# SPRING SPAWNER ESTIMATES FOR THE OKANOGAN RIVER BASIN (2008)

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## Abstract

Spring spawning surveys were conducted in the Okanogan River basin as part of the Colville Tribes' Okanogan Basin Monitoring and Evaluation Program. In 2008, 384 redds were observed along the mainstem Okanogan and 132 redds in the Similkameen River. Tributaries within the basin that were utilized by anadromous steelhead in 2008 included Salmon, Omak, Bonaparte, Ninemile, and Tunk Creeks. Escapement estimates for the entire Okanogan River were between 1,341 and 1,436 summer steelhead and of those, 213 to 266 were likely of natural origin. Escapement into Canada was estimated at 116 (32.67% had an intact adipose fin). Forty-four spring Chinook were collected at the Omak Creek trap. Mainstem steelhead redd distributions were highest in the upstream reaches of the Okanogan River and lower section of the Similkameen River, where high quality spawning gravels are common and hatchery releases are focused. Other high density spawning areas included the island section near Tonasket, and near McAlister Rapids, where braided channels and water velocities are favorable for summer steelhead. Annual collection of steelhead spawning data in future years will provide a more comprehensive depiction of spawning distribution and population trends within the Okanogan River basin.

## Introduction

The Okanogan Basin Monitoring and Evaluation Program (OBMEP), created in 2004, established a basin wide monitoring program for anadromous fish in the Okanogan River basin. OBMEP fills data gaps particularly associated with endangered summer steelhead through implementing a scientifically rigorous long-term status and trend monitoring design for habitat, water quality, and biological indicators. OBMEP uses protocols derived from the Upper Columbia Strategy (Hillman 2004) that calls 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 design. Following the Upper Columbia Strategy's guidance facilitates coordination and standardization with other monitoring and evaluation efforts in the Upper Columbia ESU (Figure 1). In 2004, OBMEP developed the methodologies for implementing redd surveys beginning in 2005 (Arterburn et al. 2004) and these methods were later revised in 2007 (Arterburn et al. 2007c).

In 2005, a complete census of all main stem habitats was conducted within the U.S. for the first time and identified several large areas that contained no redds due to unsuitable habitat for spawning. Eliminating these areas from future surveys reduces program cost without the loss of any biologically important data. A few other areas such as Tunk and Ninemile creeks have limited access due to a lack of land owner permission but these data would be similarly impacted regardless of the monitoring design used. Historic redd survey data collected by the Colville Tribes also provided important information used to establish reference reaches on Omak Creek. Collectively, several recommendations were made and in 2005 that were applied in 2006 (Arterburn and Kistler 2006).

In 2006, we uncovered new information related to summer steelhead spawning in the Okanogan River Basin. First, we were able to estimate escapement into Canada for the first time in 2006 because of the installation of a video counting system at Zosel dam in 2005. Second, we documented spawning areas in four new tributaries; Tonasket, Antoine, Wild Horse Spring, and Loup Loup Creeks. Finally, we added new information related to up-stream barriers for Tonasket, Ninemile, Wild Horse Spring, and Whistler Canyon creeks.

In 2007, stream flows in the main stem Okanogan River exceeded the optimal range conducive for conducting redd surveys but data collected in previous years was sufficient to model results based upon limited data collection opportunities. We also attempted to categorize results into both hatchery and wild fish for the first time.

This is the fourth year of steelhead redd surveys conducted by the Colville Tribes in the Okanogan Basin. An extensive literature review of historic spawning information related to the Okanogan River basin can be found in the 2005 report (Arterburn et al. 2005). This document builds upon previous information and the entirety of these previous survey reports can be accessed through our web-site at:

http://nrd.colvilletribes.com/obmep/Reports.htm

## Methods

Steelhead redd surveys were conducted downstream of identified anadromous fish migration barriers in the main stem and all accessible tributaries of the Okanogan River and Similkameen River drainages (Arterburn et al. 2007a, Walsh and Long 2006). Designated main stem and tributary survey reaches (except reaches of Tunk and Ninemile creeks) have been defined and can be viewed in Table 1. These survey reaches encompass all known spawning habitat currently available in the United States portion of the Okanogan River Basin where summer steelhead are listed as endangered within the Upper Columbia ESU (Figure 1). The area of the Okanogan downstream from Chiliwist Creek is inundated by the Columbia River (Wells Pool/Lake Pateros) and therefore lacks the appropriate velocity and substrate needed for summer steelhead to spawn. Consequently, this lower reach (~ 15 miles) of the Okanogan River has been excluded from surveys or estimates.

Redd surveys were conducted along the main stem Okanogan River between March 17 and April 28, and were conducted up to three times during the spawning period provided discharge levels remained below 3,000 cfs. Single-pass surveys of tributary habitats were conducted starting on April 29 and ending once all tributary reach surveys are completed.

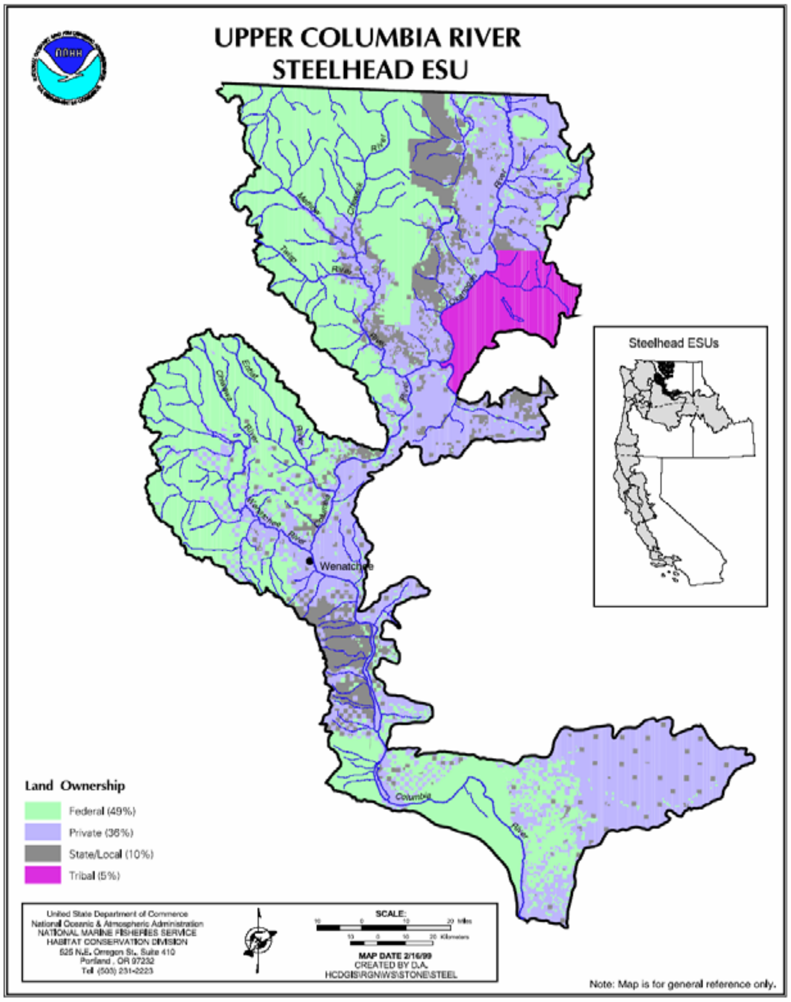


**Figure 1.** The Upper Columbia River summer steelhead evolutionarily significant unit showing land ownership. *Map courtesy of NMFS-HCD* (http://www.nwr.noaa.gov/reference/frn/1997/62FR43937.pdf).

All steelhead redd surveys were conducted, and redds verified, by at least two Colville Tribal fisheries staff members trained in the application of the OBMEP redd survey methodology (Arterburn et al. 2007c). Main stem surveys were conducted by rafts and foot in a downstream progression. All island sections or other main stem 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. Raft surveys were conducted by a minimum of two people using two, 1-man, 10’ Skookum Steelheader model catarafts. Tributary spawning areas were surveyed by foot, walking upstream.

**Table 1.** Designated redd survey reaches in the United States with location description and length in kilometers used by OBMEP in 2008.

| Redd Survey Reaches | Location Description | Reach length(km) |
|---|---|---|
| **S1/S2** | Similkameen/Okanogan Confluence(0) to Enloe Dam (14.6) | 14.6 |
| **O1** | Okanogan River south of Chiliwist Creek(23.7) to Loup Loup Creek(26.7) | 3.0 |
| **O2** | Okanogan River at Salmon Creek(41.4) to the Office(52.3) | 10.9 |
| **O3** | Okanogan River at the office(52.3) to Riverside(66.1) | 13.8 |
| **O4** | Okanogan River at Riverside(66.1) to Janis Bridge(84.6) | 18.5 |
| **O5** | Okanogan River at Janis Bridge(84.6) to Tonasket park(91.4) | 6.8 |
| **O6** | Okanogan River at Horseshoe Lake(112.4) to Confluence with Similkameen River(119.5) | 7.1 |
| **O7** | Okanogan River at confluence(119.5) to Zosel Dam(127.0) | 7.5 |
| **TU1** | Tunk Creek @Okanogan River Confluence (0) to High water mark (0.2) | 0.2 |
| **B1** | Bonaparte Creek/Okanogan River confluence (0) to Bonaparte Falls (1.6) | 1.6 |
| **N1** | Ninemile Creek from Okanogan River confluence(0) to Eder land (1.7) Maximum potential (4.3 km) | 1.7 |
| **TO1** | Tonasket Creek/Okanogan River Confluence(0) to Tonasket Falls (3.5) | 3.5 |
| **A1** | Antoine Creek/Okanogan River Confluence(0) to Antoine Barrier (1.3) | 1.3 |
| **L1** | Loup Loup Creek/Okanogan River Confluence to Loup Loup Creek diversion (2.3) | 2.3 |
| **WS1** | Wild Horse Spring Creek/Okanogan River Confluence to Barrier (1.1) | 1.1 |
| **OM1** | Omak Creek/Okanogan River Confluence(0) to Omak Creek Trap site (2.0) | 2 |
| **OM361** | Above Mission Falls (9.5) to EMAP site 345 (13.3) | 3.8 |
| **OM48** | EMAP site 48 Lower (25) to river kilometer (26) | 1 |
| **SC1** | Salmon Creek confluence with the Okanogan (0) to OID Diversion (7.2) | 7.2 |

Redds were marked by surveyor flagging tied to bushes or trees on the stream-bank adjacent to the area where redds were observed. Individual flags were marked with the survey date, direction and distance from the redd/s, consecutive flag number, total number of redds represented by the flag, and surveyor initials. Incomplete redds or test pits were not flagged or counted. The color of the flagging was changed for each survey, and re-flagged redds were not counted as new redds. Information was collected electronically with the use of a Trimble GeoExplorer XT GPS unit and downloaded into GPS Pathfinder Office® after every survey. The GIS data were reviewed and spatially corrected to accurately display coordinates in a map format. Escapement calculations were made for each main stem reach, sub watershed and the entire Okanogan River population.

We employed the method currently used by Washington Department of Fish and Wildlife (WDFW) in the Upper Columbia Basin to extrapolate escapement estimates using the sex ratio of broodstock collected randomly over the run (Andrew Murdoch, WDFW, Pers. Comm.). 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. Sex ratio data can be used to provide estimates of total spawner escapement for the population, sub-watershed, or reach.

We expanded population estimates by incorporating sex ratio data generated from several adult traps within several sub-watersheds throughout the Okanogan River basin. Total redd estimates, in combination with spawner escapement where data exists (Omak Creek trap, Bonaparte Creek trap, Inkaneep Creek trap, and Zosel Dam video counts), can be summed to estimate total escapement with a relative high level of accuracy. The sex ratio was determined by counting and sexing all adult fish collected at Wells Dam, Inkaneep Creek, Omak Creek, and Bonaparte Creek traps. The ratio of males to females is used for representative streams. Main stem habitats use values derived from Wells Dam data, medium-sized tributaries in the United States use the sex ratio from the Omak Creek trap, with medium size streams in Canada using the Inkaneep Creek Trap data, and small streams use the sex ratio from the Bonaparte Creek trap. All abundance calculations assume that each female will produce only one redd. For fish collected at the trap on Inkaneep Creek, all *O. mykiss* with a clipped adipose fin or greater than 20 inches in total length were considered steelhead as opposed to an adfluvial rainbow trout.

Estimating redds in tributaries where landowner permission could not be granted presented a hindrance in documentation spawning distribution. The method used to expand estimates to the entire creek was to multiply the density of redds/km of stream in the sampled area by the remaining length of stream accessible by summer steelhead; this method was only utilized for Ninemile, Tunk, and Salmon creeks.

