2006 OKANOGAN BASIN SNORKEL SURVEYS

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Abstract

The Colville Tribes' Fish and Wildlife Department conducted snorkel surveys throughout the Okanogan basin as part of the Okanogan Basin Monitoring and Evaluation Program. In 2006, snorkel surveys were conducted for the second time along the mainstem Okanogan River and associated tributary streams within the United States and Canada. Eighteen different species of fish were identified. The most abundant families of fish observed were Centrarchidae and Salmonidae, and the most abundant species were smallmouth bass (*Micropterus dolomieu)* and steelhead/rainbow trout (*Oncorhynchus mykiss)*. A very low number of juvenile *Oncorhynchus mykiss* were counted within main stem Basin Monitoring and Evaluation Program sites throughout the U.S. and Canada. However, additional snorkeling efforts in the Similkameen River revealed an abundance of juvenile *Oncorhynchus mykiss*. During our snorkel surveys the majority of juvenile *Oncorhynchus mykiss* were found in Okanogan River tributaries. Omak Creek had the highest abundance of juvenile *Oncorhynchus mykiss* in the United States and Inkaneep Creek had the highest abundance in Canada. Surprises from the 2006 snorkel season include: documentation of juvenile summer steelhead in Wildhorse Spring Creek; discovery of multiple yearling Chinook with intact adipose fins in the Similkameen River and; observation of the first channel catfish in the Okanogan River.

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 support 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 water from a stable, clear, 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. 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 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 suitable habitat for steelhead and Chinook salmon. Spawning areas have been indicated upstream from Lake Osoyoos (WDW 1993) and large rainbow trout have been identified in Okanagan Lake creel survey data 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 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 mainstem, 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 Program (OBMEP) collects empirical data to address a number of management questions. The snorkeling part of the OBMEP program is designed to help address the juvenile rearing response to habitat changes over time. 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 distributions, abundance, and species composition are also collected but considered secondary.

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 yearly, while rotating panel sites are sampled once every 5 years (Figures 1 & 2).

In 2006, 50-randomly selected EMAP sites were surveyed. Thirty-four sites were surveyed in the United States by the Colville Confederated Tribes (Colville Tribes) and 16 in Canada by the Okanagan Nation Alliance (ONA). 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 eighteen sites on small tributary streams and sixteen sites on the mainstem Okanogan and Similkameen Rivers. Survey sites in Canada included twelve sites on small tributary streams and four sites on the mainstem Okanagan. Fish were identified to species if possible, to family if needed and lastly into non-salmonids and salmonids 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
- between 100 and 300mm
- greater than 300mm

Sampling on small tributary streams in the United States was conducted over the period from July 21, 2006 to October 13, 2006. Snorkeling on the fourteen mainstem Okanogan and two Similkameen sites in the United States occurred between August 9 and September 27, 2006. Sampling in Canada started on July 24, 2006 and finished on September 8, 2006. Tributary snorkel surveys were performed by a single snorkeler moving upstream through the length of the reach.

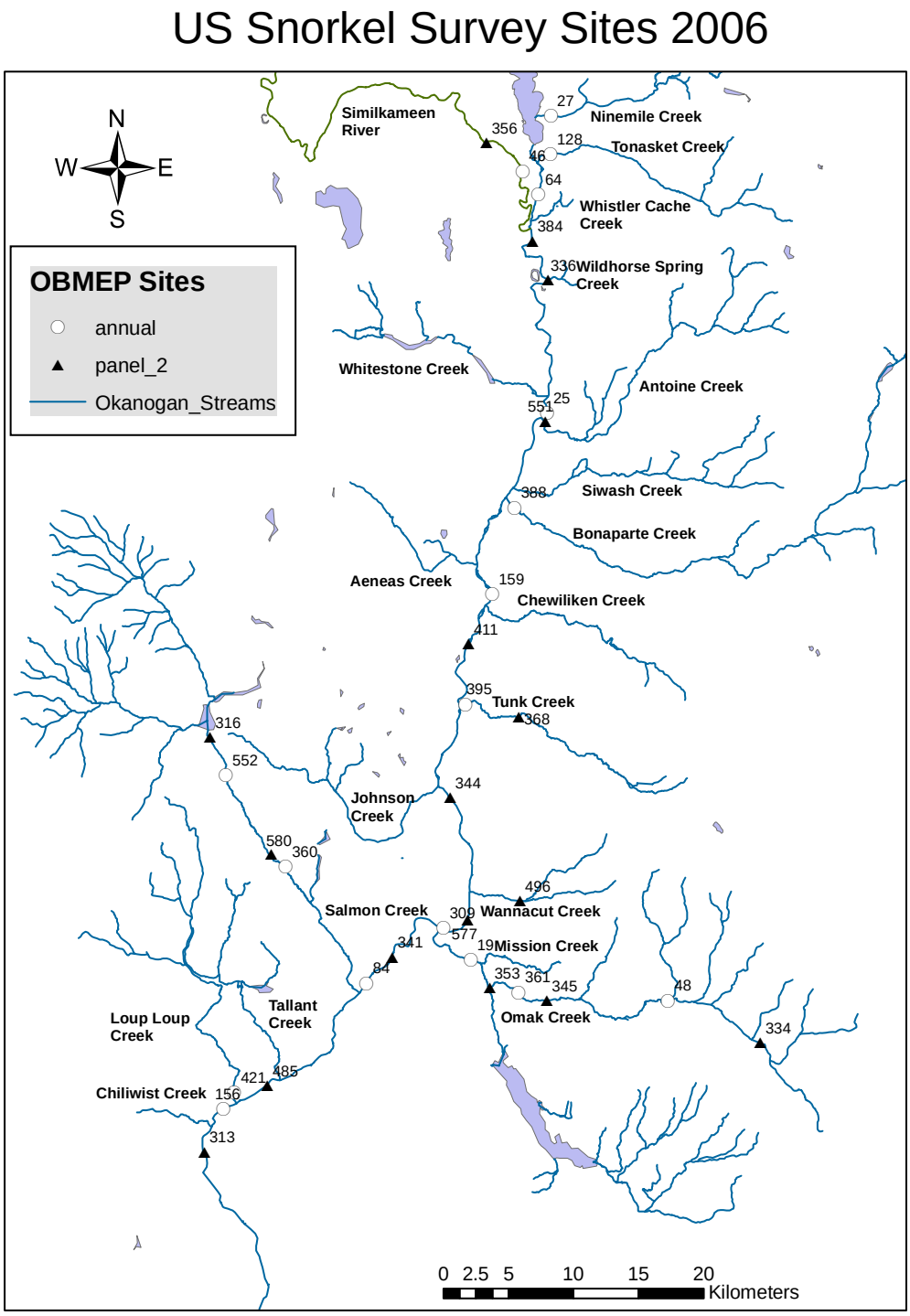

Figure 1: Okanogan Basin Monitoring and Evaluation Program snorkel and physical habitat sample sites for 2006 in the United States.

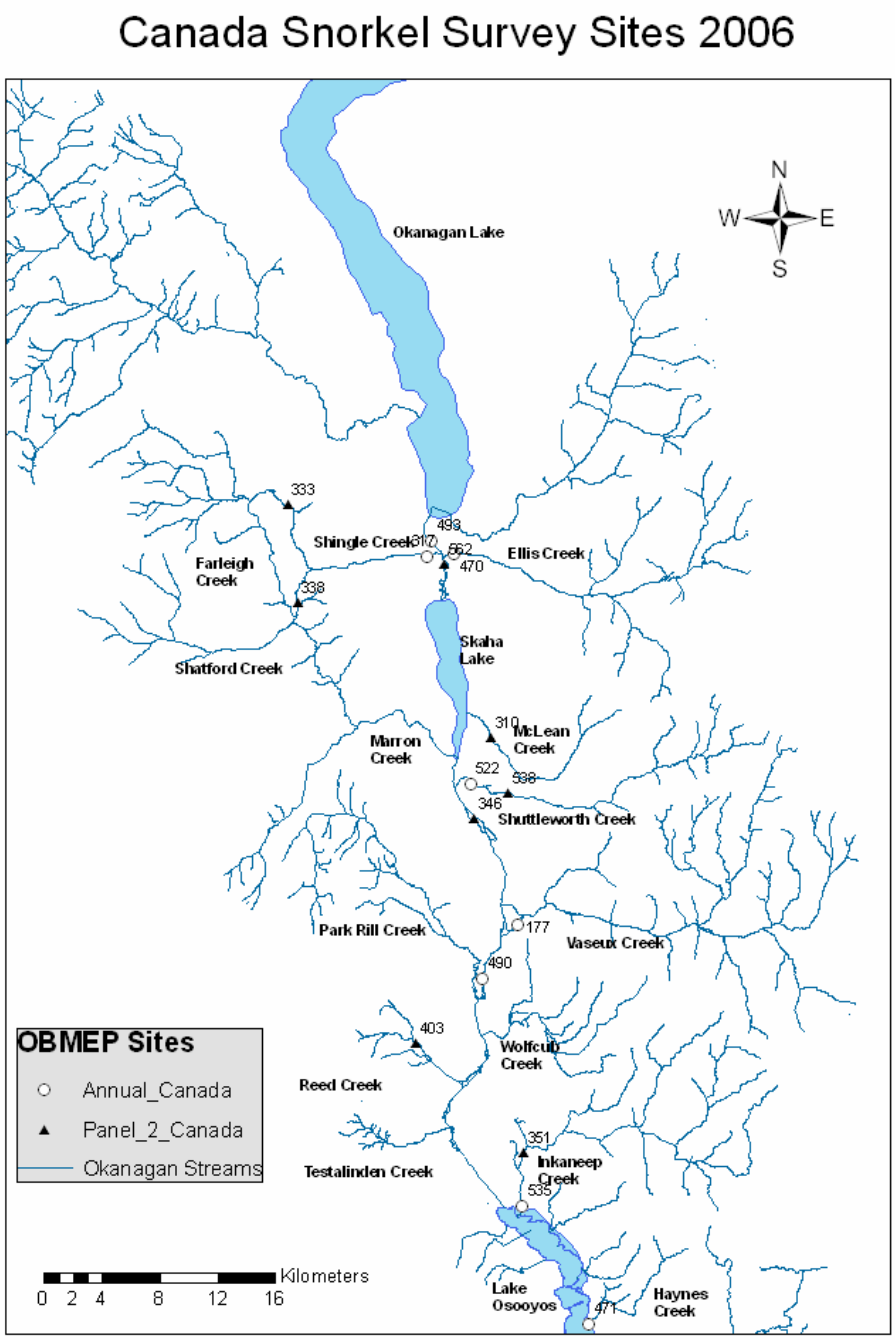

Figure 2: Okanogan Basin Monitoring and Evaluation Program snorkel and physical habitat sample sites for 2006 in Canada.

