

Colville Tribes, Fish & Wildlife Department

2011 Okanogan Basin Steelhead Escapement and Spawning Distribution



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Summary

Summer steelhead (*Oncorhynchus mykiss*) spawning distribution and abundance estimates were determined throughout the Okanogan subbasin in 2011 using redd surveys, adult weir traps, PIT tag detections, and underwater video enumeration. Within the Washington State portion of the basin, redd surveys were conducted across all available habitat up to anadromous barriers, weir traps, or underwater video sites. We estimated that between 1,479 and 1,687 summer steelhead spawned in the Okanogan River subbasin, and between 307 and 339 of those were of natural origin. Objectively determining wild origin was complicated by the unknown number of adipose-present hatchery steelhead released into the Okanogan River, the presence of adfluvial rainbow trout, and the inability to validate origin when observing steelhead on redds. In 2010 and 2011, fisheries regulations required the harvest of all steelhead with clipped adipose fins, which likely contributed to higher percentages of adipose-present spawners than had been documented in previous years. The highest density of steelhead redds continue to be documented in the lower extent of the Similkameen River and in the downstream vicinity of Zosel Dam on the Okanogan River.

Escapement into British Columbia was estimated at 174 steelhead and 38 of those likely had adipose fins. This value was calculated by counting the number of steelhead passing Zosel Dam and subtracting the estimated number of spawners in Tonasket and Ninemile Creeks. The spatial distribution of spawning in the Canadian portion of the Okanogan subbasin remains largely unknown.

Due to above-average runoff in 2011, tributaries to the Okanogan River were more readily accessible to adult steelhead. Approximately 38.9% of steelhead that spawned within the Washington State portion utilized tributary habitats, which was similar to 2010, and higher than previous years' surveys. The abundance of steelhead that spawned in tributary habitats may help to increase future years' returns of natural origin steelhead. Annual collection of steelhead spawning data continues to provide a comprehensive depiction of spawning distribution and minimum escapement trends within the Okanogan River subbasin.

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Introduction

Summer steelhead are listed as threatened in the Upper Columbia Evolutionarily Significant Unit (ESU) under the Endangered Species Act (ESA). To recover this ESU requires that all four populations (Wenatchee, Methow, Entitat, and Okanogan) meet minimum adult abundance thresholds, have positive population growth rates, and each population must be widely distributed within respective basins (UCSRB 2007). Within the Okanogan River subbasin, the Okanogan Basin Monitoring and Evaluation Program (OBMEP) monitors adult abundance attributes. Since 2004, OBMEP developed protocols derived from the Upper Columbia Strategy (Hillman 2004) that called for a complete census of all spawning. Preliminary methodologies for implementing redd surveys were developed in 2005 (Arterburn et al. 2004) and these methods were later revised in 2007 (Arterburn et al. 2007c).

In addition to redd surveys, adult weir traps, PIT tag arrays, and underwater video counting were incorporated in order to improve escapement estimates, reduce project costs, and coordinate with other on-going data collection efforts. Weir traps have been operated on Omak Creek since 2001 and Bonaparte Creek since 2006. These weir traps provided supplemental biological data, such as length, weight, sex, mark/tags, origin, and age that are also used to evaluate adult steelhead returns. Underwater video enumeration has allowed adult steelhead to be counted at fixed locations, such as Zosel Dam since 2006, and Ninemile, Antoine, and Salmon Creek since 2008. In cooperation with the Washington Department of Fish and Wildlife (WDFW), we expanded the use of PIT tag arrays, which are primarily used to monitor adult summer steelhead use of small tributaries to the Okanogan River.

This document builds upon knowledge and information gained from preceding years' surveys. An extensive literature review of historic spawning information related to the Okanogan River subbasin can be found in Arterburn et al. (2005). Previous years' data and reports can be accessed at: www.cctobmep.com. A census of all mainstem habitats was conducted within the U.S. in 2005 and identified several large areas that contained no redds due to unsuitable spawning habitat. Eliminating these areas from future surveys reduced program costs, and it is assumed there was minimal loss of relevant data. Recommendations from the 2005 surveys helped define the actual reaches that would be surveyed from 2006 through 2011.

Methods

The Okanogan River subbasin flows from the northern headwaters near Vernon, BC to the confluence with the Columbia River near Brewster, WA (Figure 1). We conducted counts of all summer steelhead spawning downstream of anadromous fish migration barriers in the mainstem and all accessible tributaries of the Okanogan and Similkameen River drainages within the United States (Arterburn et al. 2007a, Walsh and Long 2006). Adult weir traps, PIT tag arrays, and underwater video enumeration were used at locations where habitat was extensive or difficult for surveys to be performed on foot. Redd surveys were used to cover all remaining spawning habitat.

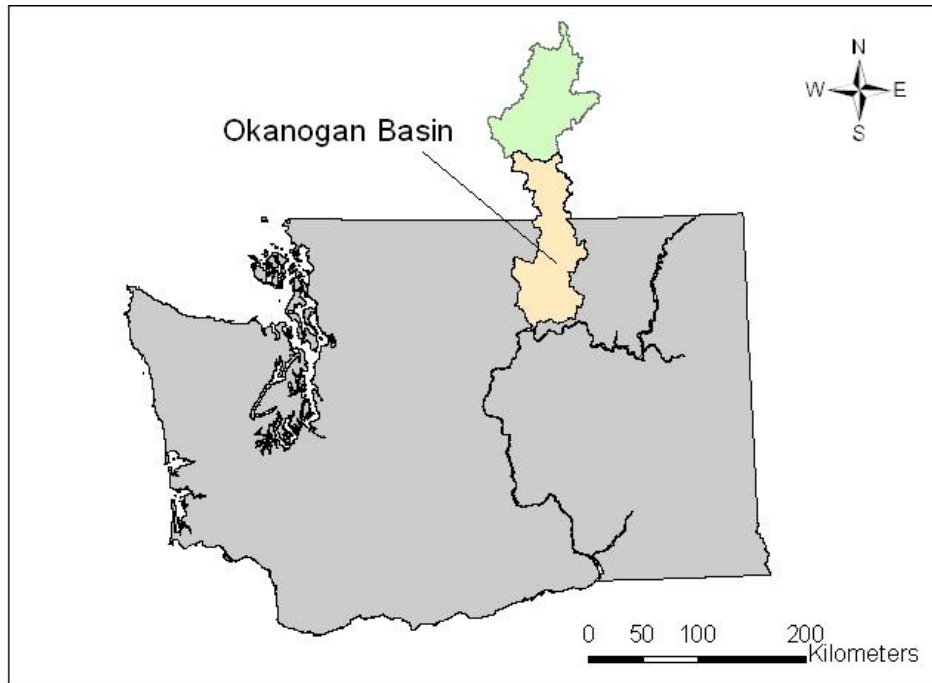


Figure 1. The extent of historic and current habitat in the Okanogan River basin accessible to anadromous fish.

At weir traps, we used protocols developed for the collection of locally adapted broodstock (Dasher 2011). Weir traps were located at Omak Creek and Bonaparte Creek in 2011. The Omak Creek trap was located approximately 1.6 kilometers upstream of the confluence with the Okanogan River (Figure 2). This trap was a semi-permanent design that has remained operational under all discharges since 2005. The Bonaparte Creek temporary picket weir trap has been installed seasonally each year since 2006 (Figure 3). At each trap, fish species was identified, weight (g) and length (mm) recorded, sex determined, tags or marks identified, and biosamples taken as needed for DNA analysis and aging. Fish were either placed upstream of the weir, taken for broodstock, or relocated downstream.

Underwater video data were collected following procedures as described in Nash (2007). Video counting was conducted at Zosel Dam, where year around data (24 hours per day, 7 days per week) have been collected since 2006 (Figure 4). Seasonal video systems were installed in Ninemile and Antoine Creeks, near their confluence with the Okanogan River. A seasonal video monitoring station was also installed in Salmon Creek, at the Okanogan Irrigation District's diversion at river kilometer (RKM) 7.2. Above this point, most of the land is privately owned and access for a complete redd survey has been unattainable.



Figure 2. Semi-permanent floating weir trap located on Omak Creek, looking downstream.



Figure 3. Seasonal picket weir trap located on Bonaparte Creek, looking downstream.



Figure 4. Image of Zosel Dam west bank video chute array, prior to (left), and during deployment (right).

Summer steelhead were enumerated in all remaining spawning habitats following the OBMEP redd survey protocol (Arterburn et al. 2007C). Designated mainstem and tributary survey reaches are listed in Table 1. The area of the Okanogan River downstream from Chiliwist Creek is inundated by the Columbia River (Wells Pool/Lake Pateros). Consequently, this lower reach (~23 km) of the Okanogan River was excluded from surveys because it lacks appropriate velocity and substrate needed for summer steelhead to spawn.

The Okanogan River was divided into seven survey reaches based on access points. The Similkameen River was surveyed as two reaches. We used discharge data, air and water temperature, and local knowledge of fish movements collected from previous years to determine when to begin surveys on the mainstem. Mainstem surveys were conducted from rafts and on foot in a downstream progression. All island sections or other mainstem areas that could not be floated due to limited access and/or obstacles (e.g. wood debris, braided channels, and diversions) were surveyed on foot. Raft surveys were conducted by a minimum of two people using 10' Skookum® Steelheader model catarafts (Redman, Oregon). Small tributaries were surveyed on foot, walking in an upstream direction. Each reach within the mainstem Okanogan and Similkameen River was surveyed three times between March 28 and May 4, 2011. Tributaries were surveyed one to four times, between March 31 and July 5.

Geographic positions of redds were collected with a Trimble GeoExplorer XT GPS unit and downloaded into GPS Pathfinder® after each survey. The GIS data were reviewed and differentially corrected. To avoid recounting, redds were marked by flagging tied to bushes or trees adjacent to the area where they 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.

Table 1. Designated Okanogan River redd survey reaches used by OBMEP in 2011.

Redd Survey Reaches	Location Description	Reach length(km)
Similkameen - S1/S2	Similkameen/Okanogan Confluence (0) to Enloe Dam (14.6)	14.6
Okanogan - O1	Okanogan River south Loup Loup Creek (26.7) to Salmon Creek (41.4)	14.7
Okanogan - O2	Okanogan River at Salmon Creek (41.4) to the office (52.3)	10.9
Okanogan - O3	Okanogan River at the office (52.3) to Riverside (66.1)	13.8
Okanogan - O4	Okanogan River at Riverside (66.1) to Janis Bridge (84.6)	18.5
Okanogan - O5	Okanogan River at Janis Bridge (84.6) to Tonasket Park (91.4)	6.8
Okanogan - O6	Okanogan River at Horseshoe Lake (112.4) to confluence with Similkameen River (119.5)	7.1
Okanogan - O7	Okanogan River at confluence (119.5) to Zosel Dam (127.0)	7.5
Tunk Creek	Tunk Creek at Okanogan River confluence (0) to high water mark (0.2)	0.2
Bonaparte Creek	Bonaparte Creek/Okanogan River confluence (0) to Bonaparte Falls (1.6)	1.6
Ninemile Creek	Ninemile Creek from Okanogan River confluence (0) to video weir (0.7)	0.7
Tonasket Creek	Tonasket Creek/Okanogan River confluence (0) to Tonasket Falls (3.5)	3.5
Antoine Creek	Antoine Creek/Okanogan River confluence (0) to video weir (1.3)	1.3
Loup Loup Creek	Loup Loup Creek/Okanogan River confluence to Loup Loup Creek diversion (2.3)	2.3
Wild Horse Sp Creek	Wild Horse Spring Creek/Okanogan River Confluence to barrier (1.1)	1.1
Omak Creek	Omak Creek/Okanogan River Confluence (0) to Omak Creek trap site (2.0)	2.0
Salmon Creek	Salmon Creek confluence with the Okanogan (0) to OID diversion (7.2)	7.2

We employed the method currently used by Washington Department of Fish and Wildlife (WDFW) in the Upper Columbia Basin to extrapolate escapement estimates from redds using the sex ratio of broodstock collected randomly over the run at Wells Dam (Andrew Murdoch, WDFW, pers. comm.). For example, if the sex ratio of a random sample of the run was 1.5:1.0 male to female, the expansion factor for the run would be 2.5 fish per redd (FPR). All escapement calculations using sex ratio multipliers assume that each female will produce only one redd. This method is used for all supplemented stocks within the Upper Columbia River basin.

Sex ratio data were used to provide an estimate of total spawner escapement for the population, tributary, and mainstem reaches. Sex ratio was determined by counting and sexing a sample of adult steelhead at Wells Dam, as well as all fish collected at the Omak weir trap. The ratio of males to females was used representatively for the streams where fish were trapped. Values derived from Wells Dam data were applied to all mainstem survey reaches and the sex ratio from the Omak Creek trap was applied to tributaries to the Okanogan River. Total redd estimates, in combination with counts at video sites, were summed to estimate total escapement within sub-watersheds.

PIT tag arrays were installed on many of the tributaries to the Okanogan in 2011. Population estimates derived from PIT tag detections were calculated following Murdoch et al. 2011. A random representative sample of steelhead were tagged at Priest Rapids Dam, two days per week over the course of the run, from July through November. An approximate tag rate of 8.3431% wild steelhead and 8.3369% hatchery steelhead were tagged at Priest Rapids Dam. These values were used to expand the

number of detections into escapement estimates for tributaries with PIT tag arrays. For example, if two hatchery and one wild steelhead were detected at a given creek, the escapement estimate would be 24 hatchery and 12 wild steelhead, calculated from the tagging rates at Priest Rapids. Based on the relatively few numbers of detections at most locations, particularly for small tributaries, escapement estimates derived from PIT tag detections may be highly variable and should be considered a general estimate. In addition to fish tagged at Priest Rapids, steelhead were also PIT tagged at Wells Dam, however sampling was not consistent across the run. Therefore, any extrapolation from detections to an escapement estimate was derived only from the Priest Rapids tag group. Detections from fish tagged at Wells Dam may be mentioned anecdotally in this report.

Results and Discussion

Sex Ratio

A sample of 842 summer steelhead, including 300 males and 542 females, were sexed at Wells Dam in 2011 by Washington Department of Fish and Wildlife personnel (Charles Frady, WDFW, pers. comm.). Adjusted proportionally for the run, the WDFW calculated that the Wells Dam data resulted in a sex ratio of 0.55 males per female or 1.55 FPR. This value was used to expand redd counts on the mainstem Okanogan River into escapement estimates.