When appropriate, a range of population estimates can be created by manipulating the local sub-watershed sex ratios as described above. Estimates that provide the highest and lowest values represent a reference range in which the likely “true” value would exist. Range estimates are much more likely to contain the “true” value, when compared to a point estimate, acknowledging the variability within the data collected.

## Results and Discussion

*Sex ratios*

Forty-one summer steelhead were collected at the Omak Creek trap (31 males; 10 females) and a ratio of 3.1 males for each female was observed, resulting in a sex ratio multiplier of 4.1. All 23 summer steelhead (14 male; 9 female) collected at the Bonaparte Creek trap resulted in a sex ratio multiplier of 2.56. At the Inkaneep Creek trap in Canada, 22 summer steelhead meeting our criteria were collected and sexed. Eleven of the 22 fish were females, rendering a male to female sex ratio of 2.0. At Wells Dam, a sample of 333 summer steelhead was examined in order to determine a sex ratio for upstream migrants during 2008. One hundred seventy-one males and 162 females were sexed by Washington Department of Fish and Wildlife personnel (Charles Frady - personal communications). Wells Dam data resulted in a ratio of 1.06:1 males per female or a sex ratio of 2.06.

*Percent wild*

Trap and dam counts provide the basis for determining the natal origin of summer steelhead in the Okanogan River basin. In 2008, WDFW estimated the number of wild summer steelhead that passed Wells Dam at 1,110 or 16.80% of the total escapement. Wells Dam values were based upon fish counts, PIT tags, coded wire tags, scale analysis, harvest, broodstock collection, and stray rates estimated for Wells Hatchery (Charlie Snow, WDFW Pers. Comm.). The proportion of these fish assigned to the Okanogan River was 216 or 12.64% of the Okanogan River summer steelhead population. This percentage was applied to all main stem Okanogan reaches.

The percent of wild summer steelhead returning to Omak Creek was 24.39%. We collected ten summer steelhead at the Omak Creek Trap that had intact adipose fins and no PIT tag or coded wire tag. Ten wild summer steelhead were also collected from Bonaparte Creek representing 43.48% of all steelhead trapped and was based upon the presence or absence of adipose fins and PIT tags. Only five fish with clipped adipose fins were collected at the Inkaneep Trap in Canada, resulting in 77.27% of all steelhead returning to Inkaneep Creek considered wild. At Zosel Dam, 56 summer steelhead had intact adipose fins representing 29.02% of the run passing upriver being classified as natural origin. Removing the 17 of the 22 steelhead collected at Inkaneep Creek resulted in 22.81% of the steelhead passing Zosel Dam to likely build redds in locations other than Inkaneep Creek during 2008. The estimated total number of wild summer steelhead spawning in the Okanogan River subbasin was 225 or 16.23% of the total summer steelhead escapement in 2008. The abundance and percent wild in 2008 was the highest recorded since data collection began in 2005.

*Okanogan and Similkameen River Main-stem*

The Okanogan River was divided into seven segments based on access points and the Similkameen River was surveyed as 2 reaches. These data are later combined into one reach (S1) to maintain consistency with previous reports. All main stem reaches were located upstream of Chiliwist Creek confluence (immediately upriver of the influence of Wells' pool). We used data collected from previous years to initiate surveys on the main stem. In 2008, visibility was excellent during all surveys. The third round of surveys was completed by April 28th and flows did not exceed 3,000 CFS until May 7, 2008 (Figure 2).

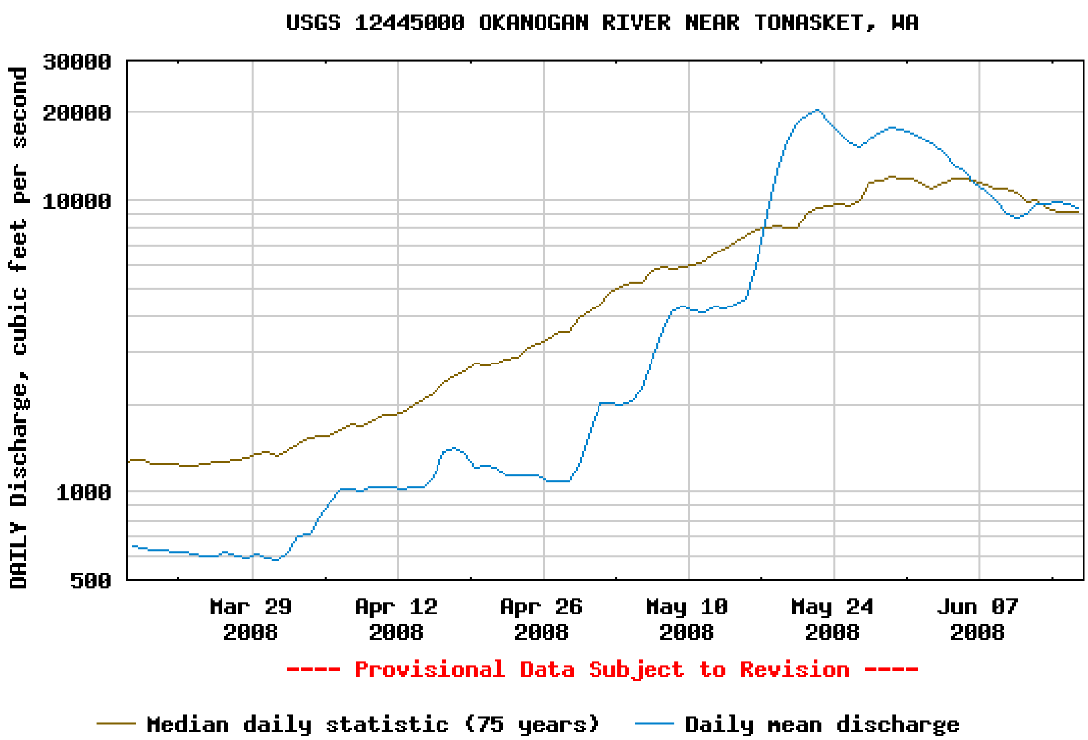


**Figure 2.** Discharge of Okanogan River as measured at Tonasket, WA for the period from March 17th to June 16, 2008 compared to the 75-year historic average (http://waterdata.usgs.gov/wa/nwis/uv?12445000).

The lower most reach on the Okanogan River (O1) was surveyed on March, 17th, 31st, and April 16th (Figure 3). A total of five steelhead redds were observed with one observed during the earliest survey, none during the second survey, and four during the final survey. Previously, summer steelhead in this reach have exhibited a preference for constructing redds on one large, mid-channel gravel bar located a short distance downstream of the confluence with Loup Loup Creek. Redds observed during 2008 represent ten summer steelhead of which one was estimated to be of wild origin. The number of redds observed in 2008 was within the range from previous surveys conducted within this reach (0-17 redds).

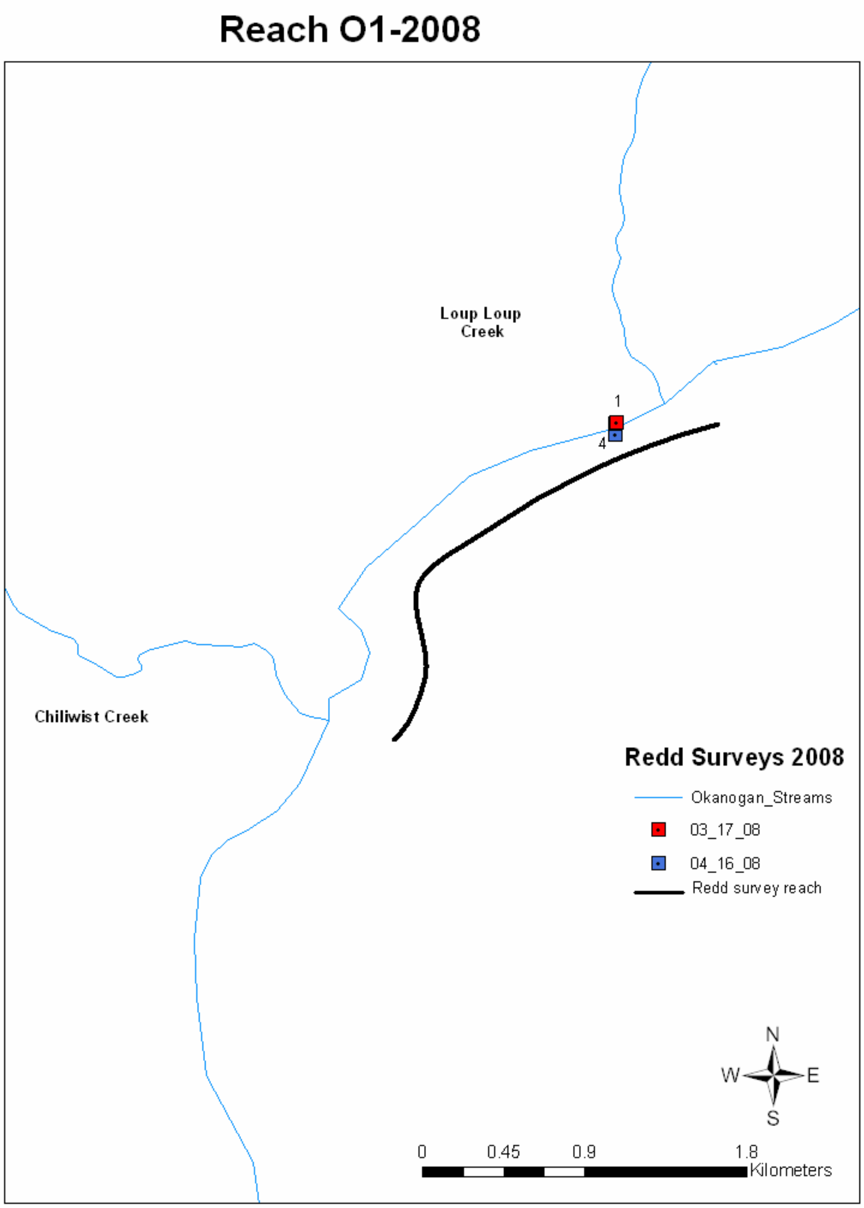


**Figure 3.** Redd distribution observed in 2008 for Okanogan River reach O1 from the confluence of Loup Loup Creek downstream to the confluence of Chiliwist Creek.

Okanogan River Reach O2 was surveyed on March, 18th when five redds were observed, April 8th when five additional redds were observed, and lastly on April 24th when another 38 redds were observed. A total of 48 steelhead redds were identified in 2008. Most of the redds were observed at a mid-channel bar downstream of the mouth of Omak Creek, in the area near the Highway 155 bridge located in Omak, WA, and the island complex upriver Shellrock Point (Figure 4). We calculated that observed redds represented 99 summer steelhead and of these 12 were likely of natural origin. The redd density across the entire reach was calculated to be 4.4 steelhead redds per kilometer. The number of redds observed in 2008 was toward the upper end of the number of redds previously surveyed within this reach (4-56 redds) and this might be because low water levels made it difficult for adult steelhead to enter Omak Creek until late in the spawning season.

**Reach O2-2008**

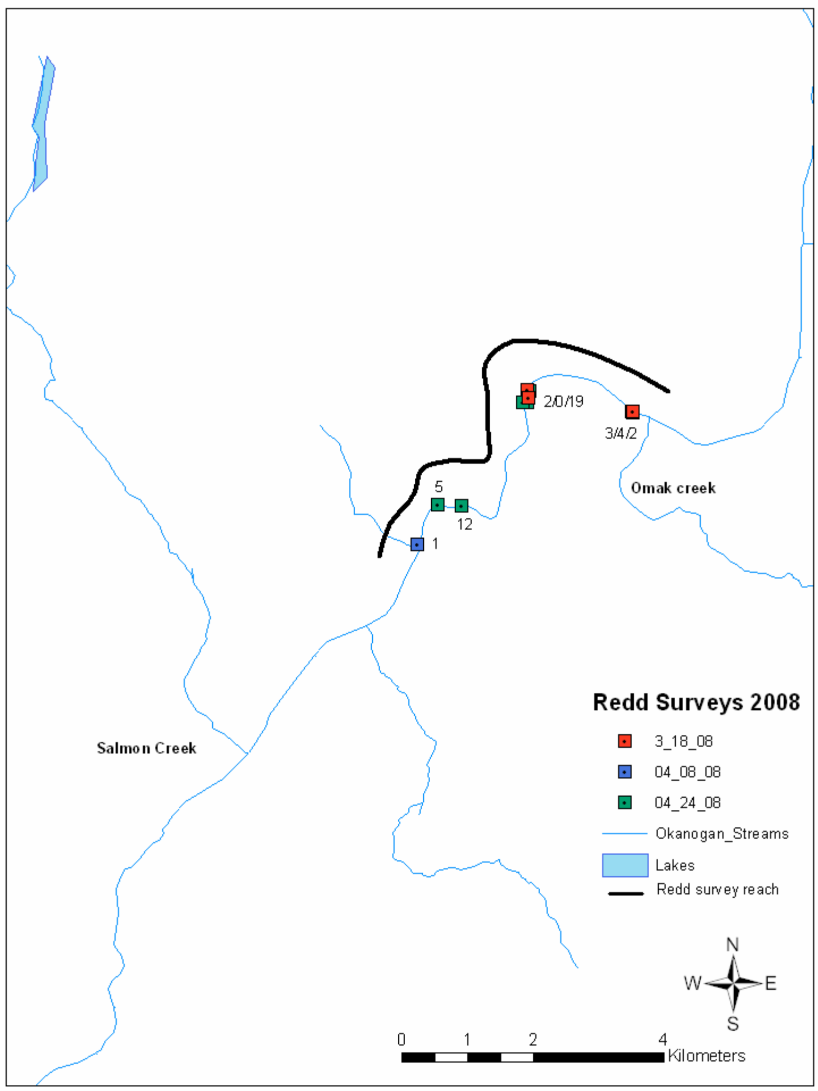


**Figure 4.** Redd distribution observed in 2008 for Okanogan River reach O2 from the confluence of Omak Creek in Omak downstream to Salmon Creek.

