2005 OKANOGAN BASIN STEELHEAD SPAWNING GROUND SURVEYS

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Abstract

Steelhead redd surveys have never been conducted in the Okanogan River Basin with the exception of 4 years of data in Omak Creek. Verifiable statements about summer steelhead spawning in the United States portion of the Okanogan Basin and tributaries were indicated in an extensive literature review, however, this study provided the first data for many areas of the Okanogan River Basin, especially related to the main-stem habitats. The peak of spawning occurred around the middle of April , appearing to progress in an upstream direction along the main-stem before focusing in tributary habitats. 470 redds were discovered in the main-stem habitats of the Similkameen and Okanogan Rivers and 164 redds were discovered in the United States tributaries. Redds were observed in the greatest concentration in and near areas with relatively steep gradient, high water velocity, moderate sized substrate, and the down-welling areas for the main-stem Okanogan River. This includes areas near the confluence between the Okanogan and Similkameen Rivers, habitat near Janis and McAllister Rapids and in Omak and Bonaparte Creeks. Omak and Bonaparte Creeks are the primary spawning tributaries located in the United States portion of the Okanogan River basin. Salmon Creek has major potential for summer steelhead spawning if water were provided for fish passage. Continued annual redd surveys are needed to determine population level abundance, timing, and distribution changes and trends. Additional research needs to be performed in order to; 1) better understand the life history and behaviors of juvenile summer steelhead hatching in the main-stem Okanogan and Similkameen Rivers, 2) determine the number of redds produced by each female, 3) establish the distribution and abundance of summer steelhead in the Canadian main-stem and tributaries, 4) determine what proportion of spawning summer steelhead are naturally or hatchery produced. The new information provided by this continuing research will help refine future hypotheses about summer steelhead in the Okanogan River Basin, perhaps showing that habitat improvements to the expansive main-stem habitats could greatly benefit Steelhead recovery efforts in the Okanogan and Similkameen River Basins.

Introduction

The Okanogan River, located in north central Washington State, is the most northern watershed accessible to anadromous fish in the entire Columbia River Basin (Figure 1). The Okanogan also represents the northern most drainage in the Upper Columbia summer steelhead evolutionary significant unit (ESU). 70% of the watershed is located in Canada. Due to an extremely low gradient, high summer water temperatures, and murky water, the habitat in the Okanogan River is different from what most people consider to be ideal for anadromous fish production. However, the most robust stock of sockeye salmon still remaining in the Columbia River Basin, and a robust stock of summer Chinook call the Okanogan River home. These fish must transverse nine major hydroelectric dams and several smaller impediments. 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 Okanogan River above the confluence and in Canada is a stable, clear, lake drained watershed. Most summer steelhead data that has been collected in the Okanogan watershed has focused on habitats located within the United States. Very little fisheries information is known about abundance, origin, distribution or habitat utilization north of the border.

For many years, information on steelhead spawning in the Okanogan Basin has had more to do with professional opinion than actual data. Occasional observations of steelhead in tributaries or angler information about catches of steelhead along the main-stem were all the information biologists had to determine where, when, and how many summer steelhead spawned in the Okanogan River Basin. Fulton (1970) noted use of Salmon and Omak Creeks and the upper Similkameen River. Chapman et al. (1994) found no justification for the indication of steelhead use of the upper Similkameen River after reviewing the historical literature. WDW et al. (1990) cited C. Bull, Ministry of Environment, as stating “it is uncertain if steelhead formerly used the upper reaches of the Okanagan River upstream of Vasseux Lake”. Historically, steelhead, Chinook, sockeye, and coho likely spawned in tributaries south of Okanogan Lake (Rae 2005). The Okanagan Nation’s name for Shingle Creek is "place where steelhead spawn" (Rae 2005). Two streams, Inkaneep and Vasseux, 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 the creel survey data from Okanogan Lake in the 1920’s. However, distributions of steelhead and Chinook in the Canadian portions of the Okanogan River basin remain 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 has been collected (WDF 1993).

Upper Columbia Summer Steelhead were listed as endangered on August 18, 1997 (http://www.nwr.noaa.gov/reference/frn/1997/62FR43937.pdf). The ESU includes all naturally spawned populations of steelhead (and their progeny) in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border. The ESU includes both the Okanogan River and Wells Hatchery stock steelhead. Major planning efforts have attempted to describe spawning habitat for summer steelhead in the Okanogan River basin, but these documents contain considerable inaccuracies related to distribution and description of spawning habitat (Entrix and Golder Associates 2001, NPCC 2004).

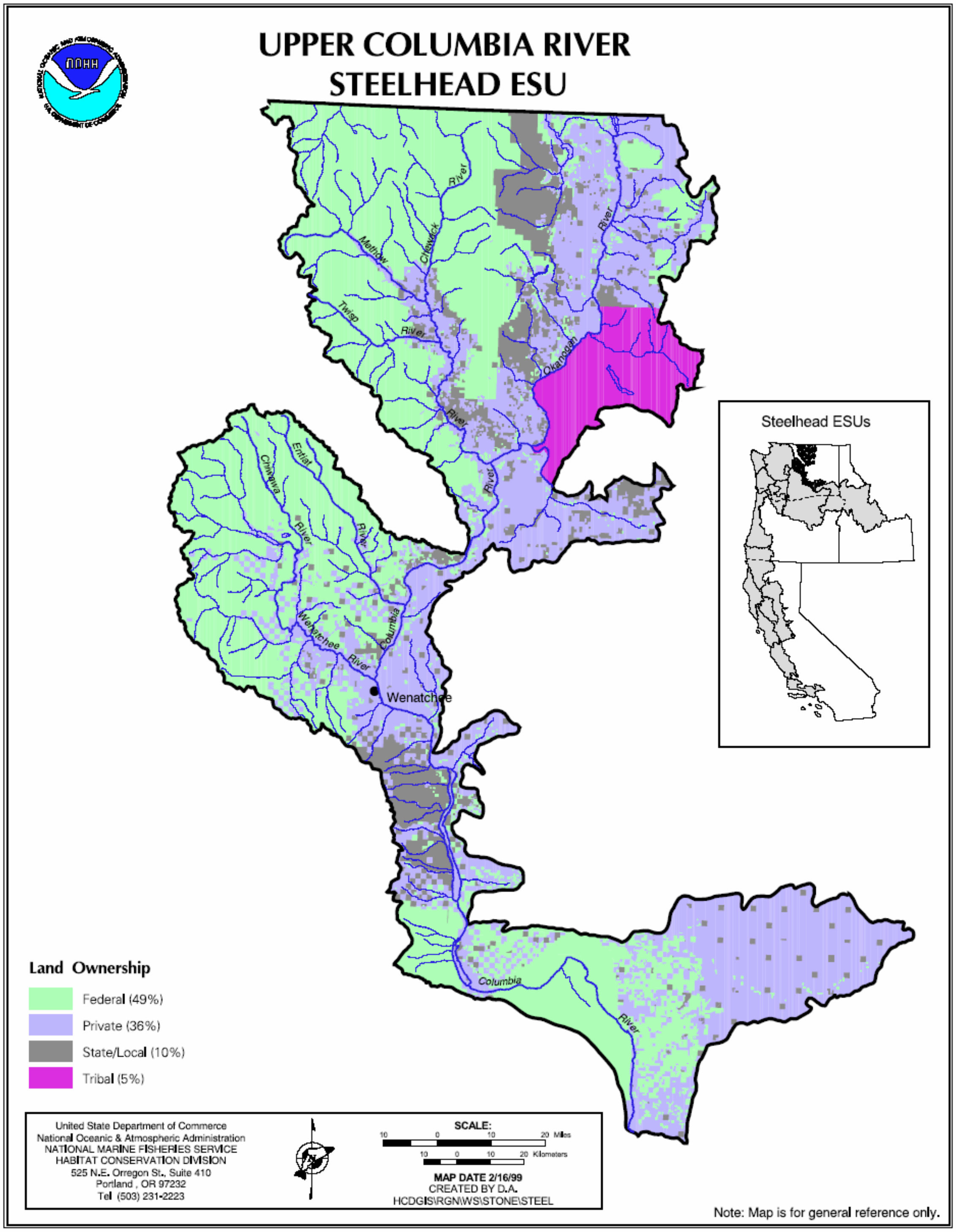

Figure 1: The Upper Columbia River summer steelhead Evolutionarily Significant Unit showing land ownership. *Map courtesy of NMFS-HCD* (http://www.nwr.noaa.gov/reference/frn/1997/62FR43937.pdf).

Since listing, the Colville Tribes have conducted several studies to determine where steelhead spawning occurs in the Okanogan Basin. Extensive literature reviews discovered the following true statements for summer steelhead spawning distributions in the Okanogan River basin. These statements and references were verified by multiple sources and ground observations in 2005.