In 2011, 56 summer steelhead were enumerated at the Omak Creek trap. A ratio of 0.8 males for each female (25 males; 31 females) was observed, yielding 1.8 FPR. There was a failure of the Bonaparte Creek adult weir trap due to high discharges, and therefore, a reliable sex ratio was undetermined for this location. For tributaries to the Okanogan where sex ratio data were not available and reliable redd surveys occurred, the surrogate value was used from Omak Creek (1.8 FPR).

Percent-Wild

The WDFW estimated the number of wild summer steelhead that escaped above Wells Dam was 1,698 or 15.2% of the total escapement in 2011. This value was based upon ad-present steelhead counts, PIT tags, coded wire tags, scale analysis, harvest, broodstock collection, and stray rates estimated for Wells Hatchery (Charles Frady, WDFW, pers. comm.). The proportion of wild fish assumed to be bound for the Okanogan River was 338, or 13.5% of the total escapement. This percentage was applied to all mainstem Okanogan River expanded redd counts in order to estimate the number of wild spawners at those locations.

The percent of wild summer steelhead that returned to tributary weir traps was determined by the presence of an intact adipose fin, PIT tag, and coded wire tag information. The percent of natural origin steelhead returning to Omak Creek was 85.7% (48 out of 56 total fish). Four wild steelhead were captured in the Bonaparte Creek trap out of five total fish; therefore, 80.0% were considered wild.

Video weirs were also used on three tributaries and the mainstem Okanogan, which provided percent-wild estimates for those locations. On Salmon Creek, 10.6% of passing adult steelhead were documented as ad-present and 57.9% for Ninemile Creek. No adult steelhead were observed in the Antoine Creek video weir. At Zosel Dam, 62 out of 270 summer steelhead (23%) were documented

having intact adipose fins. A percent-wild value of 18% was used for Tunk Creek, derived from observations of hatchery and wild steelhead on redds during foot surveys. The most conservative percent wild estimate (13.5%) was used for Wild Horse Spring Creek and Tonasket Creek. Wild steelhead production has been rare in those systems based on a history of low or intermittent flows in the lower most reaches of those systems.

Okanogan and Similkameen River Mainstem

Discharge and water clarity remained acceptable to conduct redd surveys on the mainstem surveys of the Okanogan and Similkameen Rivers in 2011 (Figure 5). Each reach within the mainstem Okanogan River and Similkameen River was surveyed three times between March 28 and May 4, 2011. The observed spawning activity of steelhead on the mainstem had concluded before early May and redd surveys were considered largely effective in documenting redds.

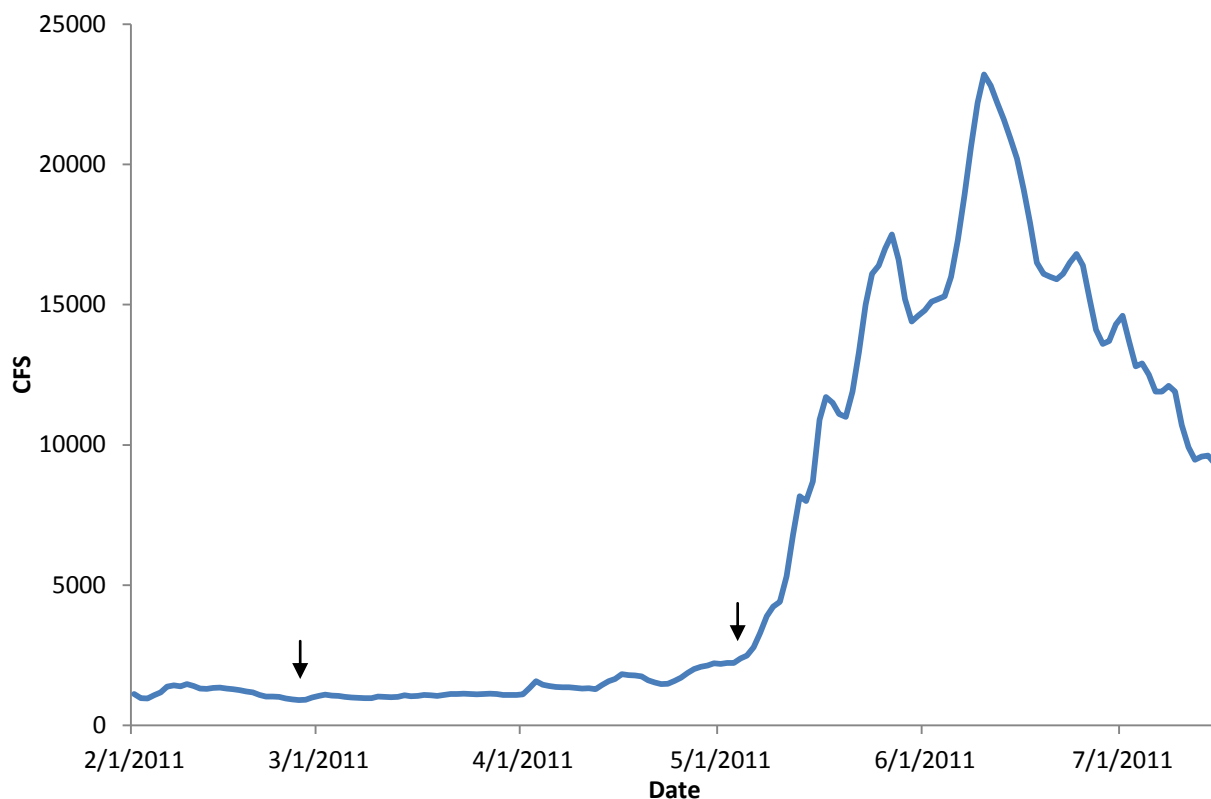


Figure 5. Discharge of the Okanogan River as measured at Tonasket, WA for the period from February to July, 2011 (http://waterdata.usgs.gov/nwis/uv?site_no=12445000). Beginning and end of mainstem redd surveys is marked by arrows.

The lower-most reach on the Okanogan River (Reach O1) was surveyed March 18, April 12, and April 21 (Figure 6). A total of 2 steelhead redds were documented, both during the second round of surveys. Using the mainstem value of 1.55 FPR, 3 steelhead were estimated to be utilizing this reach. A 13.5% wild rate applied to this value would suggest that there were likely no spawners of natural origin. No redds were observed on the mid-channel bar downstream of the Malott bridge, which had been frequently utilized in previous years, but not in 2010 or 2011.

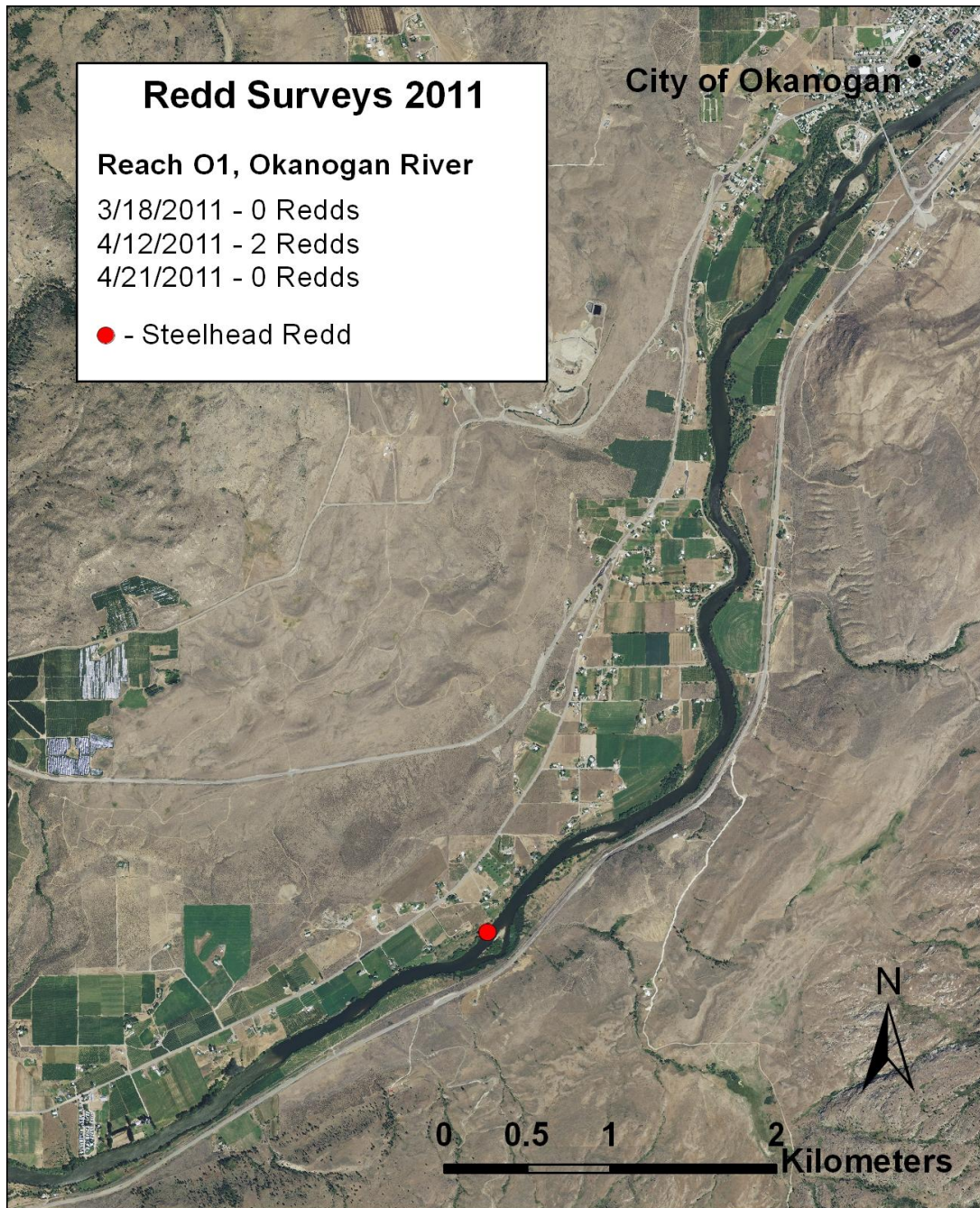


Figure 6. Redd distribution observed in 2011 for Okanogan River reach O1 from the confluence of Salmon Creek downstream to south of Loup Loup Creek.

The first two surveys of Okanogan River reach O2 were conducted on March 23 and April 6, zero redds were observed (Figure 7). The third survey occurred on April 25 and 10 redds were documented. The value of 1.55 FPR rendered 16 steelhead that likely spawned in this reach, 2 of which may have been wild. Steelhead redds were documented in areas where spawning frequently occurred in previous years, including below the downtown Omak bridge and in the vicinity of the braided channel near Shellrock Point. However, no redds were observed at the mid-channel riffle immediately downstream of Omak Creek, where redds had been commonly observed in previous years.

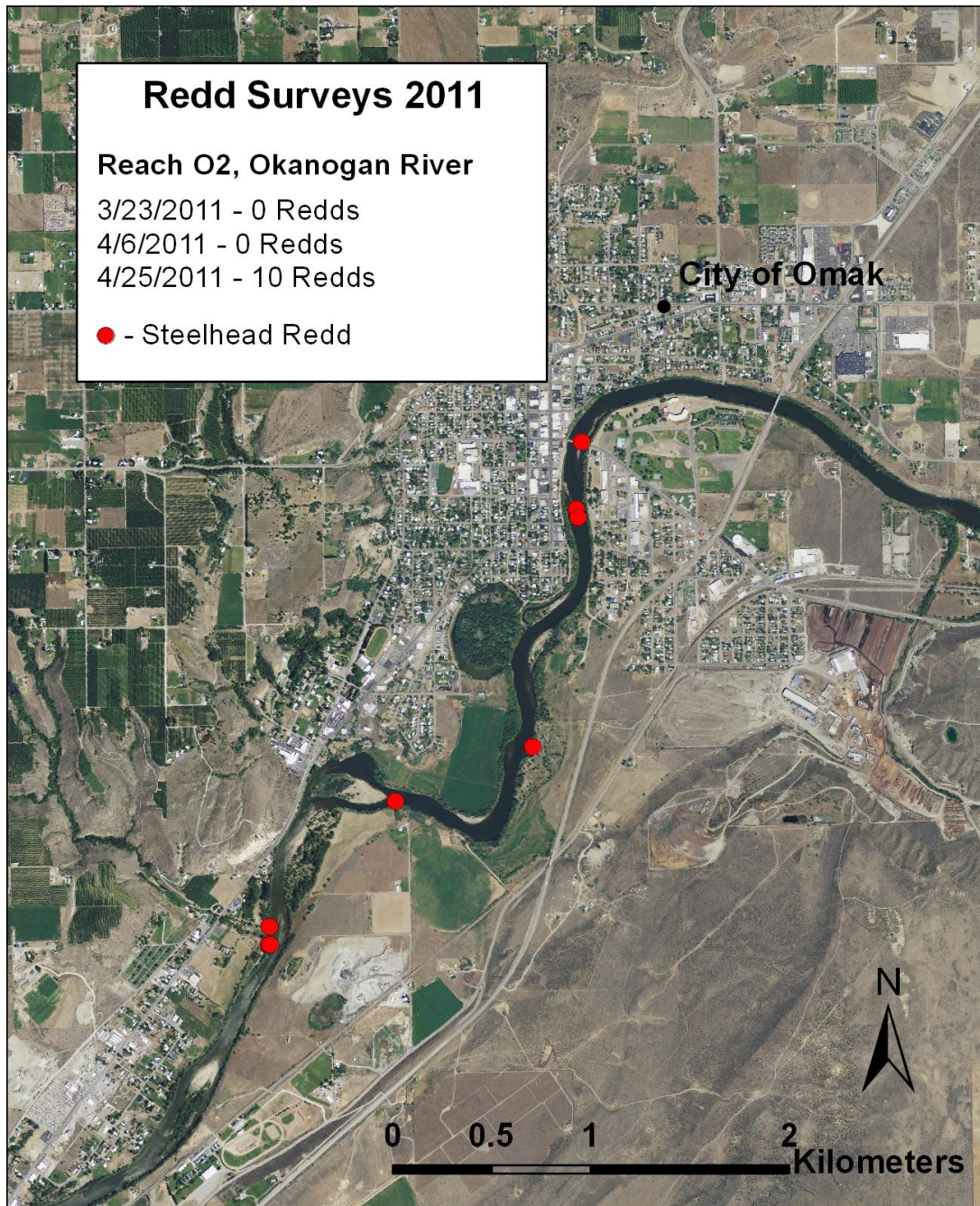


Figure 7. Redd distribution observed in 2011 for Okanogan River reach O2 from the confluence of Omak Creek in Omak, WA downstream to the confluence of Salmon Creek.