Okanogan River Reach O3 was surveyed on March 20th, April 9th, and April 26th. Eight redds were observed on April 9th with no redds counted on the first or last survey. A total of eight steelhead redds were identified. These redds were observed near mid-channel bars located near the center of this reach (Figure 5). We calculated that the number of spawning summer steelhead represented by these redds was 17 and 2 were estimated to be natural origin. The density of steelhead redds in this reach was 0.58 redds per kilometer. The number of redds observed in 2008 was within the range observed during previous surveys (2-10 redds) conducted within this reach.

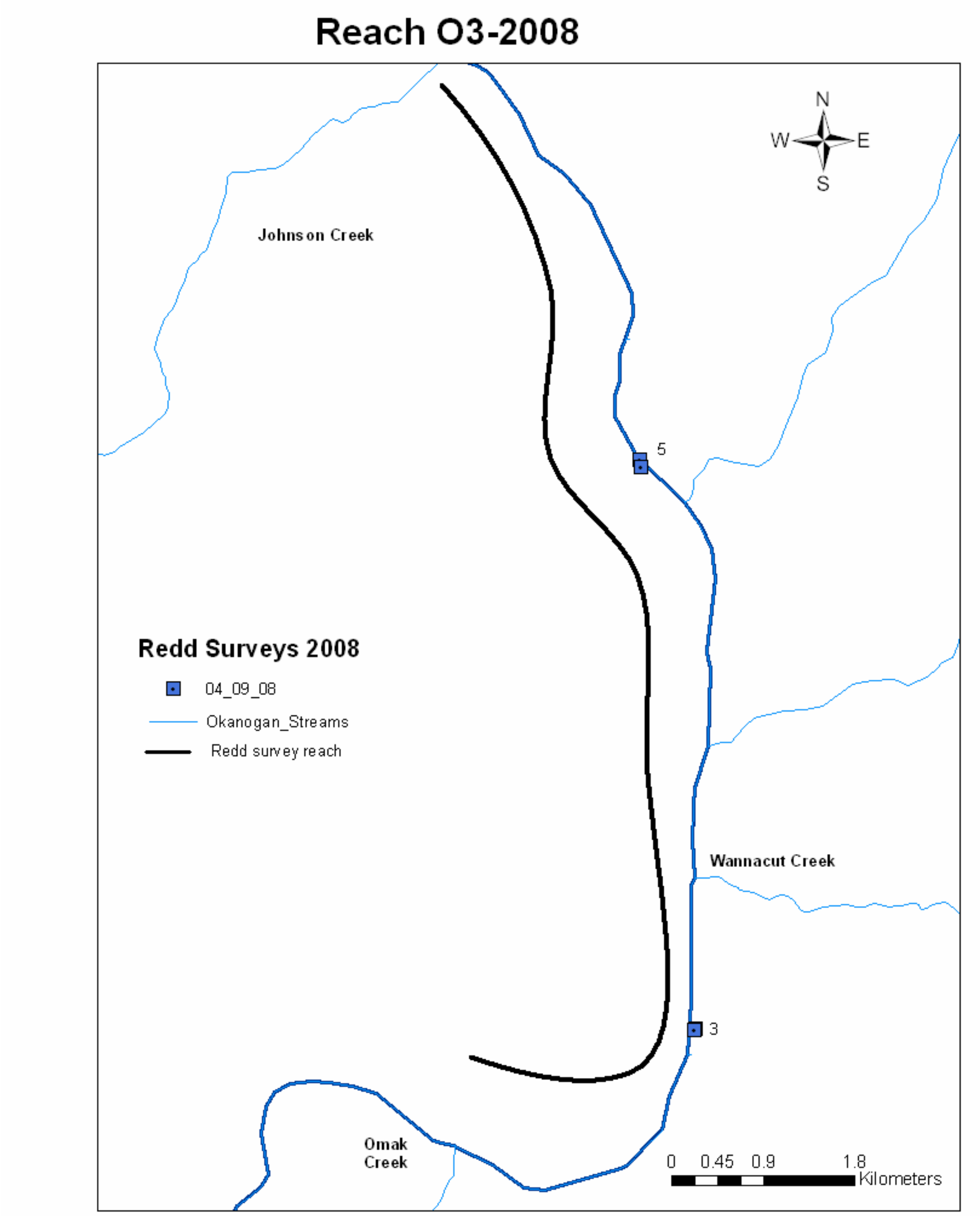


**Figure 5.** Redd distribution observed in 2008 for Okanogan River reach O3 from the town of Riverside, WA downstream to the confluence with Omak Creek in Omak, WA.

Okanogan River Reach O4 was surveyed on March 21st, April 10, and April 24 when 11, 33, and, 11 new redds were identified, respectively. A total of 55 steelhead redds were identified. The majority of these redds were located in two locations, at the lower end of the braided channel below McAllister Rapids near the confluence with Tunk Creek and in the vicinity of Janis Rapids downstream of the confluence with Chewiliken Creek (Figure 6). We estimated the number of summer steelhead spawners using this area to be 111 and the number of natural origin to be 14. Redd density was calculated to be 2.92 steelhead redds/km. The number of redds observed in 2008 was on the upper end of previously observed redds (11-58 redds) within this reach.

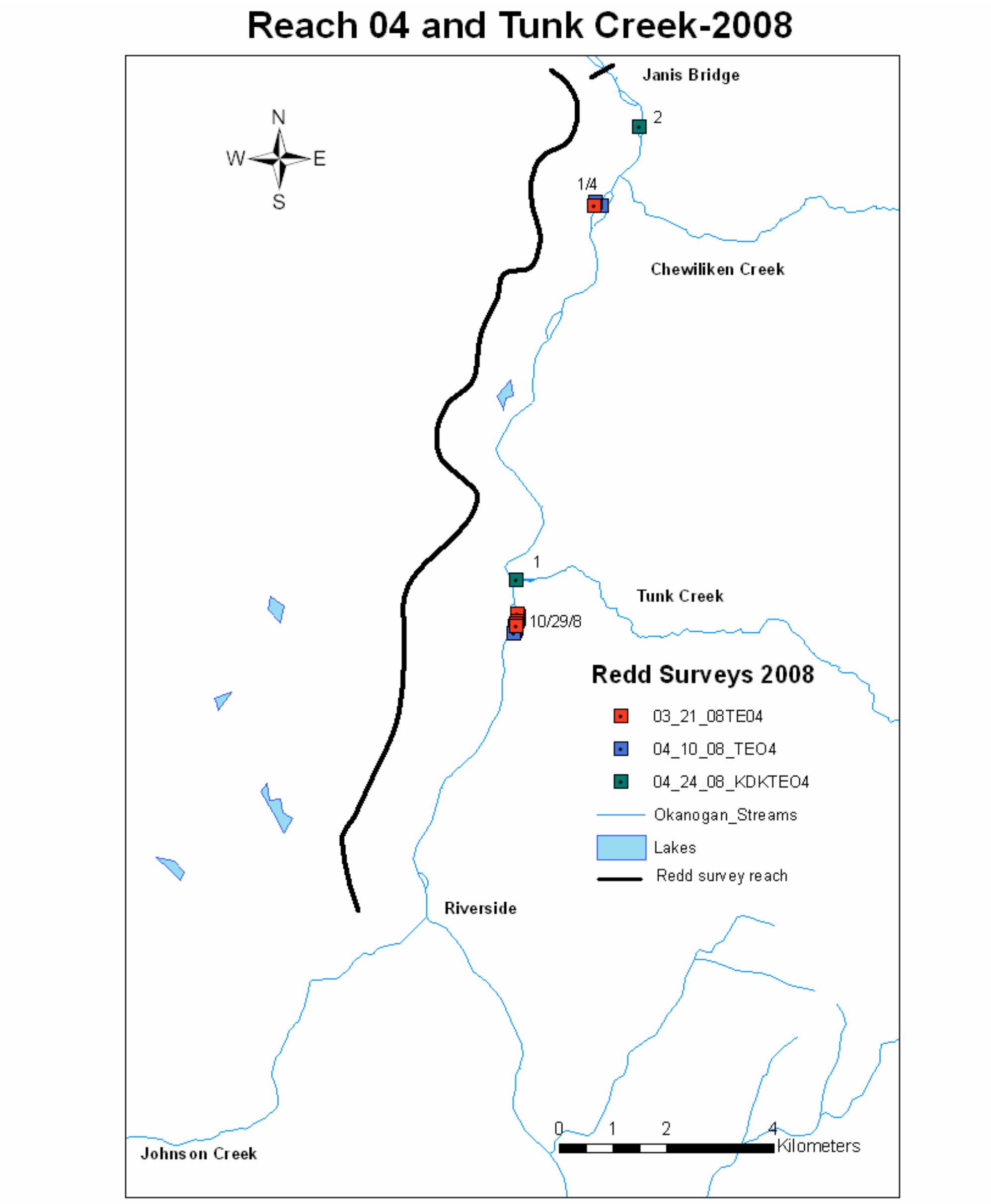


**Figure 6.** Redd distribution observed in 2008 for Okanogan River reach O4 from Janis Bridge downstream to the town of Riverside, WA.

Okanogan River Reach O5 was surveyed on March 24th and April 11th and one new redd was observed on each date. The final survey was completed on April 25th when an additional 17 redds were documented. A total of 19 redds were identified within this reach during 2008 (Figure 7). Most of the steelhead redds were observed in areas with side channels and islands near the town of Tonasket, WA. We calculated that the number of spawners using this reach was 39 summer steelhead including five from natural origin. The total number of redds represent a density of 2.79 steelhead redds per kilometer across the entire reach. The number of redds observed in 2008 was the lowest we have ever recorded within this reach (39-63 redds).

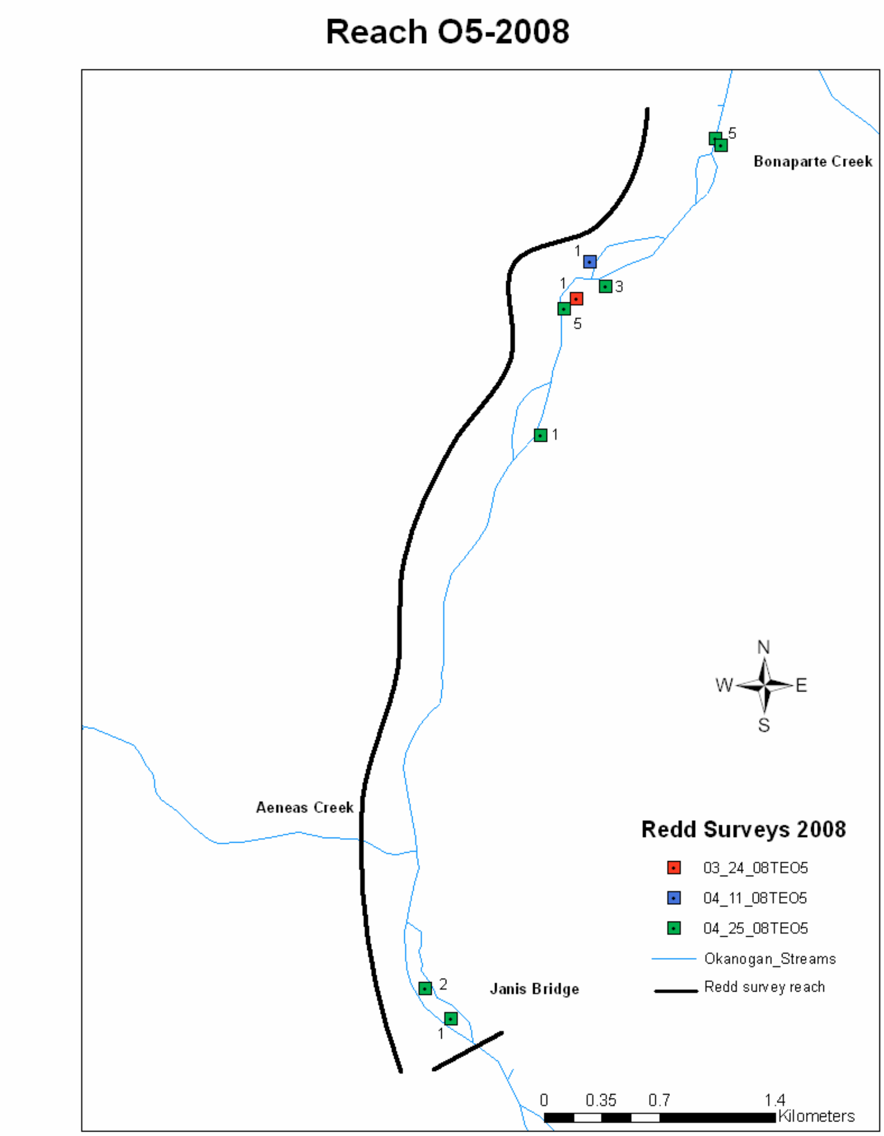


**Figure 7.** Okanogan River redd distribution observed in 2008 within reach O5 from the Chief Tonasket Park located in the town of Tonasket, WA downstream to the Highway 97 Bridge at Janis, WA.

