2007 OKANOGAN BASIN SNORKEL SURVEYS

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Abstract

The Colville Tribes' Fish and Wildlife Department conducted snorkel surveys in established EMAP sites throughout the Okanogan basin as part of the Okanogan Basin Monitoring and Evaluation Program. In 2007, snorkel surveys were conducted along the main stem Okanogan River in Canada and associated tributary streams within both the United States (US) and Canada. Eleven different species of fish were identified. The most abundant families of fish observed were Salmonidae and Cyprinidae, and the most abundant species were steelhead/rainbow trout (*Oncorhynchus mykiss)*. The majority of juvenile *O. mykiss* were found in Okanogan River tributaries accessible to returning summer steelhead adults. Bonaparte Creek had the highest density of juvenile *O. mykiss* in the United States and Inkaneep Creek had the highest density in Canada. A very low number of juvenile *O. mykiss* were counted within main stem Okanogan River sites in Canada. No snorkeling was performed in main stem sites within the US due to funding limitations. There were consistent numbers of juvenile *O. mykiss* across years at annual US tributary sites. These numbers reinforce that coldwater tributaries are vital to the survival of steelhead in the Okanogan basin. Continued efforts to support, preserve, and reestablish steelhead access to cold water tributaries in the US and Canada is warranted. Snorkel surveys should continue measuring the biological response to habitat improvements as they are implemented.

Introduction

The Okanogan River currently represents the northern extreme for the distribution of 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 Okanogan River watershed is located in Canada. Due to an extremely low gradient, high summer water temperatures and high turbidity, the 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 have been diverted in part or whole to supply the irrigation water supporting the local agrarian economy. 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 lesser quantity of warmer water from a stable, less turbid, lake-drained watershed.

For many years, spawning and rearing information related to anadromous fish in the Okanogan basin had more to do with professional opinion than actual data. The use of Salmon Creek, Omak Creek, and the upper Similkameen River by steelhead was noted in a National Marine Fisheries Service document (Fulton, 1970). In Canada, it is likely that steelhead, chinook, sockeye, and coho historically spawned in tributaries south of Okanagan 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, currently have accessible habitat for steelhead and Chinook salmon. Spawning areas were identified upstream from Lake Osoyoos (WDW 1993) and large rainbow trout were identified in an Okanagan Lake creel survey from the 1920's (Shepard 1992). 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 exists (WDF 1993).

Chapman et al. (1994) clearly links spawning activity of summer steelhead with juvenile densities. Density independent factors related to habitat, water quality, climate, and geology set the potential upper limit for juvenile production while density dependent functions such as predation, disease, and competition keep the population from achieving this upper limit (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), minimal effort has been made to compile and analyze data 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 this quote from Chapman et al (1994):

> *"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."*

No statements about rearing capacity or juvenile densities could be found for tributaries to the Okanogan River.

In an attempt to improve the understanding of the Okanogan River basin, the Okanogan Basin Monitoring and Evaluation Program (OBMEP) collects empirical data to address a number of management questions. The snorkeling part of this program monitors the egg-to-parr survival portion of the life cycle for anadromous fish native to the Okanogan Basin. Juvenile fish abundance and densities are also used as the response variable for evaluating habitat changes over time. Juvenile summer steelhead were chosen as the focal species because they require extended rearing time in freshwater habitats, are commonly found throughout the Okanogan basin and because they are federally listed as endangered. Information on both abundance and distribution are important to fishery managers, planners, and decision makers. Distribution, abundance, and species composition of non-anadromous fish are also collected but considered secondary and used only as relative abundance indicators.

Methods

A probabilistic sampling design was used to randomly select 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 yearly, while rotating panel sites are sampled once every 5 years (Figures 1 & 2).

Snorkel surveys are correlated with OBMEP physical habitat surveys and occur no more than two weeks after the habitat surveys. Four main stem Okanagan River and 12 small-tributary sites were surveyed in Canada and 18 tributary sites within the United States were also surveyed. However, no main stem Okanogan River sites in the United States were snorkeled due to funding cuts that occurred in 2007. Tributary snorkel surveys were performed by a single snorkeler moving upstream through the length of the reach. Sites observed to be dewatered during the physical habitat surveys were not snorkeled and considered to represent zero fish.

Survey reaches were snorkeled using protocols developed from the Upper Columbia strategies (Hillman 2006) and methodologies refined for OBMEP (Arterburn et al. 2005a). Fish were identified to species if possible, to family if needed and lastly into non-salmonid and salmonid groups 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 (0+ age fish)
- between 100 and 300mm (1+ and 2+ age fish)
- greater than 300mm (3+ age fish)

Sampling on small tributary streams in the United States was conducted between July 23 and October 5, 2007. Sampling in Canada started on July 5 and finished on September 5, 2007.

For this document the results are organized by; 1) country, 2) tributary or sub-watershed, and 3) main stem reach. The results are also compiled graphically to show spatial locations of observations. Analysis consisted of compiling results to determine total fish observed, juvenile *O. mykiss* identified, adult *O. mykiss* detected, and the dominant species seen in each reach. Densities were calculated for *O. mykiss* and total fish observed per hectare. The density values are the number of fish observed divided by the area observed by the snorkeler which was calculated as the product of visual distance (which was assumed to be the average wetted width if the whole channel was visible), and the reach length of each site surveyed.