Okanogan River Reach O3 was surveyed on March 24, April 7, and April 26. No redds were observed in this reach in 2011 across all three surveys. Steelhead redds documented from 2004-2010 are shown in Figure 8 for reference of historical spawning locations. Availability of suitable spawning gravel is minimal within Reach O3. Fine sediments and low water velocities dominate much of this reach, which may account for the continued low abundance of spawning steelhead.

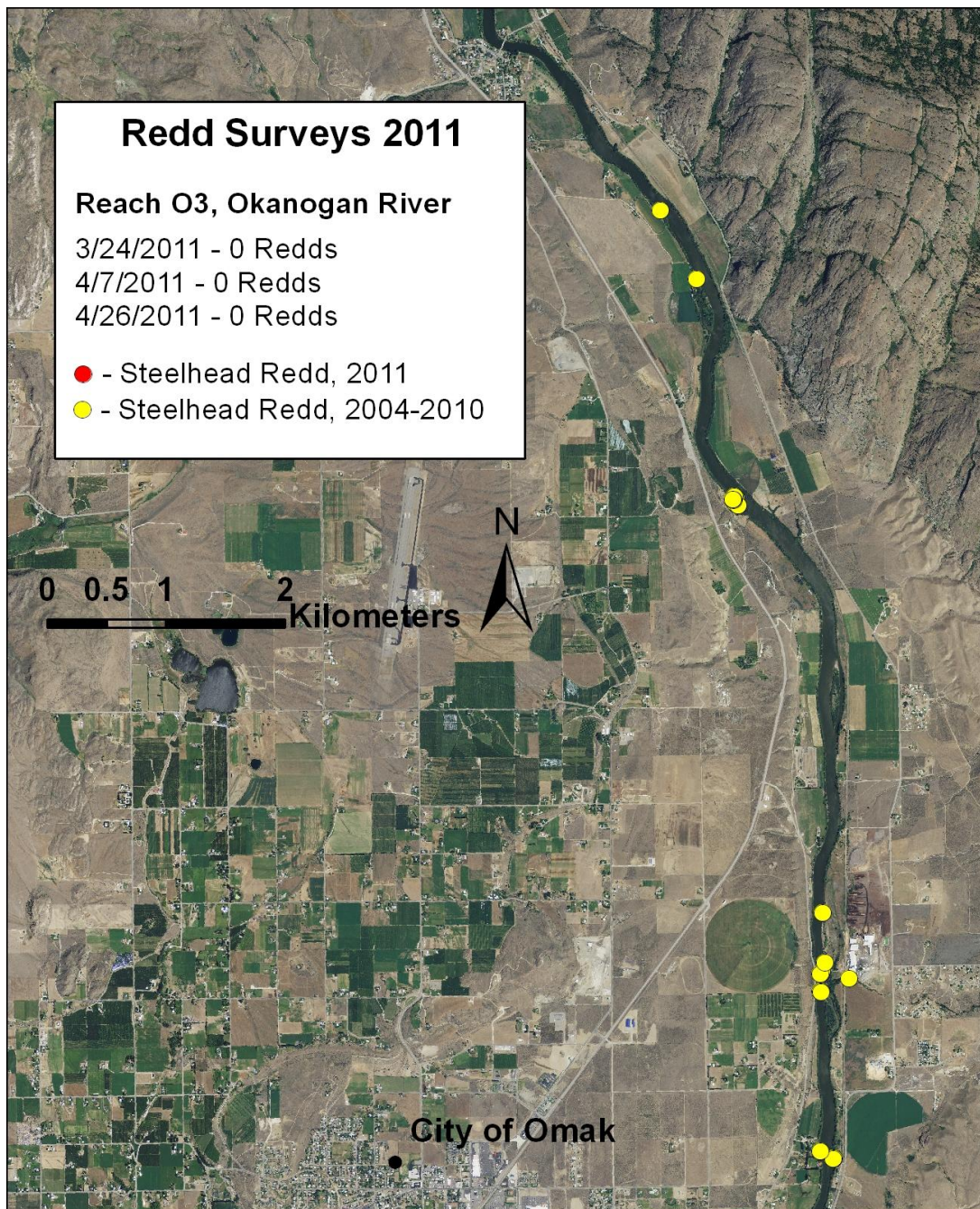


Figure 8. Redd distribution observed from 2004-2010 for Okanogan River reach O3 from the town of Riverside, WA downstream to the confluence with Omak Creek in Omak, WA. No redds were observed in 2011.

Okanogan River Reach O4 extends from Janis Bridge, south of Tonasket, WA, to the town of Riverside. Surveys of this reach occurred on March 28, April 13, and April 27 (Figure 9). A total of 9 redds were observed and all were located within the braided island complex just south of the confluence with Tunk Creek. These 9 redds likely represent a total of 14 adult steelhead, 2 of which may have been of wild origin. The number of redds observed in 2011 was the second lowest observed count within this reach (previous years range: 5-58 redds).

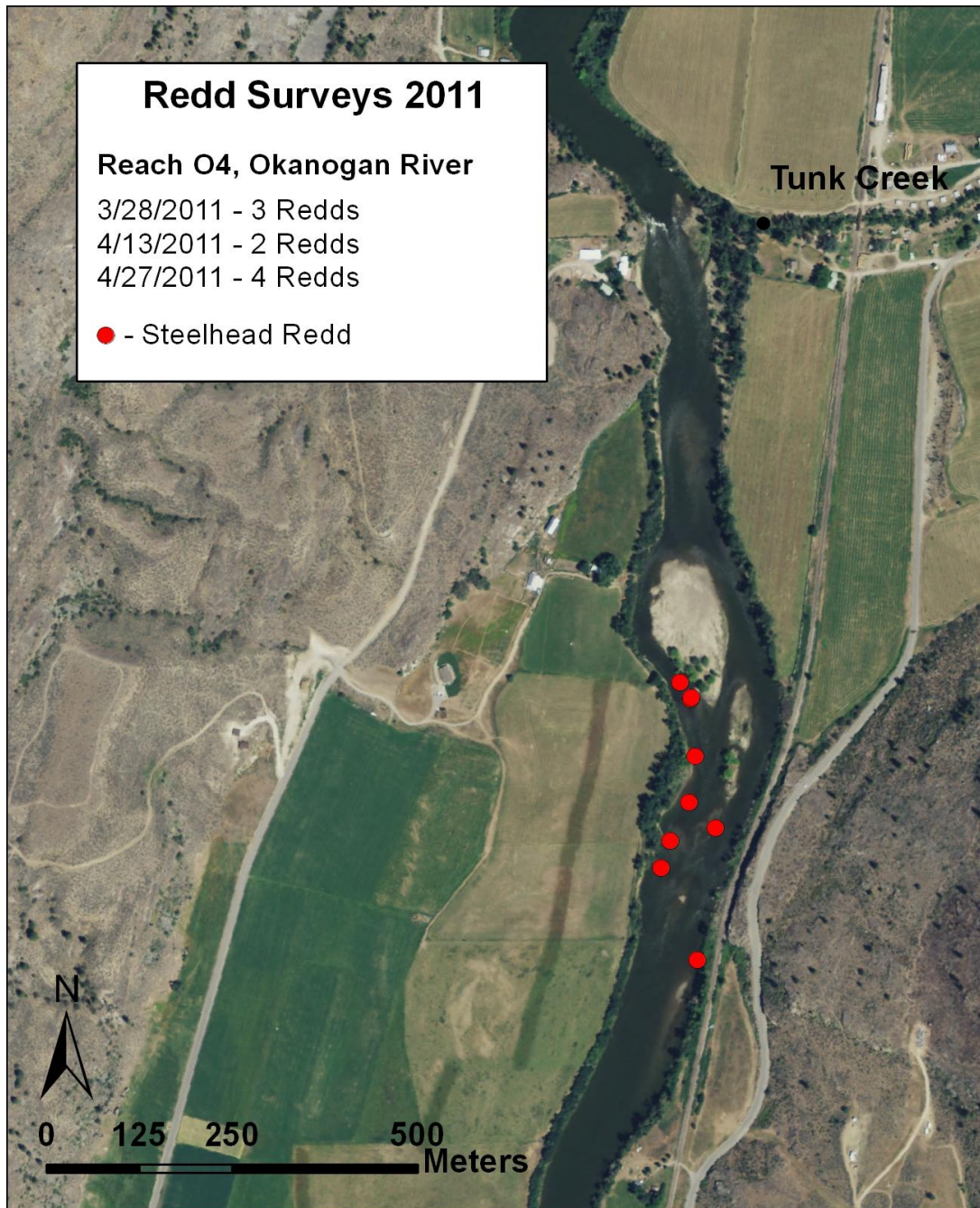


Figure 9. Redd distribution observed in 2011 for Okanogan River reach O4, from Janis Bridge downstream to the town of Riverside, WA.

Okanogan River Reach O5 was surveyed on March 29, April 14, and April 28. A total of 10 redds were identified across three surveys (Figure 10). The majority of redds continued to be observed downstream of Tonasket, in sections of braided channel. An estimated 15 spawners used this reach, based on the value of 1.55 FPR. A 13.5% wild rate rendered 2 wild steelhead.

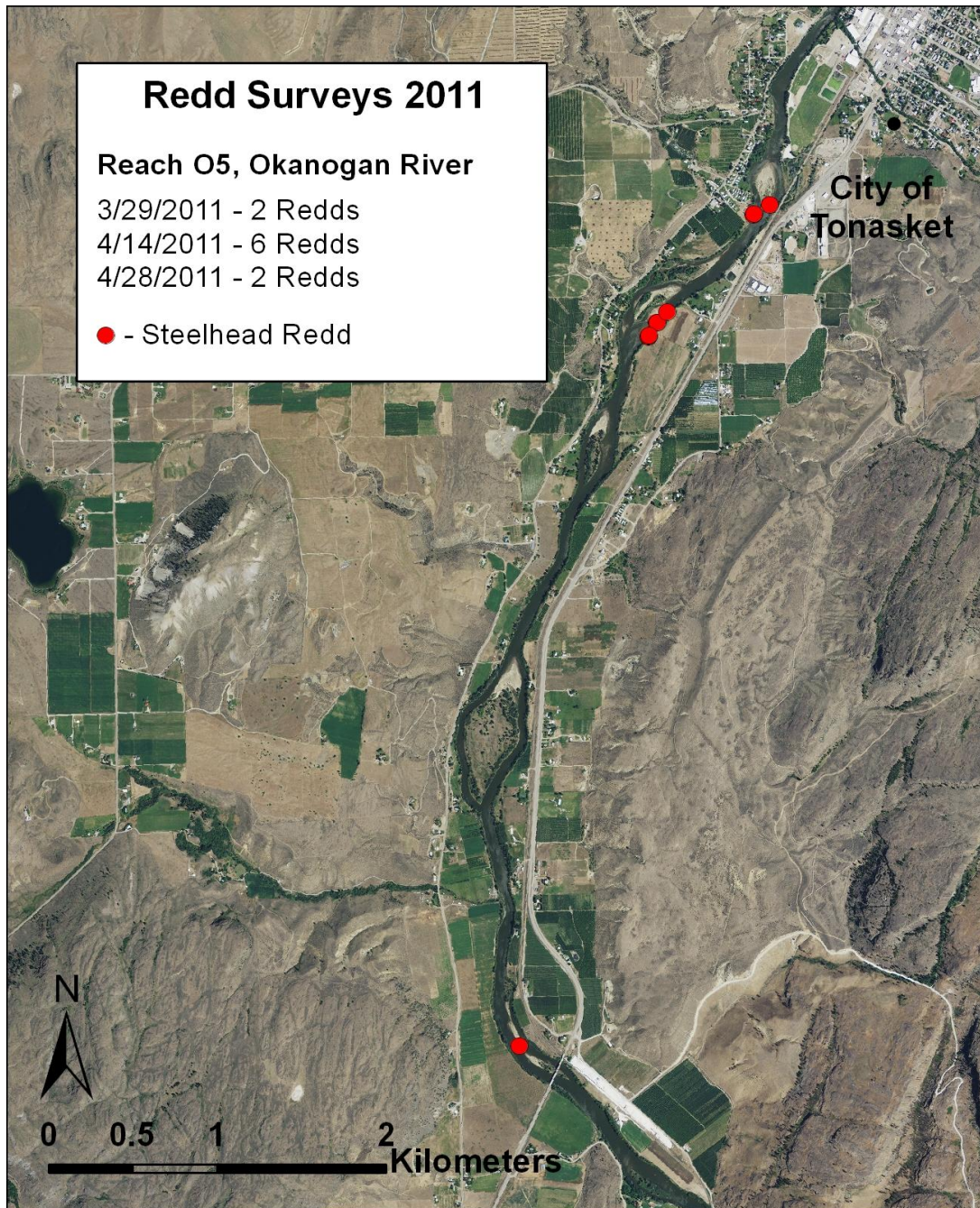


Figure 10. Okanogan River redd distribution observed in 2011 within reach O5 from the Chief Tonasket Park located in the town of Tonasket, WA downstream to the Highway 97 Bridge at Janis, WA.

Surveys were conducted on Reach O6 on March 31, April 18, and April 29. Only two redds were observed during the second survey (Figure 11). A total of 3 steelhead spawners, zero wild, were attributed to the 2 redds. No redds were identified in this reach in both 2008 and 2009; however, 40 redds were observed in 2010. Redds had been previously documented at both of the locations where redds were found in previous years.