1) Salmon Creek historically supported self-sustaining steelhead runs, but lack of flow over the last 80 years eliminates access in most years (NPCC 2004). In 2003, water released into lower Salmon Creek provided access to adult steelhead for 1 week. Several steelhead entering the stream were observed spawning and these redds produced off-spring (Fisher and Arterburn 2005). Historically, it was estimated Salmon Creek produced roughly 50% of the native summer steelhead production for the U.S. portion of the Okanogan watershed prior to the erection of Conconelly Dam (NPCC 2004).
2) Omak Creek below Mission Falls has been quantified for several years as a major steelhead production area (Fisher and Arterburn 2002, Arterburn and Fisher 2003, 2004), however redds were identified above Mission Falls in only one year prior to 2005.
3) Loup-Loup Creek has historical evidence for summer steelhead existing between the mouth and the natural falls. Today, access is blocked by a culvert only a few hundred feet upstream of the mouth, and by dewatering of the channel during most months of most years (Entrix and Golder Associates 2001).
4) Tonasket Creek between mouth and falls one adult observed and smolts were identified in 1 out of 10 years (Entrix and Golder Associates 2001).
5) In Nine-Mile Creek, adults have been observed annually since 2001, Redds were documented for the first time in 2004 and again in 2005. Surveys in this drainage are limited to the lower 1.2 miles due to private property access issues (Arterburn and Fisher 2004) so the extent of steelhead use of the creek is not fully known.
6) Tunk Creek has had annual spawning observed since 1997. Again, complete surveys are limited to the high water mark of the Okanogan River channel due to private property access issues (Entrix and Golder Associates 2001).
7) Bonaparte Creek has had annual spawning observed since the early 1990's but has never been documented or quantified in the literature (Entrix and Golder Associates 2001).
8) The Similkameen River below Enloe Dam is believed to be spawning habitat but has never been quantified or documented (Entrix and Golder Associates 2001). Passage above Enloe Dam is not possible (NPCC 2004).
9) Antoine Creek and Whitestone Creek, both in the United States, have not had sufficient data collected to determine potential for steelhead spawning. The same can be said for Park Rill, Testaliden, and Shuttleworth Creeks in Canada .
10) Spawning activity above Zosel Dam has been documented by the presence of adult steelhead and redds in Nine-mile Creek. However, agencies north of the border have differing opinions about the existence of steelhead. Biologists from the Colville Tribes and Okanagan Nation Alliance did document steelhead redds in Vasseux Creek in the spring of 2004 (Arterburn and Fisher 2004).

11) Other United States creeks such as Dan Canyon, Tallant, Felix, Wannacut, Pothole Canyon, Swapkin Canyon, Chewiliken, Mosquito, and Siwash have insufficient watershed size to produce adequate surface flows. However, based on field observations by Colville Tribal and Washington State biologists, Aeneas, Chiliwist, and Johnson Creeks may provide habitat for other life stages even though they are not accessible to adult steelhead or do not have habitat suitable for steelhead spawning to occur (Entrix and Golder Associates 2001).
12) The main-stem Okanogan River below Enloe Dam was largely considered to be a migratory corridor for summer steelhead although no surveys or research had been conducted to verify this assumption prior to this study.

The Okanogan Basin Monitoring and Evaluation Project (OBMEP) was created in March of 2004 to establish a basin wide status and trend monitoring program in the Okanogan River basin. Funded by the Bonneville Power Administration (BPA project # 200302200), OBMEP fills data gaps particularly associated with endangered summer steelhead through implementation of the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP). The EMAP protocol is a spatially-balanced, site-selection process developed for the systematic sampling of aquatic systems (Overton et al. 1990, Moore 2002). EMAP sites were selected to maintain coordination and compatibility with other monitoring and evaluation efforts in the Upper Columbia ESU. OBMEP uses protocols similar to those in the Upper Columbia Strategy (Hillman 2004) which call for a complete redd census, if possible, or an annual count of the numbers of redds within already-established index areas, or in reaches selected using randomly selected EMAP sites (Figure 2).

Methods

Steelhead redd surveys were conducted in the United State portion of the Okanogan River drainage in all accessible tributaries and along the Main-stem of the Okanogan and Similkameen Rivers. Surveys were conducted at least three times during the spawning period, March 28-May 15 along the main-stem reaches and for all annual and 2005 rotating panel EMAP sites. The final survey of each tributary was broken down into data for each EMAP reach, a 1km reach and for the entire reach that is assessable to summer steelhead with the exception of Omak Creek (Table 1). In Omak Creek, three surveys were conducted, all at EMAP sites. One-time surveys were conducted at already-established index areas, one extending 2 km upstream from the mouth of Omak Creek, the other between the mouth of Mission Creek upstream to Mission Falls. Above Mission Falls, reaches were surveyed using the downstream extent of the randomly selected EMAP sites as the farthest point downstream to begin the 1km reach.

US OBMEP sites

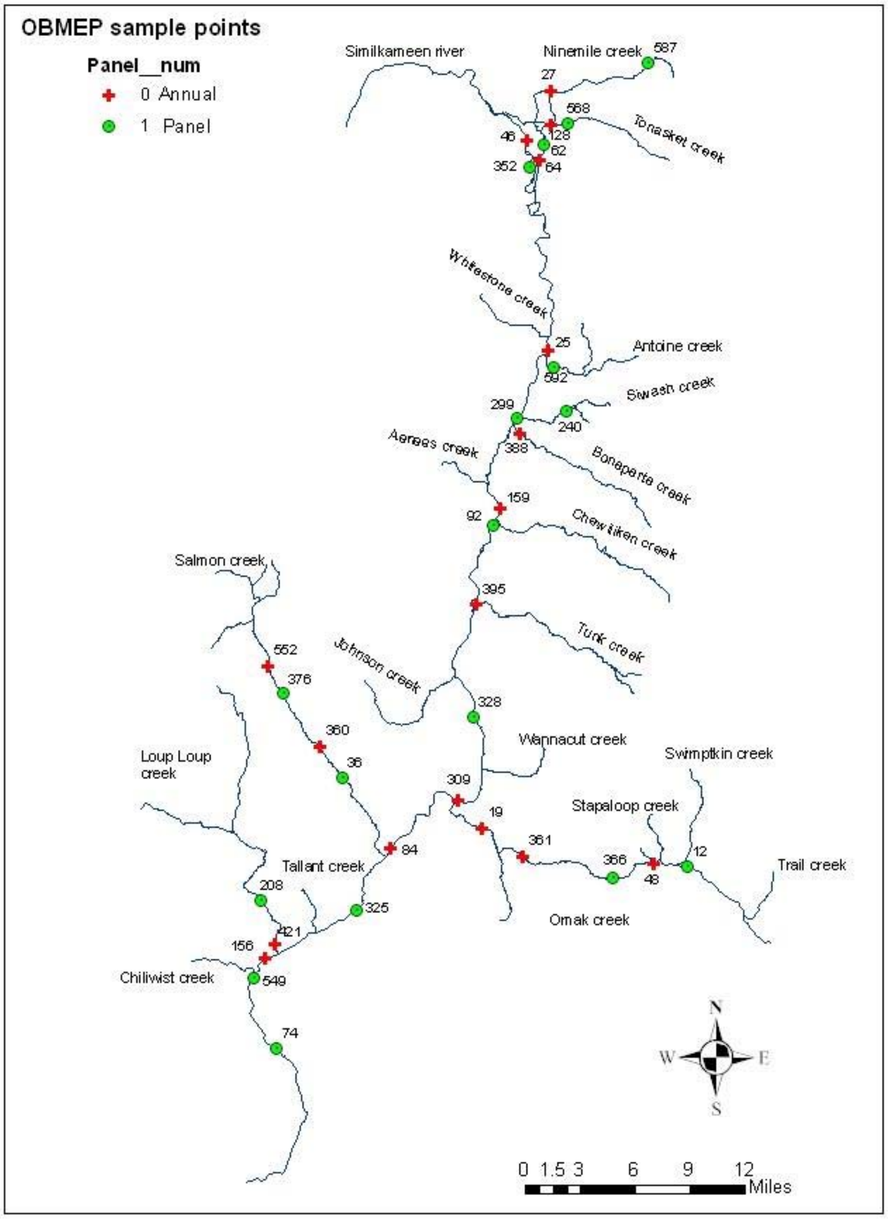

Figure 2: Probabilistic sampling design was used to select EMAP sites from a sampling universe that included all accessible habitats for anadromous fish in the United States Portion of The Okanogan River Watershed. Annual sites are sampled annually and panel sites are sampled once every 5 years.

In order to establish a baseline of data, the entire length of the Okanogan and Similkameen River was surveyed. On the Okanogan River, we surveyed from below Zosel Dam to the Washington Department of Fish and Wildlife (WDFW) area located at the confluence with Chilliwist Creek. The area of the Okanogan below Chilliwist is subject to inundation from the Columbia River (Well's Pool) and therefore lacks the appropriate flow and substrate needed for summer steelhead to spawn. The Similkameen River was surveyed from below Enloe Dam to the confluence with the Okanogan River.

Steelhead spawning areas were surveyed by foot in the tributaries or from rafts along main-stem reaches. All surveys were conducted and redds were verified by at least two trained staff. Main-stem surveys were conducted by rafts except all island sections or areas that could not be floated due to limited access and/or obstacles (e.g. Wood debris, braided channels, and diversions) were surveyed by foot. The watershed was divided into reaches to allow for ease of access and provide reference points regarding distribution maps (see Table 1). Raft surveys were conducted using a minimum of two people in two 1-man, 10' Skookum steelheader model catarafts.