Okanogan River Reach O6 was surveyed three times in 2008 (March 25th, April 14th, and May 1st) and no redds were observed within the area that extends from the Similkameen River confluence downstream to the inlet at Horseshoe Lake. Previous annual surveys identified between 3 and 19 redds within this reach. Zero redds was the lowest number of summer steelhead redds identified in this reach since surveys began. The isolated spawning habitat that exists within this reach is surrounded by habitats that contain mostly sand substrates. Perhaps the quality of the spawning habitat has degraded to the point that it is no longer of a high enough quality to attract adult steelhead spawners. This hypothesis can be tested in future years.

Okanogan River Reach O7 was surveyed three times in 2008 and a total of 249 summer steelhead redds were identified. On April 3rd, one redd was identified, April 17th, 84 redds, and on April 30th, 164 redds were counted. A majority of redds were observed downstream of Zosel Dam but above Driscoll Island in 2008 (Figure 8). Field staff observed numerous steelhead either constructing or adjacent to redds. The number of spawning steelhead estimated using this reach was 513 with an estimated 64 of natural origin. The number of steelhead spawners calculated for this reach was likely conservative in 2008 since the peak number of redds observed occurred during the last survey. It is highly likely that additional steelhead spawned after the last survey. Within this reach, the density was calculated at 33.2 redds per kilometer. The number of redds observed in 2008 was the highest recorded within this reach (141-151 redds). Spawning habitat within this reach is of high quality and hatchery stocking also occurs within this reach therefore high returns are not surprising.

Similkameen River reaches S1 and S2 were each surveyed three times in 2008 and a total of 132 summer steelhead redds were identified:

- (S1) April 2nd (24 redds); April 18th (57 redds); and April 28th (8 redds);
- (S2) April 15th (5 redds), April 29th (20 redds), and April 30th (18 redds).

Most of the steelhead redds were observed downstream of Oroville High School where a braided channel exists (Figure 8). The number of spawning steelhead using this reach was estimated to be 272, of which, 34 were estimated to be of natural origin. Redd densities across the entire reach were calculated to be 9.04 steelhead redds/km. The total number of redds observed in 2008 was the highest recorded but only slightly above the previous range of 98 to 106 since 2005. Runoff was delayed in 2008 resulting in improved spawning conditions (primarily reduced velocity) in this reach and making surveying more productive. However, high flows after eggs have been deposited may reduce spawning success due to bed load movement, resulting in egg damage and reduced survival during peak runoff.

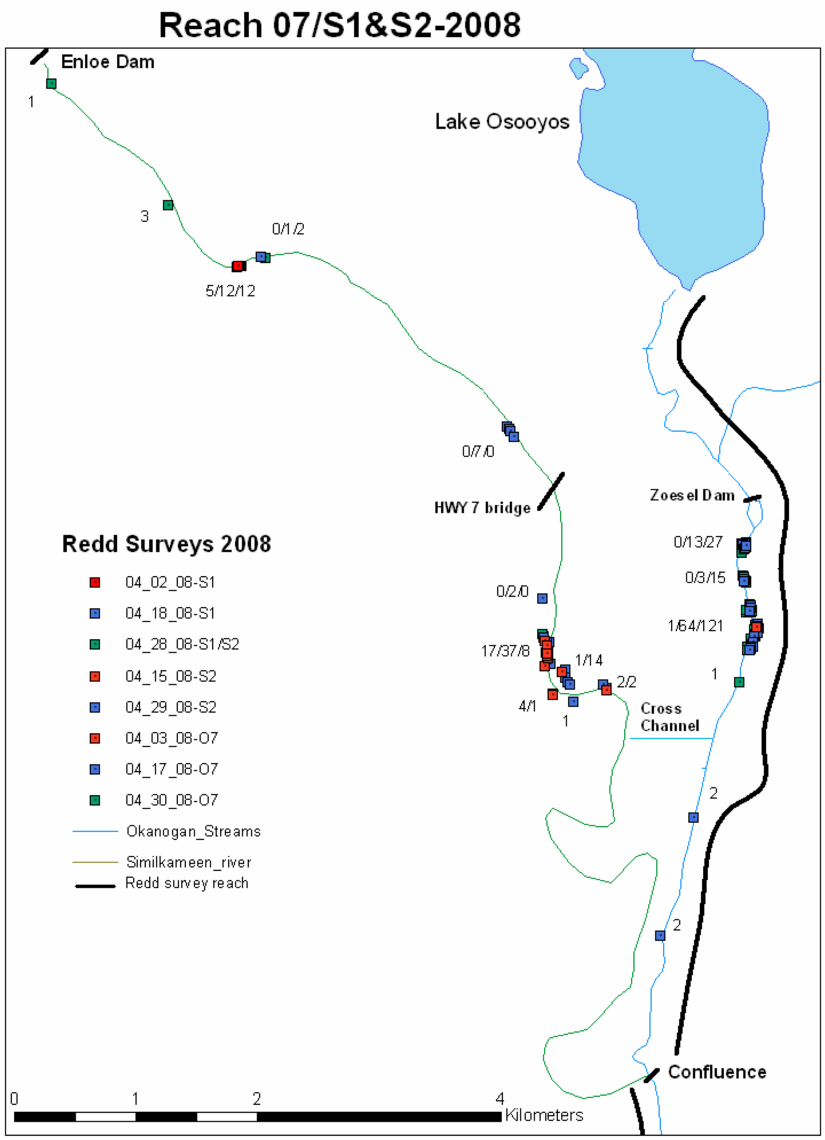


**Figure 8.** Redd distribution observed in 2008 for Okanogan River Reach O7, Similkameen River Reach S1 and Similkameen River Reach S2. Reach O7 extends from Zosel Dam downstream to the confluence with the Similkameen River. Reach S1 extends from the base of Enloe Dam downstream to the water treatment plant in Oroville, WA. Reach S2 extends from the end of Reach S1 to the confluence with the Okanogan River. Any redds observed within the cross channel are considered a part of S2.

*Tributary redd surveys in the Okanogan River basin*

Tributary habitats were surveyed as water visibility allowed. Varying snow packs and elevations of different sub-watersheds required unique schedules when surveying redds. Smaller, low elevation watersheds became more transparent by the end of May. Omak Creek, a larger watershed with higher elevation was not clear until June 16, 2008.

Steelhead redd surveys within each tributary were conducted beginning on April 29th and ending on June 16th. The extent of each survey was limited by a natural fish passage barrier or access to private land, as described in Arterburn et al. 2007a. Early spring rains in 2008 depleted much of the near average snow pack, creating an earlier than normal peak discharge (Table 2). With little storage in the smaller watersheds and minimal precipitation in April and May, many adult steelhead had difficulty gaining access into tributaries of the Okanogan River (Figure 9). Below-normal discharge in the Okanogan River mainstem further limited access into the tributaries by failing to inundate impassible deltas at the stream mouths (Figure 2).

**Table 2.** Precipitation totals measured by the National Weather Service at Omak Airport. Average precipitation column indicates average precipitation over the last 70 years.
http://www.crh.noaa.gov/product.php?site=NWS&issuedby=OMK&product=CLM&format=CI&version=6&glossary=0

| Month | Inches of precipitation in 2008 | Inches of precipitation in 2007 | Inches of precipitation in 2006 | Inches of precipitation on Average |
|---|---|---|---|---|
| March | 0.73 | 0.08 | 0.81 | 1.00 |
| April | 0.19 | 0.06 | 0.89 | 1.11 |
| May | 0.18 | 0.74 | 1.35 | 1.08 |
| Total | 1.10 | 0.88 | 3.05 | 3.08 |

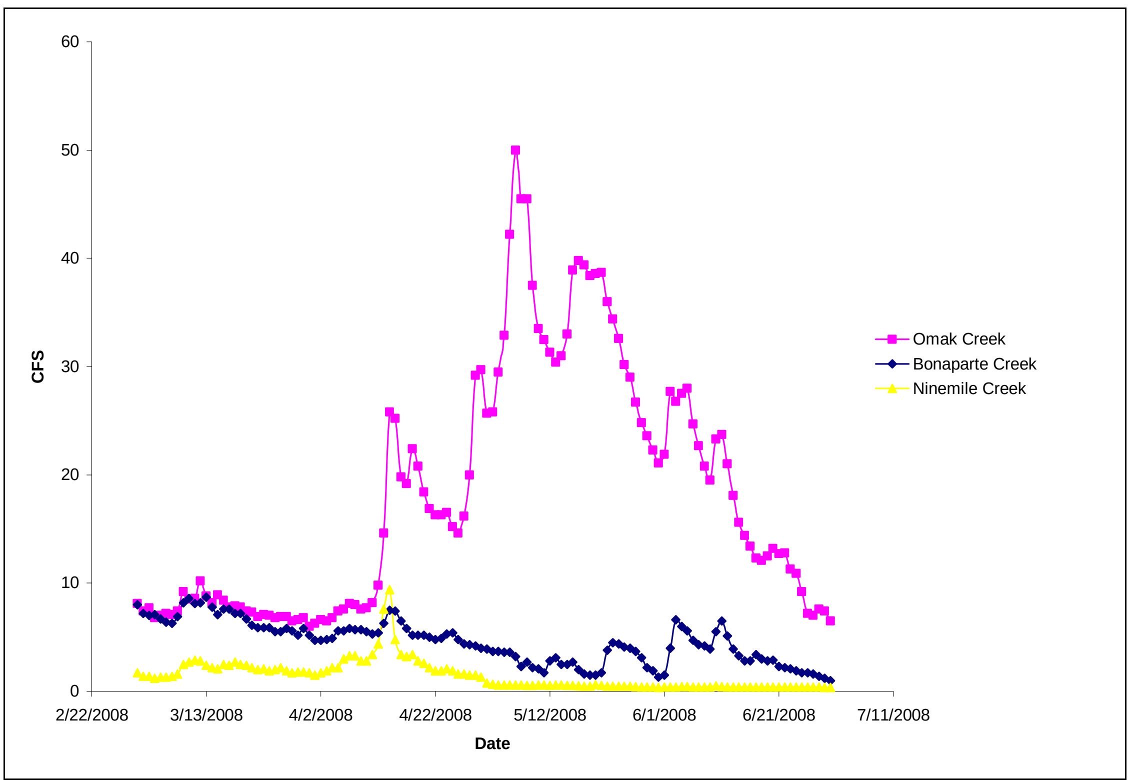


**Figure 9.** Discharge from March through June of 2008 for three tributary streams known to produce summer steelhead in the Okanogan river basin.

*Ninemile Creek*

Lack of access to private lands has been an ongoing problem on Ninemile Creek; therefore, a comprehensive survey of fish passage barriers has not been conducted. However, OBMEP personnel have verified that summer steelhead have access at a minimum of 1.7 km (lower extent of private lands) and a maximum of 4.3 km (impassable falls) of spawning and rearing habitat (Arterburn et al. 2007a). Extrapolating redd surveys is limited to the maximum habitat available, but this evaluation is subject to change as additional habitat information is obtained. Within the lower 1.7 km, 12 redds were identified on May 12th (Figure 10).

