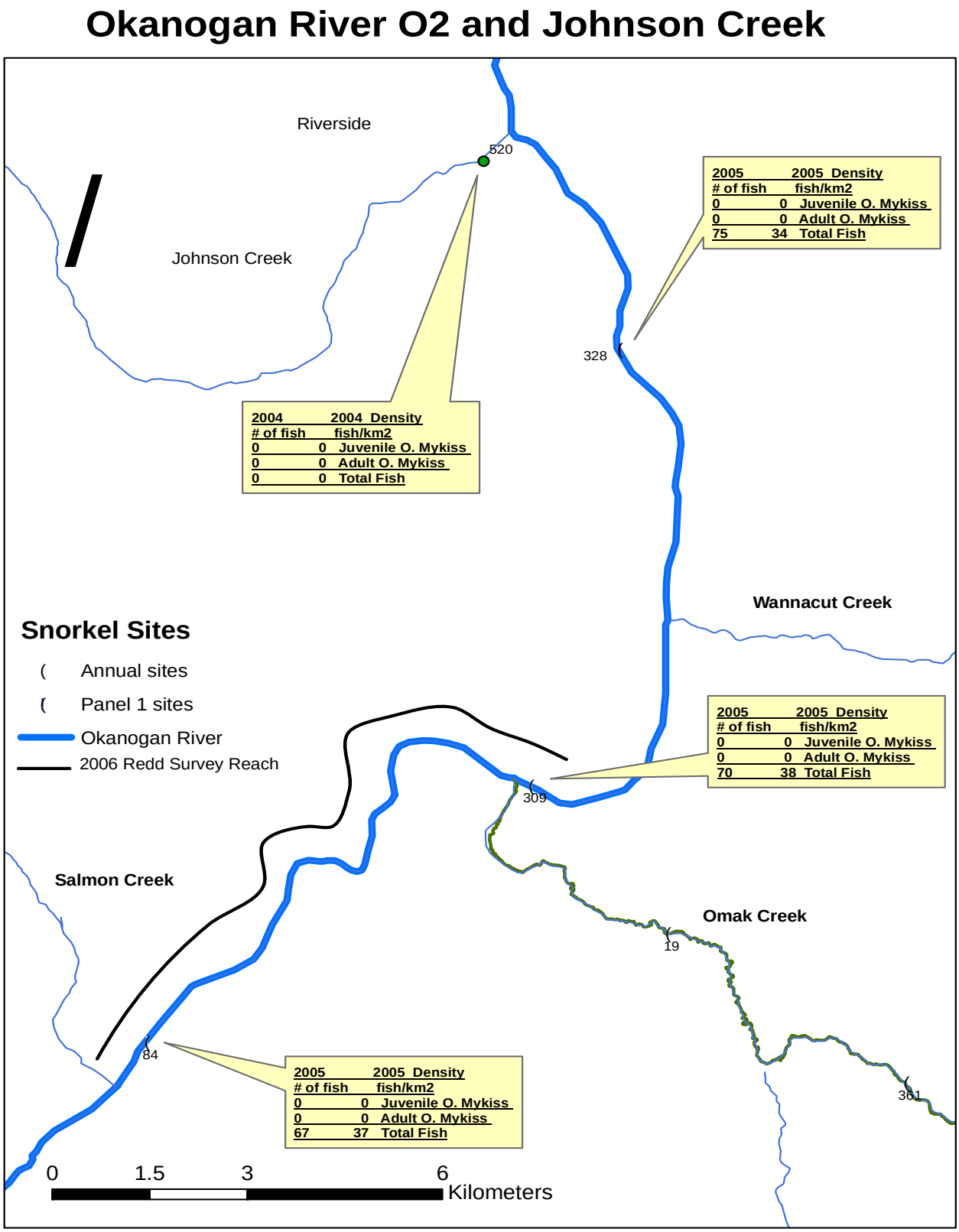

Figure 6: Snorkel survey reaches O2 and Johnson Creek.