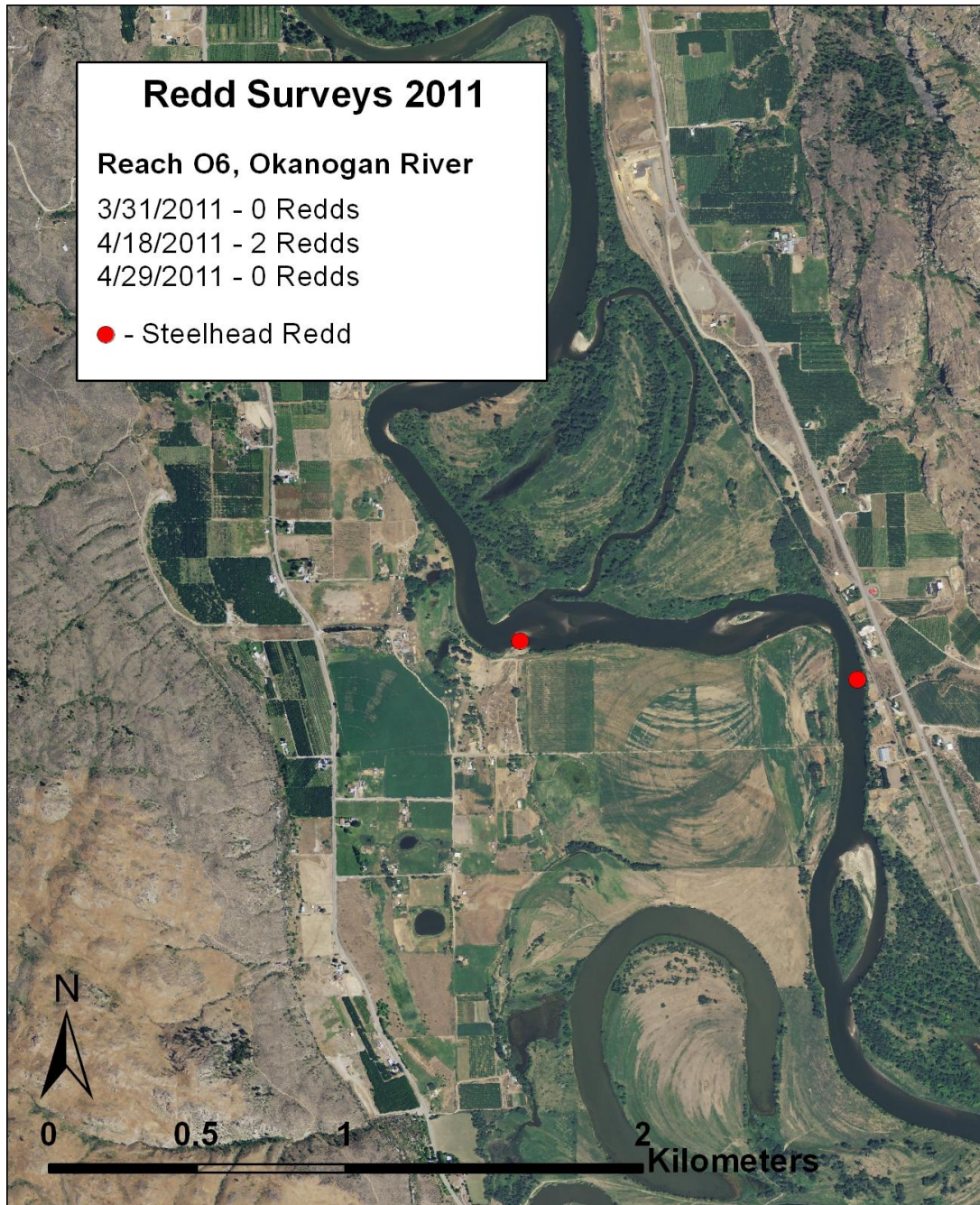


Figure 11. Redd distribution observed in 2011 within reach O6, from the confluence of the Okanogan and Similkameen Rivers to Horseshoe Lake.

Okanogan River Reach O7 was surveyed three times in 2011 and a total of 304 summer steelhead redds were identified. Thirty-seven redds were documented on April 5, 179 redds on April 20, and 87 redds on May 4. Additionally, one redd was previously observed on March 31, during a survey of a different reach. The majority of redds were observed downstream of Zosel Dam, but above Driscoll Island (Figure 12 and 13). As in previous years, much of the spawning activity was focused on ridges of gravel created by summer/fall Chinook. The value of 1.55 FPR provided a total estimate of 471 steelhead spawning within this reach. The mainstem value of 13.5% wild represented 64 of those fish as ad-present spawners. Reach O7 continues to be the most densely utilized spawning area in the Okanogan basin.

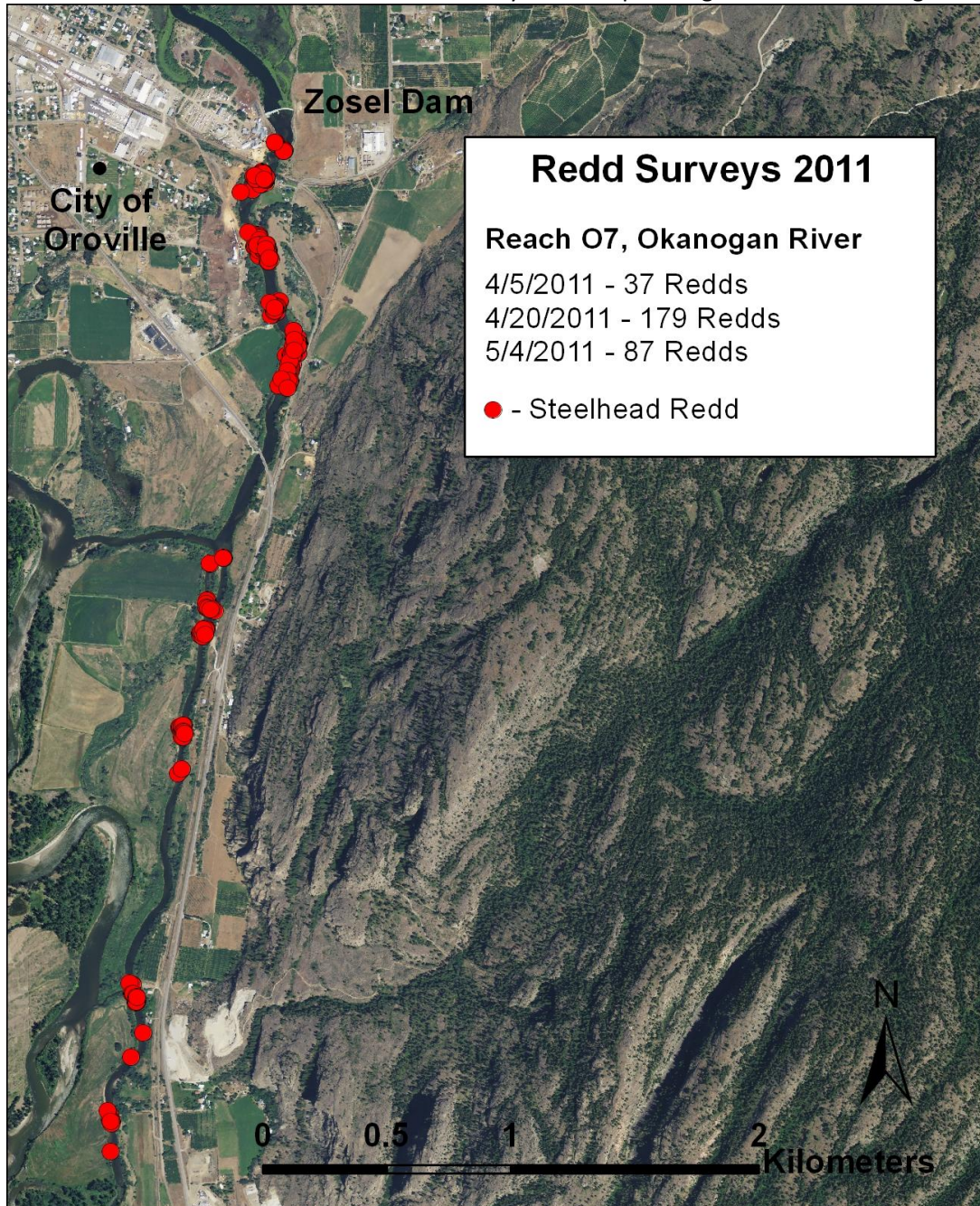


Figure 12. Redd distribution observed in 2010 for Okanogan River reach O7 which extends from Zosel Dam downstream to the confluence with the Similkameen River.

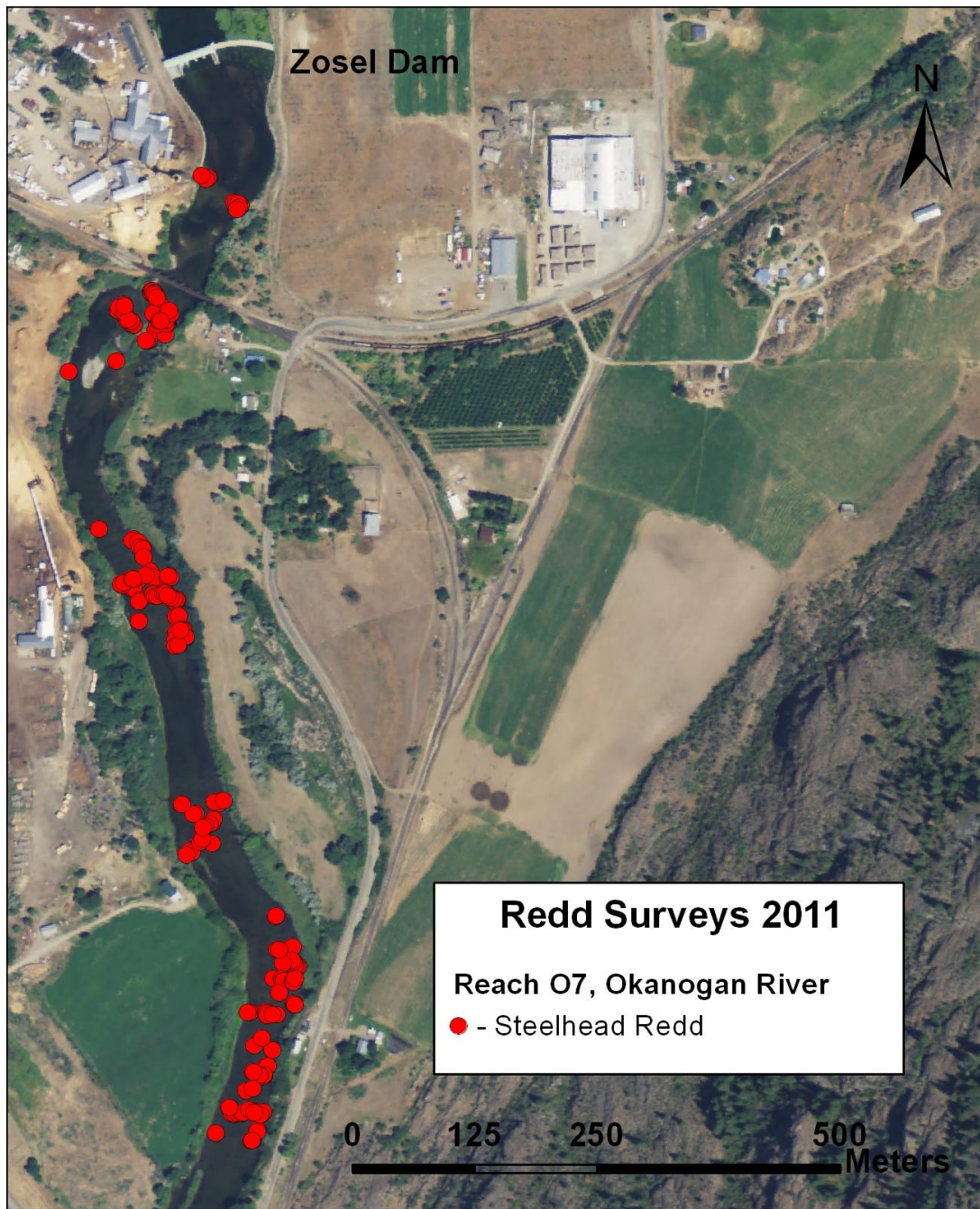


Figure 13. Map showing closer detail of redd distribution in the most extensively used spawning area on the Okanogan River, Reach O7.

Observers were able to survey the Similkameen River Reach S1 and Reach S2 three times each in 2011 due to favorable water clarity. A total of 122 redds were documented in Reach S1 which likely represented 189 steelhead spawners. In Reach S2, 138 spawners were extrapolated from 89 redds (Figure 14). From the mainstem 13.5% wild rate, 26 and 19 wild steelhead likely spawned in Reach S1 and S2, respectively. A large proportion of redds within this reach were observed near the city of Oroville, adjacent to the water treatment plant (Figure 15).

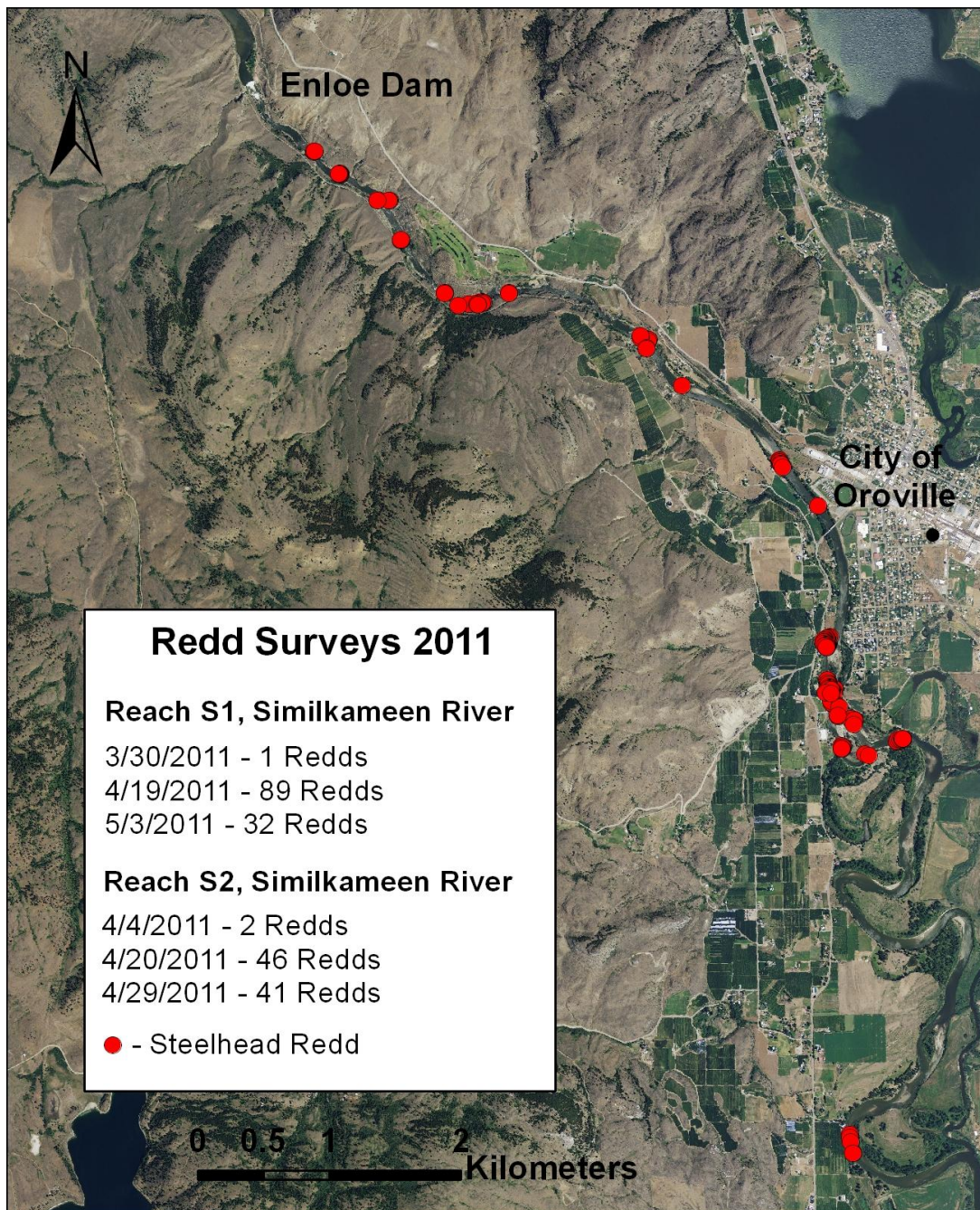


Figure 14. Redd distribution observed in 2011 for Similkameen River Reach S1 and S2. Reach S1 extends from the base of Enloe Dam downstream to the water treatment plant in Oroville, WA. Reach S2 encompasses the section between Oroville and the lower confluence with the Okanogan River.