Table 1: Reaches sampled during 2005 redd surveys of the United states portion of the Okanogan River

Reach Code	Reach (rkm)	Reach length (km)
	Main-stem Habitats	
S1	Similkameen/Okanogan Conflunce(0) to Enloe Dam (14.6)	14.6
O1	Chilliwist(24.4) to Salmon Creek(41.4)	20.0
O2	Salmon Creek(41.4) to Riverside(66.1)	24.7
O3	Riverside(66.1) to Janis(84.6)	18.5
O4	Janis Br.(84.6) To Ellisforde(98.2)	13.6
O5	Ellisforde (98.2) to Similkameen River confluence (119.5)	21.3
O6	Similkameen River confluence (119.5) to Zosel Dam(127.0)	7.5
Total distance of main-stem habitats surveyed		**120.2**
	Tributary Habitats	
TU1	Tunk cr @Okanogan river Confluence (0) to High water mark (0.2)	0.2
B1	Bonaparte Creek/Okanogan River confluence (0) toBonaparte Falls (1.6)	1.6
N1	Ninemile Creek/Okanogan River confluence (0) to Eder land (1.7)	1.7
OM1	Omak Creek/Okanogan River confluence (0) to Omak Lake Road Bridge (2.0)	2.0
OM2	EMAP Site 19 lower (5.3) to Mission Falls (9.0)	3.7
OM12	Jim Cr rd bridge(29.4) to EMAP Site 12 lower (30.4)	1.0
OM48	Staploop cr (26.8) to 500 meters below site 48 lower (27.8)	1.0
OM366	end of forest road at dutch anderson bridge (21.5) to dutch anderson br.(22.5)	1.0
OM361	Above mission falls(10.75) to EMAP site 361 upper (11.75)	1.0
TO1	Tonasket Creek/Okanogan River confluence (0) to Tonasket Falls (3.5)	3.5
Total distance of tributary habitats surveyed		**16.7**
Total distance of redd surveys conducted in 2005		**136.9**

Redds were marked by GPS and surveyor flagging tied to bushes or trees on the stream bank adjacent to the area were redds are observed. Each flag was marked with the date, coordinate, and distance away from the redd, consecutive flag number, total number of redds represented by the flag, and surveyor initials, this same information was captured electronically by entering it into a Trimble data logger. The color of the flagging was changed for each survey. Incomplete redds or test pits were not flagged and not counted. On subsequent surveys, all redds were counted and every attempt made to locate all flags from previous surveys. We noted missing flags by a gap in the numbering sequence. If a flag was found to be missing, the surveyor re-flagged redds based on the previous GPS location. Re-flagged redds were not counted as new redds.

GPS data and other information collected during field surveys were recorded on Trimble units and downloaded into ArcMap after every survey. The GIS data were reviewed and spatial corrections made to accurately display coordinates in a map format. Escapement calculations were made for each sub-population and the entire watershed. Several methods for calculating spawning escapement exist, such as the number of redds times a "fish-per-redd" estimate. WSRFB (2003) uses 2.2 chinook per redd, assuming one redd per female. For steelhead, they assume 1.23 redds per female. A more accurate method currently used by WDFW in the Upper Columbia Basin is based on the sex ratio of broodstock (not recovered carcasses) collected randomly over the run (A. Murdoch, personal communication, WDFW). For example, if the sex ratio of a random sample of the run is 1.5:1.0, the expansion factor for the run would be, 2.5 fish/redd. This method is used for all supplemented stocks within the Upper Columbia Basin. We used the more accurate method and calculated escapement using the sex ratio generated from the Omak Creek weir in addition to using the sex ratio calculated from fish collected at Well's dam. Both total redds and spawning escapement will be reported as "whole" numbers.

Along the Main-stem Okanogan and Similkameen Rivers, and on Bonaparte Creek, all redds were marked, representing a total count and not an estimate. No statistical testing is necessary to interpret results. However, this count only represents the area examined and the time period when surveys were conducted. It is likely that data were not collected over the entire course of the run due to poor access, high water, turbidity, and weather, we therefore consider the results of this effort a conservative estimate. Total redd estimates, in combination with spawner escapement where data exists (Omak Creek), can be used to estimate total escapement with a high level of accuracy. Other tributaries where landowner permission could not be granted represent a more difficult problem. The only way to expand estimates to the entire creek is to multiply the density of redds per km of stream in the sampled area by the remaining length of stream accessible by summer steelhead; this method was only needed for Nine-mile and Tunk Creeks. Sex ratio data can be used to provide estimates of total spawner escapement for the reach, watershed or sub-watershed. The sex ratio was determined by counting all adult fish returning to the Omak Creek weir and comparing the ratio of males to females and assuming that each female will produce one redd (i.e. 83 males and 65 females collected would represent a 1.28:1.0 ratio) we will also use the sex ratio estimate derived by WDFW at Wells Dam as it is unknown which ratio truly represents the Okanogan River population best.

Results

Sex ratios

All fish collected at the Omak Creek trap and as part of redd surveys on Omak Creek where fish could be handled and sex determined resulted in 148 summer steelhead being sexed and 65 fish identified as females and 83 identified as male. This makes a 1.28: 1 male to female ratio and a sex ratio as observed at the Omak Creek Trap of 2.28. At Wells Dam 463 summer steelhead were sampled, 201 males and 262 females were identified by Washington Department of Fish and Wildlife personnel (Charley Snow-personal communications) This results in a ratio of 0.77 males per female or a sex ratio of 1.77.

Okanogan and Similkameen River Main-stem

The Okanogan River was divided into six segments based on access points. All reaches were located upstream of the Wells' pool influence that is commonly agreed to be at the confluence of Chiliwist Creek and the Okanogan River. Since there has been no data to use as reference for main-stem reaches, data collected by the Colville Tribes on Omak Creek and data collected from the Methow River Basin were used to anticipate spawn timing; therefore redds were surveyed over two periods. The first period was considered to be early in the spawning season (3/29/05 to 4/11/05) and the later period was considered to be at or near the anticipated peak of spawning activity (4/13/05 to 4/28/05). We had intended to complete the surveys during a third period (post peak spawning) from 5/1/05 to 5/15/05, but increases in spring run-off and poor weather conditions shifted our attention to tributary habitats at this time.

The lower most reach on the Okanogan River (O1) was surveyed on 4/8/2005 when only one steelhead redd was observed. 16 redds were observed on 4/19/2005, the bulk of which were observed around a large, mid-channel gravel bar located a short distance downstream of the confluence with Loup-Loup Creek (Figure 3).
Conservatively, we calculated that the number of spawners using this reach was between 38 and 30 summer steelhead. The density of steelhead redds in this reach was 0.85 redds per kilometer.

Okanogan River Reach O2 was surveyed on 4/7/2005 when 28 steelhead redds were identified. 38 additional steelhead redds were observed when we surveyed the reach again on 4/20/2005. The bulk of the redds were observed around the Omak Bridge or near the Island at Shellrock Point (Figure 4). We calculated that conservatively the number of spawners using this reach was between 151 and 117 summer steelhead. The density of steelhead redds in this reach was 2.75 redds per kilometer.

Okanogan River Reach O3 was surveyed on 4/6/2005 when 46 steelhead redds were identified. We surveyed the reach again on 4/18/2005 when 12 additional steelhead redds were observed. The bulk of the steelhead redds were observed around the Janis Rapids and McAllister Rapids areas (Figure 5). We calculated that conservatively the number of spawners using this reach was between 132 and 102 summer steelhead. The density of steelhead redds in this reach was 3.11 redds per kilometer. Two summer steelhead were observed during the early survey and they appeared to be in good condition.

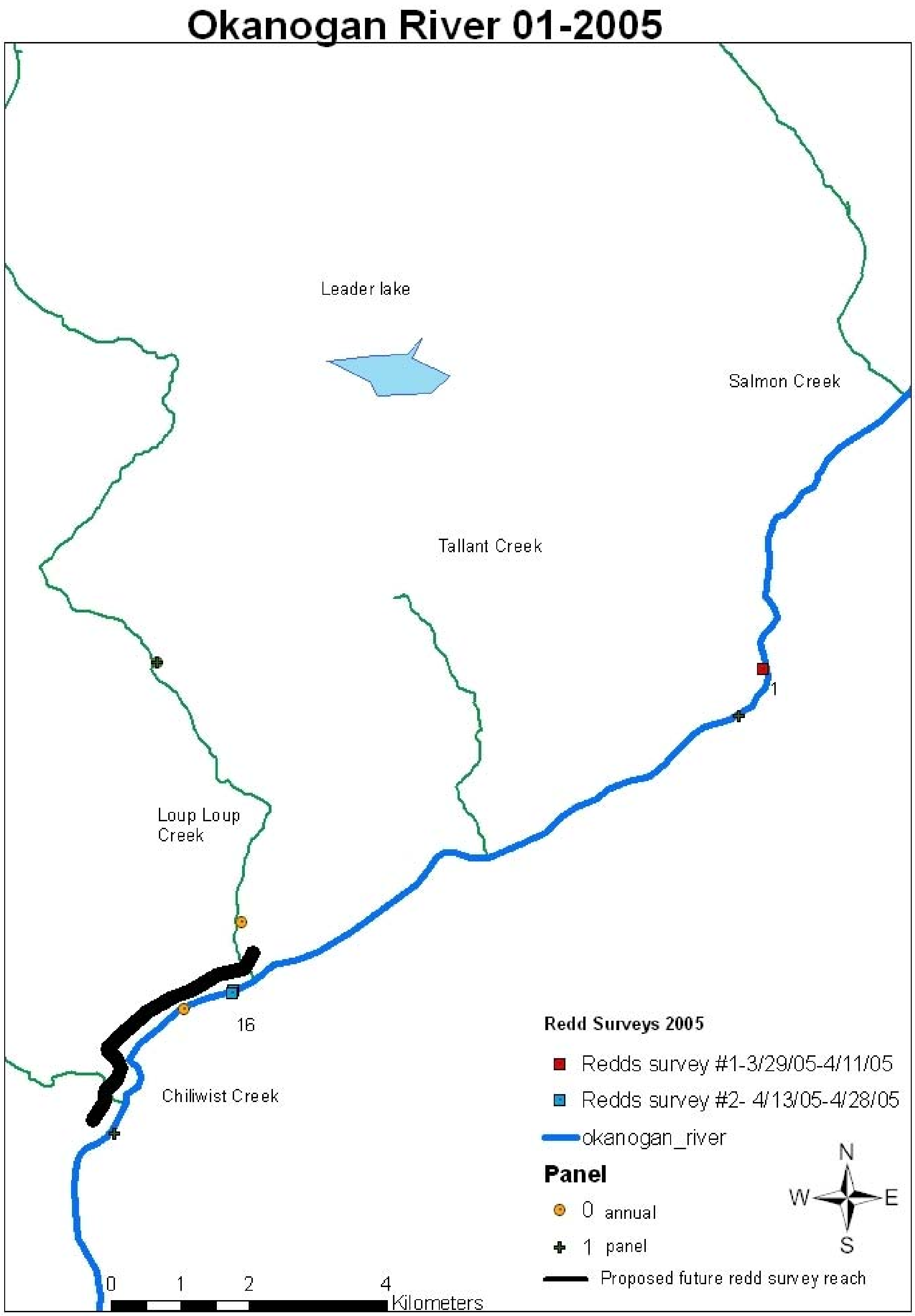

Figure 3: Redd distribution observed in 2005 for lower most Okanogan River from the confluence of Salmon Creek downstream to the confluence with Chiliwist Creek and reduce future proposed sampling area in black.