We estimated that the range of possible escapement for Ninemile Creek was a minimum of 24 and a maximum of 124. The minimum assumes a sex ratio of 2.0 and habitat is limited to the area surveyed; the maximum assumes a sex ratio of 4.1 and redds are extrapolated over the entire 4.3 km of available habitat. Our best estimate was achieved by extrapolating the observed 12 redds to the entire 4.3km and utilizing the sex ratio of 2.56 from Bonaparte Creek resulting in an estimate of 77 summer steelhead. The redd density was estimated to be 18.07 redds/km. Assuming the spawning escapement into Ninemile Creek was 77 summer steelhead, 18 fish would be of natural origin.

Our estimates for the number of summer steelhead spawning in Ninemile Creek during 2008 were the highest recorded since surveys began in 2005. When standardized across the 4.3km of habitat, past estimates were 52 in 2005, 33 in 2006, and 15 in 2007. An increase in discharge during mid-April (peak spawning) combined with the regulated water level of Lake Osoyoos likely contributed to the large number of redds identified in 2008.

*Tonasket Creek*

Tonasket Creek had reduced discharge water throughout the steelhead spawning season in 2008. There is also a migration barrier of natural falls at 3.5 km (Arterburn et al. 2007a). No redds were observed during the survey conducted on May 12$^{th}$. The number of summer steelhead spawning in Tonasket Creek during 2008 was the lowest recorded since surveys began in 2006. Past summer steelhead spawner escapement estimates for this creek were 8 in 2006 and 17 in 2007. During most years, Tonasket Creek flows intermittently during the spring and by mid-summer is usually dry in the lowermost 3 km. Dewatering of the creek bed likely explains the lack of steelhead observed in 2008

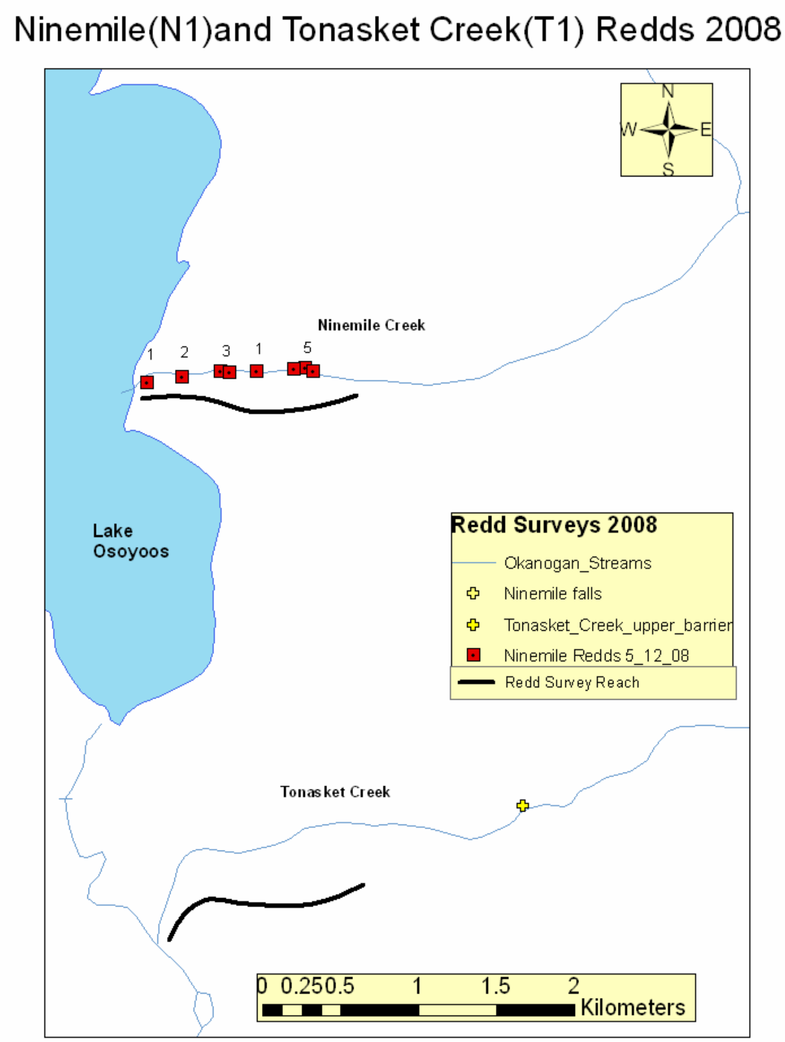


**Figure 10.** Redd distribution observed in 2008 for Ninemile and Tonasket creeks in the lower portions accessible to anadromous fish.

*Wild Horse Spring Creek*

Wild Horse Spring Creek was inaccessible prior to 2006 due to a large beaver dam located near the confluence with the Okanogan River. However, high flows during the spring of 2006 dislodged this dam. With the barrier removed, summer steelhead began utilizing this habitat. In 2006, three redds were observed by OBMEP crews and verified by WDFW biologists. Again in 2007, steelhead redds were observed within the 1.1 km of available habitat. However, no summer steelhead redds were observed in 2008 due to very low flows during the spawning period. Previous surveys estimated spawner escapement at 5 steelhead in 2006, and 12 in 2007.

*Antoine Creek*

Antoine Creek flows perennially, however, minimal spring discharge limited access by adult steelhead throughout the 2008 spawning season. When the stream was surveyed on May 19th, no summer steelhead or redds were observed. A barrier to upstream migration has been located at river kilometer 1.3 where a bedrock feature and irrigation diversion exists (Arterburn et al. 2007a). Although escapement was zero in 2008, snorkel surveys have identified multiple year-classes of both brook trout and *O. mykiss* indicating that favorable rearing conditions exist (Kistler et al. 2006, Kistler and Arterburn 2007). A relatively large delta at the confluence of Antoine Creek makes access difficult for anadromous steelhead and consideration should be given to concentrate flow and improve access during typical flow conditions. To accelerate the reestablishment of summer steelhead in Antoine Creek, approximately 3,000 smolts were released during April of 2008 (Fisher 2008).

*Bonaparte Creek*

A removable picket weir trap has been in operation since 2006 on Bonaparte Creek and was again installed on March 21, 2008. Twenty-three summer steelhead were collected, including 9 females and 14 males with 10 which were of natural origin. These fish had a mean length of approximately 591mm, the delineation between resident and anadromous fish appeared to be 559 mm. Since the weir trap was considered impassable, redd surveys to generate spawner estimates were not necessary. As in 2005 and 2006, redds in 2008 were evenly distributed throughout the 2.2 kilometers of accessible habitat (Arterburn et al. 2005, Arterburn and Kistler 2006, Arterburn et al. 2007).

Redd surveys downstream of the weir were conducted on May 12th after all steelhead were collected at the trap in 2008 (Figure 11). Two summer steelhead redds below the trap site were observed (Figure 12). Based upon the sex ratio generated from adult steelhead collected at the trap, an estimated five summer steelhead spawned downstream. Of the fish enumerated at the trap, 47.5% were of natural origin. An additional two natural-origin steelhead were estimated to have spawned downstream of the trap site. Redd density was calculated at 5.00 redds/km and the total number of summer steelhead spawners was estimated to be 28, 12 of which were of natural origin.

Our estimates for the number of summer steelhead spawning in Bonaparte Creek during 2008 were the lowest recorded since 2006. Past summer steelhead spawner escapement into this creek was 136 in 2005, 18 in 2006, and 204 in 2007. Bonaparte Creek contains only limited spawning and rearing habitat; however, this stream sees a greater proportion of adipose-present fish and contains the highest densities of rearing steelhead compared to all other tributaries within the U.S. portion of the basin. Protecting and restoring high quality habitats within the lowest 1 mile should be a high priority to ensure continued productivity from this stream.

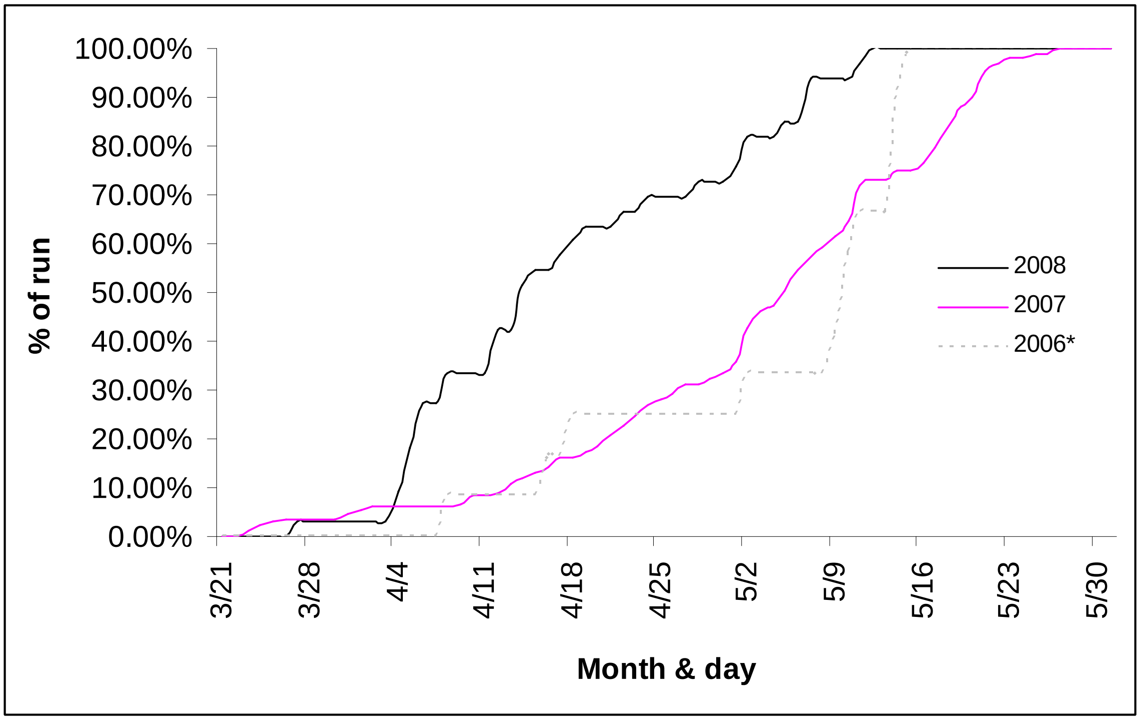


**Figure 11.** The percent of summer steelhead collected for a given date across all years that the Bonaparte Creek Trap has been in operation. The *2006 trap was only operated for part of the season.

*Tunk Creek*

Redd surveys in Tunk Creek have previously been prevented by lack of access on private land. On April 24th, one redd was identified at the confluence. The single redd observed likely represented two summer steelhead of hatchery origin. Although an additional survey was conducted on May 20th after permission was secured from the property owner, no additional redds were observed. One man-made structure was observed just above the confluence and no redds were found above this structure suggesting that it was an impediment to migrating adults at low discharges (Figure 13). Past steelhead spawner escapements at the confluence were seven in 2005, two in 2006, and unknown in 2007. The number in 2008 was the same as in 2006 (Arterburn et al., 2005; Arterburn and Kistler 2006). A section of Tunk Creek approximately ½ mile long was de-watered, probably due to a nearby well (~ 125 ft. from channel) that waters an agricultural field at a rate of 1,000gpm. Dewatering dramatically reduces the productivity of Tunk Creek and until this condition is rectified, few summer steelhead will be likely to be produced from Tunk Creek.