Mainstem sites were sampled using a single pass method with up to 6 snorkelers at a time moving downstream in teams of two. Data was collected for each transect with one team focusing on the right bank, one on the left bank and the third team roving the center of the river attempting to focus on likely fish holding structures. The snorkelers stopped at the completion of each transect to coordinate activities and record sightings on individual wrist slates. After the snorkeling was completed all teams compiled data onto one data sheet for each reach.

Results and Discussion

All species observed during snorkeling are presented in Table 1. Similar species were observed in 2005 and 2006 during snorkel surveys. We observed an additional five species in 2006, consisting of: largescale sucker (*Catostomus macrocheilus Girard),* channel catfish (*Ictalurus punctatus),* white crappie (*Pomoxis annularis),* peamouth chub (*Mylocheilus caurinus)* and bluegill (*Lepomis macrochirus*). The channel catfish was positively identified and was a large single adult observed within the Okanogan City limits. In 2005, we observed two species we didn't observe in 2006: shorthead sculpin (*Cottus confuses)* and black bullhead (*Ameiurus melas)* which could have been brown bullhead that were misidentified.

Table 1: Species observed during snorkel surveys in the Okanogan River Watershed in the summer of 2005 and 2006.

Species Observed	**Observed in 2005**	**Observed in 2006**
Sockeye Salmon *Oncorhynchus nerka*	X	X
Chinook Salmon *Oncorhynchus tshawytscha*	X	X
Steelhead *Oncorhynchus mykiss*	X	X
Brook Trout *Salvelinus fontinalis*	X	X
Mountain Whitefish *Prosopium williamsoni*	X	X
Bridgelip Sucker *Catostomus columbianus*	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

Species Observed	Observed in 2005	Observed in 2006
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
Western Painted Turtle *Chrysemys picta bellii*	X	X
Shorthead Sculpin *Cottus confusus*	X	
Black Bullhead *Ameiurus melas*	X	

A total of 3 juvenile *Oncorhynchus mykiss (O. mykiss)* were counted on mainstem Okanogan sites; 20 *O. mykiss* (13 juvenile, 7 adult) and two juvenile Chinook were observed in the Similkameen River, and 1,769 juvenile *O. mykiss* plus 473 adult *O. mykiss* were observed in tributary sites during our the Colville Tribes OBMEP surveys in 2006. We compared the number of redds observed during 2006 to the number of juvenile *O. mykiss* observed for several reaches (Table 2). The distribution of *O. mykiss* observed appears to relate more to the fact that salmonids exhibit avoidance behavior for water temperatures greater than 20°C than to spawning locations.

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). Therefore the lack of *O. mykiss* found along the mainstem Okanogan River is not surprising because snorkel surveys were conducted just after the peak of the water temperatures occurred during the low flow period (Figure 3). The Similkameen River provides the coldest main stem habitat within the Okanogan River subbasin although in some years the summer water temperatures can reach the upper mortality threshold for *O. mykiss* (Instantaneous mortality of *O. mykiss* occurs at mean daily water temperatures above 26°C according to Jenkins and Burkhead, 1993). In 2006, mean daily temperatures for the Okanogan River did not exceed 26°C (Figure 4) due to cool midsummer temperatures that likely resulted from major forest fires that burned from the beginning of July to the end of September. Smoke from the fires created many days of overcast conditions that reduced thermal radiation input and daytime air temperatures.

Table 2: Comparison of number of redds and number of juvenile *O. mykiss* observed during snorkel surveys in 2006 and the reference reach length, description, and designation for these observations.

Reference Reaches	Description (river-mile)	miles	kms	OBMEP sites surveyed	2006 # of Juvenile *O.mykiss*	2006 # of Redds
O1	Okanogan River south of Chiliwist Creek(23.7) to Salmon Creek(41.4)	17.7	28.5	313, 156, 485	0	0
O2	Okanogan River @ Salmon Creek(41.4) to CCT Office(52.3)	17.5	10.9	84, 341,309	0	4
O3	Okanogan River @ CCT Office(52.3) to Riverside(66.1)	22.2	13.8	577, 344	0	2
O4	Okanogan River @ Riverside(66.1) to Janis Bridge(84.6)	29.8	18.5	411, 159	0	11
O5	Okanogan River @ Janis Bridge(84.6) to Mouth of Siwash Creek(93.8)	9.2	14.8	NA	NA	39
O6	Okanogan River @ Mouth of Siwash Creek(93.8) to Confluence with the Similkameen River(119.5)	25.7	41.4	25, 336, 384	0	1
O7	Okanogan River at Confluence with the Similkameen(119.5) to Zosel dam(127.0)	12.1	7.5	64	0	153
S1	Similkameen River @ Okanogan confluence(0) to Enloe Dam (14.6)	14.6	23.5	356, 46	13	100
TU1	Tunk Creek @ Okanogan River confluence (0) to high water mark (0.2)	0.06	0.09	395	0	0
TU2	Tunk Creek above falls	.09	.15	368	39	NA
B1	Bonaparte Creek @ Okanogan River confluence (0) to waterfall barrier (1.6)	1.6	2.57	388	101	3

Reference Reaches	Description (river-mile)	miles	kms	OBMEP sites surveyed	2006 # of Juvenile *O.mykiss*	2006 # of Redds
N1	Ninemile Creek @ Okanogan River confluence(0) to Eder land (1.72)	1.72	2.77	27	102	11
TO1	Tonasket Creek @ Okanogan River confluence(0) to Tonasket Falls(3.5)	3.5	5.63	128	0	6
Omak Creek Lower	Omak Creek @ Okanogan River confluence(0) to Mission Falls(6.2)	6.2	10	19, 353	827	19
Omak Creek Upper	Mission Falls(6.2) to Trail Creek(21.5)	15.3	24.6	361, 345, 48, 334	332	0
Antoine Creek	Mouth(0) to Bedrock chute(1.3)	0.1	0.15	551	11	2
Salmon Creek	OID diversion(4.3) to Conconully Lake(22.3)	11.2	18	360, 580, 552, 316	122	NA
Loup Loup Creek	Mouth(0) to Falls(2.1)	2.1	3.3	421	0	8
Wanacut Creek	Panel site	0.1	0.15	496	35	NA
Haynes Creek	Annual site	0.1	0.15	471	0	NA
Canada 1	Okanagan River at Inkaneep Creek (136.6) to McIntyre Dam (151.6)	15	24.1	490	3	2
Canada 2	Okanagan River at McIntyre Dam(151.6) to Okanagan Lake(170.2	18.6	30	346, 562, 493	0	NA
Inkaneep Creek	Mouth(0) to the Falls(1.8)	1.8	2.9	535,351	98	10
Vaseux Creek	Flume at the Mouth(.36) to Canyon (3.0)	3.0	4.9	177	67	10
Shuttleworth Creek	Mouth(0) to Canyon(3.2)	3.2	5.1	522, 538	35	0

NA=Not Surveyed

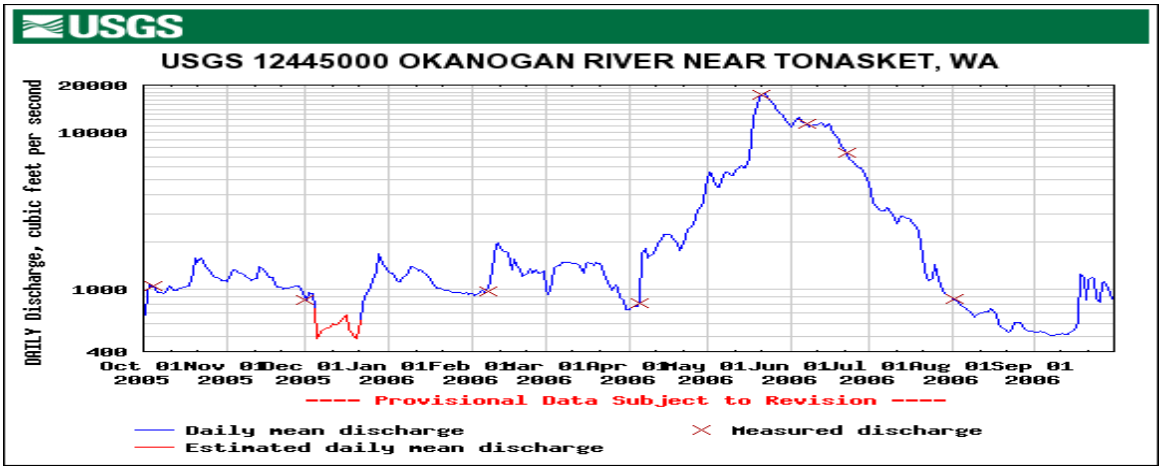

Figure 3: Discharge for the Okanogan River at Janis for the period from October 2005 to October of 2006. Snorkel surveys were conducted during the summer low flow period (August and September are at the far right of this graph).

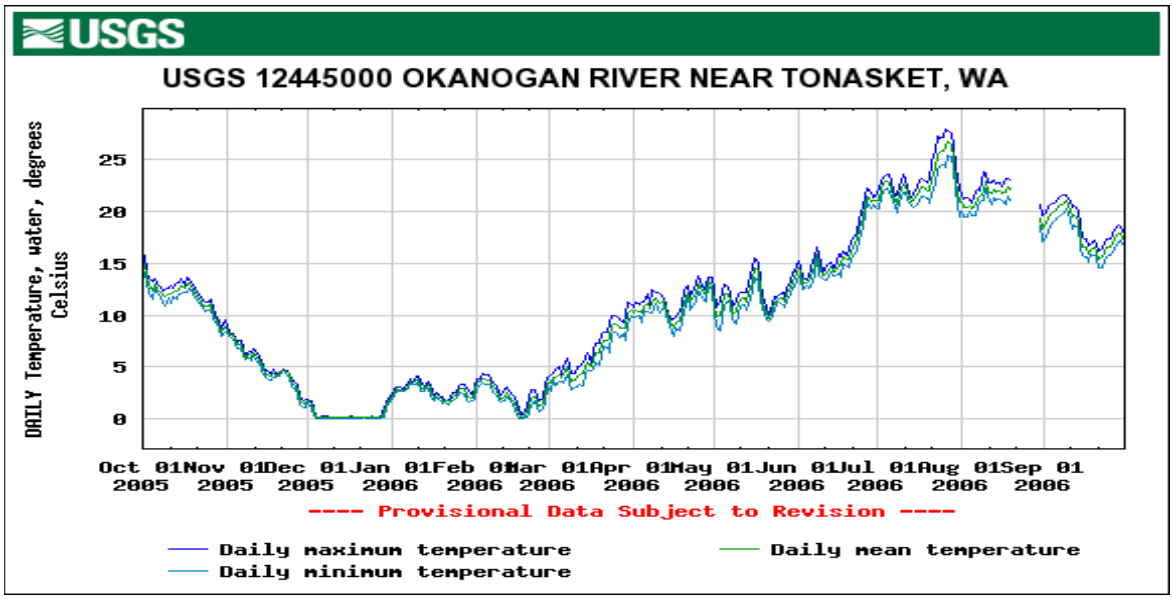

Figure 4: Temperature from the Okanogan River from October 2005 to October 2006. Mainstem snorkel surveys occurred after peak high temperatures but before temperatures had dropped to below 15° C.