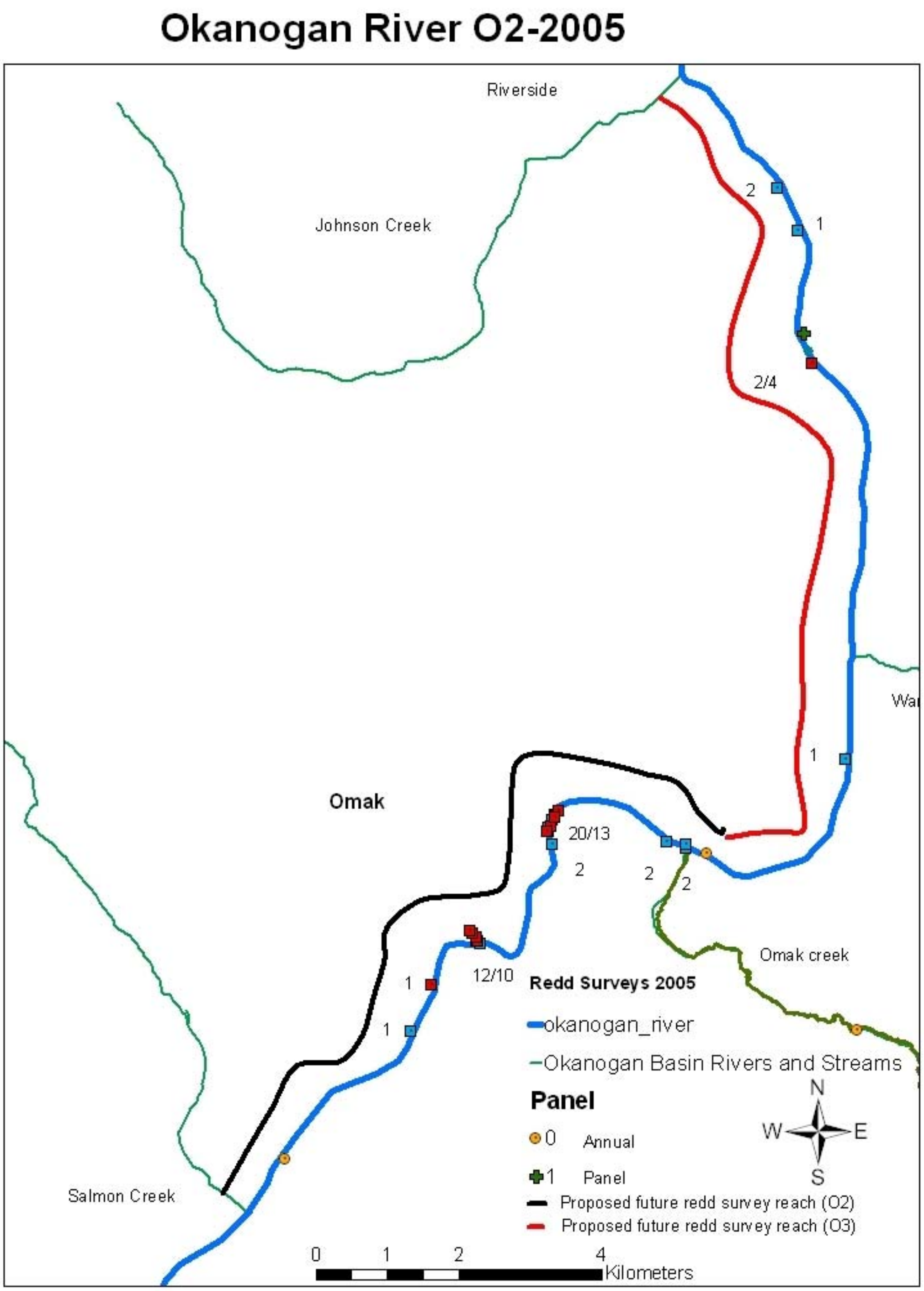

Figure 4: Redd distribution observed in 2005 for Okanogan River reach O2 from the town of Riverside, WA to the confluence of Salmon Creek and future proposed sampling areas in red and black.

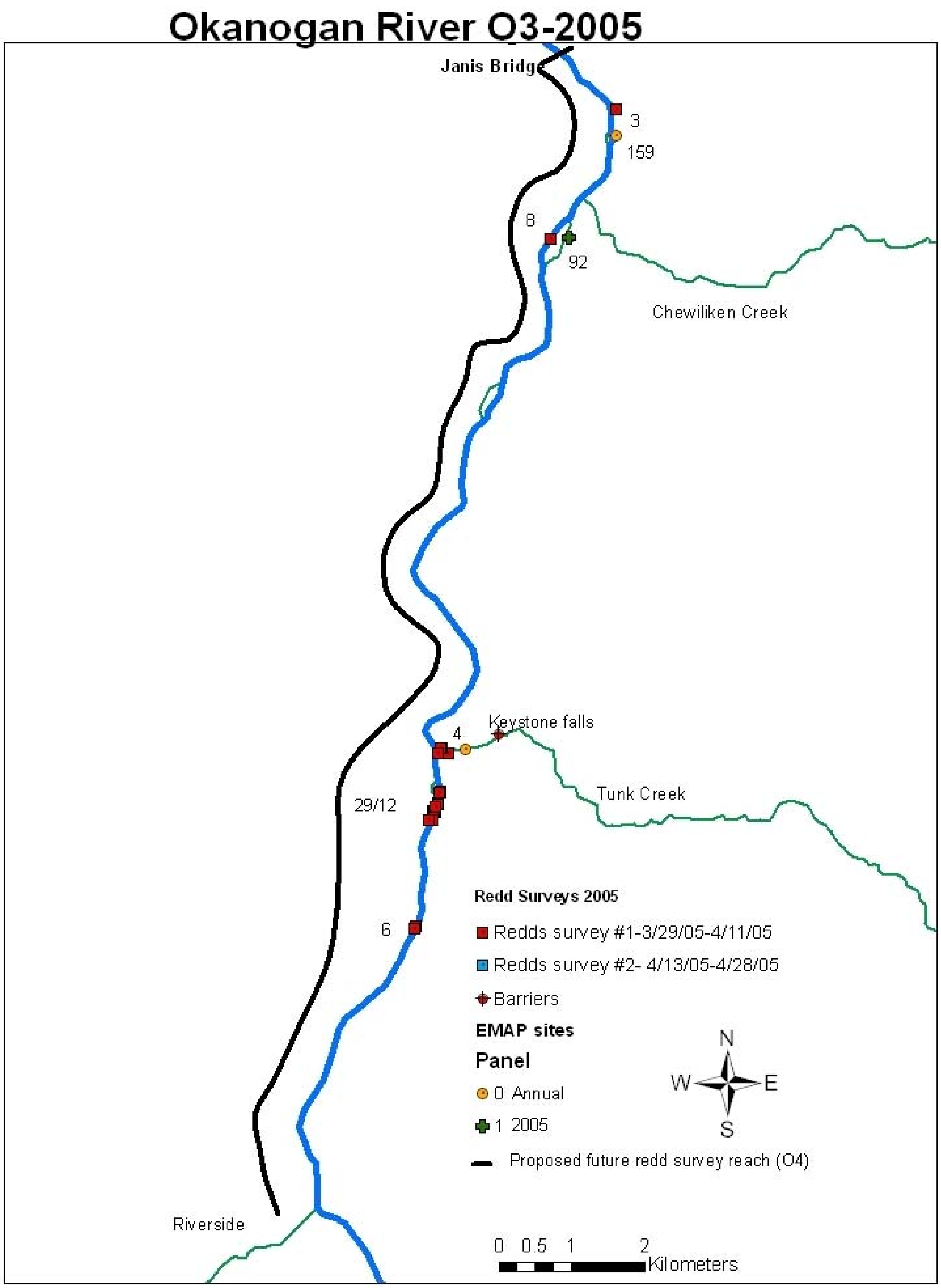

Figure 5: Redd distribution observed in 2005 for Okanogan River reach O3 from the highway 97 bridge at Janis, WA to the town of Riverside, WA at the confluence of Johnson Creek and future proposed sampling areas in black.