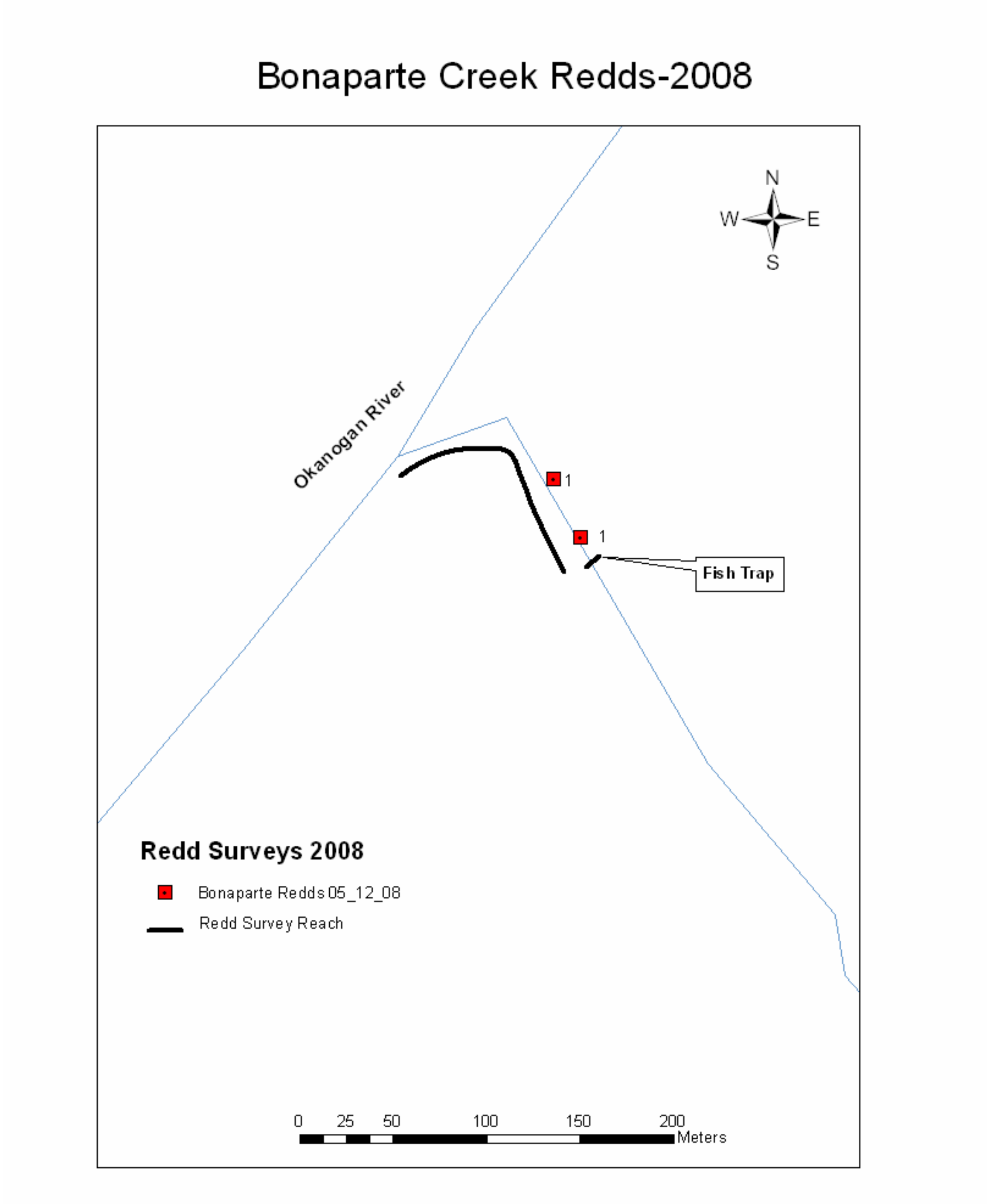


**Figure 12.** The distribution of redds observed in Bonaparte Creek during 2008 from the confluence with the Okanogan River upstream to the Bonaparte weir trap.

**Figure 13.** Passage impediment on lower Tunk Creek discovered during redd surveys in 2008 is located within 0.1km of the confluence with the Okanogan River and is likely an impediment to fish migration during low flow periods. Picture was taken on 4/24/2008.

*Wanacut Creek*

Although Wanacut Creek has a sizeable watershed (roughly 22,000 acres), utilization by summer steelhead is limited to the lower 1 km due to intermittent flows. Habitat accessible to anadromous salmonids was documented at river kilometer 2.64 (Arterburn et al. 2007). During the spring of 2007, Swimptkin Canyon, Pothole Canyon, and Wanacut creeks were flowing to the Okanogan River allowing access by summer steelhead. All three creeks were surveyed multiple times, but only one redd and one adult summer steelhead was observed in Wanacut Creek. During the spring of 2008, water from Wannacut Creek never reached the Okanogan River. Therefore, access to spawning habitat in Wannacut Creek is only available during years when snow pack is above normal.

*Omak Creek*

Fifty-three summer steelhead were collected at the trap from March 21st to May 25th (Figure 14) and 41 of these were released upstream. Six of the 12 steelhead not released above the weir were utilized as brood stock to support the locally-adapted hatchery program and the additional six fish were identified as strays and subsequently released back into the main stem Okanogan River. The average fork length of summer steelhead collected was 628mm. The fork length delineation between resident and anadromous *O. mykiss* was 483mm.

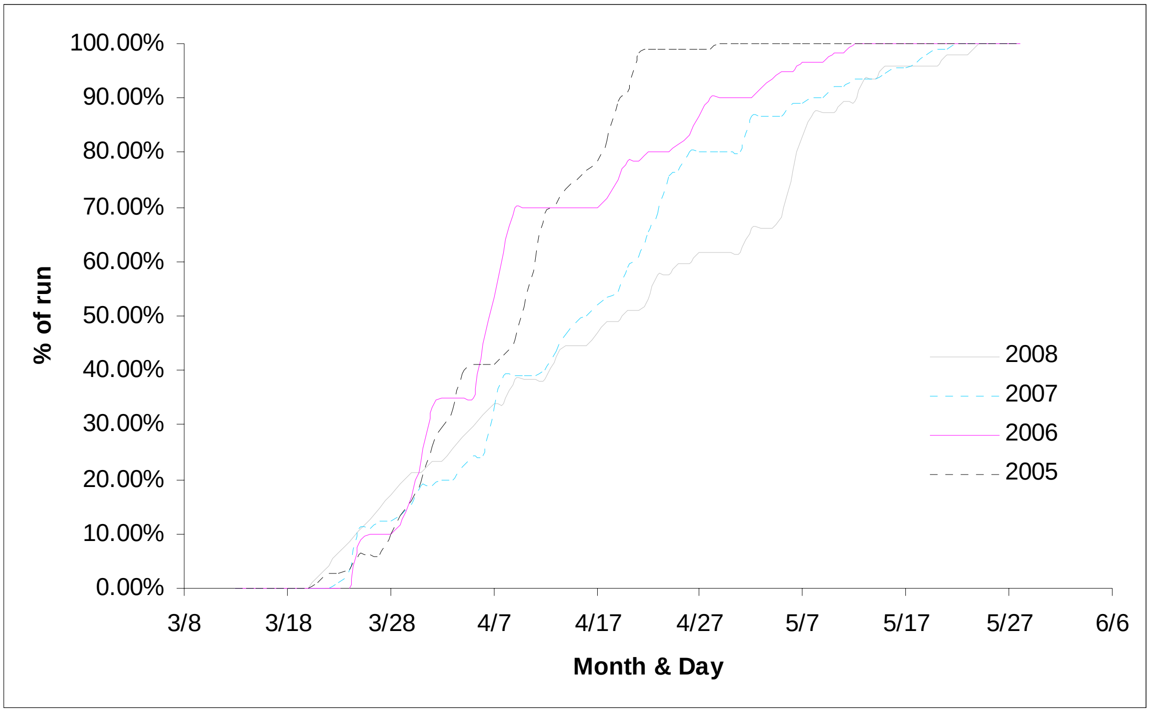


**Figure 14.** The percent of the summer steelhead collected at the Omak Creek trap across the month and days that it was operated since its installation in 2005.

A total of 15 redds were observed downstream of the trap (Figure 15). Nine kilometers of spawning habitat are accessible in Omak Creek downstream of Mission Falls and an additional 22 kilometers exist upstream. In 2008, redd surveys were not conducted between the trap and Mission Falls as spawning areas appear to be rather static over time. Mission Falls remains an impediment, and although summer steelhead attempted to ascend the falls, no redds were observed upstream in 2008.

The skewed steelhead sex ratio was multiplied by redds observed downstream of the trap, which resulted in an estimate of 61 adults. A total of 144 summer steelhead (trap and redd count) returned to Omak Creek in 2008. Of these fish, 102 were allowed to spawn within Omak Creek and 25 were estimated to be of natural origin. The 2008 spawning escapement would be considered average as compared with data from the last six years (Figure 16). Due to the previous investments and the amount of potential habitat available upstream of Mission Falls, investigations to augment passage should continue. As efforts to address passage at Mission Falls continue, so should redd surveys or another means of evaluating passage and enumeration upstream of the falls.

Spring Chinook in 2008 totaled 44 and of these returning adults, 43 were released upstream of the trap. Adult Spring Chinook salmon included 17 males and 26 females with 6 having intact adipose fins and no PIT tags meaning that these fish were either Methow River composite or natural origin recruits.  Twelve Chinook salmon redds were identified in Omak Creek (Rhonda Dasher-Colville Tribal Biologists pers. com.).  During 2008, more spring Chinook were documented returning to Omak Creek than in any previous year (10 in 2007, 6 in 2006).