Of the reaches accessible to anadromous fish we found no fish in Tonasket and Loup Loup Creeks due to a lack of flowing water although Haynes Creek had water but no *O. mykiss* were observed. There did not appear to be any correlation between the numbers of redds and the numbers of juvenile *O. mykiss* observed.

The species data that follows for the Okanogan River basin are presented by; 1) country, 2) main stem reach from Table 2, and 3) by the tributary located within the main-stem reach. Maps show spatial locations and results of snorkel surveys for 2006 (Figures 6-16). The results shown below are; total fish, juvenile *O. mykiss* and adult *O. mykiss* detected plus the dominant species seen in each reach. Information is also provided on the density (number of fish per square kilometer). The density values are the number of

fish observed divided by the area observed 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.

United States

Reach 01 (Figure 6: sites 313, 156, 485) represents the segment of the Okanogan River located from south of Chiliwist Creek to Salmon Creek (0-juvenile *O. mykiss observed)*. The dominant species was smallmouth bass. Densities of all fish were highest at site 485 (32-fish/km^2) and lowest at site 156 (20.2-fish/km^2) with an average fish density at all sites of (26.6-fish/km^2).

Loup Loup Creek (Figure 6) included only site 421 which is located below Loup Loup falls (Arterburn et al. 2007) but this reach was dry and therefore had no fish. Another site below the falls was surveyed by the Colville Tribes on September 18, 2006 to confirm successful *O. mykiss* reproduction. This site was located above a diversion dam that caused site 421 to go dry. The dominant species encountered was *O. mykiss* (63-juvenile *O. mykiss* and 1 adult *O. mykiss).* The juvenile *O. mykiss* density was 50-fish/km^2 the adult *O. mykiss* density was 0.79-fish/km^2. Eight brook trout were identified and represented the only other species of fish observed.

Reach 02 (Figure 7: sites 84, 341, 309) represents the segment of the Okanogan River located from Salmon Creek to the Colville Tribes' Anadromous Fish Division Office on Omak Creek (zero juvenile *O. mykiss* observed). One adult sockeye salmon, *Oncorhynchus nerka*, was observed in this reach at site 309 in the same place that five were observed in 2005. The dominant species observed were smallmouth bass and comprised 74% of the fish observed. Average fish density was 31.5 fish/km^2 for the entire reach. In 2005, snorkelers observed several adult *O. mykiss* in the area around the mouth of Omak Creek and in 2006 an adult *O. mykiss* was documented in the same location although this location was technically outside of the reach surveyed for site 309.

Reach 03 (Figure 8: sites 577 & 344) represents the segment of the Okanogan River located from the Colville Tribes Anadromous Fish Division Office on Omak Creek to Riverside (0-juvenile *O. mykiss observed)*. The dominant species observed at these sites were smallmouth bass which comprised 81% of all fish observed. The average fish density for this reach was (26-fish/km^2.)

Wanacut Creek (Figure 8) included only site 496 which is located above a falls (Arterburn et al. 2007). During our snorkel survey we identified 35 juvenile and 6 adult rainbow trout. The juvenile rainbow trout density was 113.3-fish/km^2 and the adult rainbow trout density was 19.4-fish/km^2. No other species of fish was observed.

Reach 04 (Figure 9: sites 411 and 159) represents the segment of the Okanogan River located from Johnson Creek upstream to the Janis Bridge (0-juvenile *O. mykiss* observed*)*. The dominant species observed at these sites were smallmouth bass and comprised 91% of the total fish observed. The average fish density for this reach was (36-fish/km^2).

Tunk Creek (Figure 9: sites 395 and 368) includes site 395 located below Tunk Falls, and site 368 which is above Tunk Falls (Arterburn et al. 2007). Site 395 was dry at the time of snorkeling except for a few small pools of water where 150 unidentified juvenile suckers (family Catostomidae) and one juvenile bullhead (family Ictaluridae) were observed. The average fish density for site 395 could not be accurately determined due to habitat conditions. Site 368 only had juvenile rainbow trout present (39-juvenile rainbow trout observed*)*. The juvenile rainbow trout density was (79.3-fish/km^2).

Reach 05 – Includes the reach of the Okanogan River from Janis Bridge upstream to the mouth of Siwash Creek. However, none of the randomly selected annual or panel 2 sites landed within this reach. Therefore, no snorkel surveys were conducted during 2006.

Bonaparte Creek (Figure 10) included only site 388 and was dominated by *O. mykiss* (101 juvenile *O. mykiss* and 13 adult *O. mykiss)*. The average density of juvenile *O. mykiss* was 272- juvenile *O. mykiss*/km^2 in 2006. The densities observed at this site in other years was much higher (579-juvenile *O. mykiss*/km^2 in 2004 and 551-juvenile *O. mykiss*/km^2 observed in 2005). However, the number of adult *O. mykiss* in 2006 (13-adult *O. mykiss*) was comparable to the average adult *O. mykiss* observed in 2004 and 2005. In 2006, a picket weir trap was operated in 2006 and only 10 adult steelhead were captured. The lack of adult spawners was further supported by the presence of only 3 summer steelhead redds identified within the 1.6 km of accessible habitat (Arterburn and Kistler 2006) whereas in 2005, 67 redds were identified within the same reach (Arterburn et al 2005). Therefore, the reduced numbers of *O. mykiss* observed is likely related to a lack of spawners rather than any change in habitat or environmental conditions. Other fish species observed in 2006 were unidentified suckers of the Catostomidae family and eastern brook trout.

Reach 06 (Figure 10: sites 25, 336 & 384) represents the segment of the Okanogan River located from the mouth of Siwash Creek upstream to the Okanogan River confluence with the Similkameen River (0-juvenile *O. mykiss* observed*)*. The dominant species was smallmouth bass which made-up 86% of all fish observed. The total fish density in this reach was (28-fish/km^2).

Antoine Creek (Figure 10) included only site 551, located below the permanent barrier to fish migration (Arterburn et al. 2007). We observed 23 eastern brook trout which made them the dominate species, 68% of all fish observed. Eleven juvenile *O. mykiss* were observed at a density of 38.4-fish/km^2. Total salmonid density was (119-fish/km^2).

Reach 07 (Figure 11: site 64) represents the segment of the Okanogan River located from the confluence with the Similkameen River to Zosel Dam (0-juvenile *O. mykiss* observed*)*. The dominant species was smallmouth bass which was 53% of all fish observed. The second most dominate species was redside shiners which was 22% of fish observed. It has been documented that redside shiners out compete and displace juvenile salmonids (Wydoski and Whittney 2003). The total fish density in this reach was (130-fish/km^2) and included several species that would typically be considered warm-water species (i.e. largemouth bass, yellow perch, common carp and bluegill). Additional

snorkeling efforts in this reach on June 29, 2007 had a similar result and failed to identify any salmonids.

Reach S1 (Figure 11: sites 46 & 356) represents the segment of the Similkameen River located between the confluence of the Okanogan River and Enloe Dam (15-juvenile *O. mykiss observed)*. A total of 30 adult sockeye salmon, 103 adult Chinook salmon and 5 yearling Chinook salmon were observed at these sites. The average juvenile *O. mykiss* density was 0.73 -fish/km^2. The dominant species differed between sites but accounted for 55% of all fish observed. At site 46 the dominant species was bridgelip sucker (*Catostomus columbianus*) but at site 356 Chinook salmon (*Oncorhynchus tshawytscha)* were dominant. Densities of all fish were 25-fish/km^2 at site 356 and 20-fish/km^2 at site 46. Additional snorkeling efforts were undertaken by the Colville Tribes on June 29, 2006 when 108 salmonids were observed comprised of mostly sub-yearling Chinook salmon. On July 20, 2006 the Colville Tribes observed several thousand larval fish, in addition to 17 juvenile salmonids (10-mountain whitefish, 6-*O. mykiss* and 1 Chinook). Three additional snorkel surveys on the Similkameen River were conducted by Entrix, Inc. on July 7, 2006, August 11, 2006, and September, 14, 2006. During these surveys 220 juvenile *O. mykiss*, 3 adult *O. mykiss*, 113 mountain whitefish, 33 Chinook salmon, and 15 sockeye salmon were observed (Cody Fleece, Entrix-biologist, Personal Communication). The *O. mykiss* observed represented multiple age classes and several of these fish had clipped adipose fins (Figure 5).

Figure 5: Juvenile steelhead with clipped adipose fin observed in the Similkameen River on August 8, 2006.

Omak Creek (Figure 12: sites 19, 353, 361, 345, 48 & 334) was divided into two reaches: 1) Omak Lower, from the confluence with the Okanogan River upstream to Mission Falls, containing EMAP sites 19 and 353; and 2) Omak Upper, from Mission

Falls upstream to Trail Creek, containing EMAP sites 361, 345, 48, and 334. The dominant species at all sites except site 334 (eastern brook trout) was *O. mykiss* and these fish represented 84% of all fish observed in Omak Creek during 2006 surveys.

Omak Lower (Figure 12: sites 19 and 353) had a total combined juvenile *O. mykiss* count of 827, and a combined average juvenile *O. mykiss* density of 430-fish/km^2. The total count of adult *O. mykiss* was 155 and a combined average adult *O. mykiss* density of 73 -fish/km^2. *O. mykiss* densities increased as you progressed upstream toward Mission Falls. The average fish density for all species at these sites was 692-fish/km^2. The second most abundant fish were unidentified suckers from the Catostomidae family, making up 19% of the fish observed.

Omak Upper (Figure 12: sites 361, 345, 48 and 334). Mission Falls was considered to be a passage barrier before 2006. Habitat modifications were made to these falls during 2006 in order to aid fish passage. During redd surveys in the spring of 2006 no redds were observed above Mission Falls (Arterburn and Kistler 2006) therefore, fish observed above the falls are not considered summer steelhead. A total of 261 juvenile rainbow trout and 289 adult rainbow trout were observed at these sites in 2006. The juvenile rainbow trout densities ranged from 128-fish/km^2 at site 345 to 1.6-fish/km^2 at site 334 where the dominant species was eastern brook trout. Rainbow trout densities decreased as you progressed upstream of Mission Falls. The average fish density for all species at these sites was 159.25-fish/km^2.