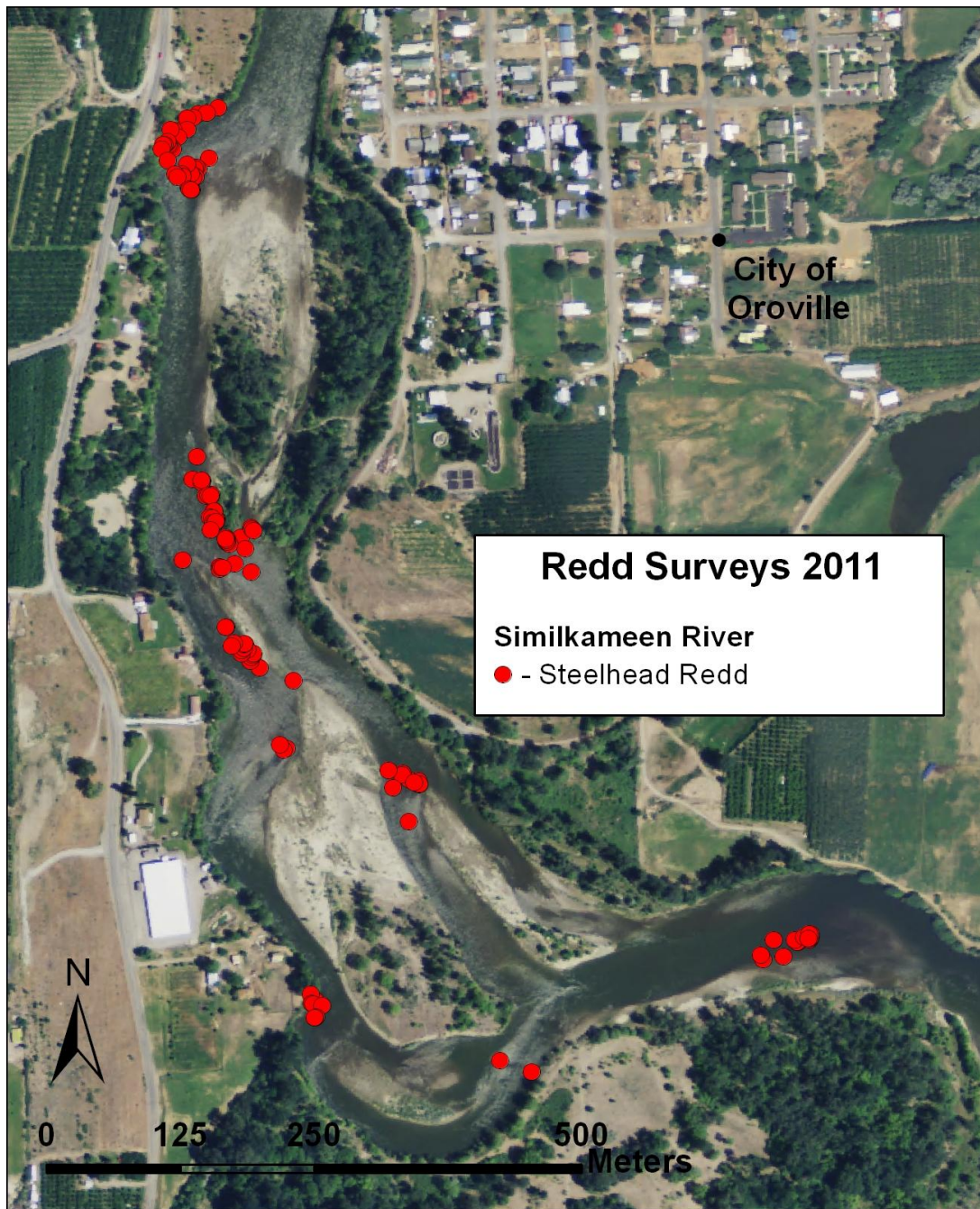


Figure 15. Map showing closer detail of redd distribution in the most extensively used spawning area on the Similkameen River.

Tributary redd surveys in the Okanogan River subbasin

Tributary surveys began as soon as water clarity allowed or landowner access was granted. Steelhead redd surveys within tributary habitats were conducted from March 31 through July 5. The upstream extent of each survey was limited by either a natural fish passage barrier or access to private land, as described in Arterburn et al. (2007a). Above-normal precipitation (Table 2) and discharge (Figure 16) in 2011 allowed adult steelhead to access many of the tributaries, including those which are frequently inaccessible due to low flows or dry creek beds. However, increased flows frequently resulted in reduced water clarity, which limited the effectiveness of redd surveys on many small tributaries.

Table 2. Precipitation totals measured by the National Weather Service at the Omak airport for March, April, and May 2011. <http://www.crh.noaa.gov/>

Month	2011	2010	2009	2008	2007	2006	Avg Precip (1981-2010)
March	2.72	0.52	0.93	0.73	0.08	0.81	0.89
April	0.23	1.21	0.19	0.19	0.06	0.89	0.91
May	2.96	3.05	1.23	0.18	0.74	1.35	1.18
Total	5.91	4.78	2.35	1.10	0.88	3.05	2.98

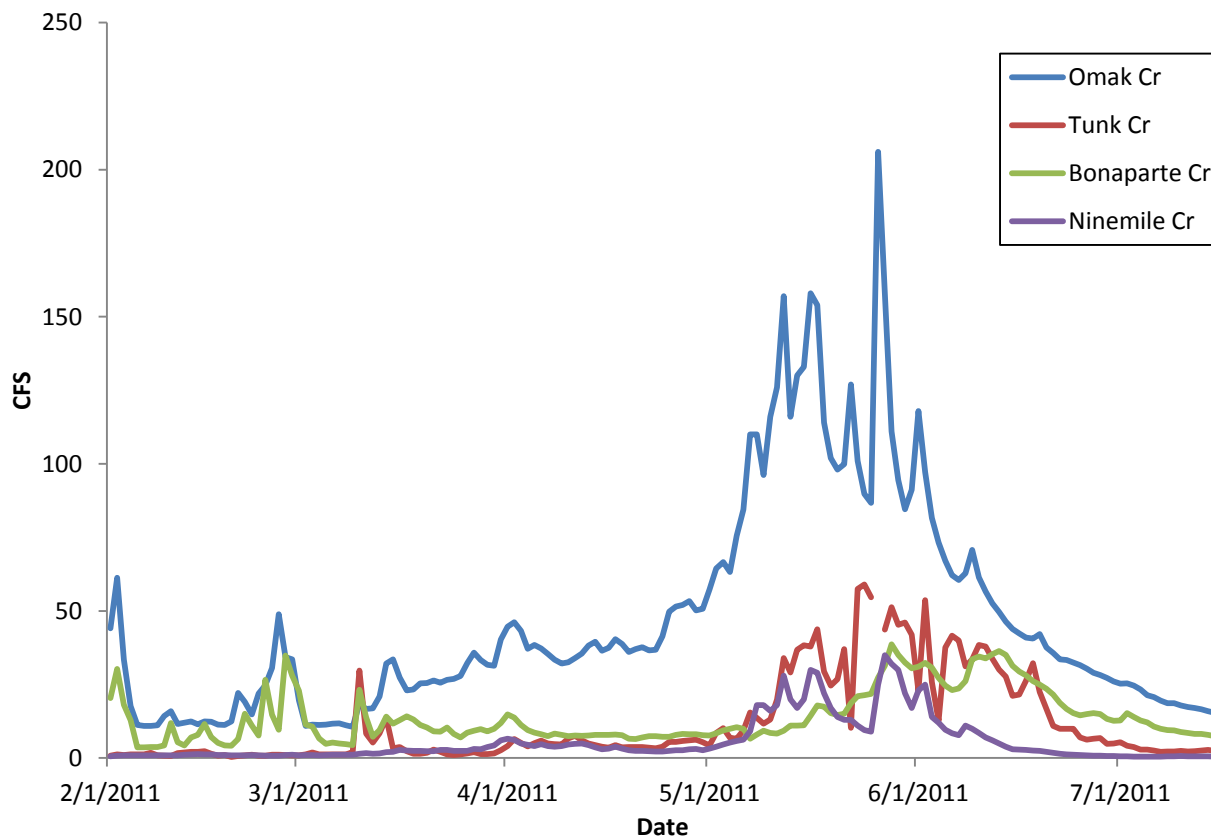


Figure 16. Discharge from February through June of 2011 for four tributary streams known to produce summer steelhead in the Okanogan basin. Data were obtained from the USGS and WA Dept of Ecology.

Loup Loup Creek

A history of low stream flows on Loup Loup Creek restricted anadromous fish access in the previous years, primarily due to an impediment (culvert) located at RKM 0.1. However, adequate flows allowed steelhead access into Loup Loup Creek and passage above the culvert in 2010 and 2011. Well above average discharge in 2011 limited redd survey effectiveness due to limited water visibility. Only one redd was documented on June 9, after visibility improved (Figure 17). A section of Loup Loup Creek was not surveyed due to access related issues and is marked in the figure below.

Due to the inability of redd surveys to comprehensively document spawning activity on Loup Loup Creek, PIT tag data were used to develop a local escapement estimate. One PIT tagged hatchery steelhead was detected at the seasonal PIT tag array located at the mouth of Loup Loup Creek. Based on the Priest Rapids Dam hatchery steelhead release tag rate of 8.3369%, twelve hatchery steelhead were expanded from this detection. It is likely that the escapement estimate calculated from PIT tag detections, rather than the one documented redd, more likely represented the actual number of steelhead using Loup Loup Creek in 2011.

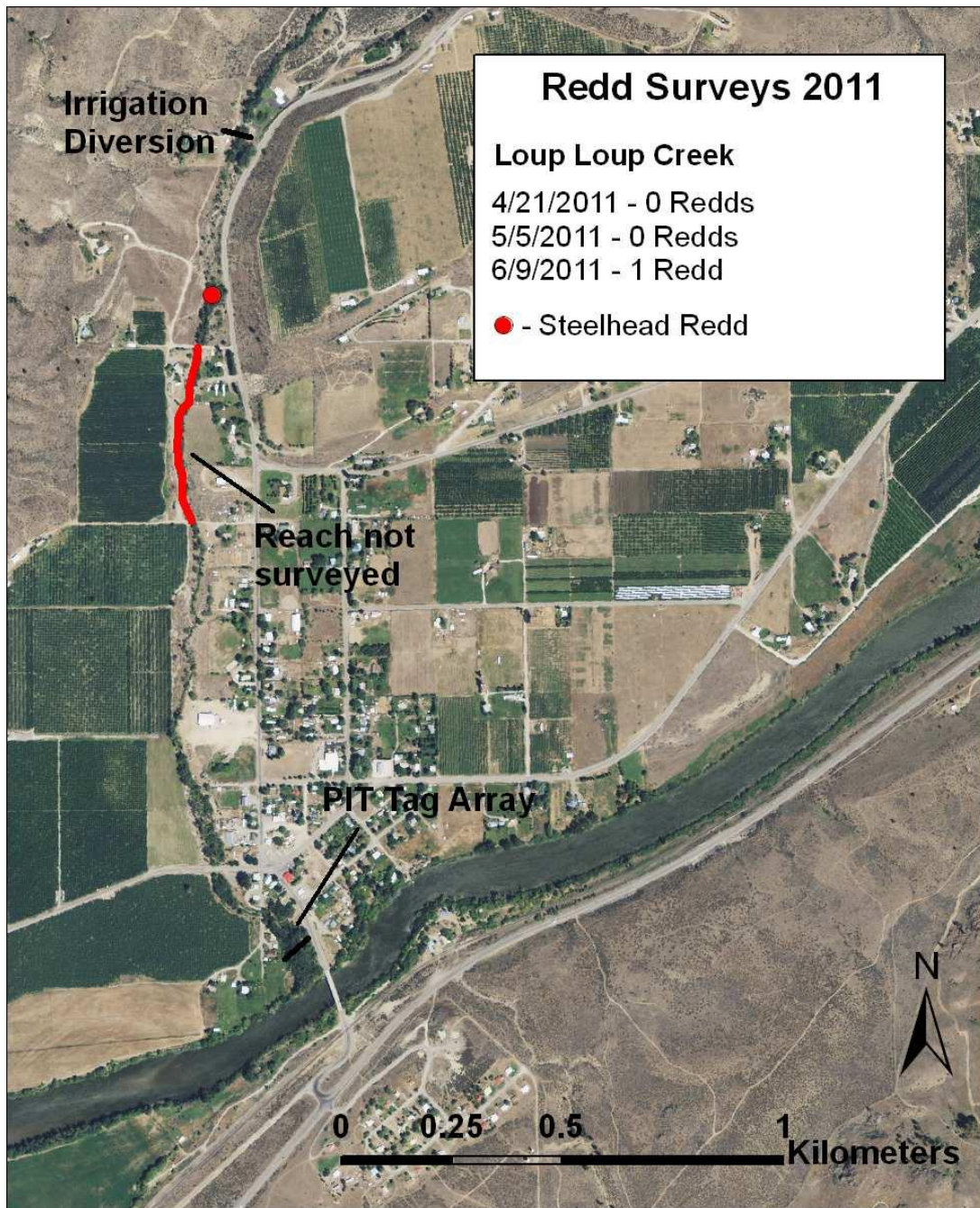


Figure 17. Map of summer steelhead redds observed in Loup Loup Creek, from the confluence with the Okanogan River to the irrigation diversion (barrier), during the spring of 2011. One section of the creek was not surveyed due to access related issues.