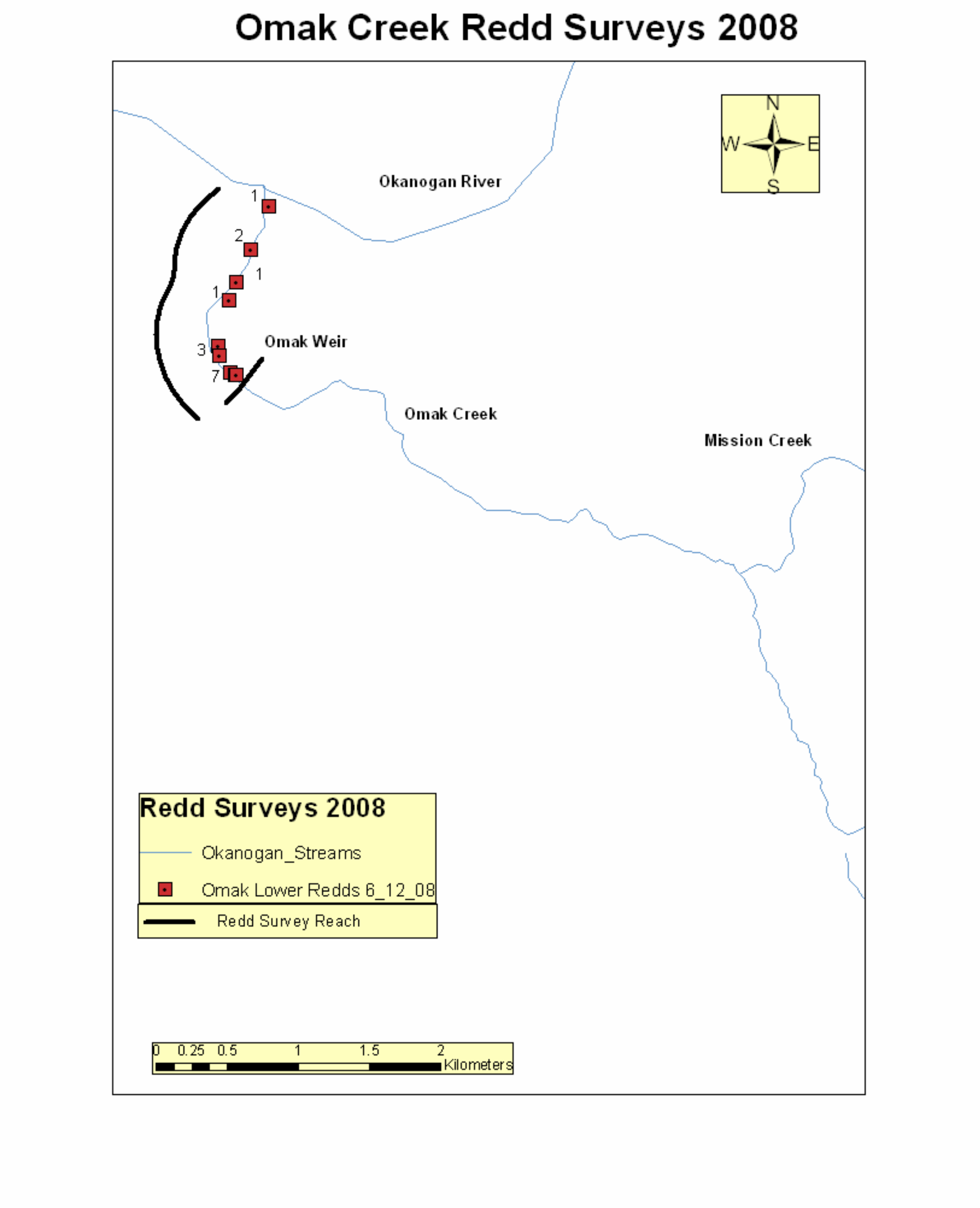


**Figure 15.** Map of summer steelhead redds observed below the Omak Creek trap during the spring of 2008.

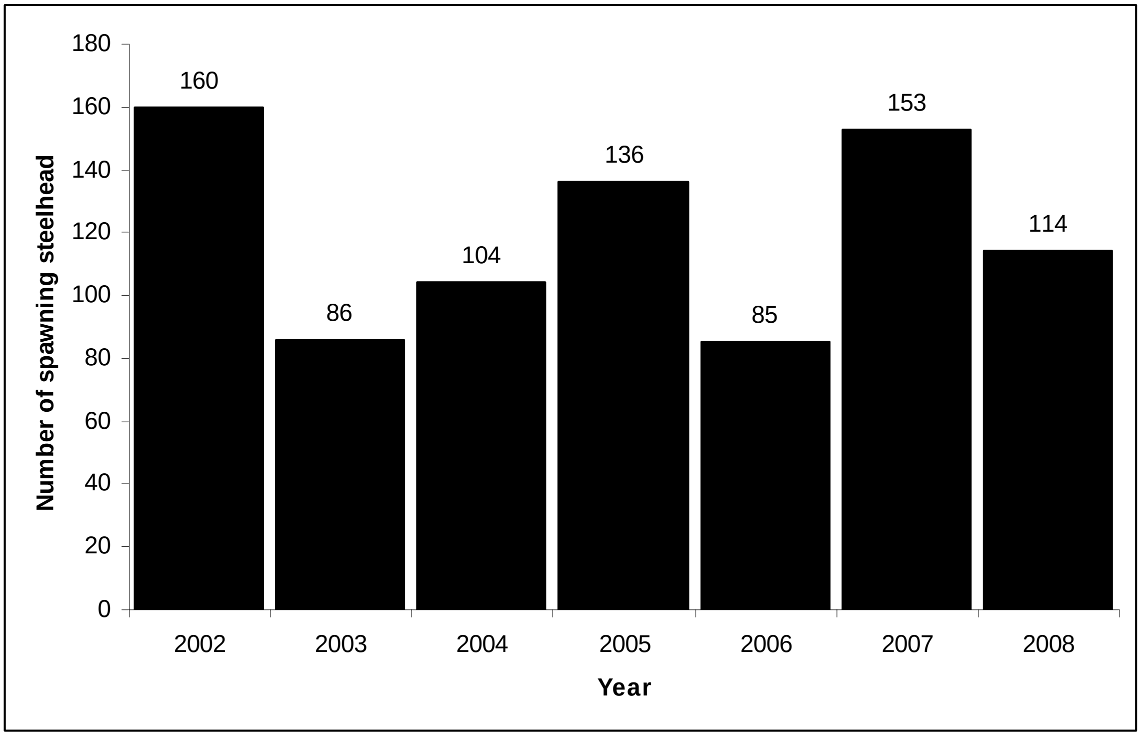


**Figure 16.** Number of summer steelhead spawners returning to Omak Creek from 2002 to 2008.

*Salmon Creek*

Since the early 1900's, Salmon Creek has been entirely diverted for irrigation usage. The resulting dry stream channel extends from the Okanogan Irrigation District (OID) diversion dam (7.2 km) to the confluence with the Okanogan River. Occasionally, uncontrolled spills occur downstream of the OID diversion dam. These spills usually occur after summer steelhead spawn (mid-May to June). However, summer steelhead passage flows were evaluated during a controlled release of 22 cfs from April 1 through April 14, 2003. During this two week period, six redds were constructed within the lower reach of Salmon Creek (Fisher and Arterburn 2003).

As a result of these passage evaluation studies, a long-term water lease was negotiated between the Colville Tribes and the OID that provided sufficient water for smolt releases in 2007 and 2008. In the future, water will be managed in conjunction with a low flow channel (constructed in the fall of 2008) to provide limited access for both adult and smolt steelhead. The controlled releases will likely be initiated in March or April and extend into May.

We observed no redds in the lower 7.2 km of Salmon Creek during 2008, which was anticipated based upon water releases which were timed for smolt out-plants. However, six redds were observed in 2007 and the number of redds extrapolated for the entire watershed was estimated to be 46 summer steelhead. Even though no redds were observed downstream, access upstream of the OID diversion was not permitted due to a lack of landowner permission, thus, redds were unknown in this reach.

Once adult migration flows begin in 2009, spawners will be counted using underwater video equipment that is custom-designed for the fish ladder at the OID diversion (Figure 17). Dramatic increases in steelhead production are anticipated due to flows provided by via a water lease agreement signed between the Colville Tribes and OID, synchronizing water releases to coincide with adult steelhead migration timing, and adult returns from smolt releases (20,260) into Salmon Creek during the spring of 2007.

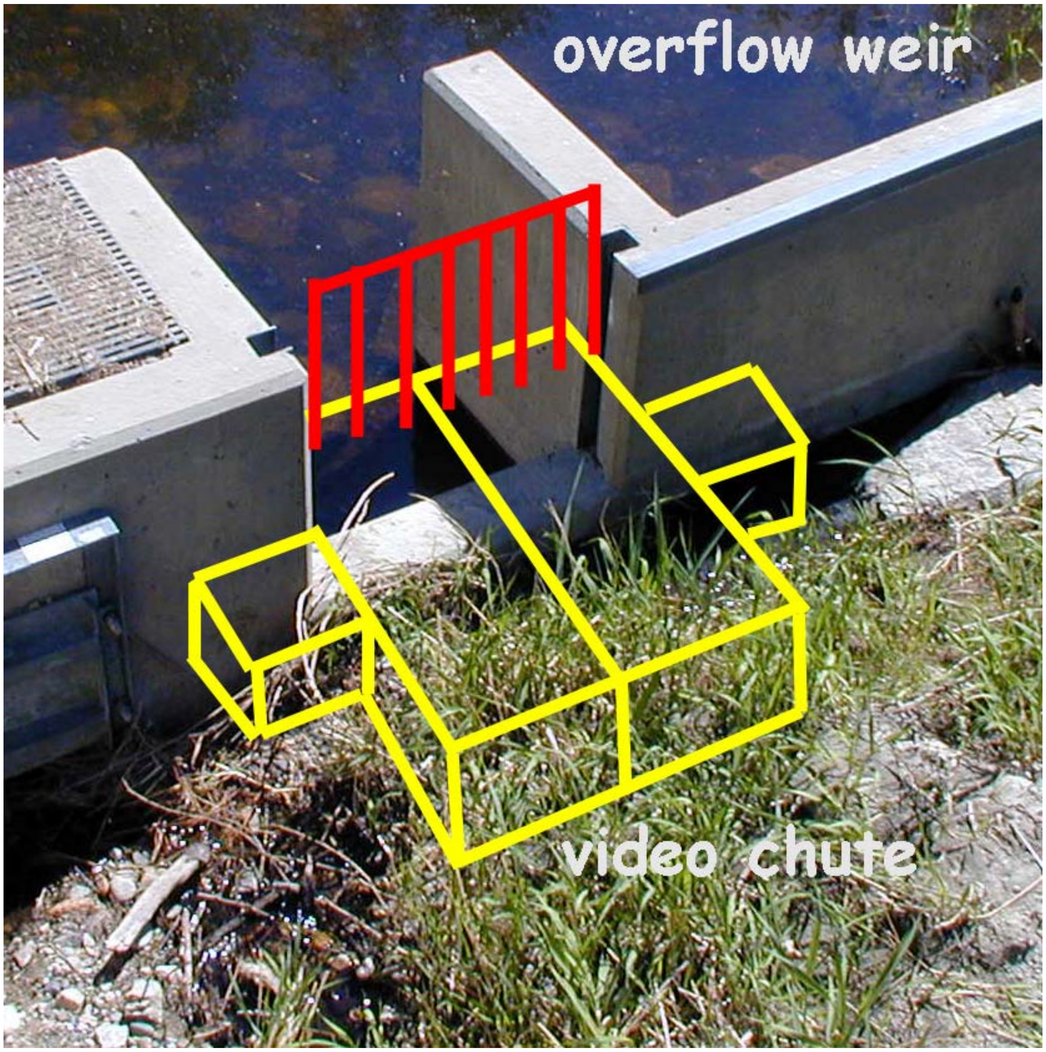


**Figure 17.** Conceptual design of custom built underwater video chute to be installed and operated at the OID diversion fishway on Salmon Creek beginning in 2009.

*Loup Loup Creek*

Loup Loup Creek was surveyed for redds on May 20th and no redds were observed. Low stream flows in 2008 were insufficient to provide passage at the lower most impediment (culvert) located at river kilometer 0.1. This was the second year in the last four that no redds were identified in Loup Loup Creek. When sufficient flows are present to allow passage into Loup Loup Creek, summer steelhead attempt to spawn in this creek but production is limited by instream flow as a result of irrigation diversions (Arterburn et al. 2007b). Past surveys have established that an estimated 12 summer steelhead spawned in this creek in 2006 and another 18 in 2007. Use by spawning steelhead would likely increase substantially if perennial flows were reestablished, passage impediments were removed (culverts), and steelhead were supplemented using locally-adapted hatchery stocks. Steelhead redd surveys will continue in Loup Loup Creek to provide baseline information, and document the effectiveness of habitat rehabilitation projects, once implemented.

*Escapement into Canada*

Since 2005, OBMEP has attempted to conduct redd surveys in Canada to compliment survey data collected in the United States. Although OBMEP redd survey data are very promising in the United States, results haven't been as successful in Canada. To accurately calculate steelhead escapement into Canada, Zosel Dam video counts and a removable trap located on Inkaneep Creek have been utilized.

To calculate the number of spawners entering Canada, the estimated number of spawners that enter Ninemile (77) and Tonasket (0) creeks must be subtracted from the total number counted at Zosel Dam. These two creeks are located upriver of Zosel Dam but south of the international border. During 2008, 193 summer steelhead were counted passing Zosel Dam. Seventy seven were estimated as destined for United States tributaries. Therefore, 116 summer steelhead were expected to spawn in the Canadian portion of the Okanagan Basin.

Wild fish, as determined by the presence of an adipose fin were calculated using a similar procedure. Fifty-six summer steelhead were enumerated at Zosel Dam (Table 3). The estimated number entering Ninemile (18) and Tonasket (0) creeks was subtracted from the total (56). Of the summer steelhead destined for Canada, an estimated 38 were naturally-produced; 32.76% of the total escapement.

**Table 3.** The number of summer steelhead that passed Zosel Dam by month in 2008. Adipose-present fish are designated as Wild; adipose-clipped fish are considered Hatchery.

| Month | Number of Hatchery Adults | Number of Wild Adults | Total |
|---|---|---|---|
| August | 3 | 1 | 4 |
| September | 1 | 2 | 3 |
| October | 6 | 5 | 11 |
| November | 5 | 2 | 7 |
| December | 5 | 1 | 6 |
| January | 4 | 0 | 4 |
| February | 7 | 0 | 7 |
| March | 12 | 11 | 23 |
| April | 94 | 34 | 128 |
| **Total** | **137** | **56** | **193** |

*Inkaneep Trap*

At the trap on Inkaneep Creek, 62 steelhead were collected which includes both anadromous steelhead and resident adfluvial rainbow trout. In an attempt to separate anadromous fish, a fork length of > 500mm was considered a steelhead. A fork length of 500 mm is the threshold used to regulate anglers in Washington State. In 2009, scale samples will be evaluated for exposure to marine environments using radio-isotopes to verify these fork length assumptions. After applying the length criteria, 22 fish were recognized as adult summer steelhead, including all marked fish, known to be summer steelhead as no resident rainbow trout had been marked by clipping the adipose fin. Of the adult steelhead collected at Inkaneep Creek, the average fork length was 546 mm which was the shortest mean length of the three streams where picket-traps were installed. Of the designated steelhead, 11 were male, 11 female and 77.27% were considered natural origin, the highest percentage documented in 2008. No redd survey was conducted downstream of the trap as this short distance of habitat (~ 0.5km) is not considered conducive to spawning.

*Canadian Distribution*

From redd survey data collected in 2006 by the Okanagan Nation Alliance, 90% of the summer steelhead redds were identified in two tributaries; Vaseux Creek (45%) and Inkaneep Creek (45%) with 10% of the redds being observed in the main stem Okanogan River upstream of Lake Osoyoos, but downstream of McIntyre Dam (Long et al. 2006). An approximated distribution can be calculated from these data by taking the number of steelhead entering Canada (estimated to be 116 summer steelhead). Previously, the number of steelhead entering Inkaneep Creek was calculated to be 22 summer steelhead.

The remaining 94 summer steelhead have a distribution that remains undefined. Difficulties associated with collecting data on adult spawners in Canada are in the process of being resolved. Design elements should include the following:
1) development of methodology to measure the abundance of adult steelhead at a sub-watershed scale, 2) harvest of these fish in recreational fisheries at Lake Osoyoos and its

tributaries, which is unknown, 3) pre-spawn mortality as some of the fish pass Zosel Dam many months prior to spawning, 4) steelhead are spawning in areas that have yet to be discovered, as several small streams are accessible to steelhead during spring runoff but are difficult to monitor due to poor visibility, or 5) fallback through Zosel Dam. The last two items can be estimated using methods provided in the literature.

For adult summer steelhead, it has been estimated that a minimum of 94% of steelhead passing main stem Columbia River dams survived to known spawning areas, or remained above the dam (English et al. 2001, 2003). More recent PIT tag data indicates that survival from McNary Dam to Wells Dam averaged 97% per project. Using these values would result in a reduction in Zosel Dam counts of between 6 and 12 summer steelhead.