Salmon Creek (Figure 13: sites 360, 580, 316 & 552) A total of 122 juvenile and 10 adult *O. mykiss* were observed at these sites in 2006. The juvenile *O. mykiss* densities ranged from 13.5-fish/km^2 at site 316 to 109.2-fish/km^2 at site 580. The dominant species at all sites was *O. mykiss* and comprised 72% of all fish observed. The average fish density for all *O. mykiss* at these sites was 41.74-fish/km^2. The average fish density for all species at these sites was 59.2-fish/km^2. It is uncertain what portion of the O. mykiss population in Salmon Creek to considered resident rainbow trout due to lack of flows below the Okanogan Irrigation District (OID) diversion at river mile 4.3. 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 offspring from adult steelhead. There are efforts underway to provide minimum flows to Salmon Creek in the future that would allow for annual access up to and past the OID diversion.

Reach TO1 (Figure 14) represents Tonasket Creek and included on site 128. No fish were observed at site 128. This section of the creek usually goes dry during the mid-summer. 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 and spawning adult steelhead have been documented when that occurs (Arterburn and Kistler 2006).

Reach N1 (Figure 14) represents Nine mile Creek and includes site 27. A total of 102 juvenile *O. mykiss* and zero adult *O. mykiss* were observed at this site. The juvenile *O. mykiss* density was (366-fish/km^2). There were zero non-salmonid species observed.

Canada

Canadian sites were surveyed by the Okanagan Nation Alliance. There were four juvenile *O. mykiss* observed in the mainstem Okanagan River and 438 observed in the tributaries in Canada. Inkaneep Creek (site 535 and 351); Vaseux Creek (177), McLean Creek (310), Shingle Creek (317 and 333), Shatford Creek (338) and Shuttleworth Creek (538) had juvenile *O. mykiss* present. Only Inkaneep Creek and Vaseux Creek are regularly accessible to anadromous salmonids. Juvenile *O. mykiss* detected at sites 535 and 177 have the potential to be steelhead progeny while *O. mykiss* at the other tributary sites are resident rainbow trout.

Canada Reach 1 (Figure 15: site 490) includes the segment of the mainstem Okanagan River in Canada from the United States/Canadian border to McIntyre Dam (3-juvenile *O. mykiss* observed*)*. The dominant fish species were Centrarchids. These fish comprised 39% of all fish observed. The average fish densities observed at this site was 10.9-fish/km^2 and average juvenile *O. mykiss* density was 0.4-fish/km^2.

Haynes Creek (Figure 14: site 471) was snorkeled but no fish were observed at this site. The lack of any fish observed in this creek for 2005 and 2006 indicates that this is poor habitat for salmonids and therefore is perhaps outside of the scope for this project which is focused on anadromous fish. We suggest moving the annual OBMEP sites from Haynes Creek to another tributary with more potential such as McLean Creek starting in 2007.

Inkaneep Creek (Figure 15: site 535 and 351) the dominant species observed at these sites were *O. mykiss* with a total combined count of 99 juveniles. Juvenile *O. mykiss* density at site 535 was 107-fish/km^2 and juvenile rainbow trout densities were 39-fish/km^2 at site 351. The total count of adult *O. mykiss* was 1 fish at site 535. The only other fish observed at these sites were five eastern brook trout at site 351. The average fish density at these two sites was 44.12-fish/ km^2.

Reed Creek (Figure 15: site 403) No fish were observed at this site but water conditions made visibility poor.

Vaseux Creek (Figure 15) included only site 177, where 67 juvenile *O. mykiss* were observed with a density of 42 fish/km^2. No adult *O. mykiss* were observed. The dominant fish were minnows of the family Cyprinidae and these fish made-up 70% of all fish observed at this site. Total fish densities observed were 138-fish/km^2.

Reach Canada 2 (Figure 16: sites 346, 562, 493) represents the segment of the main stem Okanagan River in Canada from McIntyre Dam to Okanagan Lake (0-juvenile *O. mykiss* observed*)*. Mountain whitefish were the most abundant species observed. These fish made-up 44% of the fish observed at these sites with a total fish density at all sites of (3.6-fish/km^2).

Shuttleworth Creek (Figure 16: site 522 and 538) included site 522 where no juvenile *O. mykiss* were observed and site 538 where 35 juvenile *O. mykiss* were observed. The dominate species for site 538 was *O. mykiss* at a density of 22.4-fish/km^2. However, the

dominant species for site 522 were minnows in the family Cyprinidae which made up 100% of fish observed and resulted in a density of 87.4-fish/km^2. The average density for all fish was 20.5- fish/km^2.

McLean Creek (Figure 16) included only site 310 and 35 juvenile *O. mykiss* were observed. Juvenile *O. mykiss* density was 97.2-fish/km^2. The only other fish observed was 1 minnow of the family Cyprinidae. Total fish density at this site was 100-fish/km^2.

Ellis Creek (Figure 16) included only sit e 470 where 1 juvenile *O. mykiss* was observed along with 19 minnows from the family Cyprinidae. Juvenile *O. mykiss* density was 0.9-fish/km^2 and the total fish density was 17.3-fish/km^2 for this site.

Shingle Creek (Figure 16) included both sites 317 & 333. One juvenile *O. mykiss* was observed at site 317 and 117 juvenile *O. mykiss* were observed at site 333. No adult *O. mykiss* were observed at either site. 6 Cyprinids were observed at site 317 and were the only other species observed at either site. Total juvenile *O. mykiss* density was 1.6-fish/km^2 at site 317 and 150 fish/km^2 at site 333. The average density for all fish at all sites was 43.5-fish/km^2.

Shatford Creek (Figure 16) included only site 338, where 101 juvenile *O. mykiss* were observed along with 5 sculpins (members of the family Cottidae). No adult *O. mykiss* were observed. Total juvenile *O. mykiss* density was 119.4-fish/km^2. Total fish density at this site was 125.3- fish/km^2.

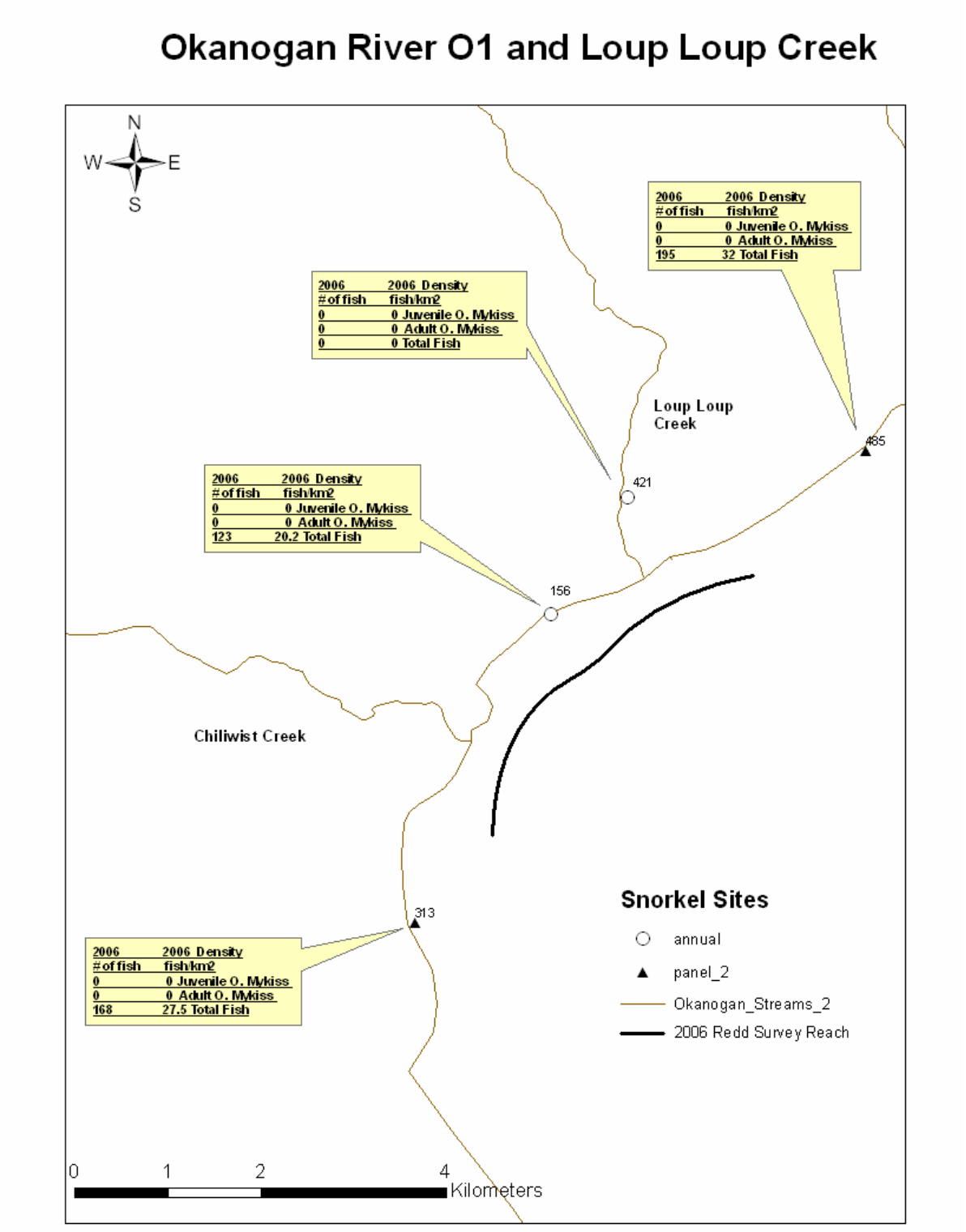

Figure 6: Snorkel survey observations for Reach O1 (South of Chiliwist Creek upstream to Salmon Creek) indicated that smallmouth bass were the dominate species and fish densities averaged 26.6 fish/km^2.