Okanogan River O3 and Tunk Creek

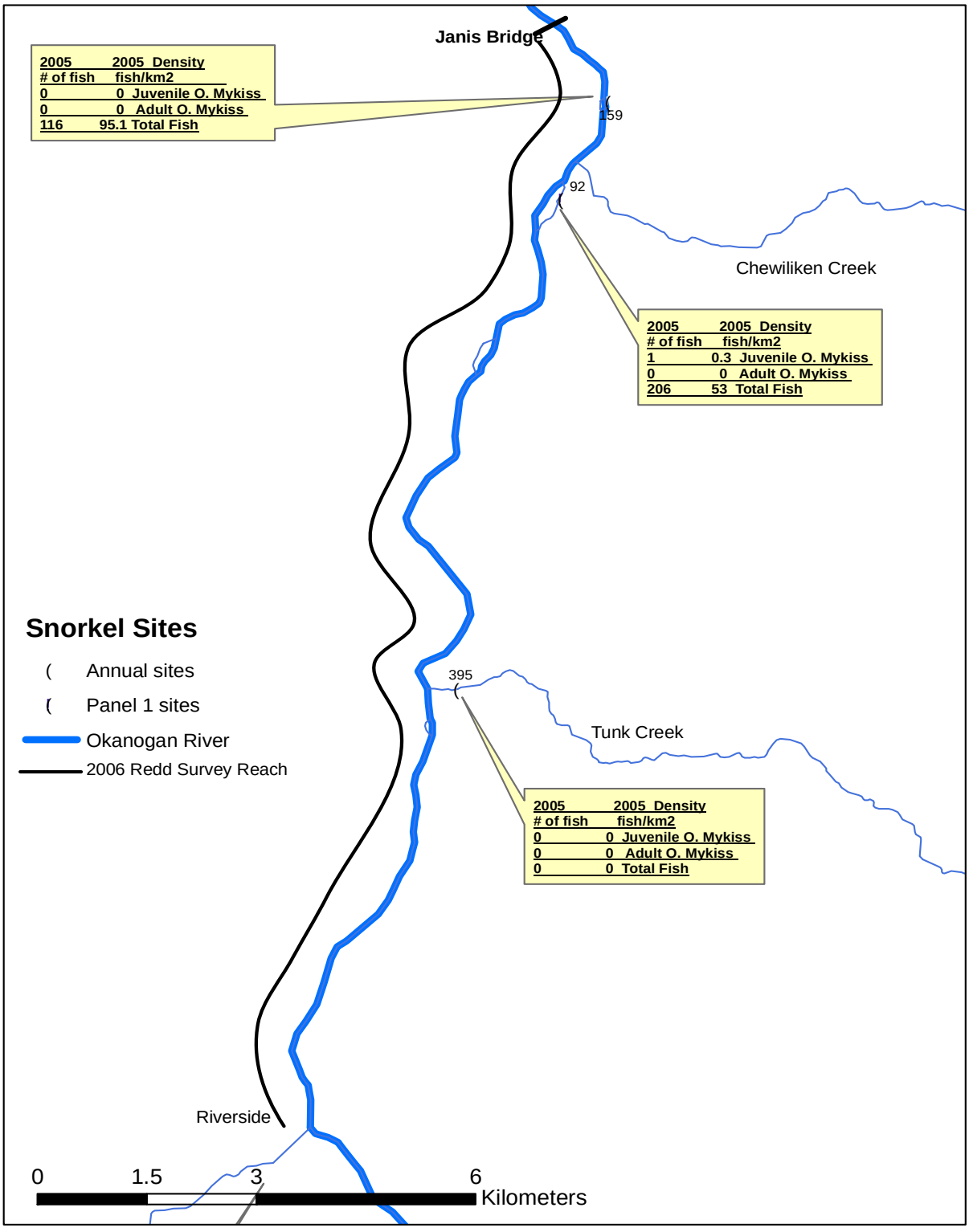

Figure 7: Snorkel survey reaches O3 and Tunk Creek.

Okanogan River O4 Bonaparte, Siwash and Antoine Creek

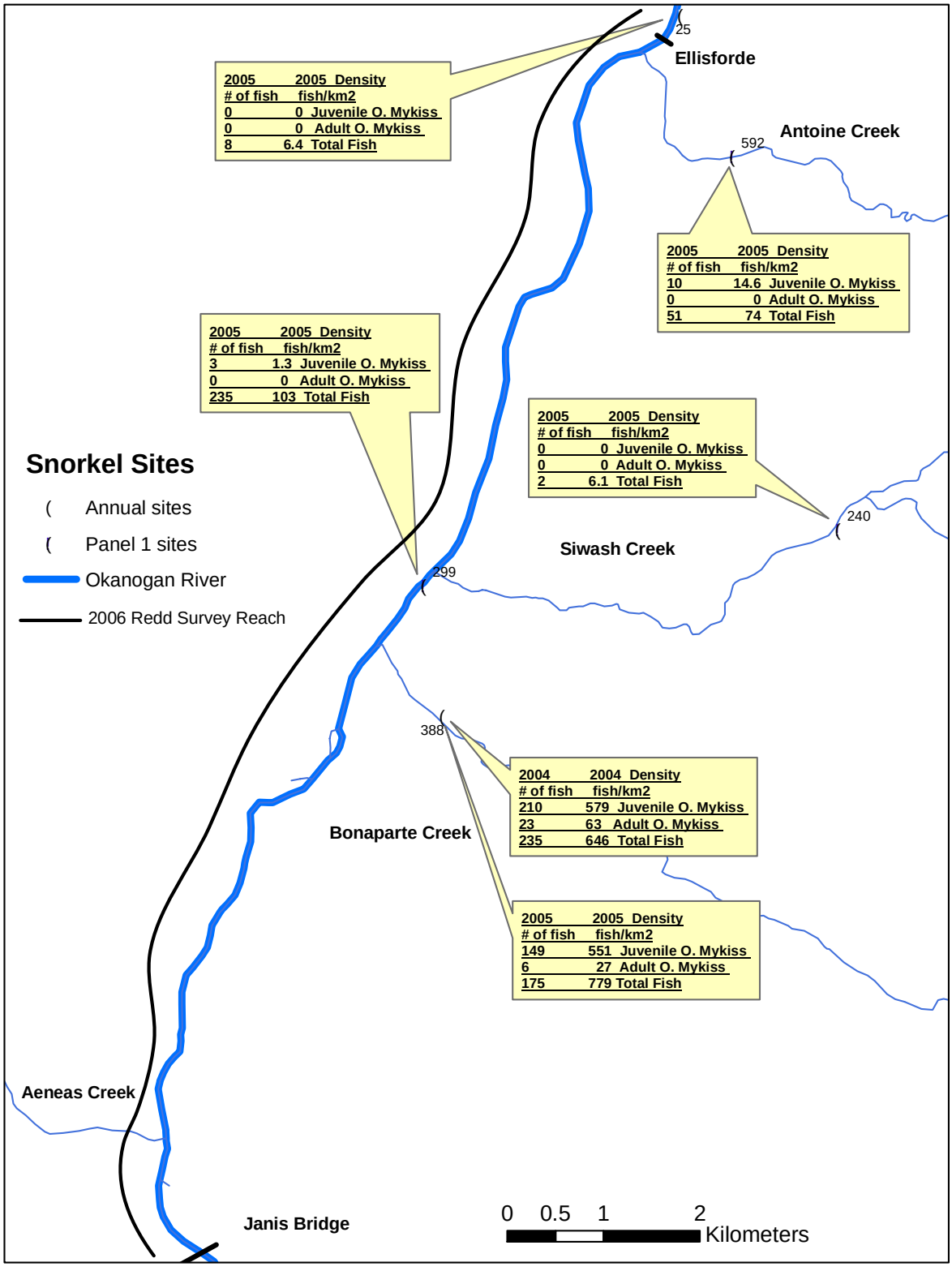

Figure 8. Snorkel survey reaches O4, Bonaparte, Siwash and Antoine Creeks.