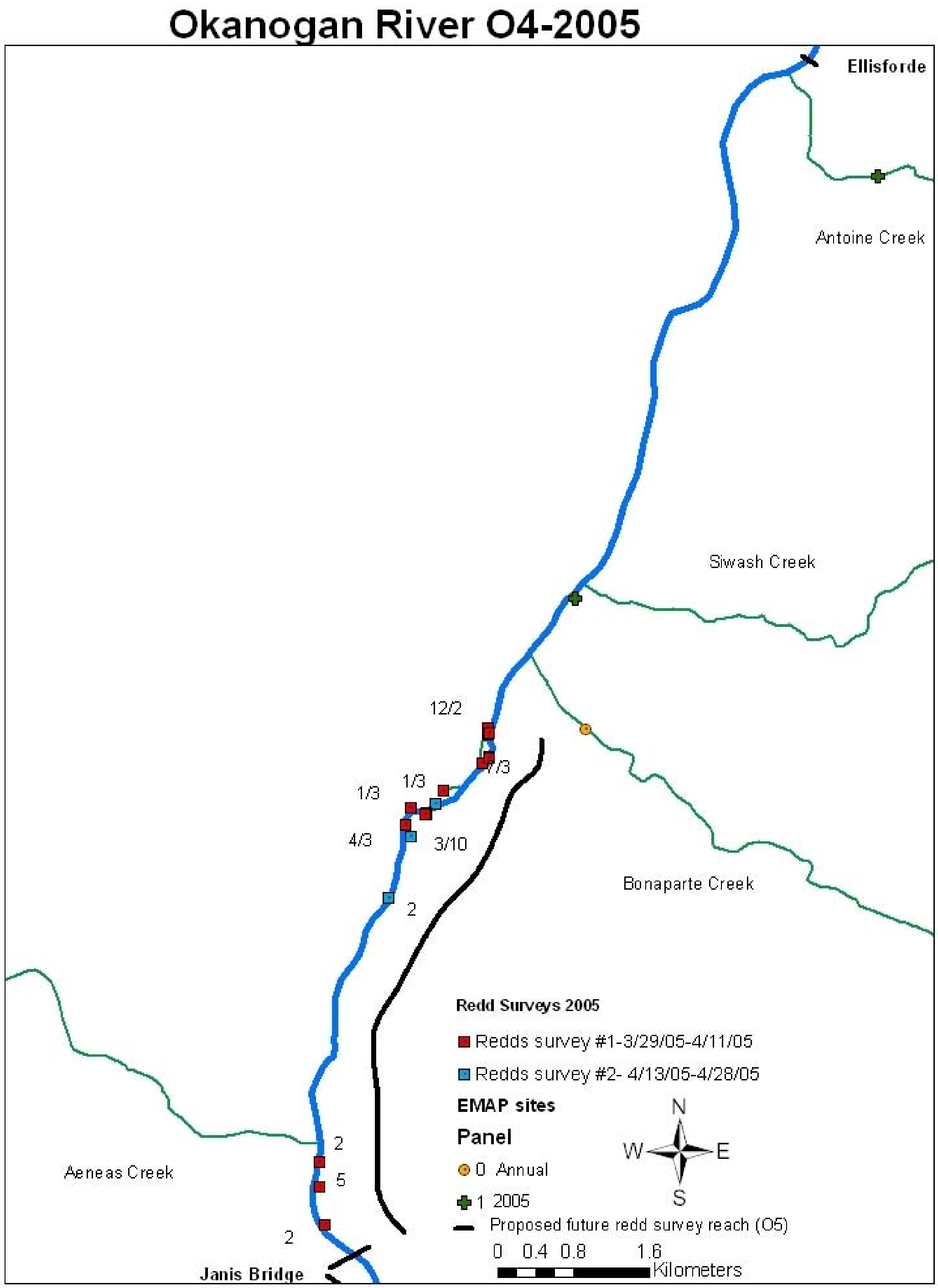

Figure 6 Redd distribution observed in 2005 for Okanogan River reach O4 from the Oroville-Tonasket Irrigation District settling pond access at Ellisforde, WA to the Highway 97 bridge at Janis, WA and future proposed sampling areas in black.

Okanogan River Reach O4 was surveyed on 3/29/2005; 37 steelhead redds were identified. The reach was surveyed again on 4/15/2005 and 26 additional steelhead redds were observed. The bulk of the steelhead redds were observed downstream of the boat ramp in Tonasket, WA, and upstream of the Highway 97 bridge (Figure 6). We calculated that conservatively the number of spawners using this reach was between 143 and 111 summer steelhead. The density of steelhead redds in this reach was 4.63 redds/km.

One steelhead redd was observed in Okanogan River Reach O5 on 4/4/2005. We surveyed the reach again on 4/22/2005 and 18 additional steelhead redds were observed. Steelhead redds were found only in the reach downstream of the confluence with the Similkameen River but upstream of the confluence with Mosquito Creek (Figure 7). We calculated that conservatively the number of spawners using this reach was between 43 and 34 summer steelhead. The density of steelhead redds in this reach was 0.89 redds per kilometer.

Okanogan River Reach O6 was surveyed on 4/1/2005 when 19 steelhead redds were identified. We surveyed the reach again on 4/21/2005 when 122 additional steelhead redds were observed. Steelhead redds were located throughout this reach but higher densities of redds were found downstream of the Highway 97 bridge at Oroville (Figure 8). We calculated that conservatively the number of spawners using this reach was between 321 and 250 summer steelhead. The density of steelhead redds in this reach was 18.8 redds/km. One summer steelhead was observed during the early survey and 13 were observed during the final survey. All steelhead observed, were lively and appeared to be in good condition. Several steelhead were observed actively spawning and of these, 2 were considered male and 2 female, 3 fish were observed without an adipose fin and 2 had full adipose fins (40%).

Similkameen River Reach S1 was surveyed on 3/30/2005 and 19 steelhead redds were identified. We surveyed the reach again on 4/13/2005 and observed 87 additional redds. Steelhead redds were found mostly in the reach below the City of Oroville bridge but upstream of the cross-channel where one redd was identified and included in the totals for this reach (Figure 8). We conservatively calculated spawners using this reach at between 241 and 188 summer steelhead. The density of steelhead redds in this reach was 7.26 redds per kilometer. One summer steelhead was observed during the early survey and 7 were observed during the final survey all steelhead were lively and appeared to be in good condition.

United States Tributaries to the Okanogan River

Each tributary of the Okanogan River represents a unique data set, therefore the results of each tributary will be described individually. A complete census of each tributary was attempted. Nine-mile and Tunk Creeks could only be surveyed over a limited area due to lack of landowner permission.

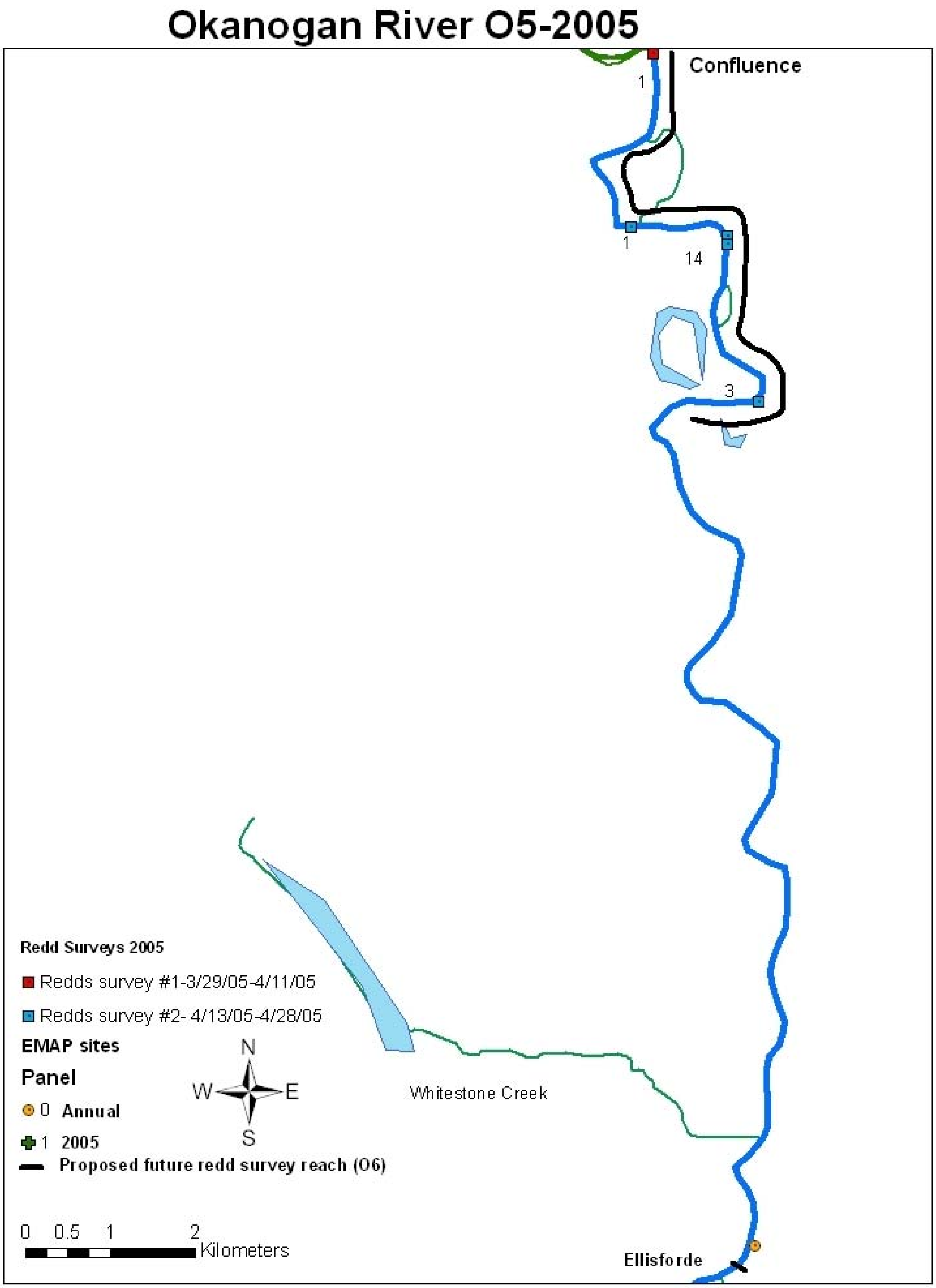

Figure 7: Okanogan River redd distribution observed in 2005 Reach O5 from confluence with the Similkameen River downstream to the Oroville-Tonasket Irrigation District settling pond access at Ellisforde, WA and future proposed sampling areas in black.