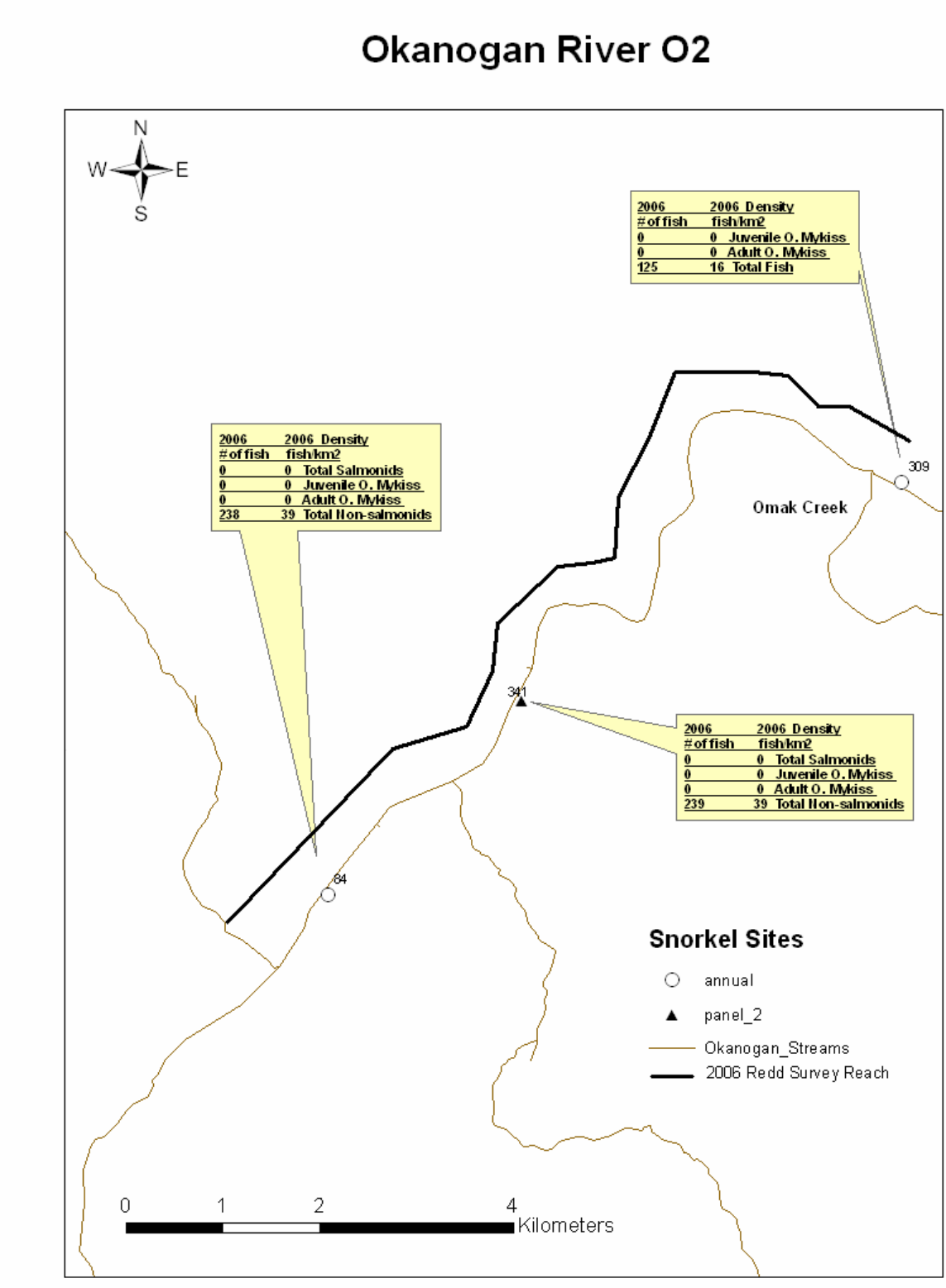

Figure 7: Snorkel survey observations for Reach O2 (Salmon Creek upstream to Omak Creek) indicated that smallmouth bass were the dominate species. Fish densities averaged 31.5 fish/km^2. In both 2005 and 2006 adult salmonids were identified just downstream of site 309 at the confluence with Omak Creek.

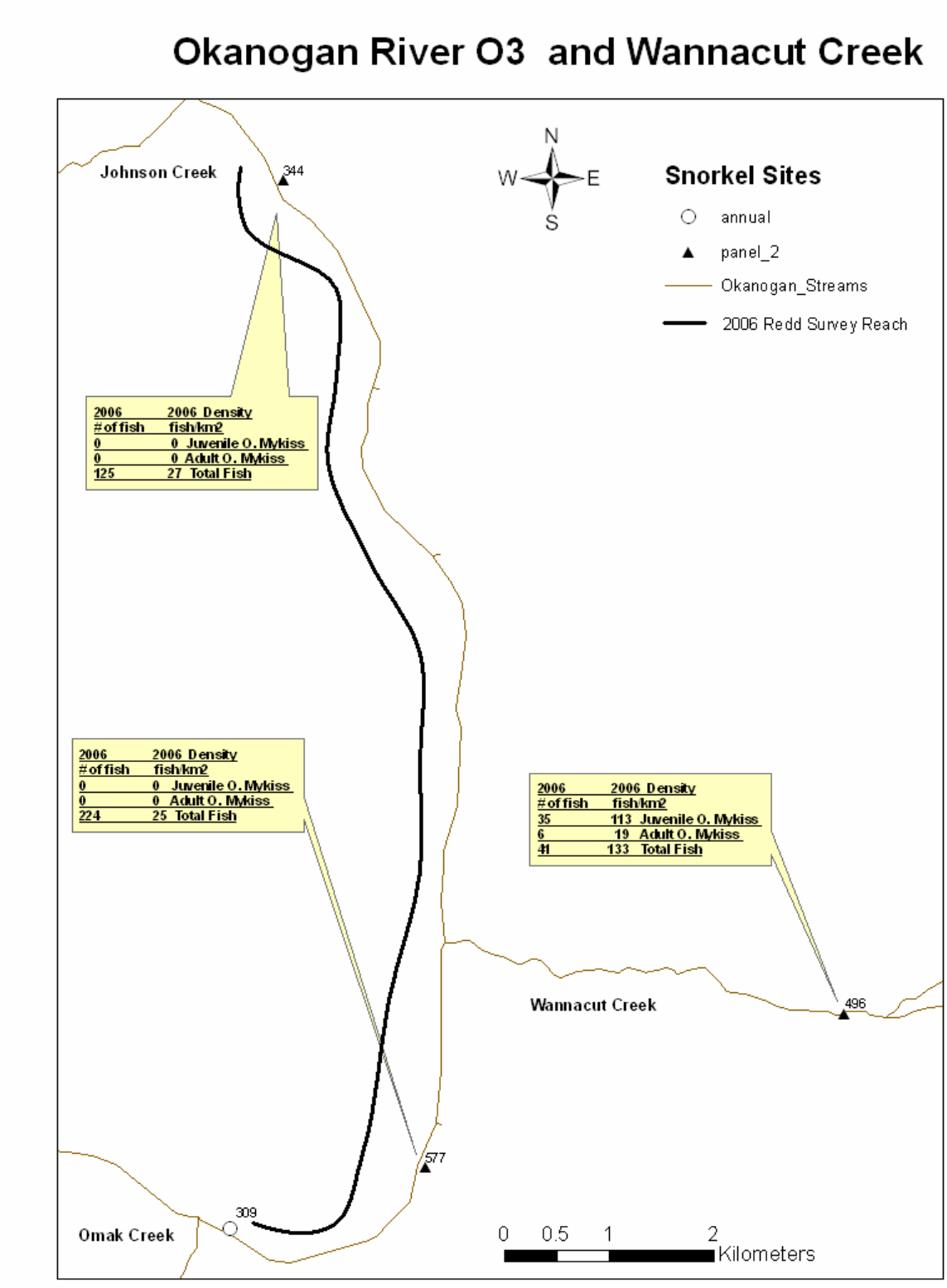

Figure 8: Snorkel survey observations for Reach O3 (Omak Creek to Johnson Creek) indicated that smallmouth bass were the dominate species and fish densities averaged 26 fish/km^2. Site 496 in Wanacut Creek is located upstream of Wanacut Falls and the only fish species observed was *O. mykiss.*

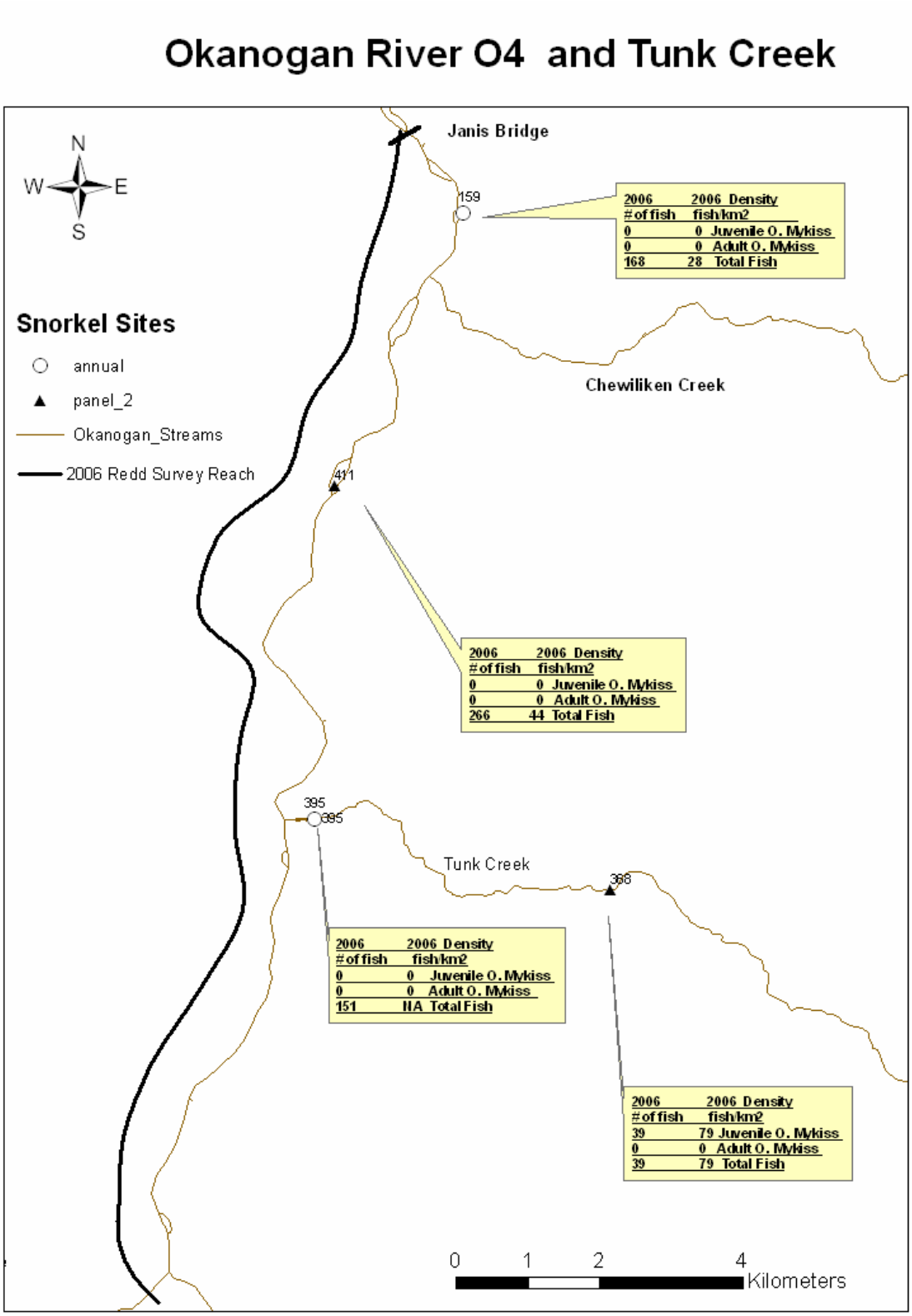

Figure 9: Snorkel survey observations for Reach O4 (Johnson Creek to Janis Bridge) indicated that smallmouth bass were the dominate species and fish densities averaged 36 fish/km^2. Site 398 in Tunk Creek is located upstream of Tunk Falls and the only fish species observed was *O. mykiss.* Site 395 was downstream of Tunk Falls but no salmonids were observed in the isolated pools that existed during 2006.