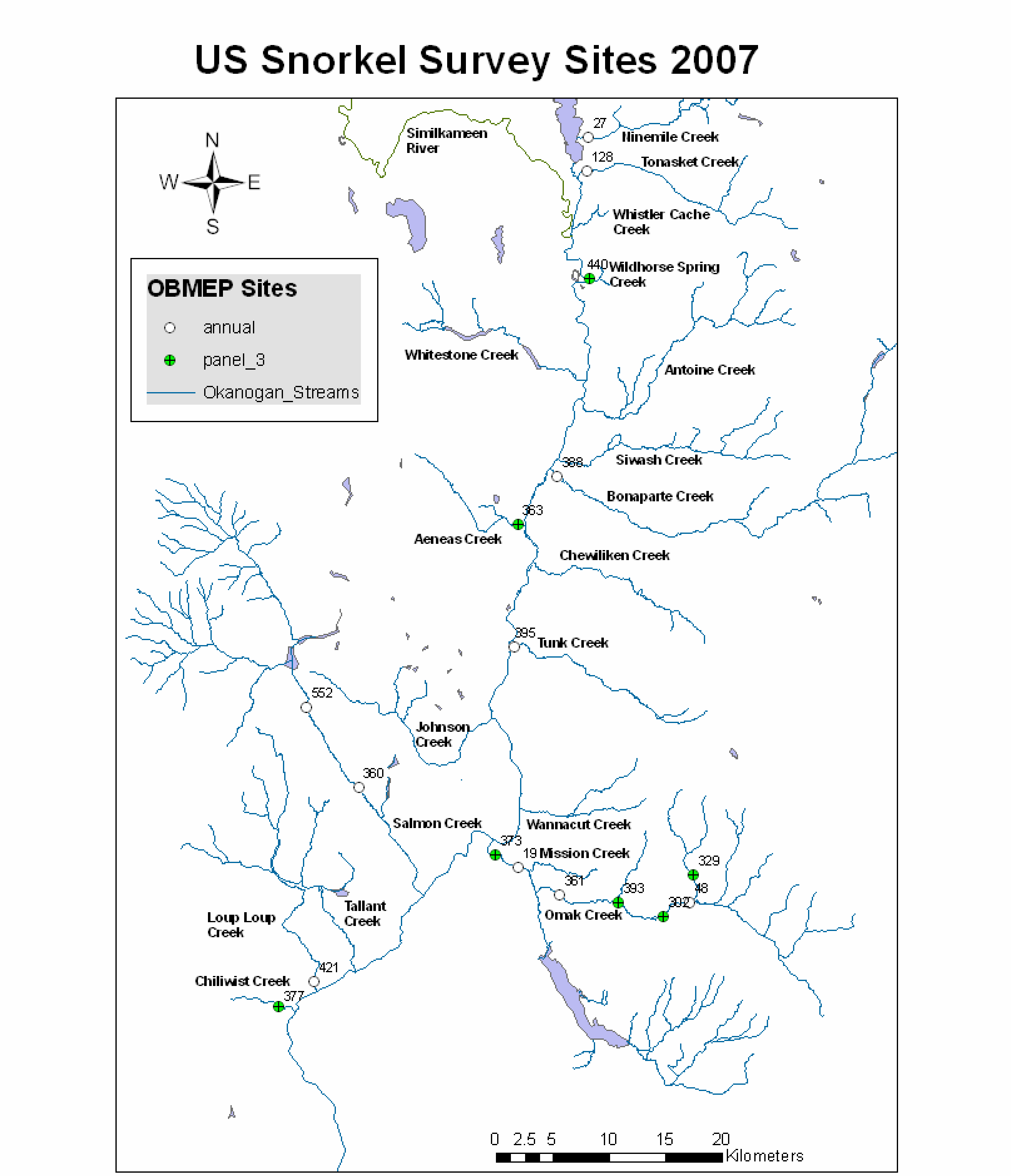

Figure 1: The locations of United States snorkel sites monitored by OBMEP in 2007.

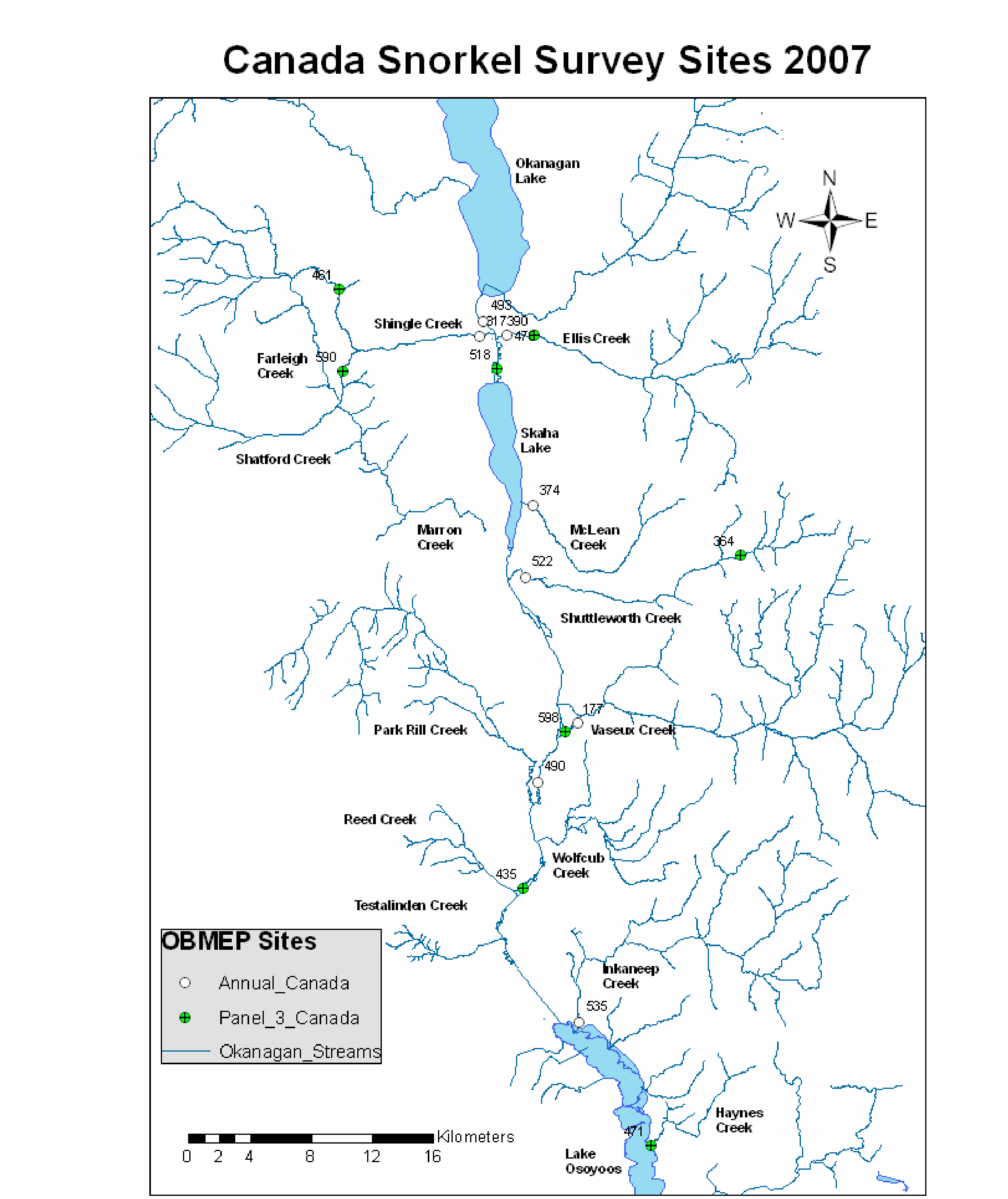

Figure 2: The location of snorkel sites monitored in Canada by OBMEP in 2007.

Results and Discussion

<u>*Species Richness*</u>

All fish species observed by OBMEP field crews during snorkeling efforts since inception of the program are presented in Table 1. The salmonid species observed in 2005, 2006, and 2007 were similar with the exception of westslope cutthroat trout which were documented in Aeneas Creek. Westslope cutthroat trout are thought to be native to the Wenatchee, Entiat, and Methow rivers but the widespread stocking of nonnative cutthroat and rainbow trout make it impossible to identify the origin of these fish positively (Behnke 1992). Cutthroat trout populations in the Okanogan basin do not typically exist in areas accessible by redband trout or steelhead; therefore documented barriers to anadromous fish (Arterburn et al. 2007b) have helped sustain these disjunct populations.

The total number of fish species observed in 2007 was eight and was substantially less than the observed 18 species in 2006 and the 15 observed in 2005. The reduction in species observed was due to elimination of snorkel surveys in main stem portions of the United States due to funding cuts. Main stem habitats typically contain greater species richness than tributary habitats. Tributary habitats support mostly cold-water species from the families Salmonidae, Catostomidae, and Cottidae. However, the main stem habitats are strongly influenced by higher temperatures and can inhibit the presence of cold water species. However, limited quantities of all species listed in Table 1 can be found in all portions of the basin at different times of the season.