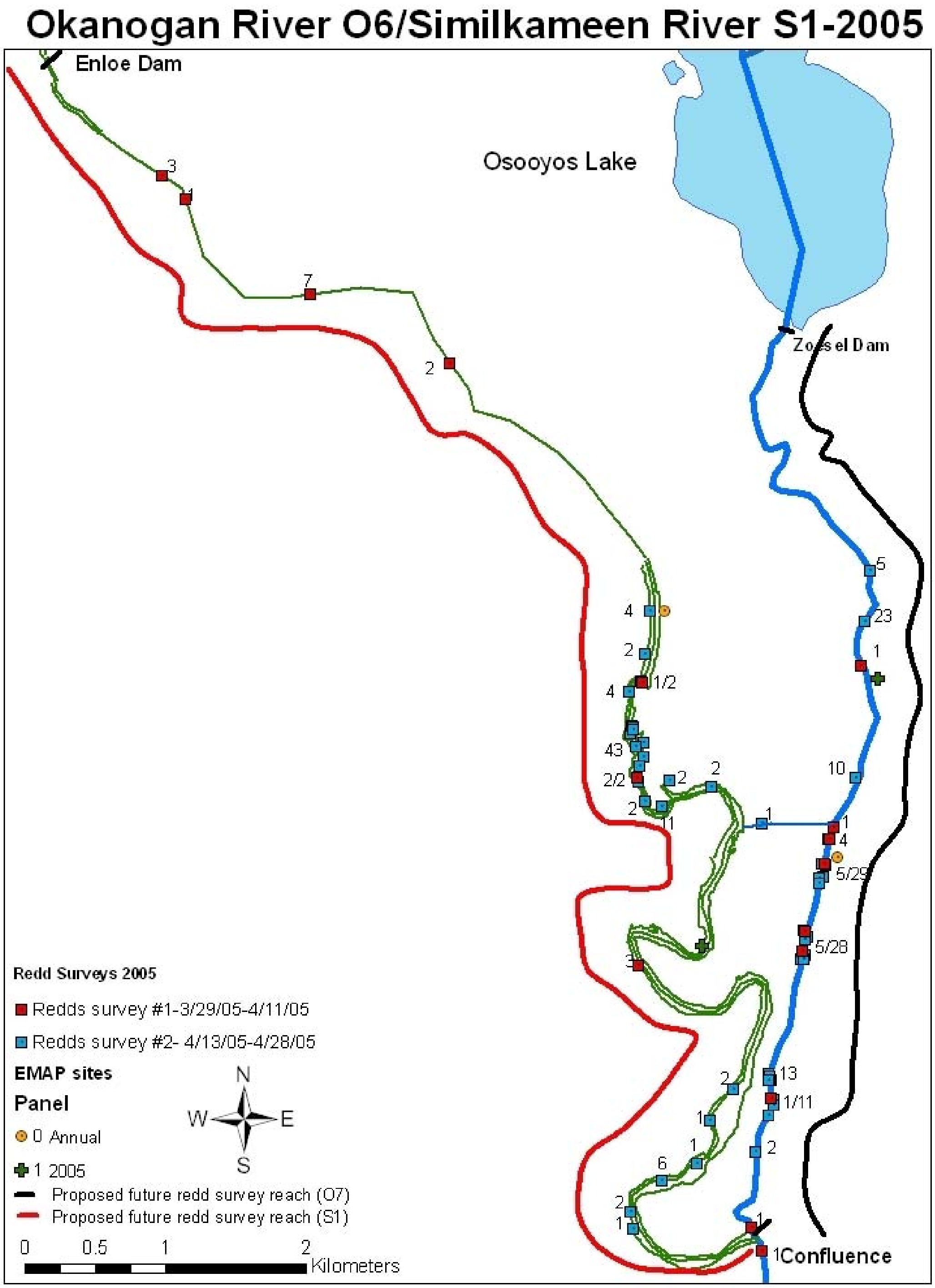

Figure 8: Redd distribution observed in 2005 for Okanogan River Reach O6 and Similkameen River Reach S1. Reach O6 extends from Zosel Dam downstream to the confluence with the Similkameen River. Reach S1 extends from Enloe Dam downstream to the confluence with the Okanogan River and includes the cross-flow channel habitats. Future proposed sampling areas are indicated in red and black but are unchanged.

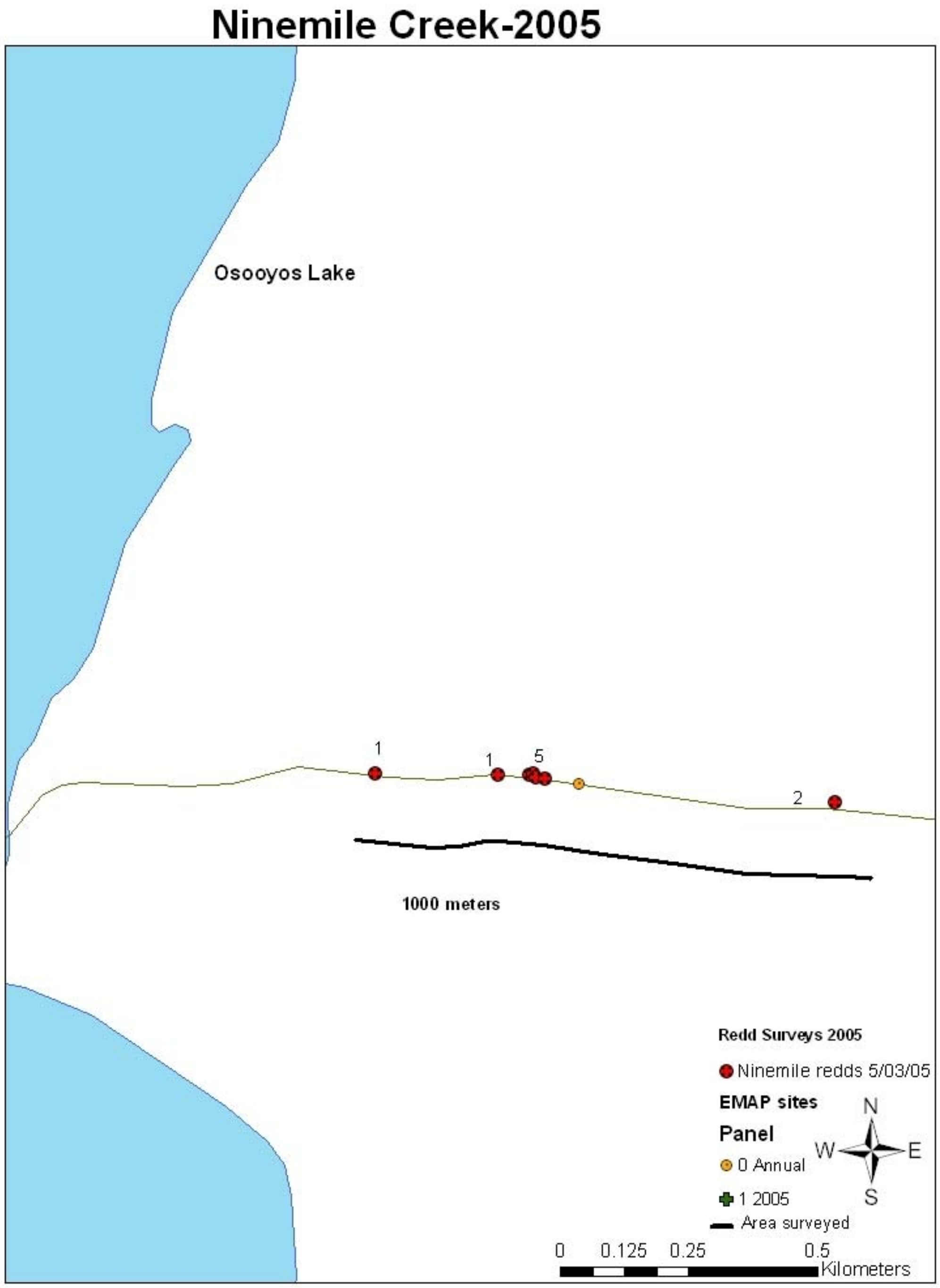

Figure 9: Redd distribution observed in 2005 for Nine-mile Creek in the accessible lower 1.7km reach from the confluence with the Okanogan River upstream to the Edder property boundary. A one kilometer reach and location of EMAP sampling site are indicated.