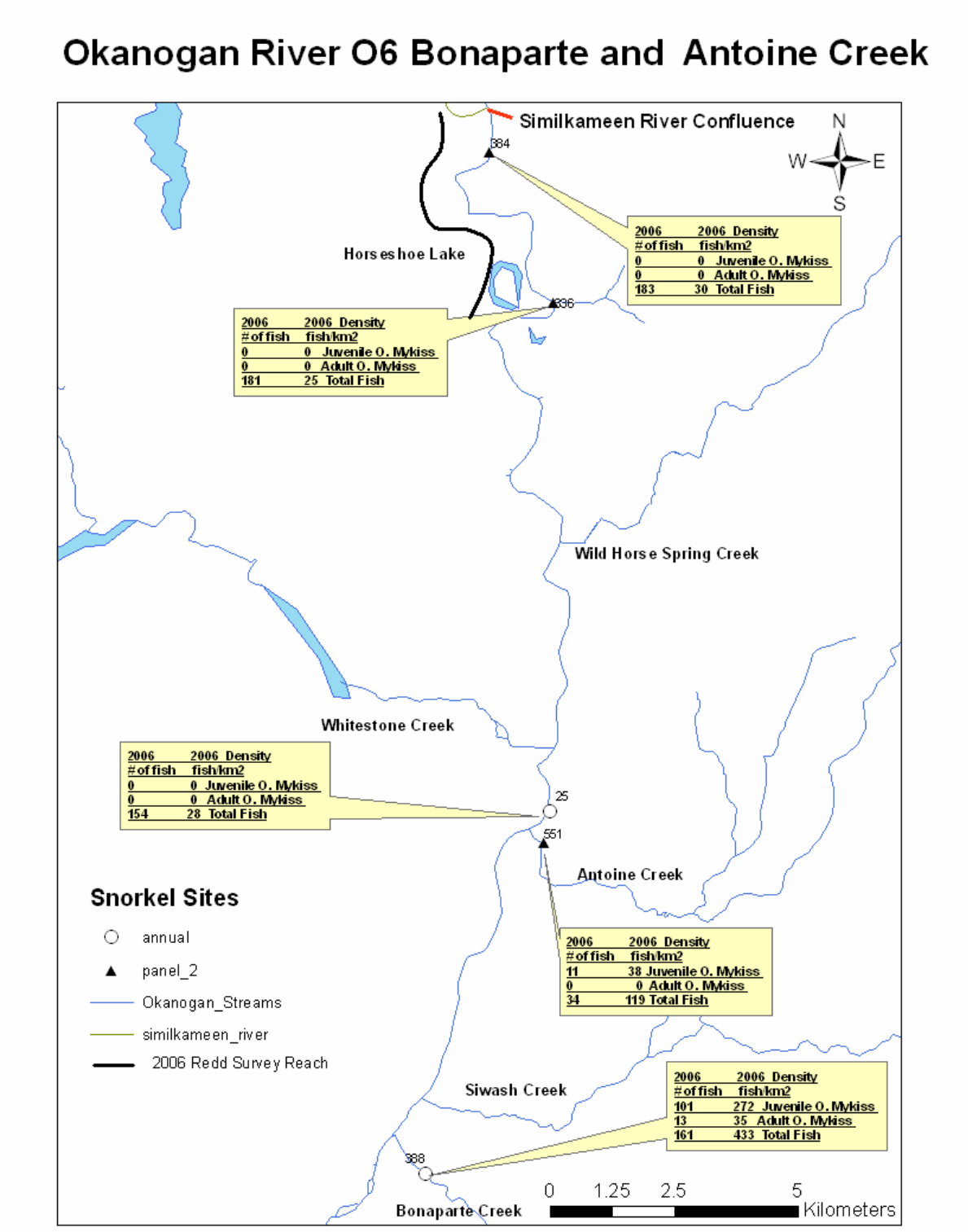

Figure 10: Snorkel survey observations for Reach O6 (Siwash Creek upstream to the confluence with the Similkameen River) indicated that smallmouth bass were the dominate species and fish densities averaged 28 fish/km^2. Site 388 is located on Bonaparte Creek below Bonaparte Falls and the dominate species was *O. mykiss.* Site 551 is located below the anadromous fish barrier on Antoine Creek; eastern brook trout were the dominate species and total salmonid density was 119 fish/km^2.

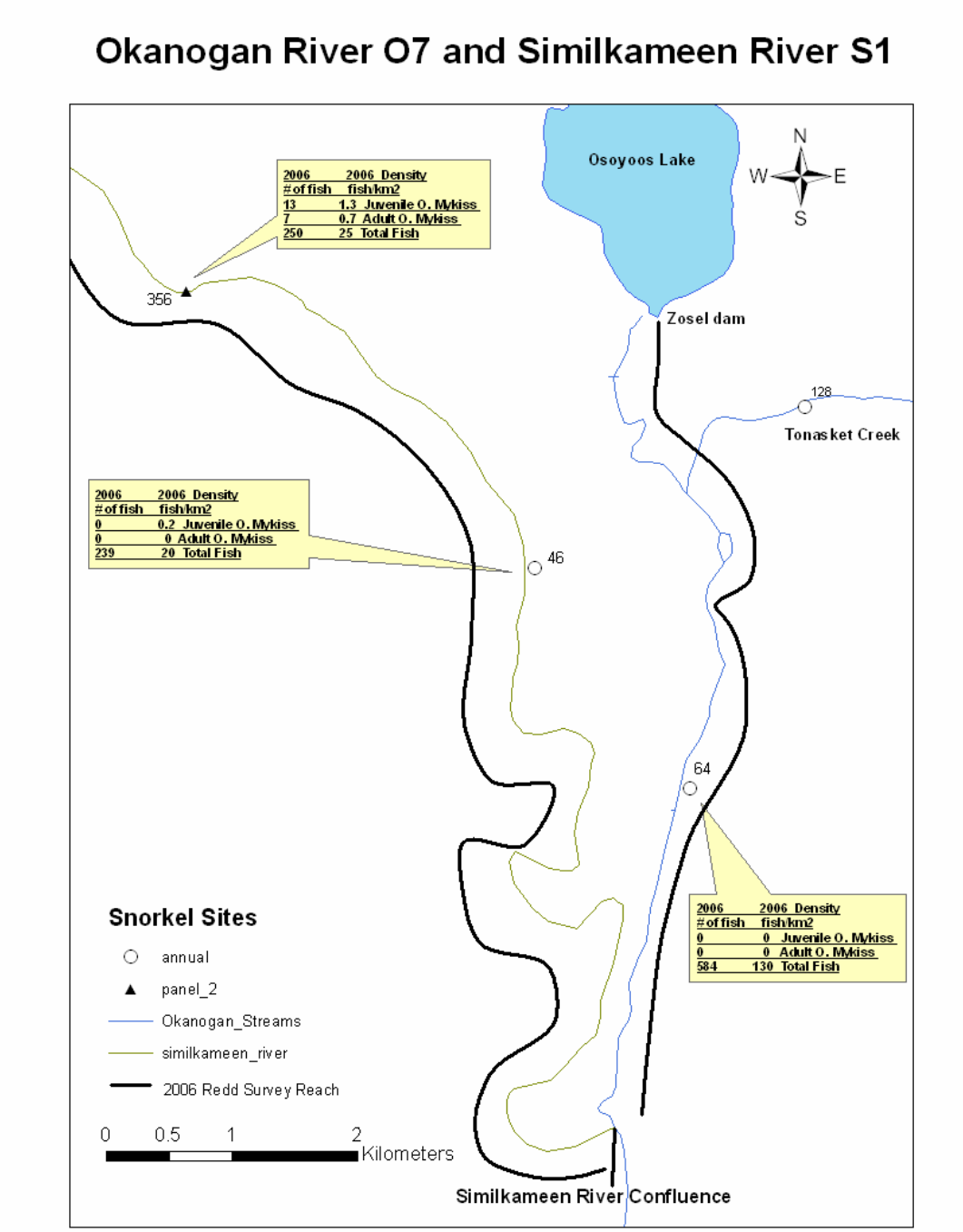

Figure 11: Snorkel survey observations for Reach O7 (the Okanogan River confluence with the Similkameen River upstream to Zosel Dam) indicated the presence of several warm water species that combined for a total fish density of 130 fish/km^2. The dominant species was smallmouth bass. Snorkel survey observations for Reach S1 (the Similkameen River confluence with the Okanogan River upstream to Enloe Dam) indicated the presence of several coldwater species that varied in dominance from Chinook Salmon in the upper reaches to bridgelip suckers in the lower reaches. Total fish densities in Reach S1 averaged 23 fish/km^2 during 2006.