<u>*Total* Oncorhynchus mykiss *observed*</u>

During 2007, a total of 1,507 juvenile and 8 adult *O. mykiss* were observed at all sites within the Okanogan River basin. Three juvenile and 1 adult *O. mykiss* were counted at main stem Okanogan River sites located within Canada, an additional 1,504 juvenile and 7 adult *O. mykiss* were identified in tributary sites. The highest numbers of juvenile *O. mykiss* were observed in Vaseux Creek, followed by Inkaneep Creek, and Bonaparte Creek.

The number of juvenile *O. mykiss* observed in 2007 were compared to the number of redds observed for several perennial reaches in Bonaparte, Omak and Ninemile creeks (Table 2). Correlations between redd density and juvenile *O. mykiss* were recognized in Bonaparte, Omak and Ninemile creeks. Juvenile *O. mykiss* densities were lower at common sites in 2007 when compared to the 4-year average with the exception of sites located on Bonaparte and Inkaneep Creeks (Table 3).

Table 1: Fish species observed during snorkel surveys in the Okanogan River Watershed in the summer of 2005, 2006 and 2007.

Species Observed	Observed in 2005	Observed in 2006	Observed in 2007
Sockeye Salmon *Oncorhynchus nerka*	X	X	X
Chinook Salmon *Oncorhynchus tshawytscha*	X	X	
Summer Steelhead *Oncorhynchus mykiss*	X	X	X
Cutthroat Trout *Oncorhynchus clarki lewisi*			X
Brook Trout *Salvelinus fontinalis*	X	X	X
Mountain Whitefish *Prosopium williamsoni*	X	X	X
Bridgelip Sucker *Catostomus columbianus*	X	X	X
Yellow Perch *Perca flavescens*	X	X	
Redside Shiner *Richardsonius balteatus*	X	X	
Northern Pikeminnow *Ptychocheilus oregonensis*	X	X	
Common Carp *Cyprinus carpio*	X	X	
Smallmouth Bass *Micropterus dolomieu*	X	X	
Largemouth Bass *Micropterus salmoides*	X	X	
Pumpkinseed *Lepomis gibbosus*	X	X	
Largescale Sucker *Catostomus macrocheilus Girard*		X	
Channel Catfish *Ictalurus punctatus*		X	
White Crappie *Pomoxis annularis*		X	
Peamouth *Mylocheilus caurinus*		X	
Bluegill *Lepomis macrochirus*		X	
Shorthead Sculpin *Cottus confusus*	X		X
Black Bullhead *Ameiurus melas*	X		X
Total Fish Species Observed	**15**	**18**	**8**

Table 2: Descriptions of reference reaches used for comparing the number of juvenile *O. mykiss* observed by snorkel surveys, number of fish/ha and number of redds documented in redd surveys (Arterburn et al. 2007).

Reference Reaches	River Mile	Total Reach length (KM)	OBMEP Snorkel Site ID#	Juvenile *O. mykiss*	Area in Hectares	Juvenile *O. mykiss* Density(fish/ha)	# of Redds
Tunk Creek TU1	0-0. 2	0.32	395	0	0.01	0	NA
Bonaparte Creek-B1	0-1.6	2.57	388	220	0.02	9,389	70
Ninemile Creek-N1	0-1.72	2.77	27	15	0.02	653	3
Tonasket Creek-TO1	0-3.5	5.63	128	2	0.01	198	6
Omak Creek Lower	0-6.2	10	19/373	157	0.13	1,208	47
Omak Creek Upper	6.2-21.5	24.6	361/393/ 48/302	192	0.43	447	2
Salmon Creek	4.3-22.3	18	360/552	211	0.22	959	NA
Stapaloop Creek	1.5-1.6	0.15	329	40	0.03	1,333	0
Loup Loup Creek	0-2.1	3.3	421	0	0	0	6
Wanacut Creek	0-1	1.6	NA	0	0.02	0	1
Aeneas Creek	0.5-0.6	0.15	363	21	0.21	102	NA
Wild Horse Spring Creek	0.2-0.3	0.15	440	0	0.01	0	7
Okanagan River-Canada 1	136.6-151.6	24.1	435/490	1	2.24	0.4	0
Okanagan River-Canada 2	151.6-170.2	30	518/493	2	2.7	0.7	NA
Haynes Creek	0.2- 0.3	0.15	471	0	0.01	0	0
McLean Creek	0.55-0.65	0.15	374	178	0.03	5,307	NA
Inkaneep Creek	0-1.8	2.9	535	295	0.07	4,358	2
Vaseux Creek	0.36-3.0	4.9	177/598	643	0.42	1,531	0
Shuttleworth Creek	0-3.2	5.1	522/ 538	25	0.2	125	0
Shingle Creek	0-0.7 & 8.3-8.4	0.3	317/461	39	0.12	325	NA
Shatford Creek	1.2-1.3	0.15	590	117	0.07	1,789	NA
Ellis Creek	0-1.8	0.3	390/470	12	0.11	110	NA

NA=Not Surveyed

Table 3: Comparison of the juvenile *O. mykiss* densities (fish/ha) across years (2004-2007) at select sites and the 4 year averages for each site.

OBMEP-site	2004	2005	2006	2007	4-year average
388-Bonaparte Creek	5,790	3,630	2,720	9,389	5,382
19-Omak Creek	390	3,590	2,560	1,065	1,901
48-Omak Creek	850	1,160	820	695	881
360-Salmon Creek	1,040	1,960	150	931	1,020
27-Ninemile Creek	1,020	1,560	3,720	653	1,738
535-Inkaneep Creek	300	1,530	1,070	4,358	1,814

Table 4: Average relative juvenile *O. mykiss* abundance (# of fish/site) at annual sites across years

Location	2004	2005	2006	2007
Okanogan River	None Detected	0.3	0	None Detected
Similkameen River	None Detected	0	2	None Detected
U.S. Tributaries	93.2	87.7	86.4	90.6
Canada	5	6.9	11.1	85

United States snorkel observations by sub-watershed

Loup Loup Creek included only Site 421 which is located below Loup Loup Falls; the terminus for anadromous fish (Arterburn et al. 2007). This reach was dry and therefore had no fish.

Wanacut Creek included one reference site located below the falls identified as the terminus for anadromous fish (Arterburn et al. 2007). No fish were identified during the snorkel survey.

Tunk Creek included site 395 located below Tunk Falls which is the terminus for anadromous fish (Arterburn et al. 2007). Site 395 was dry at the time of snorkeling except for a few small pools of water. No fish were identified during the snorkel survey.

Aeneas Creek (Figure 3) included Site 363 located above the barrier to anadromous fish (Arterburn et al. 2007). Twenty one juvenile *O. mykiss*, 8 westslope cutthroat trout and 159 eastern brook trout were identified. The density of juvenile *O. mykiss* was 102/ha and the total fish density was 920 fish/ha.

Bonaparte Creek (Figure3) included site 388 and was dominated by *O. mykiss* (220 juvenile and 0 adult). The density of juvenile *O. mykiss* was 9,389/ha. The density observed at this site was much higher than previous years (Table 3) and was considered an abundant year for steelhead spawning (Arterburn et al. 2007a). Other fish species observed in 2007 were bridgelip suckers (63) and eastern brook trout (135). The total fish density for all species at this site was 18,050 fish/ha.