The lack of access has been an on-going problem on Ninemile Creek. No survey of fish passage barriers has ever been conducted between river kilometers 1.7 and 9.1. The barrier at river kilometer 9.1 was discovered only recently. Several surveys below river kilometer 1.7 have uncovered an impedance to passage at approximately river kilometer 1.3 that could be a major obstacle during low water years such as 2005. Extrapolating redd surveys beyond the lower 1.7 km of Ninemile Creek is not possible due to a lack of habitat information. A total of 9 redds were identified on 5/1/05 but no summer steelhead were observed (Figure 9). We estimate the total escapement for Ninemile Creek to be greater than the range from 16 to 21 summer steelhead.

The only access on Tunk Creek was within the high water mark of the Okanogan River channel, therefore we conducted foot surveys in conjunction with raft surveys for Reach O3. The high water mark along the Okanogan River provides access to the lower 0.2km, however only 1.0km of habitat exists in Tunk Creek below the historic natural barrier of Keystone Falls. We observed 4 redds in Tunk Creek (Figure 5) on 4/18/05 in the lower 0.2km. Expanding these data to include the full 1km results in the estimated density of 20 redds per km. This was used to estimate an escapement for Tunk Creek of between 7 and 46 summer steelhead. No actively spawning summer steelhead were observed in Tunk Creek during our surveys.

The entire length of usable anadromous fish habitat on Bonaparte Creek, from the confluence with the Okanogan River to below Bonaparte Falls, was surveyed on 5/2/05. Visibility was good and survey crews attempted to observe as many fish as possible. Our redd census documented 67 redds and resulted in a possible escapement range of between 119 and 153 summer steelhead (Figure 10). Bonaparte Creek had a high density of redds throughout most of the available habitat with a density of 41.88 summer steelhead per kilometer. We observed 19 live and 3 dead summer steelhead, 10 had adipose fins removed while 6 had intact adipose fins (38%). All carcasses were of fish that had already spawned, including 3 males and one female positively identified.

Omak Creek was unique for redd surveys because a weir/trap has been installed at river km 1.5 to collect all fish migrating upstream. A total of 35 redds were observed below the trap and 31 redds observed above the trap (Figure 11). The Colville Tribes released 93 summer steelhead above the weir out of a total of 112 that were trapped. The distance from the confluence with the Okanogan River upstream to Mission Falls represents 9.0 km of available habitat; surveys were conducted over a total of 5.7 km (63%). Using the observed total of 31 redds, the remaining portions of Omak Creek was calculated to have contained 11 additional redds. This brings the calculated total of 77 redds for the entire 9km reach. Dividing the known escapement by the sex ratio, one would expect to observe 41 redds above the trap. 42 were counted, showing excellent correlation between redd estimates and trap observations. By using the total number of summer steelhead collected at the trap and redd estimates below the trap we calculated the possible range of escapement into Omak Creek at between 174 and 192 steelhead. Only five summer steelhead with adipose fins were observed in Omak Creek (3.5%). Redd densities were 23.33 redds/km below the trap and 5.6 redds/km above the weir.

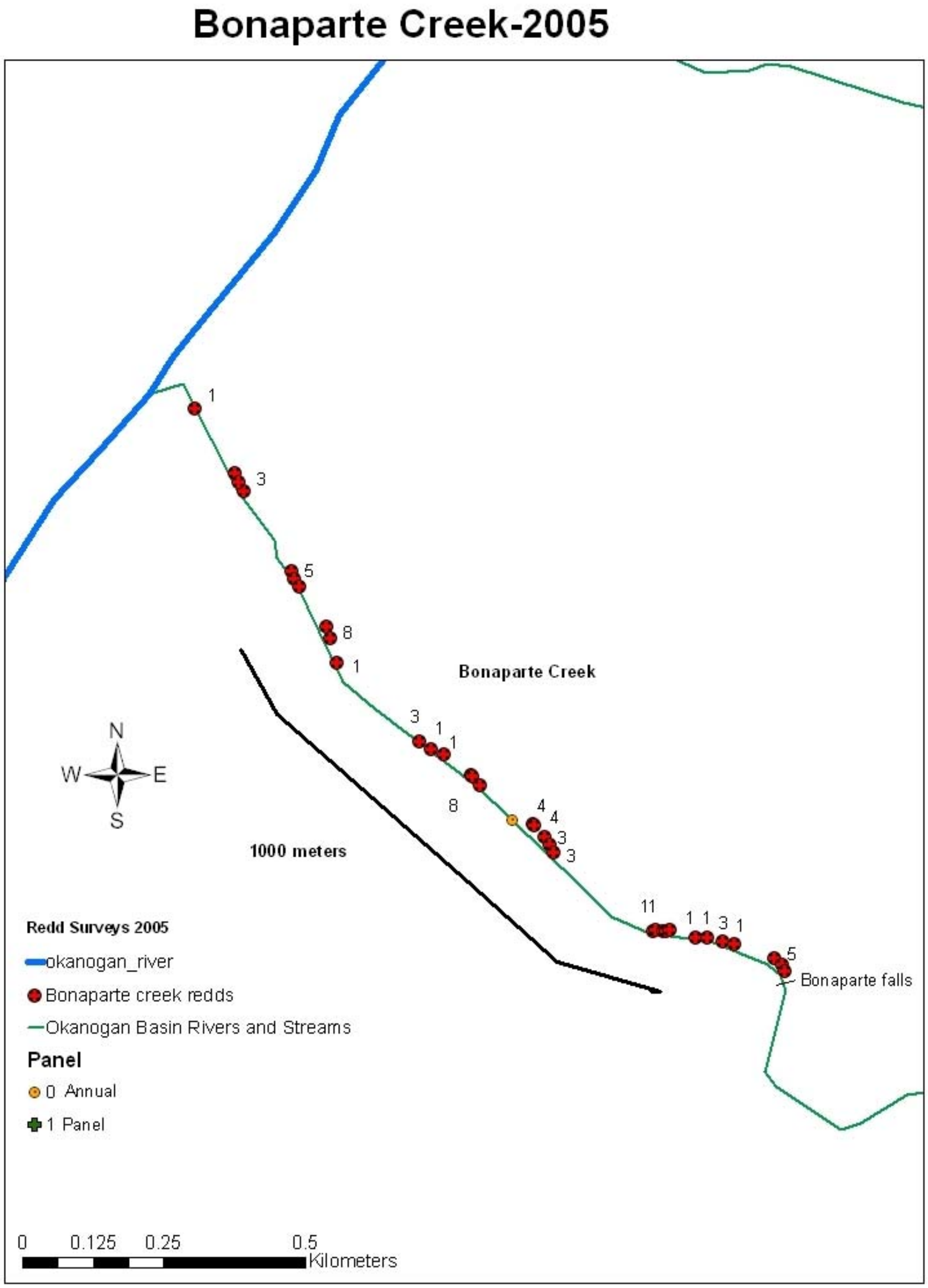

Figure 10: Bonaparte Creek redd distribution observed in 2005 in entire anadromous reach of 1.6km extending from the confluence with the Okanogan River upstream to Bonaparte Falls which is a natural barrier. A 1km reach (in black) and location of EMAP sampling site are indicated for reference.