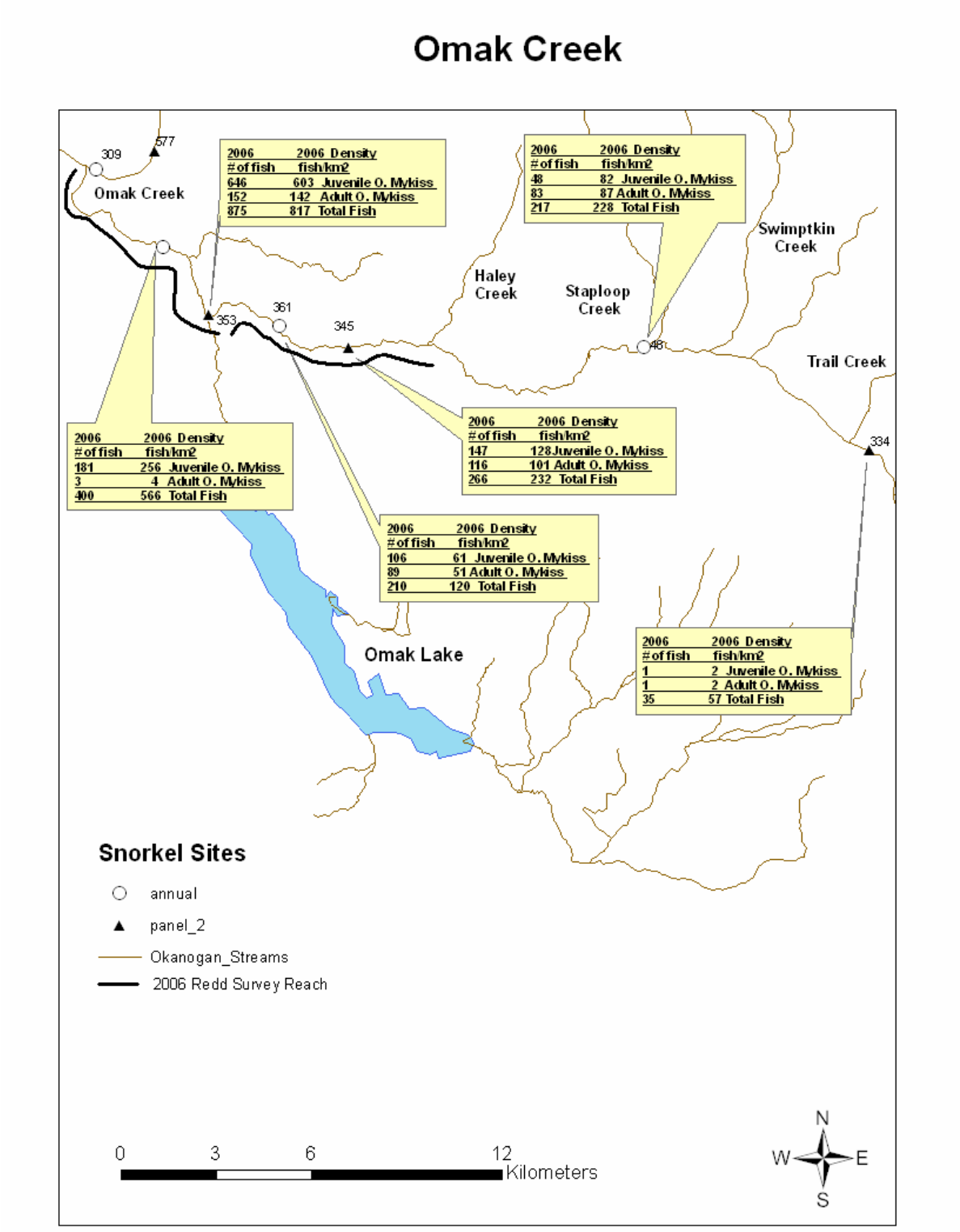

Figure 12: Snorkel survey observations for Omak Creek. Lower Omak Creek would be from site 353 downstream and upper Omak Creek would be considered above site 353. The dominant species was *O. mykiss*. Total fish densities averaged 692 fish/km^2 in lower Omak Creek and 159 fish/km^2 in upper Omak Creek during 2006.

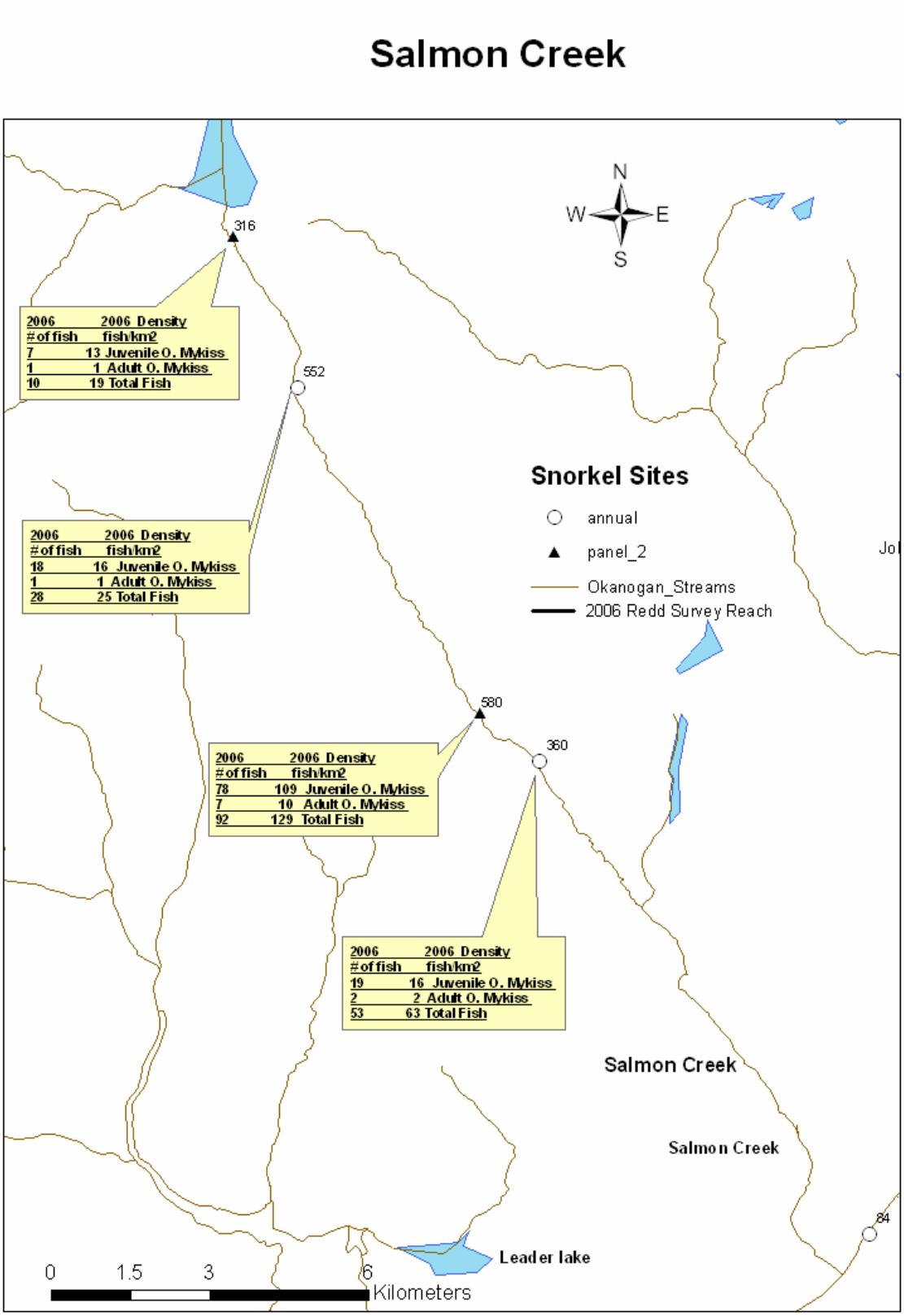

Figure 13: Snorkel survey observations for Salmon Creek (all sites are located above the OID diversion). The dominant species at all sites was *O. mykiss* and comprised 72% of all fish observed. Total fish densities averaged 41.74 fish/km^2 during 2006.

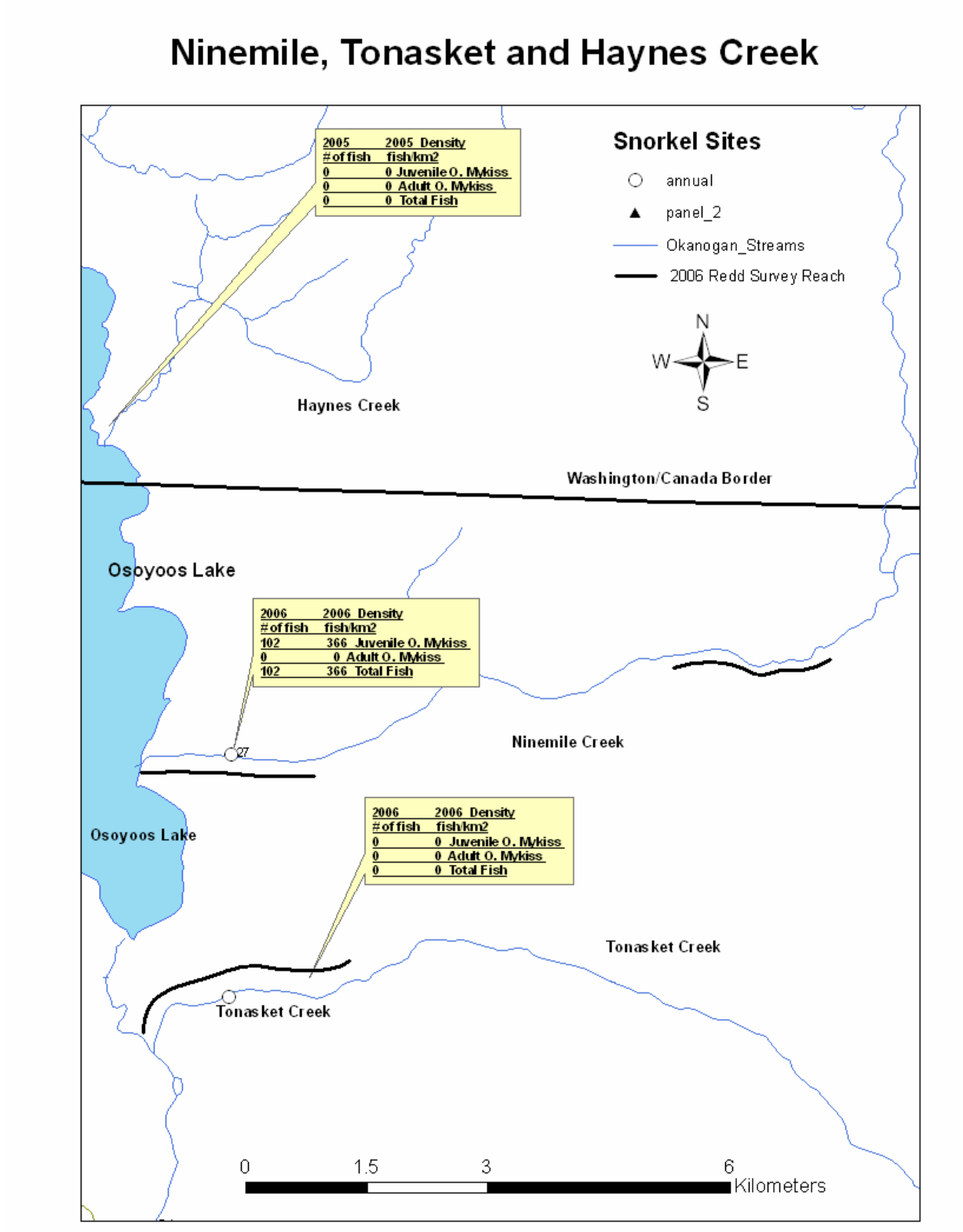

Figure 14: Snorkel survey reaches N1-Ninemile, TO-Tonasket and Haynes Creek. A total of 102 juvenile *O. mykiss* were observed at Ninemile Creek, site 27 with a juvenile *O. mykiss* density of 366 fish/km^2. No fish were observed at site 128, Tonasket Creek or site 471 Haynes Creek.