Wild Horse Spring Creek (Figure 3) included Site 440, located below the terminus for anadromy (Arterburn et al. 2007). No fish were observed during the snorkel survey. However, juvenile *O. mykiss* were identified in spot surveys throughout the watershed in 2006 and 2007.

Stapaloop Creek (Figure 4) included Site 329 and was dominated by *O. mykiss* (40 juvenile and 0 adults). The density of juvenile *O. mykiss* was 1,333/ha in 2007. Other fish observed included 7 eastern brook trout.

Omak Creek (Figure 4: sites 19, 373, 361, 393, 48 & 302) was divided into two reaches: 1) *Omak Lower*, from the confluence with the Okanogan River upstream to Mission Falls (RM 0 to 6.2), containing EMAP sites 19 and 373; and 2) *Omak Upper*, from Mission Falls upstream to Trail Creek (RM 6.2 to 21.5), containing EMAP sites 361, 393, 48, and 302. The dominant species at all sites, in both reaches, except one, was *O. mykiss* which represented 74% of all fish observed in Omak Creek during 2007 surveys.

Omak Lower (Figure 4: sites 19 & 373) 157 juvenile *O. mykiss* were observed, this represents a combined average juvenile *O. mykiss* density of 1,208/ha. The densities of *O. mykiss* increased as you progressed upstream toward Mission Falls. The average fish density for all species at these sites was 1,450-fish/ha. Site 19 has been surveyed since 2004. The average juvenile *O. mykiss* density at this site was 1,065/ha, which was less than the previous two years but greater than 2004 (Table 3).

Omak Upper (Figure 4: sites 361, 393, 48 & 302). Mission Falls is considered the current terminus for anadromous fish (Arterburn et al. 2007), although a steelhead redd was located upstream of the falls in 2001. Habitat modifications were made to these falls during 2006 in order to aid fish passage. During redd surveys in the spring of 2007 two redds were observed within the falls but no redds were observed upstream of Mission Falls (Arterburn et al 2007a) therefore, fish observed upstream of the falls are considered resident. A total of 192 juvenile rainbow trout were observed at these sites in 2007. The juvenile rainbow trout densities ranged from 750-fish/ha at site 302 to 280-fish/ha at site 393 where the dominant species was eastern brook trout. The average fish density for all juvenile *O. mykiss* at these sites was 510-fish/ha. Site 48 has been surveyed since 2004. The average juvenile *O. mykiss* density at this site was 695-fish/ha, which was less than the previous three years (Table 3). One factor that may contribute to the reduction in fish production at this site is the increasing amounts of fine sediment. Although rehabilitation efforts have been underway since 2000 to address sediment issues resulting from timber harvest activities and high road densities in the upper reaches of the Omak Creek watershed, the volume of fine sediment within residual pools (V*) increased nearly 100% between 2000 and 2005 (Chris Fisher-Colville Tribes unpublished data). The measurable benefits from such headwater restoration activities will not be realized for decades as sediment transport is a slow process (Waters 1995).

Salmon Creek (Figure 5: sites 360 & 552) both of these sites are upstream of the Okanogan Irrigation District diversion dam. Since this dam diverts 100 percent of the flow in Salmon Creek, access is denied to anadromous fish at the mouth; therefore, we considered all *O. mykiss* to be resident. A total of 211 juvenile and 2 adult *O. mykiss* were observed at these sites in 2007. The juvenile *O. mykiss* densities ranged from 931/ha at site 360 to 1,013/ha at site 552. The dominant species at both sites was *O.*

mykiss and comprised 71% of all fish observed. The average fish density for all *O. mykiss* at these sites was 959-fish/ha. The average fish density for all species at these sites was 1,400-fish/ha. Site 360 has been surveyed since 2004. The average juvenile *O. mykiss* density was more than 2006 but less than 2005 and 2004 (Table 3).

Tonasket Creek (Figure 6, site 128), Two juvenile *O. mykiss* were observed at site 128. The density of juvenile *O. mykiss* was 198/ha however, this section of the creek usually goes dry during the mid-summer and these fish observed most likely perished soon after our survey.

Ninemile Creek (Figure 6, site 27), during 2007, 15 juvenile *O. mykiss* and 2 eastern brook trout were observed at this site. The juvenile *O. mykiss* density was 653/ha. Since 2004 the average juvenile *O. mykiss* density at this site was less than the previous three years (Table 3).

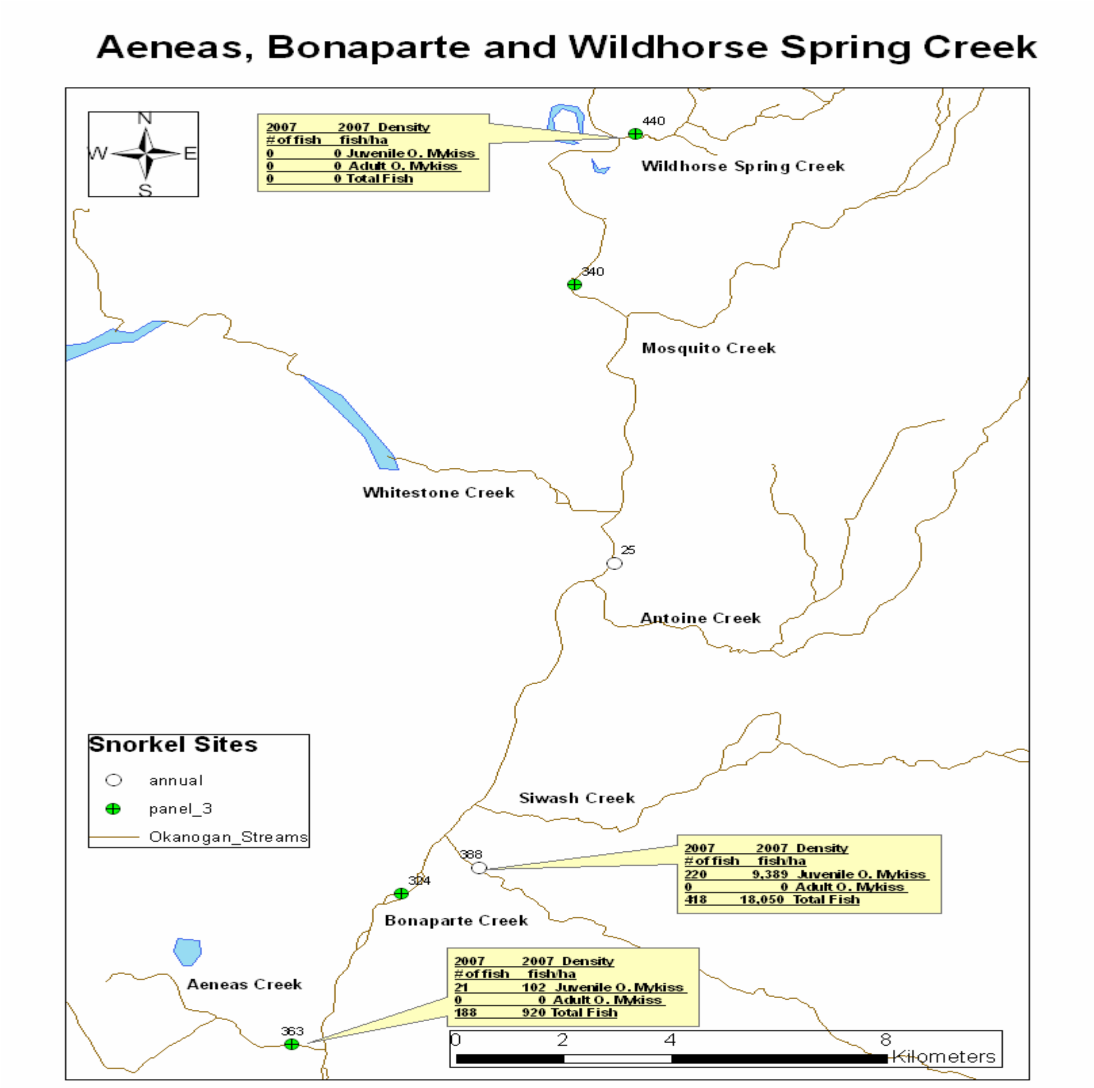

Figure 3: Snorkel survey observations for Aeneas, Bonaparte and Wildhorse Spring creeks.