Okanogan River O6 and Similkameen River S1

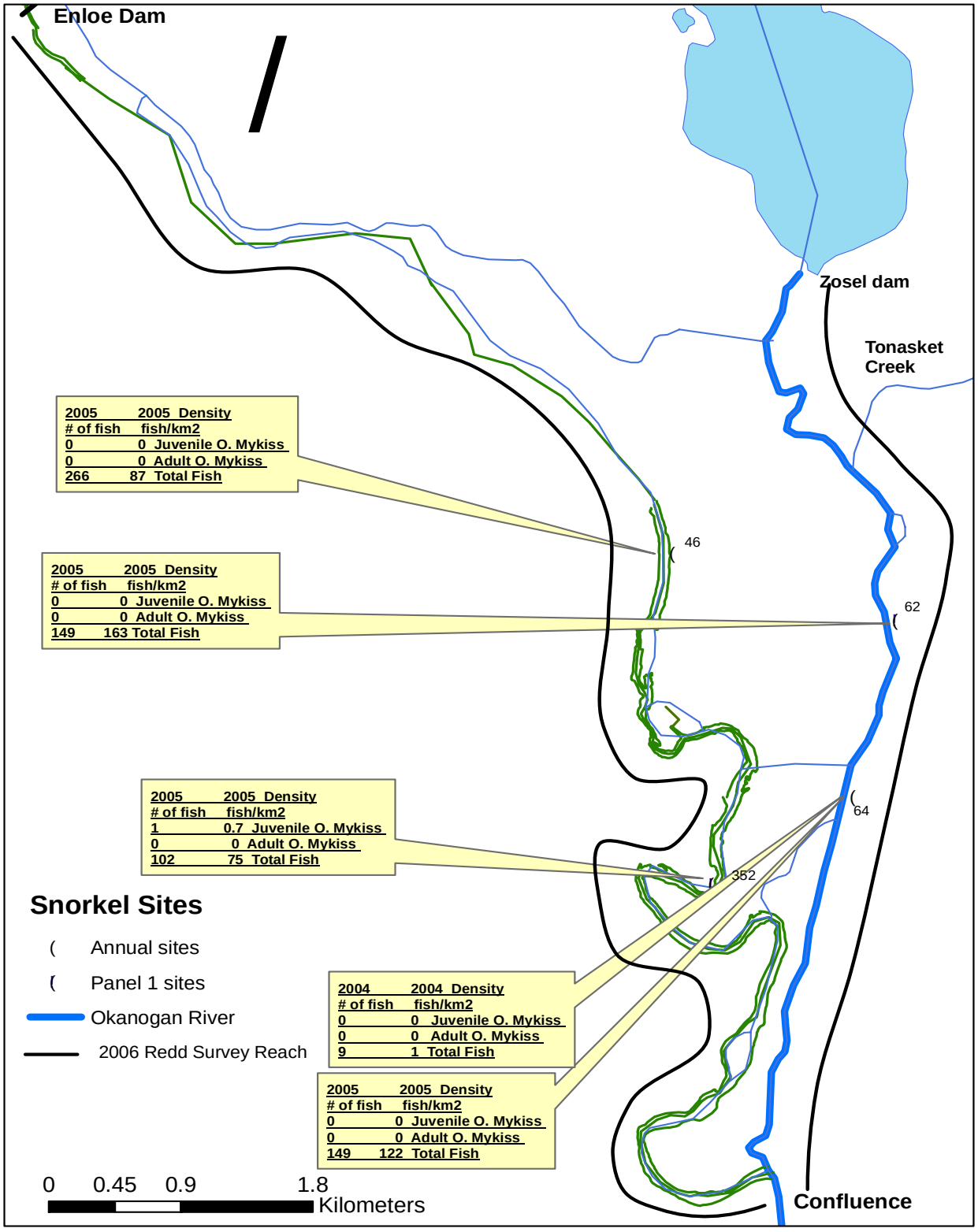

Figure 9: Snorkel survey reaches O6 and S1.