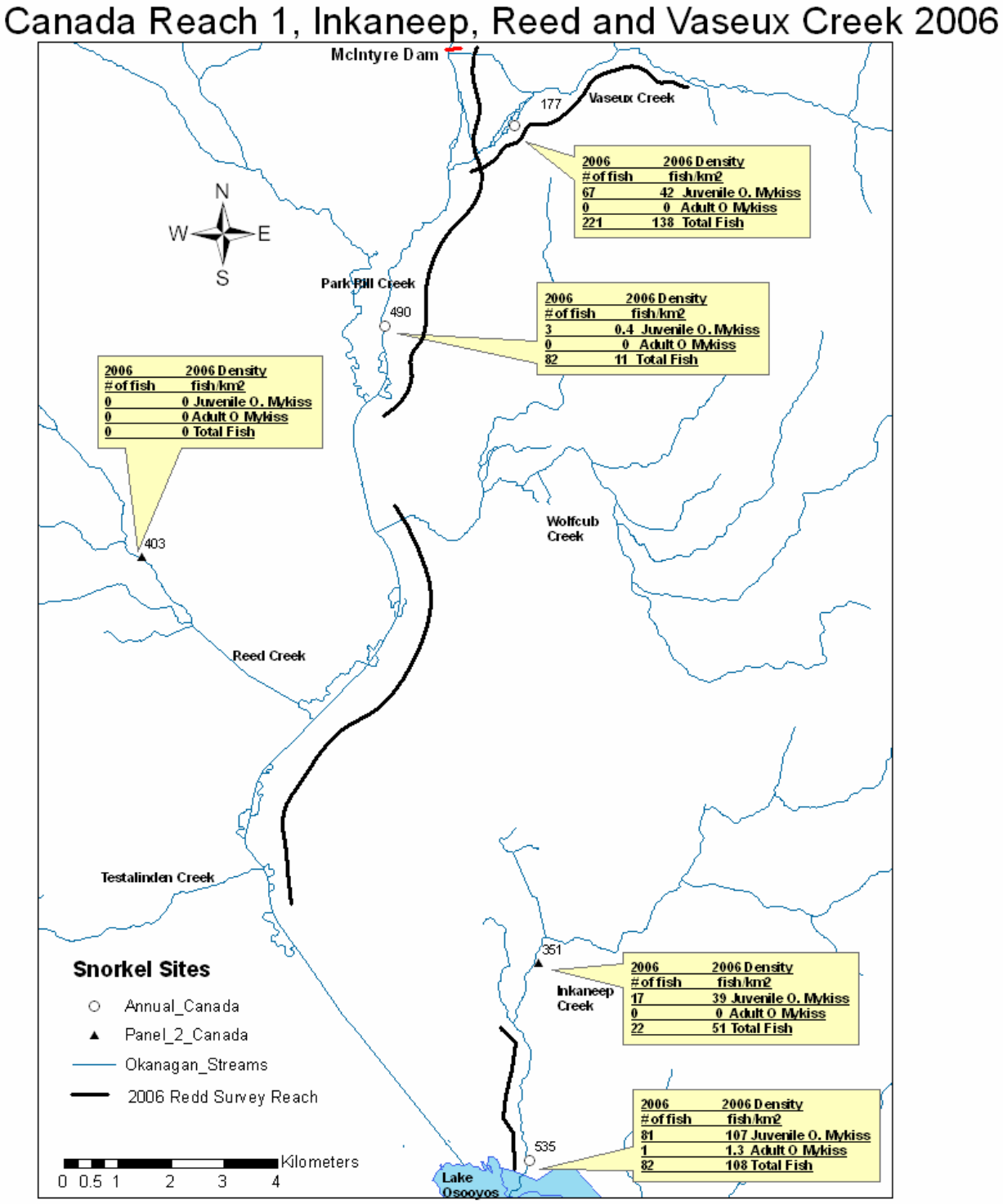

Figure 15: Canada Reach 1, Inkaneep, Reed and Vaseux Creeks. The segment of the mainstem Okanagan River in Canada from the United States/Canadian border to McIntyre Dam (4 juvenile *O. mykiss* observed in the mainstem river, 166 juvenile *O. mykiss* observed in the tributaries.)

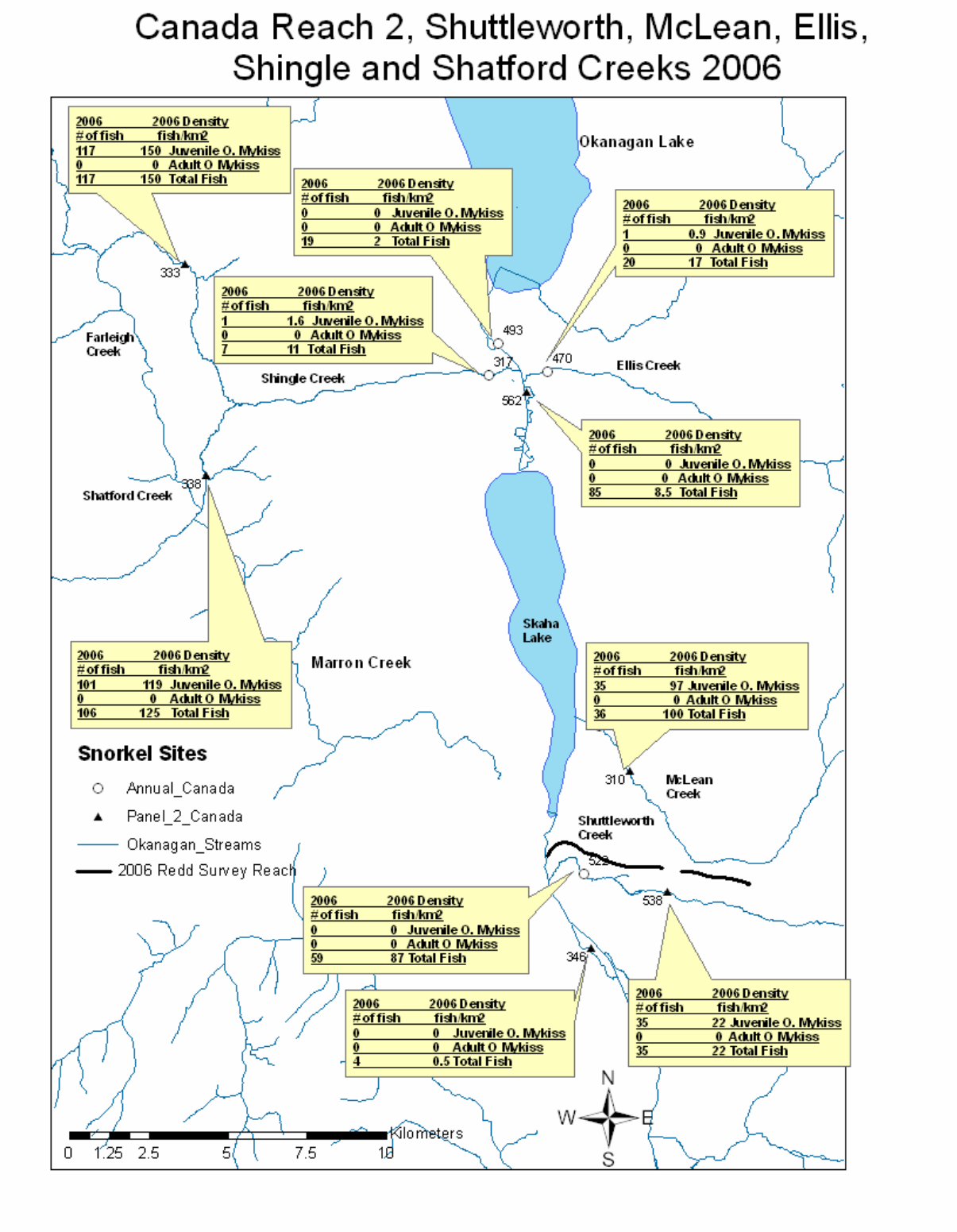

Figure 16: Canada Reach 2, Shuttleworth, McLean, Ellis, Shingle and Shatford Creeks. The segment of the mainstem Okanagan River in Canada from McIntyre Dam to Okanagan Lake (zero juvenile *O. mykiss* observed in the mainstem river, 290 juvenile *O. mykiss* observed in the tributaries.)

Conclusions

Snorkel surveys were conducted throughout the Okanogan basin as part of the Okanogan Basin Monitoring and Evaluation Project (OBMEP) in 2006. Surveys were conducted in both the United States and Canadian portions of the basin. Tributaries and mainstem river sites available to anadromous fish and upstream habitats were surveyed. The majority of the juvenile *Oncorhynchus 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. Omak Creek had the highest densities of juvenile *O. mykiss* in 2006.

The Colville Tribes documented steelhead spawning in the mainstem Okanogan and Similkameen Rivers for the first time in 2005 (Arterburn et al. 2005). The identification of redds along the main-stem resulted in questions about juvenile recruitment. Snorkel surveys conducted by OBMEP occur after the high water temperatures therefore no one was surprised that few juvenile *O. mykiss* were found at main-stem sites (6 in 2005, and 13 in 2006). Therefore additional snorkeling effort took place in 2006 and was specifically targeted on the Similkameen River. These additional efforts resulted in many addition *O. mykiss* being documented from several year classes (Colville Tribes efforts observed an additional 21 juvenile *O. mykiss* while Entrix, Inc observed an additional 220 juvenile *O. mykiss).*

The results showed a large increase in juvenile *O. mykiss* abundance in both upper and lower Omak Creek reaches in 2006. We hypothesize that this resulted from three factors: first, passage improvements at Mission Falls during the fall of 2005; second steelhead smolt releases above Mission Falls in recent years; and lastly normal snowfall and the spring freshet eliminated many beaver dams that acted as barriers and inundated quality spawning habitats in 2005. Conversely, juvenile *O. mykiss* densities were much lower on Bonaparte Creek in 2006 as a result of few spawners entering this creek. It has been hypothesized that adult steelhead were having difficulties navigating the delta at the mouth of this creek in 2006. Therefore, we will attempt to observe and modify (as needed) the mouth of Bonaparte Creek to assist adults attempting to return during the spawning migration in 2007.

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. Information collected in 2006 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, Shingle and Shatford Creeks are also above McIntyre Dam and upstream of Skaha Lake Dam and 2006 data show these creeks as having potential for future steelhead spawning and rearing once current barriers are removed. Opening access to tributaries above McIntyre Dam should be considered a priority for current restoration activities.

New information uncovered as part of the OBMEP snorkel surveys during 2006 includes the following:

- OBMEP snorkelers positively identified 5 yearling Chinook with intact adipose fins in the Similkameen River.
- The first documented channel catfish was discovered in the Okanogan River.
- Juvenile summer steelhead production was documented in Wildhorse Spring Creek.

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