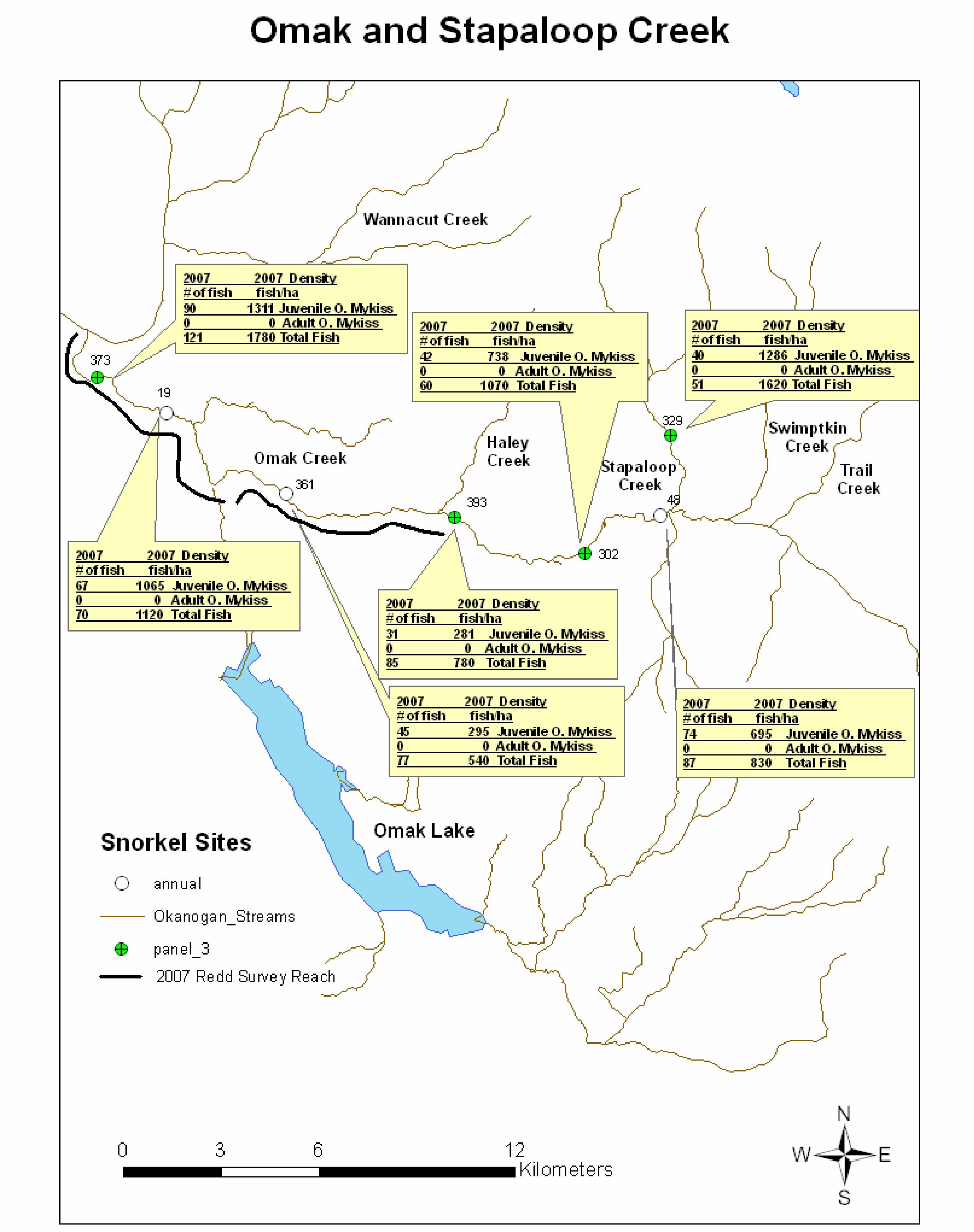

Figure 4: Snorkel survey observations for Omak and Stapaloop creeks.