Omak Creek

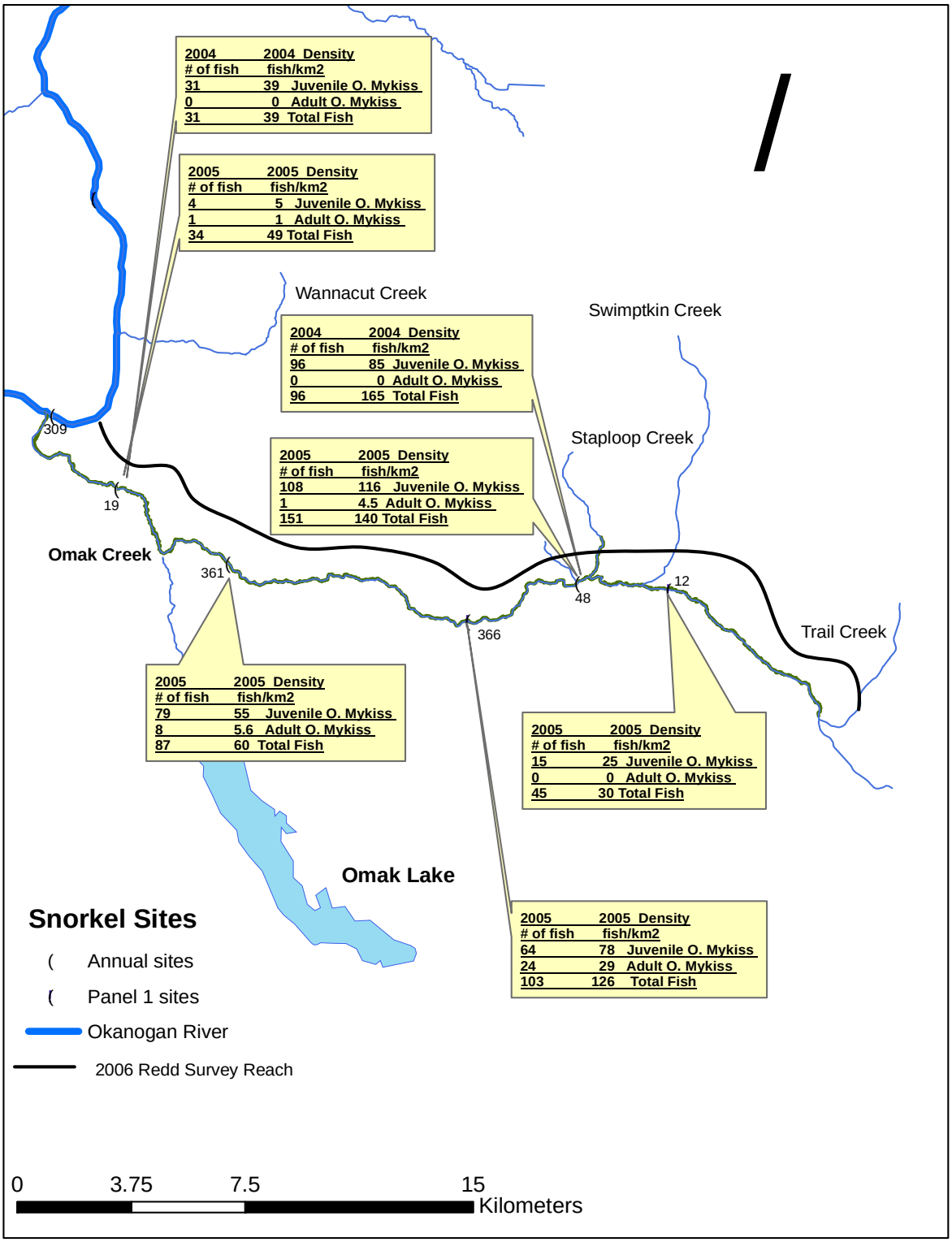

Figure 10: Snorkel survey reach Omak Creek Lower and Omak Creek Upper.

Salmon Creek

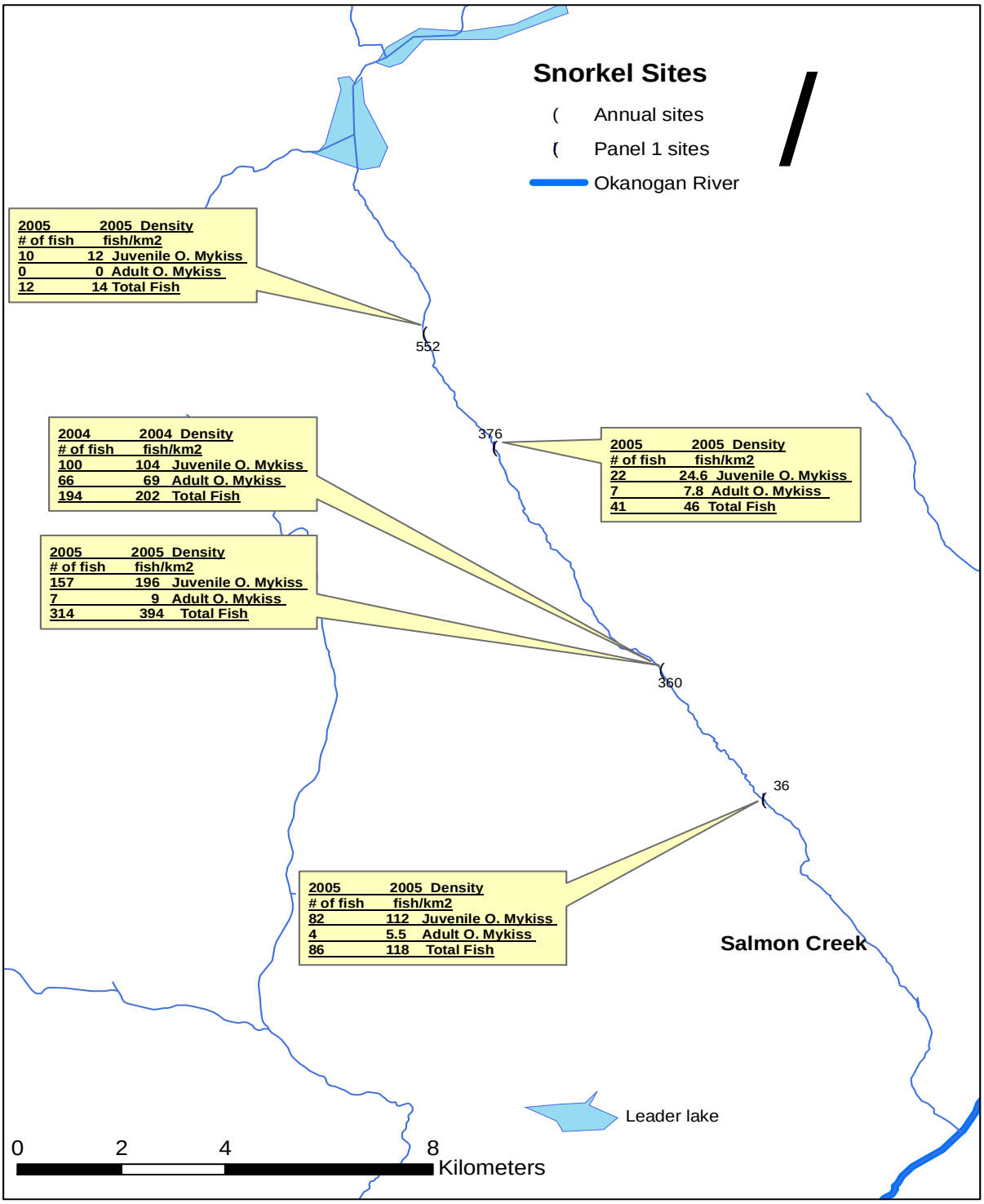

Figure 11: Snorkel survey reach Salmon Creek.