Salmon Creek

Since the early 1900's, the majority of water from Salmon Creek has been diverted for irrigation usage. The resulting dry stream channel extended from the Okanogan Irrigation District (OID) diversion dam (7.2 km) to the confluence with the Okanogan River. Occasionally, uncontrolled spills occurred downstream of the OID diversion dam on high water years. These spills typically occur in mid-May to June, which is after summer steelhead have already moved into tributaries to spawn. In order to provide sufficient water during the migration window of spring-spawning steelhead, the Tribes purchased water from the OID and allowed it to flow down the channel to the Okanogan River. After several years of successful evaluations of steelhead passage, the Tribes negotiated a long term water lease agreement with the OID in order to provide water for returning adults and out-migrating juveniles.

In 2011, water was again provided for a migration window, primarily for summer steelhead (Chris Fisher, Colville Tribes, pers. comm.). The potential for adult steelhead to access Salmon Creek from the mainstem Okanogan began the first week of March. Additionally, above average spring rainfall in 2011 significantly increased the amount of runoff that came down Salmon Creek in May and June (Figure 18). It is unknown to what extent scour events could have negatively impacted steelhead redds.

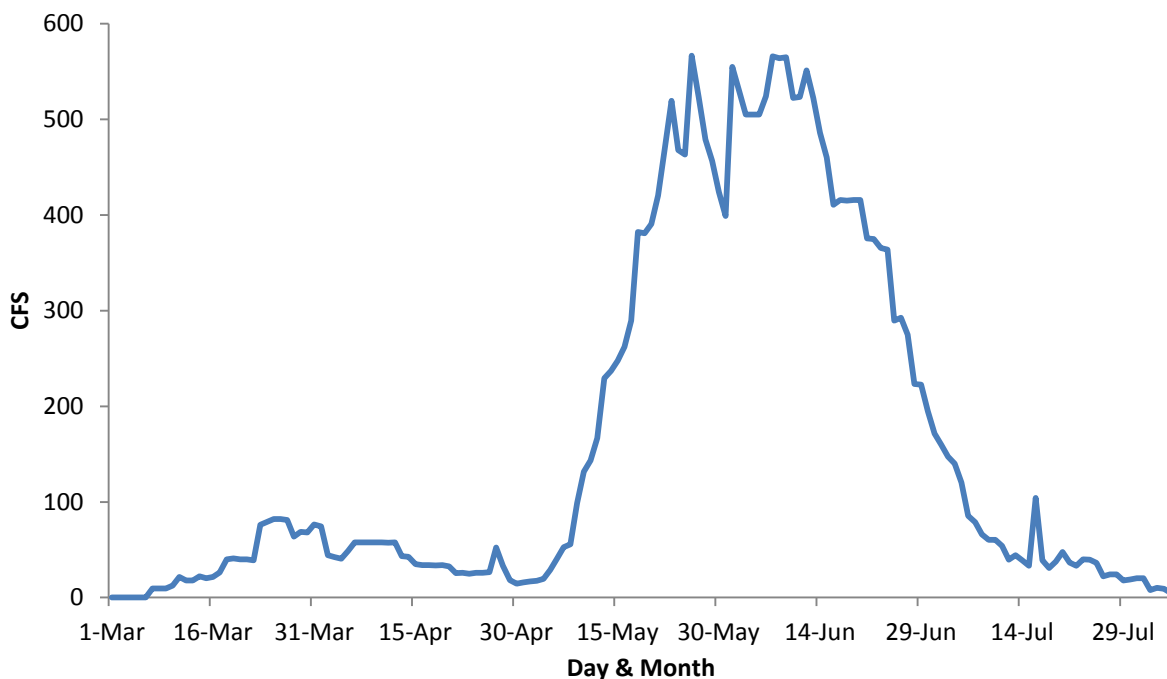


Figure 18. Release of water from Salmon Creek to allow steelhead passage and subsequent high water runoff occurring in 2011.

A specialized underwater video apparatus was installed into the fish ladder of the OID diversion dam in 2011. A total of 66 adult steelhead were observed passing upstream through the video chamber and 7 of those had intact adipose fins. The first steelhead was seen on April 3 and the final fish was counted on May 8. Due to the sustained high discharge rates occurring in 2011, water spilled over the concrete fish-ways at the diversion site. It is possible that an unknown number steelhead passed upstream of the diversion without passing through the video array during two separate high water events, March 22 - March 31 and May 20 - July 7.

The lower reach of Salmon Creek was surveyed for redds on May 2 and the upper reach was surveyed on May 5. A total of 45 steelhead redds were documented in the lower 7.2 km of Salmon Creek (Figure 19). Surveys could not be conducted after this date due to sustained high discharge rates until July. At that date, any previously constructed redds were unidentifiable. Using a FPR value of 1.8 (from Omak Creek) rendered 81 documented spawners below the diversion. Ad-present fish made up 10.6% of the fish observed in the video weir. This rate was applied to the redd count downstream of the video weir, which rendered 9 ad-present steelhead spawning between the confluence with the Okanogan River and the diversion site. The combined estimate of 147 spawners, from redd surveys and video observations, should be considered a minimum escapement estimate, due to high water and incomplete surveys in 2011.

Sixteen hatchery and one wild steelhead from the Priest Rapids release group were detected at the PIT tag array on Salmon Creek. The calculated escapement estimate from those detections were 192 hatchery and 12 wild steelhead. In addition to the tag detections, three redds were constructed downstream of the array, which added 5 more hatchery steelhead. The total spawning estimate for Salmon Creek based on tag detections and 3 downstream redds was 209 steelhead, 12 of which were likely wild (Table 3).

Table 3. Two methods for calculating escapement estimates in Salmon Creek. (A) Video counts at the OID diversion and redd surveys conducted below the diversion and (B) expansion based on PIT tag detections.

A. Redd surveys and video count, Salmon Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Below Diversion (Redd surveys)	45	81	9
Above Diversion (Video monitoring)	Surveys not conducted	66	7
Total	n/a	147	16

B. PIT Tag detection estimation, Salmon Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Total	n/a	204	12

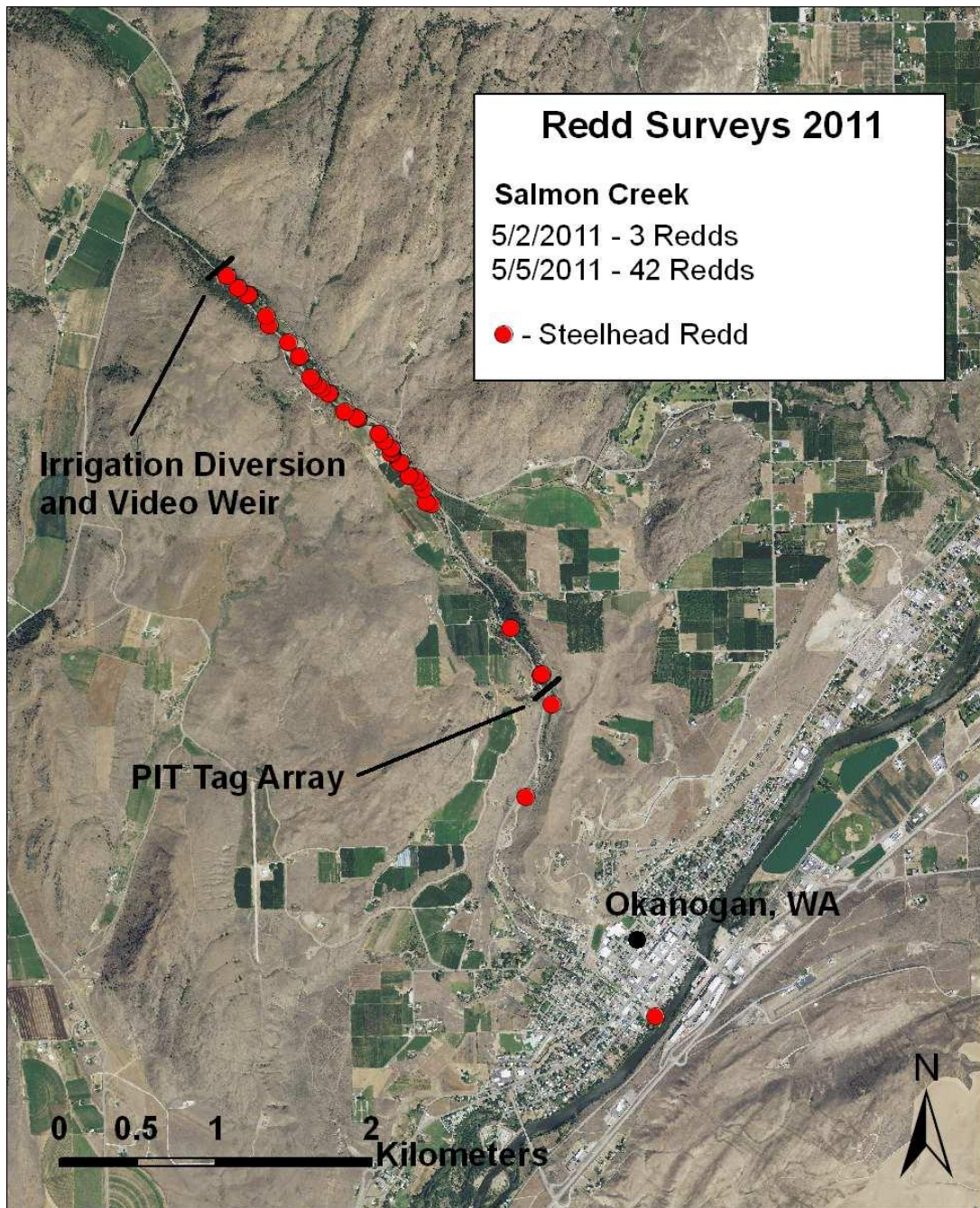


Figure 19. Map of summer steelhead redds observed below the Salmon Creek trap during the spring of 2011. The lower reach, below the PIT tag array, was surveyed on May 2 and the upper reach was surveyed on May 5.

Omak Creek

The highest proportion of wild steelhead was recorded at the weir trap in 2011, since data were first collected in 2001, with 85.7% of all steelhead being of natural origin (Table 4). Twenty-five male and 31 female steelhead were sexed at the trap, rendering a sex ratio of 0.8 M:F (1.8 FPR), which was applied to redd surveys occurring downstream of the trap. The run timing at the Omak Creek weir appeared to be the second earliest since 2005 (Figure 21).

Redd surveys identified 29 redds below the Omak Creek weir trap (Figure 22). Only one redd survey was conducted in 2011 because discharge levels were not conducive to survey spawning activity until July, after all spawning activity had ceased. Using the FPR value of 1.8 from the Omak Creek weir trap, an estimated 52 steelhead likely spawned between the mouth of Omak Creek and the trap. Thirteen redds were constructed immediately downstream of the weir trap, possibly suggesting trap avoidance behavior. However, trap avoidance continued to be less prevalent than in prior years, based on trap modifications made in 2009 (Rhonda Dasher, Colville Tribes Biologist, pers. comm.). Based on combined redd surveys and weir counts, we estimated that a total of 108 adult steelhead spawned in Omak Creek in 2011 (Figure 20).

Table 4. Proportions and totals of male, female, and wild summer steelhead passed above the Omak Creek trap in 2011.

Omak Creek Adult Weir Trap, 2011	Total (N)	Wild (N)	Percent-Wild (%)
Total	56	48	85.7%
Males	25	20	80.0%
Females	31	28	90.3%

A permanent PIT tag array was located on Omak Creek, just upstream from the confluence with the Okanogan River, but below the adult weir trap. Eight wild and 3 hatchery steelhead from the Priest Rapids release group were detected at this location in the spring of 2011. A total of 96 wild and 36 hatchery steelhead were calculated from those PIT tag detections. No steelhead redds were observed below the PIT tag array. Therefore, it is probable that a minimum of 108, but more likely 132 steelhead spawned in Omak Creek in 2011 (Table 5).

Table 5. Two methods for calculating escapement estimates in Omak Creek. (A) Weir counts and redd surveys below the weir and (B) expansion based on PIT tag detections.

A. Redd survey and adult weir count, Omak Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Below Weir (Redd surveys)	29	52	45
Above Adult Weir	Surveys not conducted	56	48
Total	n/a	108	93

B. PIT Tag detection estimation, Omak Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Total	n/a	132	96

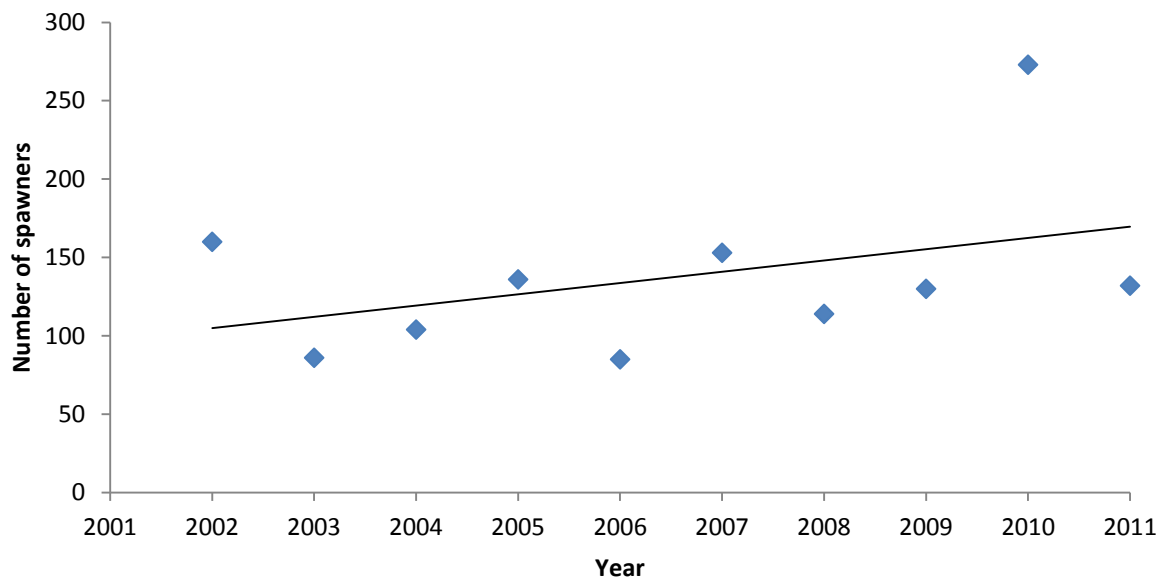


Figure 20. Total number of summer steelhead estimated to have spawned in Omak Creek, 2002 to 2011.