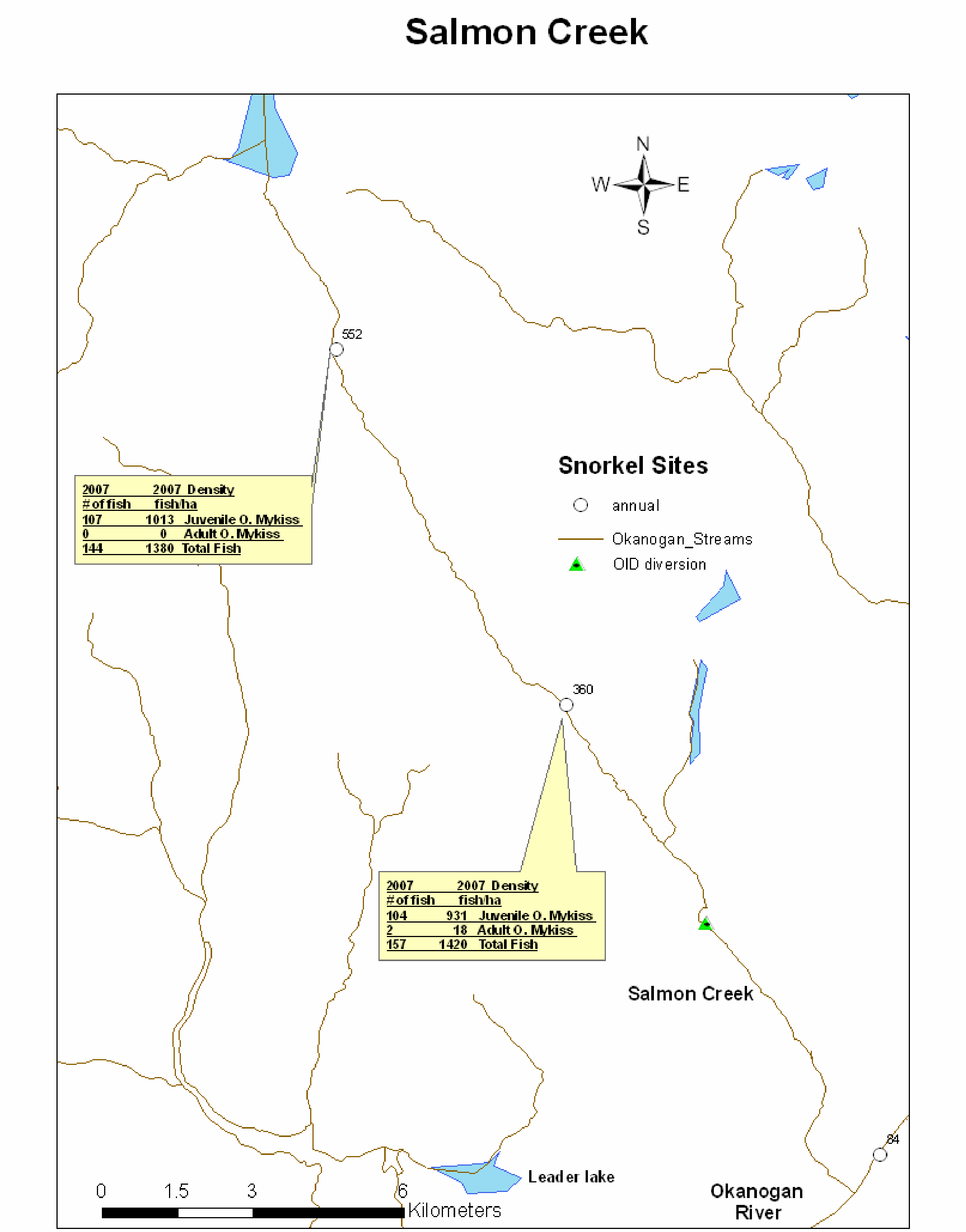

Figure 5: Snorkel survey observations for Salmon Creek (all sites are located above the OID diversion).

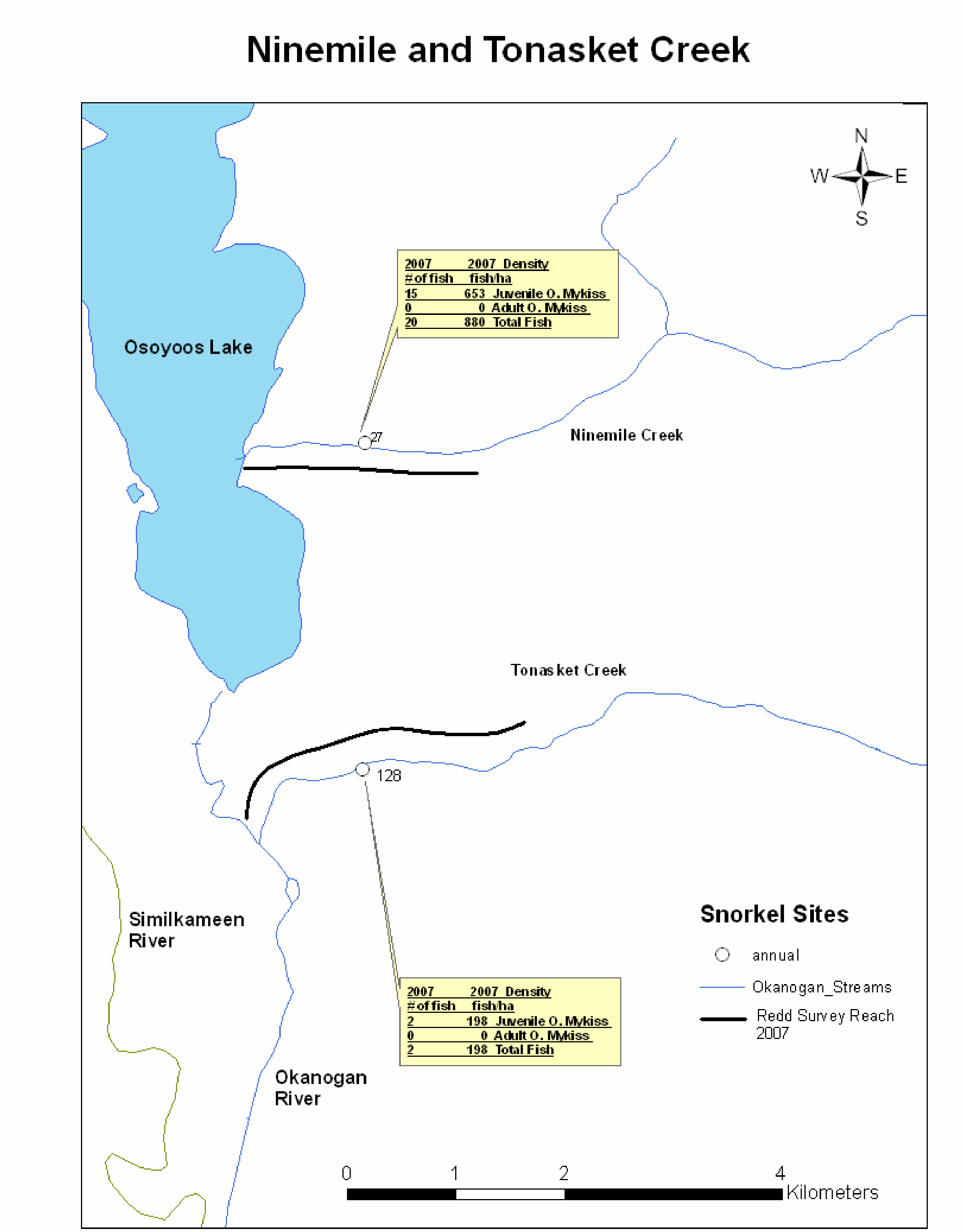

Figure 6: The locations of snorkel reaches and fish observed in Ninemile and Tonasket creeks during 2007.

Snorkel observations by sub-watershed in Canada

Snorkel sites located in Canada were surveyed by the natural resource staff of the Okanagan Nation Alliance. There were three juvenile and one adult *O. mykiss* observed in the main stem Okanagan River and 1,309 juvenile along with five adult *O. mykiss* observed in the tributaries in Canada. Inkaneep Creek (site 535); Vaseux Creek (177, 598), McLean Creek (374), Shingle Creek (590 and 461), Shatford Creek (590), Shuttleworth Creek (522, 364) and Ellis Creek (470) all had juvenile *O. mykiss* present. However, only Inkaneep Creek and Vaseux Creek are accessible to anadromous salmonids. Juvenile *O. mykiss* detected at sites 535, 177 and 598 have the potential to be steelhead progeny while *O. mykiss* at the other tributary sites are offspring from resident rainbow trout.

Canada Reach 1 (Figure 7: site 490 and 435) includes the segment of the main stem Okanagan River in Canada from the United States/Canadian border to McIntyre Dam (1-juvenile and zero-adult *O. mykiss* observed*)*. The dominant fish species were unknown fish from the Cyprinidae family. These fish comprised 62% of all fish observed. The average fish densities observed at these sites were 20-fish/ha and 0.4 juvenile *O. mykiss* per hectare.

Haynes Creek site 471 was snorkeled but no fish were observed at this site. The lack of any fish observed in this creek for 2005, 2006 and 2007 and the fact that the creek only flows intermittently, indicates that this is poor habitat for salmonids and fish in general. Data collected to date from Haynes Creek supports that this creek is not utilized by anadromous fish and therefore this annual site was switched with one of the panel sites on McLean Creek.