Ninemile, Tonasket and Haynes Creek

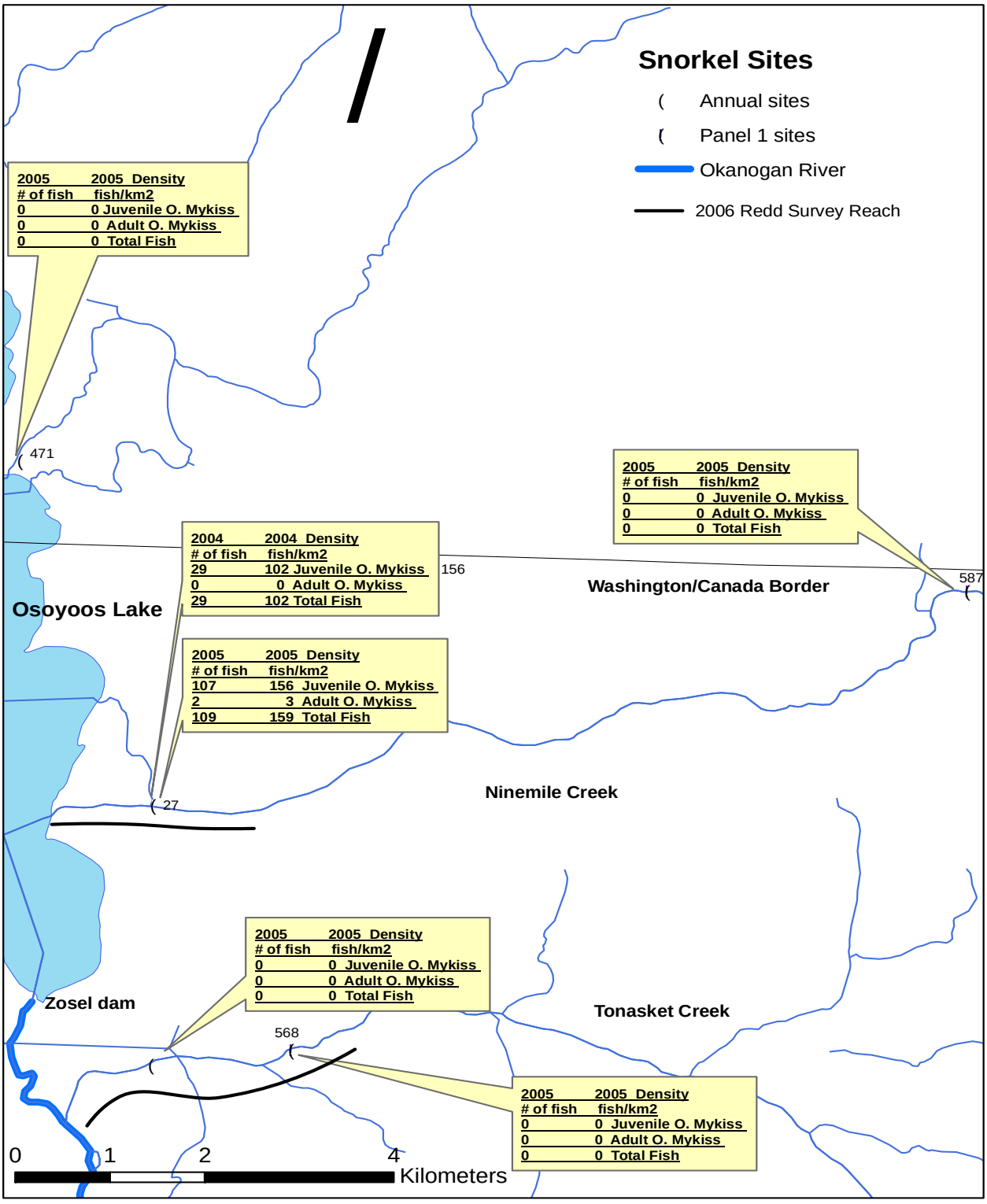

Figure 12: Snorkel survey reaches Ninemile, Tonasket and Haynes Creeks.