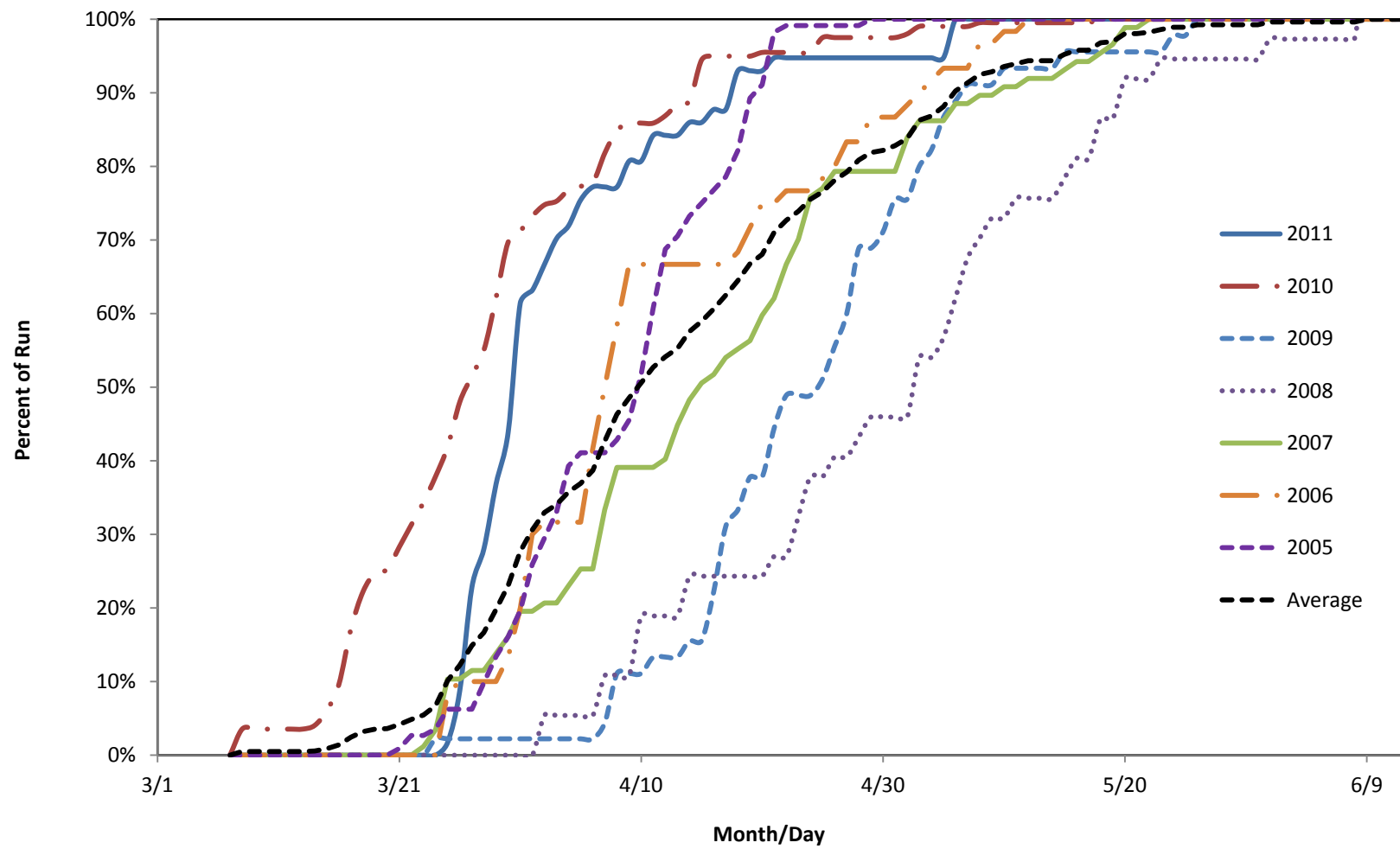


Figure 21. Run timing of summer steelhead captured at the Omak Creek weir trap, 2005-2011.

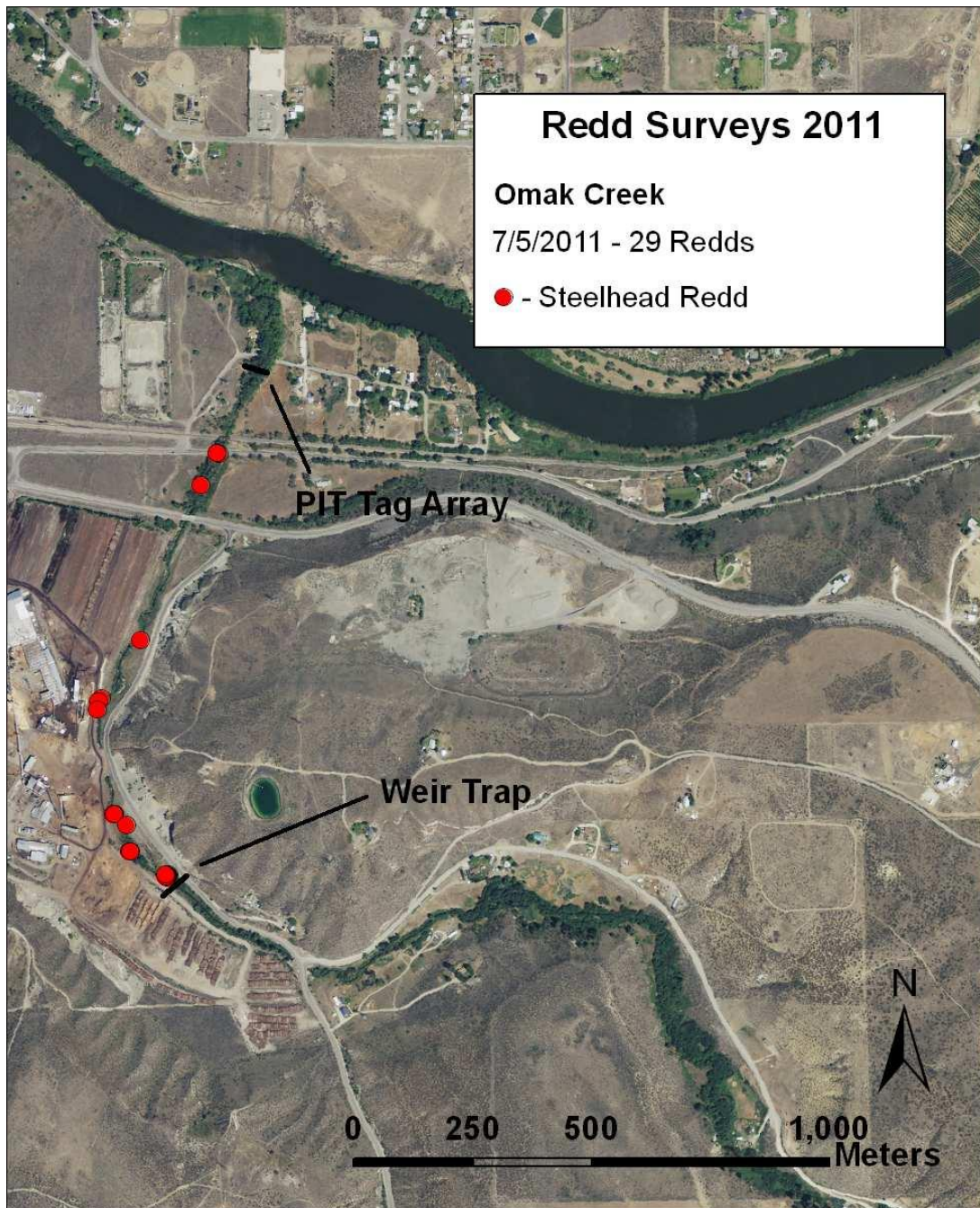


Figure 22. Map of summer steelhead redds observed below the Omak Creek trap during the spring of 2011.

Wanacut Creek

Although sufficient flows existed to allow water to reach the Okanogan River, no adult steelhead or redds were observed in Wanacut Creek in 2011. No steelhead were detected on the seasonal PIT tag array, which was located just upstream of the confluence with the Okanogan. A seasonal PIT tag array will again be installed in 2012 to help further examine the potential benefits of stream restoration activities on returning adult steelhead in Wanacut Creek.

Tunk Creek

On April 13, one redd was identified immediately upstream of the Tunk Creek confluence with the Okanogan River. One additional redd was documented on April 27 and 30 identified on May 5 (Figure 23). Using a value of 1.8 FPR derived from the Omak Creek weir trap, provided an estimate of 56 steelhead that spawned in Tunk Creek. On May 5, 11 steelhead were observed on redds in Tunk Creek, with two of these being ad-present and nine being marked hatchery fish. Extrapolating this percent wild-rate (18%) to the total of 56 steelhead, represented 10 wild spawners. Tunk Creek was only surveyed completely up to the barrier in the two years prior to 2011; escapement estimates were 10 steelhead in 2009 and 109 in 2010.

A seasonal PIT tag array was installed near the mouth of Tunk Creek in the spring of 2011. One wild and 4 hatchery steelhead were detected at this location. Based on the Priest Rapids release group, the calculated spawning escapement was 12 wild and 48 hatchery fish. Both methods used appeared to validate one another (the redd survey expansion estimated 56 total, 10 wild steelhead and the PIT tag detection estimated 60 total, 12 wild steelhead).

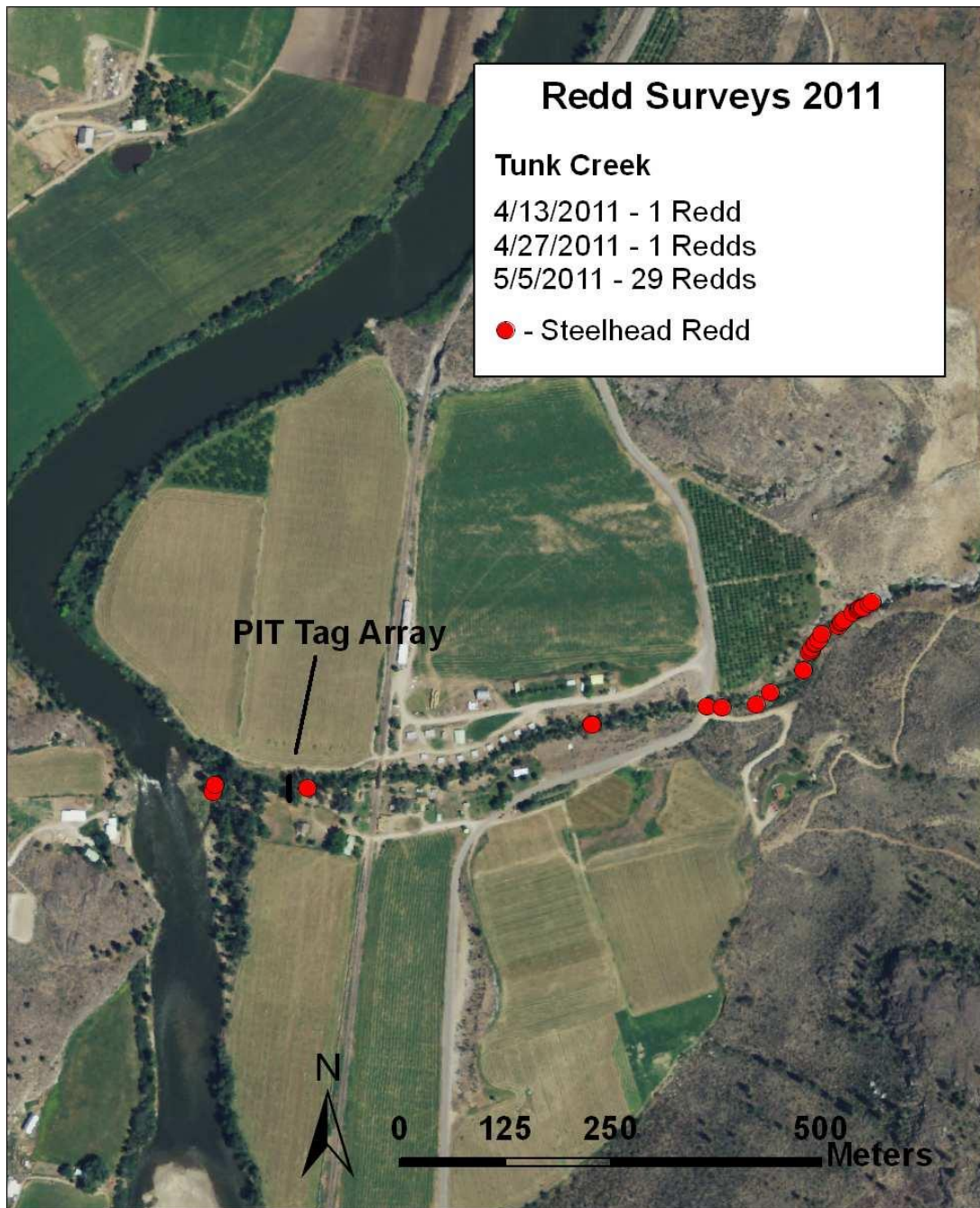


Figure 23. The distribution of redds observed in Tunk Creek during 2011, from the confluence with the Okanogan River upstream to Tunk Falls (anadromous barrier).