We estimated that 38 summer steelhead entered Canada. Subtracting the wild steelhead identified at the Inkaneep Trap (17) leaves 21 adipose present summer steelhead with unknown natal streams. Application of potential fallback or mortality factors would account for one of the summer steelhead with unknown distribution.

*Bringing it all together*

In the United States, summer steelhead are listed as "endangered" under the Endangered Species Act in the Upper Columbia River Evolutionary Significant Unit. Detailed percent-wild information for 2008 is provided in this document and every attempt has been made to ensure that these estimates are as accurate as possible. However, these data should be used with caution as definitive methodologies to determine natural origin are not currently possible. Mean values presented in this document represent our best scientific estimate from the best available information, but should not be considered absolute. Thus, high and low estimates are also provided to represent the full range of possible values.

The total escapement estimate for Okanogan River summer steelhead spawners in 2008 was between 1,341 and 1,436 (Table 4). For the first year since OBMEP began collecting data, the WDFW estimate did not fall within our range of potential values. The WDFW estimate was also the highest since we began tracking these values. The WDFW estimates are derived from Wells Dam passage counts modified by subtracting harvest information and divided by river basin through the use of radio telemetry data (English et al. 2001, 2003). The radio telemetry data is over a decade old and perhaps these values need to be revalidated. In 2008, WDFW estimated maximum spawner escapement into the Okanogan River Basin at 1,720 summer steelhead (Charles Frady, WDFW, Personal Communications).

The abundance of wild fish is a subset of the total escapement estimate and the best available information is used to provide an accurate estimate in the Okanogan River Basin. The WDFW escapement estimate was 233 and OBMEP estimated that between 213 and 266 wild summer steelhead likely spawned within the Okanogan River basin in 2008 (Table 5). The WDFW estimate fell within the range of OBMEP values again in

2008 and both agencies had the highest values recorded since data collection began in 2005. The substantial increase in wild fish is at least partially due to incomplete hatchery marking of summer steelhead smolts released into the basin. In 2008, greater attention to other marks and tags resulted in more adipose fin present fish being classified as hatchery fish than in any of the preceding years. Some of this increase may also be attributed to habitat improvement efforts and projects that have been completed over the last 3 to 4 years or more.

A summary of the best available counts and estimates for each reach or sub-watershed throughout the Okanogan River basin is presented in Table 6. Our surveys indicate that main stem spawning is common throughout the Okanogan River but is more heavily focused in the northern portion of the Okanogan and lower Similkameen rivers. The lack of redds in the main stem Okanagan River in Canada is surprising as considerable, high-quality habitat exists. Within the United States portion of the basin, most hatchery steelhead are scatter planted at various locations along the Okanogan and Similkameen rivers; no hatchery stocking occurs in Canada. Therefore, it is highly likely that redd distributions are heavily influenced by the stocking locations used by WDFW. Summer steelhead that spawn in tributary habitats of the Okanogan River are more likely to find suitable environmental conditions and rearing habitats than those spawning in the main stem. If more summer steelhead were stocked into Okanogan basin tributaries, the chances of these tributaries contributing to recovery efforts would be greatly enhanced.

**Table 4.** Total escapement of summer steelhead for the Okanogan River since 2005 including combined hatchery and natural-origin summer steelhead estimates. In 2005 and 2006, only low and high estimates were provided so a simple arithmetic mean was computed for both years. The OBMEP estimate for 2007 was based on estimated main stem data and the 2008 estimate is derived from data presented in Table 6.

| Okanogan River summer steelhead spawner population trend data | | | | |
|---|---|---|---|---|
| **Year** | **WDFW escapement estimate** | **OBMEP spawner survey estimate** | | |
| | | Low | Mean | High |
| 2005 | 1,322 | 1,147 | 1,315 | 1,482 |
| 2006 | 811 | 779 | 855 | 930 |
| 2007 | 1,258 | 1,234 | 1266* | 1,280 |
| 2008 | 1,720 | 1,341 | 1,386 | 1,436 |

* Contains estimated main stem reach data rather than empirical data as in other years.

**Table 5.** Natural origin summer steelhead estimates for the Okanogan River since 2005. The estimates in 2005 and 2006 were calculated by multiplying the average wild percent for the Okanogan River. In 2006 and 2007 various sources data were used, such as trap, video, PIT tags, and coded wire tags were used to develop data for Table 6 at the sub-watershed scale. The WDFW estimate is based upon Wells Dam counts and scale analysis. The OBMEP estimate for 2007 is based on estimated main stem reach data.

| Okanogan River wild summer steelhead spawner population trend data | | | | |
|---|---|---|---|---|
| **Year** | **WDFW escapement estimate** | **OBMEP spawner survey estimate** | | |
| | | Low | Mean | High |
| 2005 | N/A | 143 | 164 | 185 |
| 2006 | 132 | 127 | 139 | 151 |
| 2007 | 116 | 148 | 152* | 155 |
| 2008 | 233 | 213 | 225 | 266 |

* Contains estimated main stem reach data rather than empirical data as in other years.

**Table 6.** Redd counts and spawner counts for each sub-watershed or counting location along with the estimated number of wild summer steelhead represented by each in 2008. The grand total for the entire Okanogan River population is presented with subtotals for tributary and main stem habitat types in the United States and Canada.

| Category | Description/location | 2008 Spawners | Redd count | # wild |
|---|---|---|---|---|
| US Tributary | Spawners placed above Omak trap | 41 | N/A | 10 |
| US Tributary | Spawners below Omak trap | 61 | 15 | 15 |
| US Tributary | Spawners placed above Bonaparte trap | 23 | N/A | 10 |
| US Tributary | Spawners below Bonaparte trap | 5 | 2 | 2 |
| US Tributary | Spawners observed passing Zosel Dam | 193 | N/A | 56 |
| US Tributary | Spawners into Salmon Creek | Unknown | 0 | Unknown |
| US Tributary | Spawners into Wanacut Creek | 0 | 0 | 0 |
| US Tributary | Spawners into Loup Loup Creek | 0 | 0 | 0 |
| US Tributary | Spawners into Antoine Creek | 0 | 0 | 0 |
| US Tributary | Spawners into Tonasket Creek | 0 | 0 | 0 |
| US Tributary | Spawners into Ninemile Creek | 77 | 30 | 18 |
| US Tributary | Spawners into Tunk Creek | 2 | 1 | 0 |
| US Tributary | Spawners into Wild Horse Spring Creek | 0 | 0 | 0 |
| Canada Tributary | Spawners placed above Inkaneep trap | 22 | N/A | 17 |
| Canada Tributary | Spawners below Inkaneep trap | N/D | N/D | N/D |
| Canada Tributary | Spawners into Vaseux Creek | N/D | N/D | N/D |
| Canada Main stem | Spawners into Canadian main stem | N/D | N/D | N/D |
| Canada | Unknown or undefined distribution | 94 | N/D | 38 |
| US Main stem | Spawners into reach O1 | 10 | 5 | 1 |
| US Main stem | Spawners into reach O2 | 99 | 48 | 12 |
| US Main stem | Spawners into reach O3 | 17 | 8 | 2 |
| US Main stem | Spawners into reach O4 | 111 | 55 | 14 |
| US Main stem | Spawners into reach O5 | 39 | 19 | 5 |
| US Main stem | Spawners into reach O6 | 0 | 0 | 0 |
| US Main stem | Spawners into reach O7 | 513 | 249 | 64 |
| US Main stem | Spawners into reach SI/S2 | 272 | 132 | 34 |
| **Subtotals** | **Adult escapement into US main stem** | **1061** | **516** | **132** |
| **Subtotals** | **Adult escapement into US tributaries** | **209** | **N/A** | **55** |
| **Subtotals** | **Adult escapement into Canada** | **116** | **N/D** | **38** |
| **Grand total** | | **1,386** | | **225** |

## Conclusions

Steelhead spawner data clearly show that redd surveys throughout the United States portion of the Okanogan River basin are possible in both tributary and main stem habitats and the distribution of spawning can be effectively quantified. Baseline information for spawning habitat distribution, spawn timing, and spawner escapement have been determined, but additional annual data are necessary to strengthen the body of information for use in trend analysis. Spring spawner data provides a reliable estimate of spawner abundance and slightly less reliable estimates of origin for returning adults. Dependable and reliable estimates such as these are critical for tracking recovery of endangered upper Columbia summer steelhead within the Okanogan River basin. Using a combination of redd surveys, weir traps, video counting chambers, PIT tags, and other marks provides results that are more accurate and precise than would be expected from one methodology alone.

Annual variations in redd distribution can be profound for small tributaries within the Okanogan River basin. Changes in spawner distributions are primarily driven by four factors:

1) The discharge and elevation of the Okanogan River;
2) The discharge of the tributary streams;
3) The timing of runoff that alters the shape of the hydrograph, and most importantly;
4) The stocking location of hatchery smolts.

The first three items are largely part of the natural environmental conditions present in the basin, although they can be altered dramatically by such things as dam releases, irrigation withdrawals, and climate change. These items are inherently difficult for fisheries managers to address. However, the choice of juvenile stocking locations is well within the jurisdiction of fisheries managers to change or modify for the benefit of a given stock. Within the Okanogan River basin, more effort should be given toward developing locally-adapted summer steelhead broodstocks and stocking into tributary habitats that provide the most suitable environmental and rearing conditions. Years such as 2006 and 2008 clearly show how the discharge of the Okanogan River can dramatically alter spawning locations and reduce the number of summer steelhead utilizing tributary streams especially when coupled with a late runoff. Habitat alterations at the mouths of key spawning tributaries can help, provided sufficient discharge is available for adult steelhead to migrate up the tributary stream.

The 2008 data shows similarities with previous surveys; mainstem redd distributions were highest in the upstream reaches of the Okanogan River and lower section of the Similkameen River, where high quality spawning gravels are common and hatchery releases are focused. Other high density spawning areas included the island section near Tonasket, and near McAlister Rapids, where braided channels and increased water velocities maintain clean gravels (1 to 3 inch) preferred by summer steelhead (Smith 1973). Most steelhead redds were observed near Chinook spawning areas or redd mounds or near mid-channel islands. Future habitat improvement efforts should key on providing and sustaining more sites that support a gravel substrate along the main stem

Okanogan River and in close proximity to a cold water refugia to improve egg to fry production for both Chinook and steelhead and over summer juvenile survival for steelhead.

Water availability in the Okanogan River basin approximated normal in 2008, however, much of the snow runoff in the lower elevations occurred prior to steelhead spawning. The remaining snow pack did not melt until late in the spawning period thus many steelhead selected spawning locations along the main stem Okanogan and Similkameen rivers. Many of the small tributaries were either inaccessible due to the low elevation of the Okanogan River or had insufficient discharge for good up stream migration of adult steelhead once they were accessible.

Data collection in previous years and recommendations provided considerable help in 2008; run timing and flows under which we could sample were much better understood. However, data collected in 2008 indicates that over the last four years the timing of redd construction is slowly progressing later each year. In 2009, redd surveys could begin one week later than in years past to help ensure a pre-spawn, peak-spawn, and post-spawn redd surveys get completed. Our main stem redd surveys in 2008 were likely biased low as the post-spawn survey was only slightly lower than the peak spawn survey. Adult spawner counts will be further enhanced in 2009 with the addition of video counting arrays installed on Salmon Creek, Ninemile Creek, and Antoine Creek.

In 2008, we modified the enumeration of summer steelhead at all trap locations by using a length cutoff of roughly 20 inches (500mm). Using this filter helps us differentiate between summer steelhead and adfluvial rainbow trout that occur in both the United States and Canada. The use of this length has been upheld by supplemental DNA data collected in Omak Creek; both DNA and scale data will be evaluated in 2009 to help validate this length for the Inkaneep Creek trap in Canada. Further refinements in distinguishing summer steelhead from other life history forms of *O. mykiss* will continue to evolve in future spring spawner surveys.

Spring spawner data collected over the last four years clearly show that redd surveys are possible and can be enhanced by using underwater video, traps, tags, and marks. However, hatchery activities that do not mark all fish in an easily identifiable way make origin analysis difficult. It is difficult to determine if increasing trends in wild fish are a result of more wild fish production or fewer summer steelhead being marked with an adipose clip. Evaluation of natural production would be enhanced in the future by ensuring that all hatchery summer steelhead are marked by the removal of the adipose fin. Another alternative would be to clip the adipose fin on most but PIT tagging those that are not clipped and expanding the number of PIT tag antennae available for tag interrogation within the Okanogan River basin. Baseline information for spawning habitat distribution, spawn timing, and spawner escapement have been determined but additional years of data are necessary to refine this information and allow for trend analysis.

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