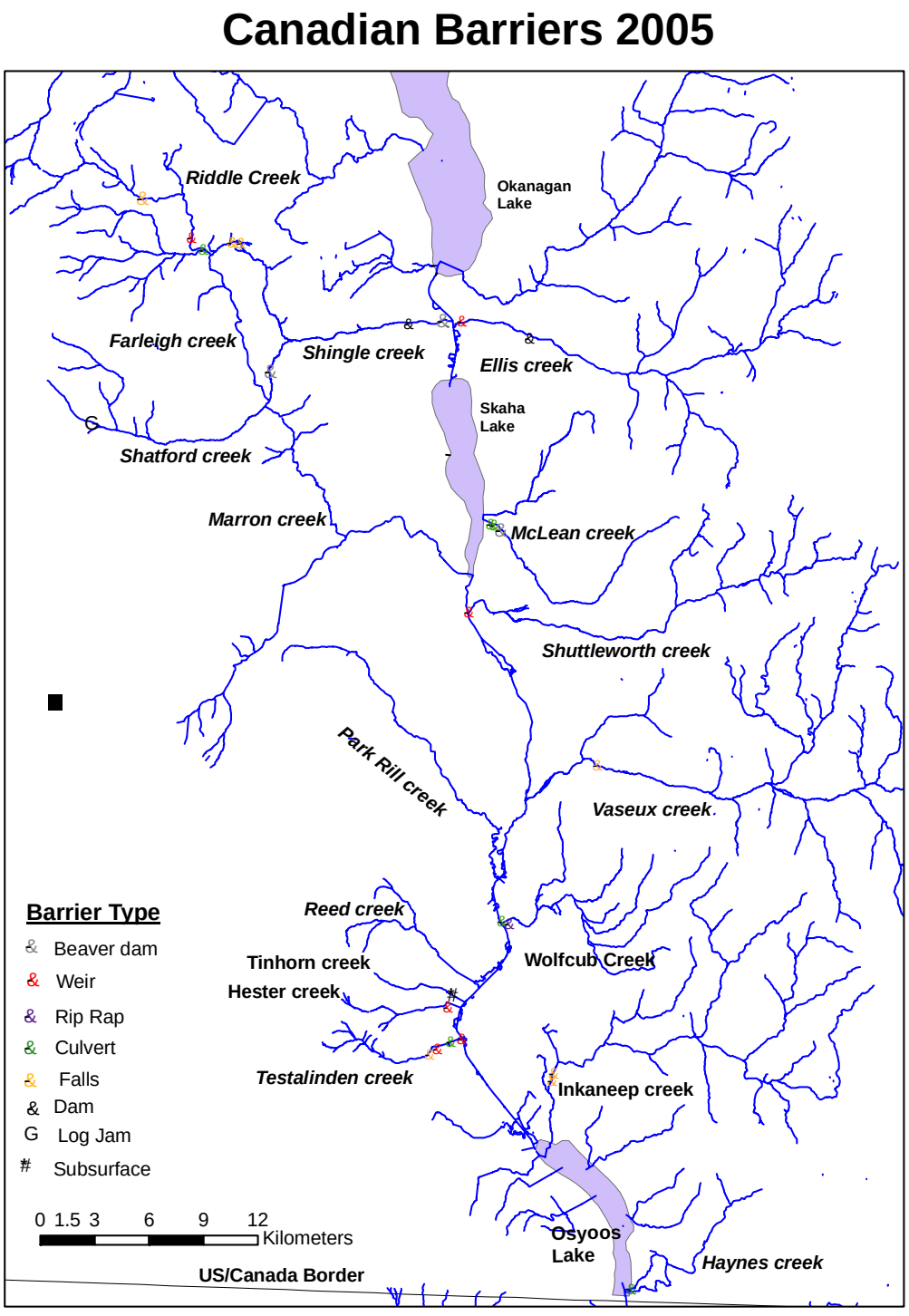

Figure 13: Barriers on Canadian tributary streams

Canada 1

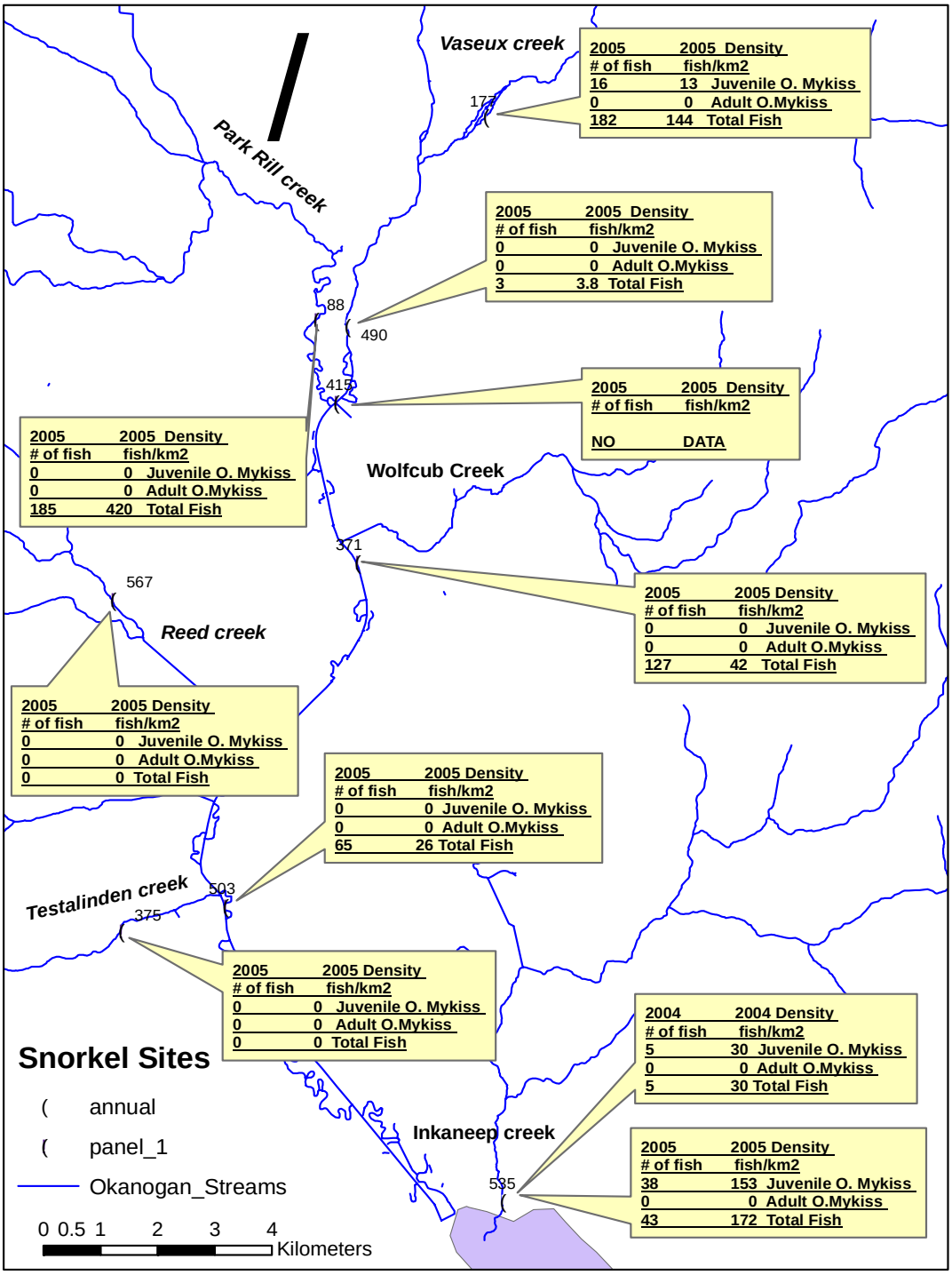

Figure 14: Reach Canada 1

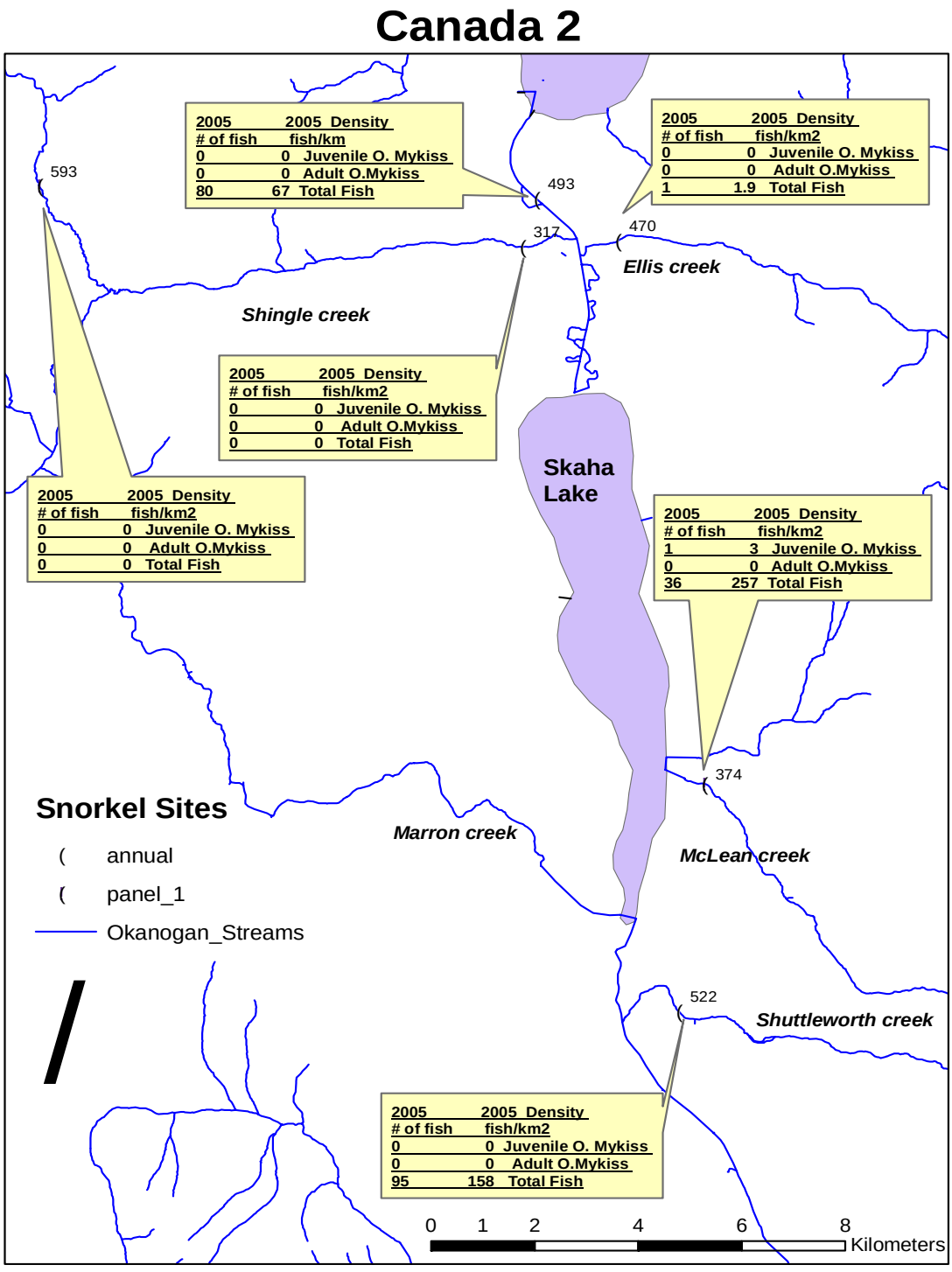

Figure 15: Reach Canada 2

Conclusions

Snorkel surveys were conducted throughout the Okanogan basin as part of the Okanogan Basin Monitoring and Evaluation Project (OBMEP) in 2005. Surveys were conducted in both the United States and Canadian portions of the basin. Tributaries and main-stem river sites were surveyed. Streams available to anadromous fish and upstream habitats were surveyed. The majority of the juvenile *O. mykiss* were found in the tributaries of the United States portion of the Okanogan River basin. Coldwater tributaries are vital to the survival of steelhead in the Okanogan basin. Bonaparte Creek had the highest densities of juvenile *O. mykiss* in both years surveyed.

The Colville Tribes documented steelhead spawning in the mainstem Okanogan and Similkameen Rivers for the first time in 2005 (Arterburn et al. 2005). The lack of juvenile *O. mykiss* rearing in the main-stem was not surprising but does raise the question of where the juveniles are going? Are they surviving within or outside the basin? Further research into these questions and others is not only warranted but vital to understanding the role that the Okanogan River plays in the overall summer steelhead production for the Upper Columbia ESU. We will be trying to answer these questions in the coming years as part of OBMEP.

We expect to see more juvenile *O. mykiss* in both upper and lower Omak Creek reaches in the future for three reasons. The first is the passage barrier removal at Mission Falls during the fall of 2005; the second being the steelhead smolt releases that occurred above Mission Falls in recent years; and lastly that with normal snow fall the spring freshet will eliminate many beaver dams that acted as barriers and inundated quality spawning habitats in 2005.

Both Salmon and Loup-Loup Creeks historically supported summer steelhead populations (Arterburn et al. 2005). High densities of resident *O. mykiss* in Salmon and Loup-Loup Creeks indicate that large increases in productivity and abundance can be gained from providing discharge sufficient to provide a migration corridor. Additionally, gains in spatial structure would also result from these activities. Establishing a baseline of snorkel data today will provide for evaluation of these efforts in the future.