Omak Creek-2005

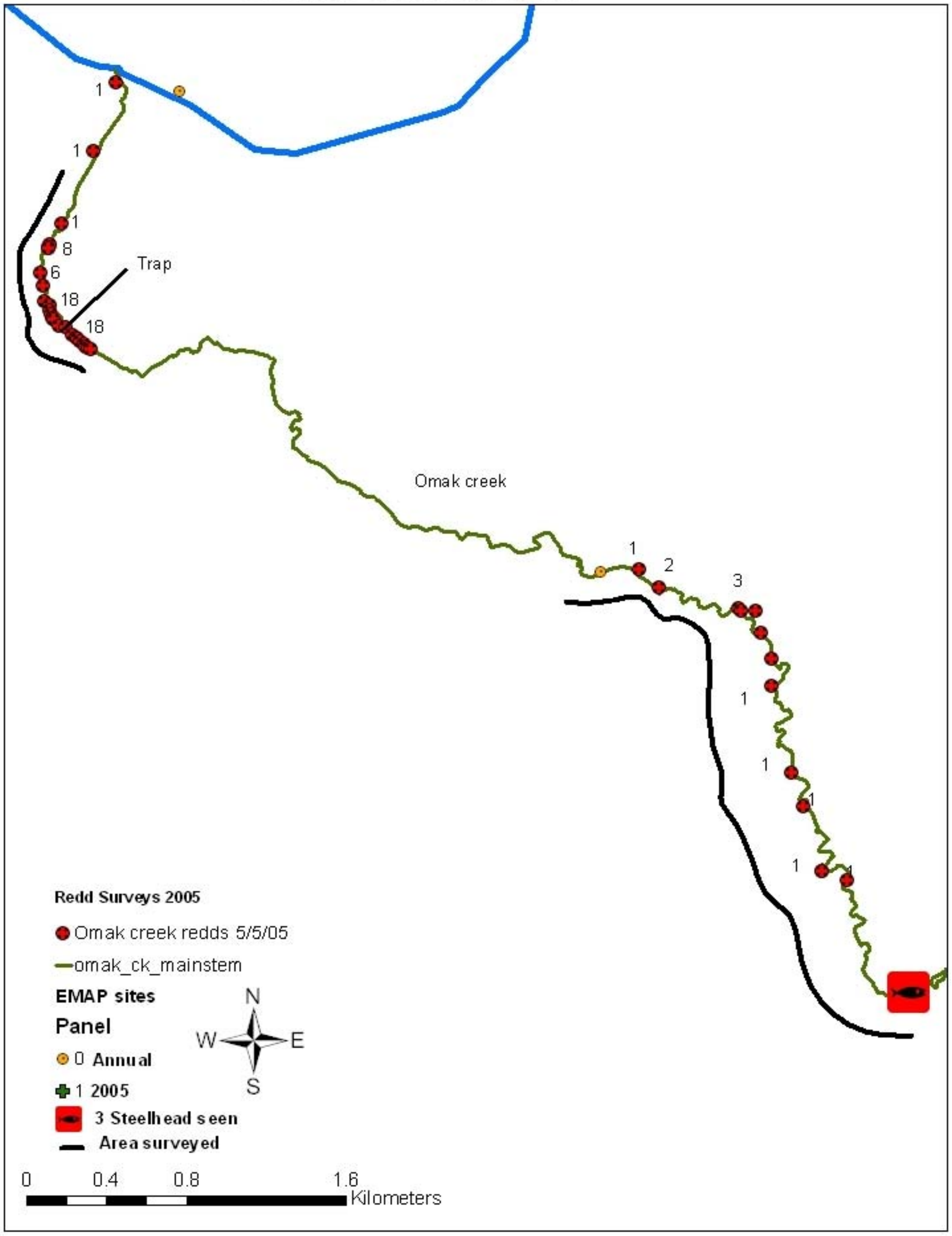

Figure 11: Observed Omak Creek redd distribution in 2005. The lower reach extended from the confluence with the Okanogan River upstream to the bridge on Omak Lake Rd (rkm 2.0) and the reach from Moomaw's fence upstream to Mission Falls (rkm 5.3 to 9.0). Mission Falls is a natural barrier. Reference reaches are indicated by the black line and red box indicates live fish near falls located above last observed redd.

Discussion

In 2005, river conditions were atypical in both the Okanogan and Similkameen Rivers. Low snow pack and warm conditions in February contributed to low flows in March and April (Figure 12) creating a window of opportunity for good visibility and access for five consecutive weeks. A warming trend towards the end of April resulted in a snow and ice melt that drastically affected visibility and flow in both the Okanogan and Similkameen. This ended surveys in both systems. Completion of the first round of redd surveys prior to April 1 would help ensure that a 3 pass redd survey could be finished on the Main-stem Okanogan River prior to the ascending limb of the hydrograph (Figure 12). Discharges below 3,000 CFS typically represent river levels with reasonable visibility for conducting redd surveys. However, flows greater than 3,000 CFS preclude such activities. Historic discharge data suggest high water would preclude redd surveys at about the same time as would be expected during a normal water year (Figure 12).

A lack of data related to run timing made scheduling surveys difficult. The only usable reference data was collected by the Colville Tribes for Omak Creek. Using data from Omak Creek we scheduled redd surveys to begin the last week in March when redds typically appear in the lower portion of Omak Creek. However, Okanogan River Reaches O3 and O4 had higher numbers of redds observed during the early survey than the latter survey. This indicates that peak spawning activity may have occurred in these mid-Okanogan reaches prior to our first survey. Future surveys should perhaps begin a week earlier around March 21st to ensure that early spawning activity is identified at least in the reaches down stream of the town of Tonasket, WA. When examining all the main-stem data it is apparent that peak spawning activity occurred sometime around the second week in April and appeared to progress upstream. Therefore, in 2006 it is suggested that the first survey pass be completed prior to April 1, with the second survey conducted between April 1 and April 13. The third survey would begin between April 14 and April 27. Surveys would begin with downstream reaches and progress to reaches further upstream.

Main-stem redd distribution was highest in the upstream reaches of the Okanogan and Similkameen Rivers. This is a result of stocking activities releasing hatchery fish into this area. High quality spawning gravels are also common in this area. Other high density spawning areas at Tonasket, Janis Rapids, McAlister Rapids, Omak, Shellrock Point, and Malott contain braided channel areas where higher gradients and slightly increased water velocities maintain clean gravels(1 to 3 inch) preferred by summer steelhead (Smith 1973). Where habitats were conducive, steelhead built redds in close proximity to one another, especially in pool tail-out areas and at the heads of mid-channel islands. Scattered redds were observed in most areas where clean gravels of appropriate size were found. Future habitat improvement efforts should key on providing and sustaining more sites that support a gravel substrate that can be kept clear of fine sediments. Improving the abundance and quality of gravel areas in the Okanogan River basin would improve production for all salmon species.

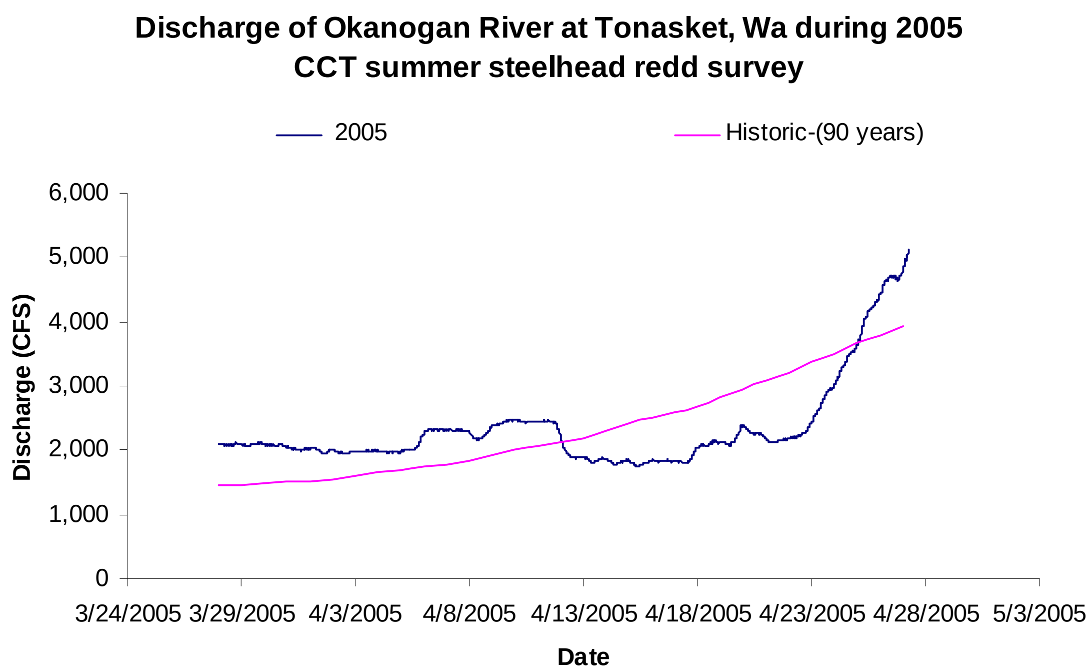

Figure 12: Discharge of Okanogan River as measured at Tonasket, WA for the period from march 24th to May 1, 2005 compared to the 90-year historic average (http://waterdata.usgs.gov/wa/nwis/uv?12445000).

After conditions on the mainstem Okanogan degraded, attention focused on enumerating redds in the tributaries. In the future we will be employing an alternative method for enumerating redds in the tributaries. All redds will be counted during one peak survey to maintain consistency with existing monitoring efforts and to follow guidance from Mosey and Murphy (2002). Omak Creek will be surveyed in already-established index areas using this same method. The Similkameen River will be surveyed in its entire reach that is available to steelhead and we propose the index areas listed in Table 2 on the Okanogan River be surveyed annually.

Observations in Omak Creek and Bonaparte Creek indicate that as conditions worsen in the mainstem Okanogan, fish push up into the smaller tributaries due to increased access. The number of redds in the smaller tributaries peaked during the first week in May. The increase in number of redds was significant between initial observations during the middle of April and the first week in May. One additional source of error is the assumption that each female produces only one redd and research into determining the number of redds produced for each female could make future escapement estimates more accurate.

Conclusions

The total escapement for the Okanogan River in the United States was estimated at between 1,147 and 1,482 summer steelhead spawners (Table 2). This is consistent with the escapement estimates derived from Wells Dam passage counts and creel survey information conducted by WDFW which estimated total Okanogan River Basin escapement at 1,322 summer steelhead (Bob Jateff-personal communications). Our survey indicates that in regards to total production, main-stem spawning is perhaps more important for summer steelhead than spawning in the tributary habitat. However, more information on life history adaptations and survival are needed to quantify recruitment. Additional research into spawning and production in the Canadian portion of the drainage is needed to fully evaluate the Okanogan River Basin. Continued redd surveys on an annual basis will allow for evaluation of trends and changes in the distribution of important spawning areas over time. This study determined that redd surveys throughout the Okanogan River Basin are possible in both tributary and main-stem habitats and the distribution of spawning can be effectively quantified using these methodologies. Baseline information for spawning habitat distribution, spawn timing, and spawner escapement have been determined but additional years of data will refine this information.

Table 2.- Total redds and corresponding number of summer steelhead for the Okanogan River basin in 2005.

2005 Redd Surveys

Dates when data were collected	Location	Total Redds	Total Redds	Redd Density	Steelhead[1,3]	Steelhead[2,4]
		Observed (#)	Expanded (#)	(Redds/km)	(Max. #)	(Min. #)
3/29/05-4/22/05	Main-stem	470		4.38	1072	832
4/18/05-5/5/05	Tributaries	146	164	16.40	411	316
Okanogan River Spawning Population Estimate					**1482**	**1147**

1-Calculated using a sex ratio of 2.28,based on observations at the Omak Creek weir
2-Calculated using a sex ratio of 1.77, based on observations at Well's Dam
3-The minimum number of steelhead is based on a sex ratio of 1.77 and only the number of redds observed
4-Maximum steelhead is based on sex ratio of 2.28 and expanded number of redds were applicable

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