Inkaneep Creek (Figure 7: site 535) the dominant species observed at these sites were juvenile *O. mykiss* with 295 being observed. Juvenile *O. mykiss* density was 4,358/ha. The only other fish observed at these sites were three unidentified Cyprinids. This site has been surveyed since 2004. The average juvenile *O. mykiss* density in 2007 at this site was much higher than 2004-2006 (Table 3). Currently, this creek is believed to produce more summer steelhead than any other stream in the Canadian portion of the Okanagan basin.

Vaseux Creek (Figure 7: site 177 and 598) both of these sites were below the barrier to anadromous fish and therefore all fish observed were considered steelhead. A total of 643 juvenile *O. mykiss* were observed at these sites in 2007, although 27 of them were dead at site 598 due to dewatering. The juvenile *O. mykiss* density was 1848-fish/ha at site 598 and 1036-fish/ha at site 177. The only other fish observed at these sites were 209 minnows. Total fish densities observed were 2,390-fish/ha at site 598 and 1,520-fish/ha at site 177. Although this creek has great potential to produce juvenile *O. mykiss* water quantity issues greatly limit consistent fish production (Kistler and Arterburn 2007).

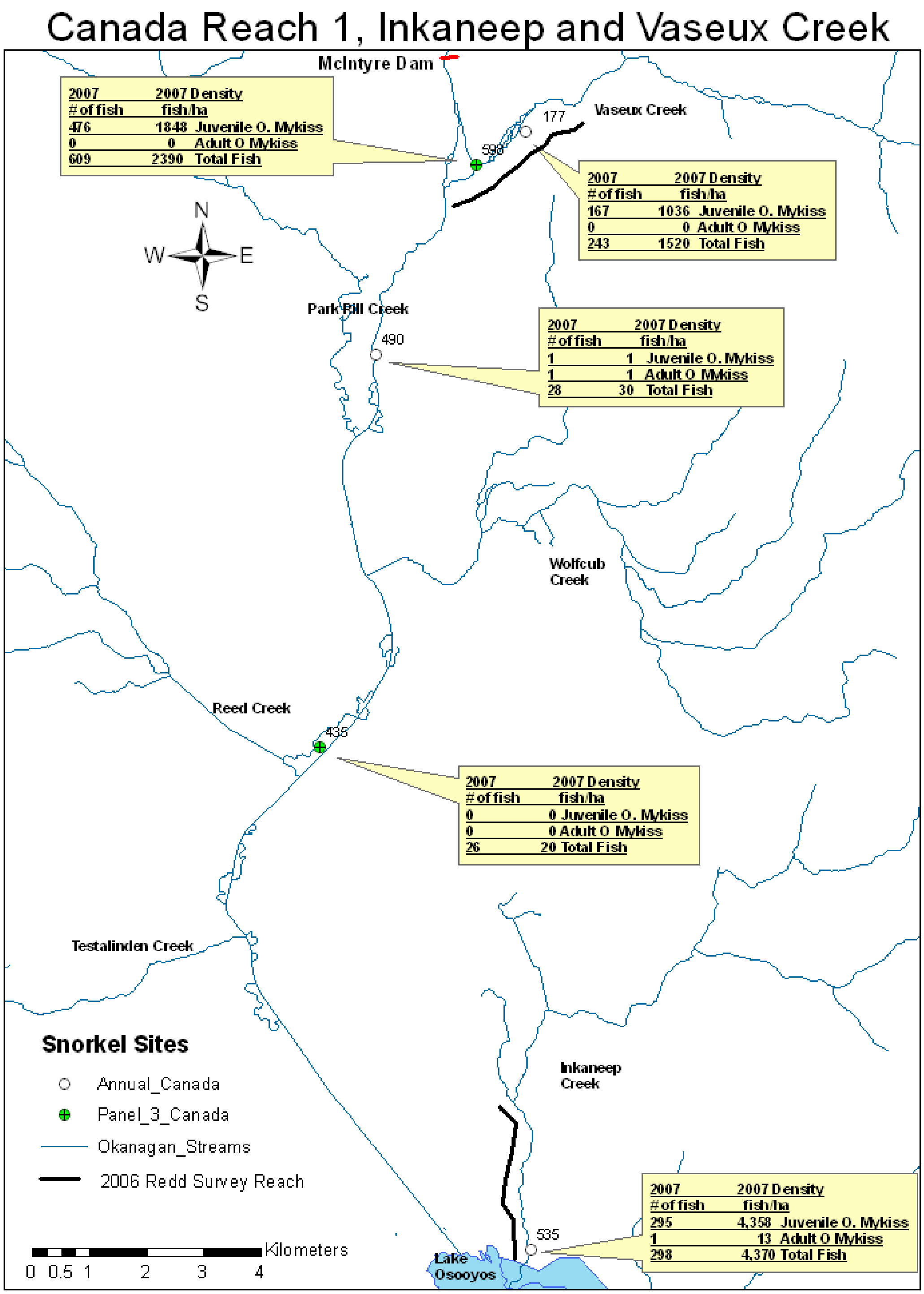

Figure 7: Snorkel site locations and fish observed for Vaseux Creek, Inkaneep Creek and the segment of the main stem Okanagan River in Canada from the 49th Parallel upstream to McIntyre Dam.

All fish observed at the following sites are considered resident fish due to anadromous fish blockage at McIntyre Dam on the Okanagan main stem.

Canada Reach 2 (Figure 8: sites 518 and 493) represents the segment of the main stem Okanagan River in Canada from McIntyre Dam to Okanagan Lake. Two juvenile *O. mykiss* were observed at site 493 with a fish density of 0.7-fish/ha. Individuals of the Cyprinidae family were most abundant within this reach. These fish made-up 30% of the fish observed at these sites with a total average fish density at these two sites of 30-fish/ha.

Shuttleworth Creek (Figure 8: site 522 and 364) site 522 had 25 juvenile *O. mykiss* observed with a density of 253-fish/ha. Site 364 had no juvenile *O. mykiss*, however 22 eastern brook trout were observed resulting in a fish density of 573-fish/ha. Other fish observed at site 522 were 18 cyprinids. The average density for all fish at these two sites was 590-fish/ha.

McLean Creek (Figure 8: site 374) had 178 resident, juvenile *O. mykiss* observed with a density of 5,307/ha. This creek has excellent potential for steelhead rearing, based on the number of fish observed at this site, once barriers to fish passage at both McIntyre and Skaha dam are removed.

Ellis Creek (Figure 8: site 470) only one site out of two surveyed for habitat parameters (site 470) was snorkeled. 1 adult *O. mykiss* and 12 juvenile *O. mykiss* were observed along with 45 unidentified Cyprinids. Juvenile *O. mykiss* density was 110-fish/ha and the total fish density was 570-fish/ha.

Shingle Creek (Figure 8: site 317 and 461) 39 juvenile *O. mykiss* were observed at site 461 and no juvenile *O. mykiss* were observed at site 317. Sixty-one cyprinids and 10 juvenile sockeye (*Oncorhynchus nerka*) were observed at site 317 and were the only other species observed at either site. Density of juvenile *O. mykiss* was 325-fish/ha at site 461. The average density within both reaches was 830-fish/ha.

Shatford Creek (Figure 8: site 590) 4 adult and 117 juvenile *O. mykiss* were observed along with 61 eastern brook trout. Density of juvenile *O. mykiss* was 1,789-fish/ha. Total fish density at this site was 2,810-fish/ha.