In Canada, very little empirical data on anadromous fish exists. As more information is collected in the coming years, management and recovery efforts can be better focused to derive greater benefits at a lower cost. Preliminary efforts to address data gaps have identified Inkaneep and Vaseux Creeks as steelhead production areas. New information has pointed toward Shuttleworth Creek, located above McIntyre Dam, as having potential for steelhead spawning and rearing. McIntyre Dam is the current terminus of anadromy along the Okanagan River. McLean Creek is also above McIntyre Dam and just upstream of Skaha Lake Dam but new data show this creek as having potential for steelhead spawning and rearing habitat once current barriers are removed. Opening access to tributaries above McIntyre Dam should be considered a priority for current restoration activities. We plan on expanding redd surveys into Canada in 2006 and will be able to compare our juvenile numbers with redd counts in the future.

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Appendix A

Snorkel Summary Spread Sheets

Table 1. Fish encounter data in the Okanogan Basin, US portion, 2004 and 2005

Reach	Locations	Categories	2005 # of fish(dominant species)	2005 Density fish/km2	2004 # of fish(dominant species)	2004 Density fish/km
O1	Okanogan River 74	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	27 (11 Small Mouth Bass)	8.6		
	Okanogan River 549	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	84 (46 Sucker)	27.6		
	Okanogan River 156	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	199 (86 Whitefish)	109.0		
	Okanogan River 325	Juvenile O. mykiss	1	0.4	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	144 (46 Whitefish and 43 Sucker)	59.0		
O2	Okanogan River 84	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	67 (Small Mouth Bass)	36.6		
	Okanogan River 309	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	70 (36 Sucker)	38.2		
	Okanogan River 328	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	73 (56 Sucker)	34.0		

O3	**Okanogan River 159**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	116 (61 Small Mouth Bass)	95.1		
O3	**Okanogan River 92**	**Juvenile O. mykiss**	1	0.3	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	206 (73 Sucker and 71 Small Mouth Bass)	52.5		
O4	**Okanogan River 299**	**Juvenile O. mykiss**	3	1.3	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	235 (123 Whitefish)	103.3		
	Okanogan River 25	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	8 (7 Minnow)	6.4		
O6	**Okanogan River 64**	**Juvenile O. mykiss**	0	0.0	0	0.00
		Adult O. mykiss	0	0.0	0	0.00
		Total Fish	149 (119 Small Mouth Bass)	122.0	9 (7 Minnow)	1.10
	Okanogan River 62	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	149 (121 Small Mouth Bass)	163.0		
S1	**Similkameen River 46**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	266 (159 Sucker)	87.3		

	Similkameen River 352	**Juvenile O. mykiss**	1	0.7	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	102 (38 Sucker)	75.0		
Omak Lower	**Omak Creek 19**	**Juvenile O. mykiss**	4	5.0	31	38.60
		Adult O. mykiss	1	1.2	0	0.00
		Total Fish	34 (29 Suckers)	48.6	31 (O. mykiss)	38.60
Omak Upper	**Omak Creek 48**	**Juvenile O. mykiss**	108	116.0	96	84.69
		Adult O. mykiss	1	4.5	0	0.00
		Total Fish	151 (O. mykiss)	140.4	96 (O. mykiss)	164.60
Omak Upper	**Omak Creek 12**	**Juvenile O. mykiss**	15	24.7	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	45 (30 Eastern Brook Trout)	30.0		
	Omak Creek 366	**Juvenile O. mykiss**	64	77.9	**Not Surveyed**	
		Adult O. mykiss	24	29.2		
		Total Fish	103 (O. mykiss)	125.7		
	Omak Creek 361	**Juvenile O. mykiss**	79	54.9	**Not Surveyed**	
		Adult O. mykiss	8	5.6		
		Total Fish	87 (O. mykiss)	60.4		
Salmon	**Salmon Creek 552**	**Juvenile O. mykiss**	10	11.9	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	12 (O. mykiss)	14.4		
	Salmon Creek 360	**Juvenile O. mykiss**	157	196.4	100	104.00
		Adult O. mykiss	7	8.8	66	68.50
		Total Fish	314 (O. mykiss)	393.5	194 (O. mykiss)	201.60

	Salmon Creek 36	**Juvenile O. mykiss**	82	112.4	**Not Surveyed**	
		Adult O. mykiss	4	5.5		
		Total Fish	86 (O. mykiss)	117.9		
	Salmon Creek 376	**Juvenile O. mykiss**	22	24.6	**Not Surveyed**	
		Adult O. mykiss	7	7.8		
		Total Fish	41 (O. mykiss)	45.8		
B1	**Bonaparte Creek 388**	**Juvenile O. mykiss**	149	551.1	210	578.85
		Adult O. mykiss	6	26.7	23	63.40
		Total Fish	175 (O. mykiss)	778.8	235 (O. mykiss)	646.30
TO1	**Tonasket Creek 128**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	0	0.0		
TO1	**Tonasket Creek 568**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	0	0.0		
N1	**Ninemile Creek 27**	**Juvenile O. mykiss**	107	156.0	29	101.75
		Adult O. mykiss	2	2.9	0	0.00
		Total Fish	109 (O. mykiss)	158.9	29 (O. mykiss)	101.75
	Ninemile Creek 587	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	0	0.0		
Antoine	**Antoine Creek 592**	**Juvenile O. mykiss**	10	14.6	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	51 (41 Eastern Brook Trout)	74.1		

Loup Loup	**Loup Loup Creek 421**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	0	0.0		
	Loup Loup Creek 208	**Juvenile O. mykiss**	32	105.2	**Not Surveyed**	
		Adult O. mykiss	5	16.4		
		Total Fish	176 (139 Eastern Brook Trout)	578.6		
Siwash	**Siwash Creek 240**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	2 (2 Eastern Brook Trout)	6.1		
TU1	**Tunk creek 395**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**	
		Adult O. mykiss	0	0.0		
		Total Fish	0	0.0		
Johnson	**Johnson Creek 520**	**Juvenile O. mykiss**	**Not Surveyed**		0	0.00
		Adult O. mykiss			0	0.00
		Total Fish			0	0.00

1-Sites that were not surveyed in either 2004 or 2005

Table 2. Fish encounter data in the Okanogan Basin, Canada portion, 2004 and 2005

Reach	Locations	Categories	2005 # of fish(dominant species)	2005 Density fish/km2	2004 # of fish	2004 Density fish/km
Canada 1	Okanogan River 503	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	55 (36 Sucker)	26.0		
	Okanogan River 371	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	127 (88 Whitefish)	42.3		
	Okanogan River 415	Juvenile O. mykiss	Data Lost [2]		Not Surveyed	
		Adult O. mykiss				
		Total Fish				
	Okanogan River 490	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	3 (2 carp)	3.8		
	Inkaneep Creek 535	Juvenile O. mykiss	38	152.6	5	30.1
		Adult O. mykiss	0	0.0	0	0.0
		Total Fish	43 (O. mykiss)	172.3	5 (O. mykiss)	30.1
	Testalinden Creek 375	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	0	0.0		
	Reed Creek 567	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	0	0.0		
	Park Rill Creek 88	Juvenile O. mykiss	0	0.0	Not Surveyed	
		Adult O. mykiss	0	0.0		
		Total Fish	185 (Unidentified)	420.3		

	Vaseux Creek 177	**Juvenile O. mykiss**	16	12.6	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	182 (Unidentified trout)	143.6	
	Haynes Creek 471	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	0	0.0	
Canada 2	**Okanogan River 493**	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	80(26 Suckers)	66.6	
	Shuttleworth Creek 522	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	95 (66 Minnow)	158.3	
	McLean Creek 374	**Juvenile O. mykiss**	1	3.3	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	36 (Unidentified-longnose dace?)	257.0	
	Shingle Creek 317	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	0	0.0	
	Ellis Creek 470	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	1(Minnow)	1.9	
	Shingle Creek 593	**Juvenile O. mykiss**	0	0.0	**Not Surveyed**
		Adult O. mykiss	0	0.0	
		Total Fish	0	0.0	

1-Sites that were not surveyed in 2004

2-Site that was surveyed in 2005 but data sheets were misplaced and not recovered