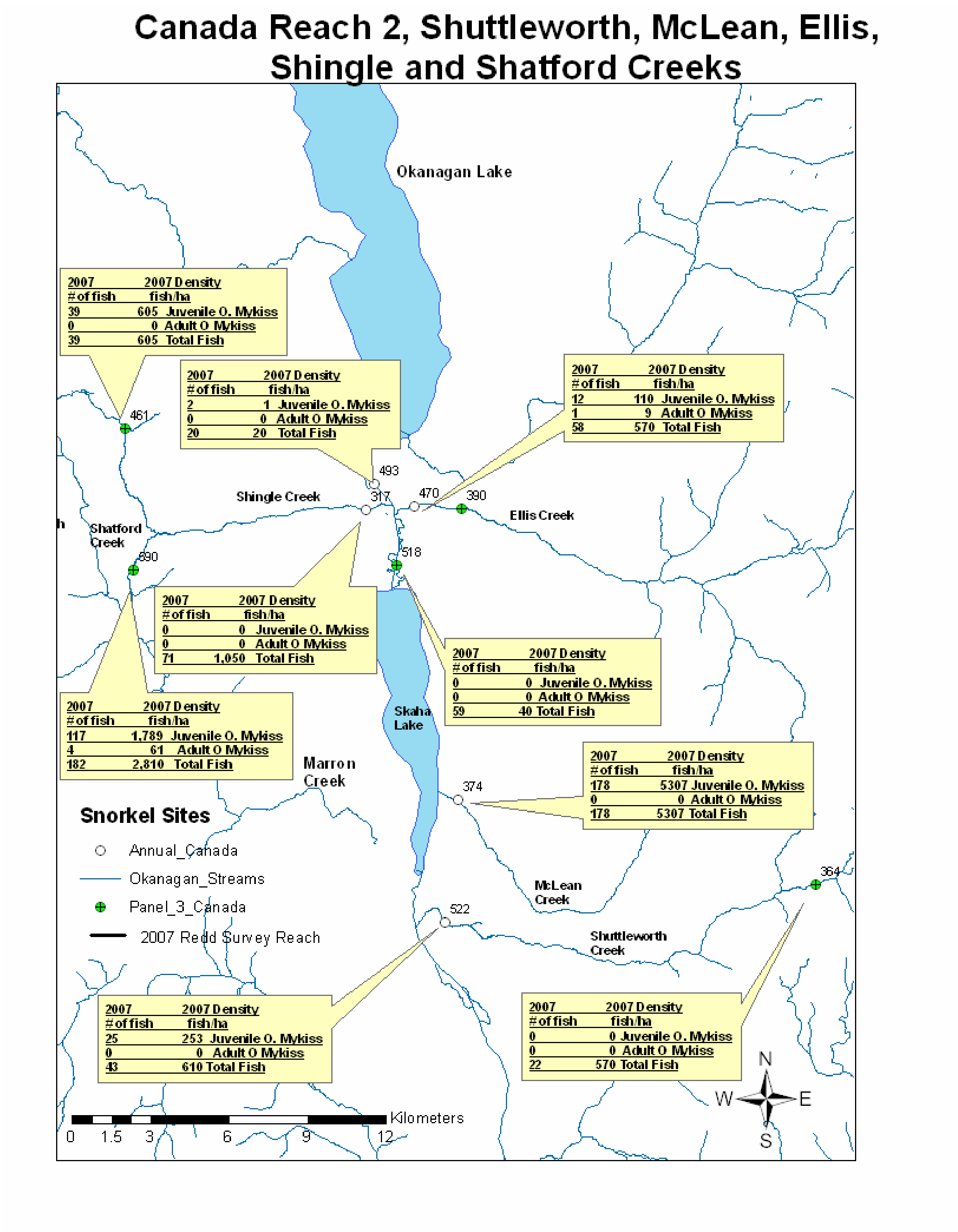

Figure 8: The locations of snorkel sites and fish observed in Shuttleworth, McLean, Ellis, Shingle and Shatford creeks along with the segment of the main stem Okanagan River in Canada from McIntyre Dam to Okanagan Lake.

Conclusions

Coldwater tributaries are vital to the survival of steelhead in the Okanogan basin. There was a large increase in juvenile *O. mykiss* abundance in Bonaparte, Vaseux, and Inkaneep creeks in 2007 when compared to previous year's surveys. Increased numbers of juvenile steelhead in Bonaparte Creek were likely due to an increase in the number of adult steelhead that utilized this creek. High Okanogan River discharge in the spring of 2007 allowed increased access to Bonaparte Creek (Arterburn et al 2007a). Secondly, discharge was the lowest recorded (0.5 cfs) while conducting the snorkel survey, which likely caused the fish to be more concentrated and thus elevated calculated densities. In Inkaneep and Vaseux creeks, a more experienced field crew resulted in vastly increased detections of juvenile steelhead. Additional years of monitoring and more cross training between the Colville Tribes and the Okanagan Nation Alliance will reduce inconsistencies and improve fish identification certainty.

A high degree of inter-annual variation of *O. mykiss* densities within snorkel sites has been observed (Table 3). These differences have been investigated by comparing observed *O. mykiss* densities to:

- The number of summer steelhead redds observed earlier in the spring.
- The minimum discharges from the current and previous year.
- The number of hatchery summer steelhead smolt releases in Omak Creek.
- The maximum discharge from the current year.

Many factors play a role in the variation in numbers of juvenile *O. mykiss* detected during snorkel surveys. None of the above proved to be consistently correlated to explain this variation. However, when juvenile *O. mykiss* counts were aggregated across many sites within a similar macro habitat the average numbers per annual site remained consistent across years in the US tributaries, Similkameen and Okanogan Rivers (Table 4). Numbers were not consistent in the Canadian tributaries and this is closely linked with difficulties that occurred in 2004 when only one site was snorkeled during a high water event that obscured visibility, and because methodologies were not closely adhered to in 2005 and 2006. Vast improvements occurred in 2007 thus data in Canadian tributaries were more comparable to US tributaries.

In some small, cold water tributaries we found that limiting snorkel surveys to a small reach may have a high likelihood of failing to detect fish, resulting in a poor production estimate. No juvenile *O. mykiss* were observed in Wanacut or Wildhorse Spring creeks at randomly selected survey sites in 2007. However on spot surveys in Wild Horse Spring Creek we did observe juvenile *O. mykiss.* In years to come we will attempt to snorkel a minimum of 1,000 meters or the entire reach accessible to anadromous fish, whichever is less, in small tributaries to avoid getting data points with zero's when this does not properly describe a sub-watershed.

Shuttleworth Creek will be accessible to summer steelhead in 2009, or once passage is provided at McIntyre Dam. Based upon habitat and barrier surveys, Shuttleworth Creek provides more than 3 miles of potential spawning and rearing habitat. McLean, Shingle, Shatford and Ellis creeks are upriver of both McIntyre and Skaha Lake dams. Physical habitat data reflect these creeks have potential to support steelhead spawning and rearing. In addition, further refinement of selected snorkeling sites and seasoning of staff will result in improved data collection and will be the foundation for future projects accelerating the recovery of a historically-abundant species. Snorkel surveys should continue to measure the biological response to these recovery efforts.

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