Bonaparte Creek

An adult weir trap was installed on Bonaparte Creek in 2011. A total of four wild steelhead and one hatchery steelhead were collected at the Bonaparte Creek weir (Table 6). Difficulties with high discharge rates, paired with damage to the weir trap, may have led to an undetermined number to steelhead passing by the trap without being counted. Redd surveys were conducted downstream of the Bonaparte Creek trap on April 14 and April 28. A total of 4 steelhead redds were observed (Figure 24). Based upon the value of 1.8 FPR generated from adult steelhead collected at the Omak Creek weir trap, an estimated 7 summer steelhead spawned downstream. The percent-wild value, calculated at the trap site and applied to downstream redds, provided an estimate of 6 wild fish that spawned downstream of the weir. When the redd survey estimate and weir count were summed, the result was 12 total spawners in Bonaparte Creek, 10 of them likely wild.

Although preliminary plans existed to construct a permanent PIT tag array in Bonaparte Creek in early 2011, installation did not occur due to complications with providing power to the site and noise issues. Therefore, a secondary escapement estimate could not be determined from tag detections. Due to high water events and the subsequent difficulties surrounding the weir trap, the final number of steelhead in Bonaparte Creek should be considered a minimum estimate.

Table 6. Proportions and totals of male, female, and wild summer steelhead at the Bonaparte Creek weir trap in 2011.

Bonaparte Creek Adult Weir Trap, 2011	Total (N)	Wild (N)	Percent-Wild (%)
Total	5	4	80%

Antoine Creek

Antoine Creek flows perennially; however, minimal discharge across an alluvial fan at the mouth of the creek may have deterred access of adult steelhead throughout much of the 2011 spawning season. When the stream was surveyed on May 9, one summer steelhead redd was observed between the confluence with the Okanogan River to the video weir/PIT tag array (Figure 25). No adult steelhead were documented passing through the video weir in 2011, which operated from March 20 – May 17. However, one hatchery steelhead was documented on the PIT tag array (two antennas downstream of the video system and two antennas upstream) during a short timeframe when turbid water obscured video observation. Due to the fact that the steelhead was tagged at Wells Dam and not from the representative random mark group at Priest Rapids, an expanded escapement estimate was not calculated from that detection.

Although escapement was zero in 2008, 2009, and 2010, and only two steelhead in 2011, snorkel surveys have identified multiple year-classes of both brook trout and *O. mykiss*, indicating that rearing conditions exist (Kistler et al. 2006, Kistler and Arterburn 2007). To accelerate the reestablishment of summer steelhead in Antoine Creek, approximately 3,000 juvenile steelhead were released during April of 2008 (Fisher 2008). However, the relatively large delta at the confluence of Antoine Creek makes access difficult for returning adult steelhead. Consideration should be given to increasing flow and improving adult steelhead access during typical flow conditions.

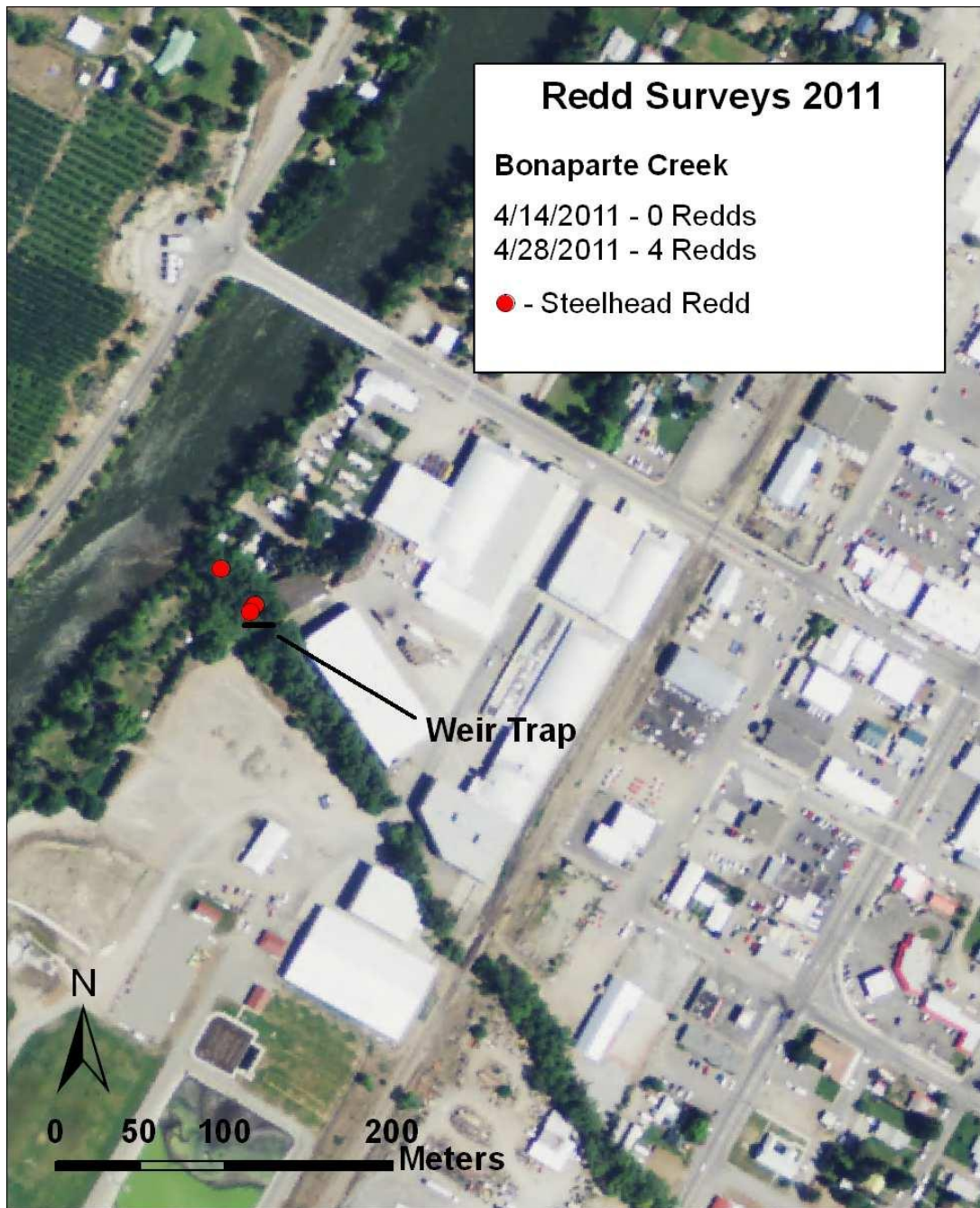


Figure 24. Distribution of redds observed in Bonaparte Creek during 2011, from the confluence with the Okanogan River upstream to the Bonaparte weir trap.



Figure 25. Redd distribution observed in 2011 for Antoine Creek from the confluence with the Okanogan River upstream to the video array.

Wild Horse Spring Creek

Wild Horse Spring Creek was surveyed March 31, April 18, April 29, and June 9, 2011. A total of 21 redds were documented (Figure 26). Thirty-three steelhead, five of those considered of natural-origin, were estimated to have spawned in this creek in 2011 based on 1.55 FPR and a 13.5% wild rate. The majority of redds on Wild Horse Spring Creek were documented for a second year in a row in a recently rehabilitated section of creek, immediately upstream (east) of Hwy 97. The stream channel rehabilitation created more habitat complexity, added spawning substrate, reestablished stream channel, and stabilized banks through riparian shrub plantings along approximately 300 meters of creek. Between April 29 and June 9 surveys, turbid water prevented observation of redds and an unknown number of redds may have been not counted.

A PIT tag array located near the mouth of Wild Horse Spring Creek documented a total of 2 wild and 9 hatchery steelhead during the spring of 2011. Expanding those detections with the tag rate of steelhead at Priest Rapids Dam rendered 24 wild and 108 hatchery steelhead. It is likely that the actual escapement value is closer to the PIT tag derived estimate of 132 steelhead, rather than the 33 that was estimated by redd surveys, due to peak spawning being missed during high run off.

Tonasket Creek

During most years, Tonasket Creek flows intermittently during the spring and completely dries up by mid-summer in the lower-most 3 km. However, above average flows existed in 2011 and allowed for steelhead passage. Steelhead redd surveys were conducted on Tonasket Creek only on June 23 and were constrained on previous dates by limited water visibility. A total of three redds were identified (Figure 27). The mainstem value of 1.55 FPR and 13.5% wild rate was applied to those redds, based on the fact that access to steelhead has been limited and few observations of spawning have been documented in previous years. Expanded redd counts represented five spawners, one of which may have been ad-present. Based on the delayed redd surveys, which could not be conducted until the end of June, this number should represent a minimum number of spawners.

A PIT tag array located near the mouth of Tonasket Creek documented one wild and 4 hatchery steelhead (Priest Rapids mark group), which were expanded to 12 wild and 48 hatchery steelhead. This escapement estimate likely better represented the actual number of steelhead that spawned in Tonasket Creek in 2011.

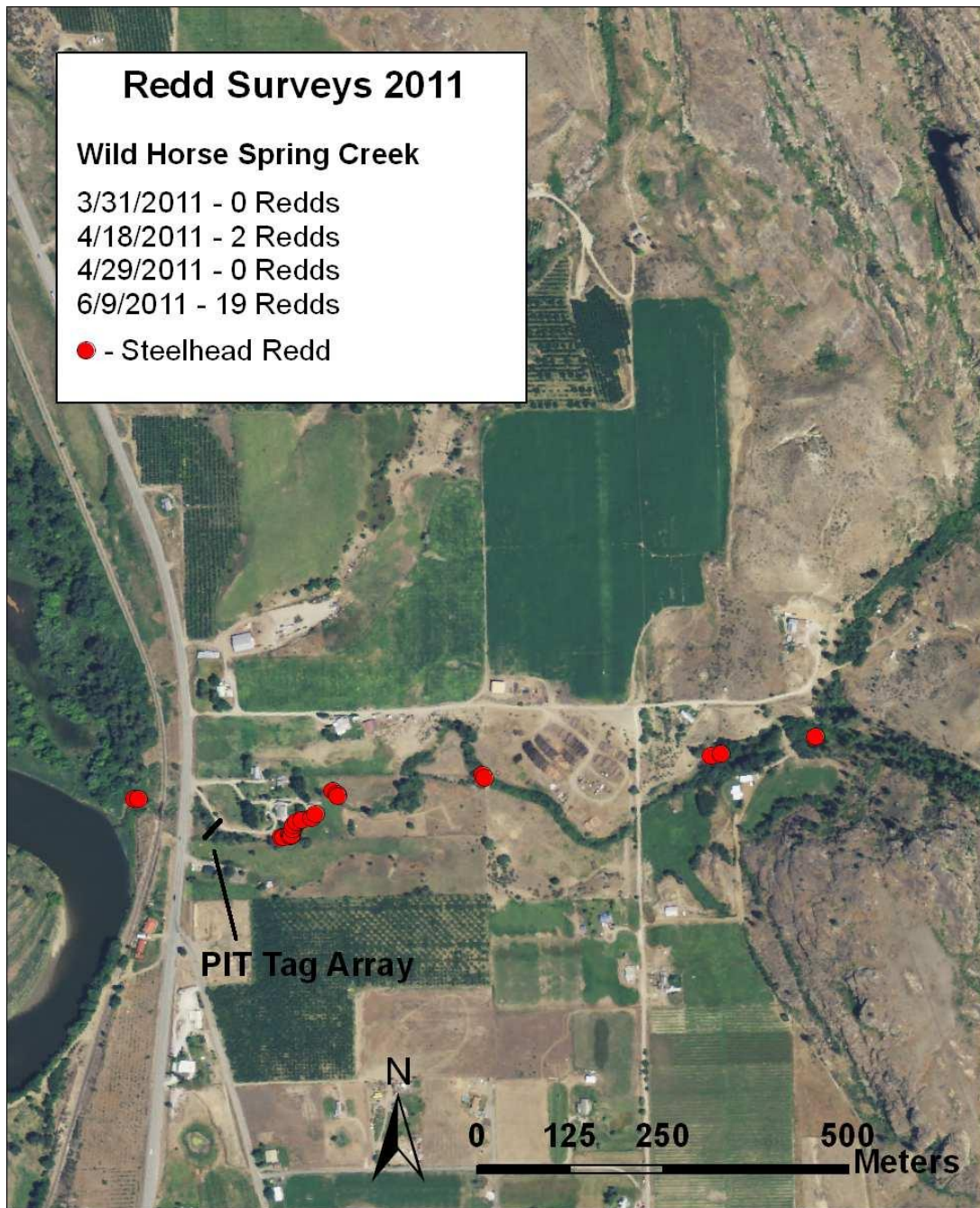


Figure 26. Redd distribution observed in 2011 for Wild Horse Spring Creek from the confluence with the Okanogan River upstream to the anadromous barrier.



Figure 27. Redd distribution observed in 2011 for Tonasket Creek, from the confluence with the Okanogan River upstream to the anadromous barrier.

Ninemile Creek

The lower 0.7 km of Ninemile Creek was surveyed on June 9 and no redds were observed. Discharge and water clarity during the month of May prevented redd surveys from occurring prior to this date. Significant stream bed movement occurred and deposition of substrate up to two feet deep was noted in many areas. It is likely that an unknown number of redds were constructed in Ninemile Creek, but were unidentifiable by June. For spatial reference, redds documented from previous years surveys from 2004 to 2010 are shown in Figure 28. A video counting array at RKM 0.7 documented 8 hatchery and 11 ad-present adult steelhead that passed above this point. The digital video recorder was disabled from April 1 through April 6 and the first steelhead were observed passing the video array on April 7, as soon as repairs were made. Significant sediment deposition buried and disabled the video system on May 4 through the end of the spring runoff period. Therefore, the 19 steelhead observed passing the video system should be considered a minimum escapement estimate.

A permanent PIT tag array was in place throughout 2011 at the same location as the underwater video system. Based on the tag rate of the Priest Rapids release group, two hatchery and one wild detection were expanded to 24 and 12 fish, respectively (Table 7).

Table 7. Two methods for calculating escapement estimates for Ninemile Creek. (A) Video count and redd survey conducted below the video station and (B) expansion based on PIT tag detections.

A. Redd survey and video count, Ninemile Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Below Video Weir (Redd surveys)	0	0	0
Above Video Weir	Surveys not conducted	19	11
Total	n/a	19	11

B. PIT Tag detection estimation, Ninemile Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Total	n/a	36	12

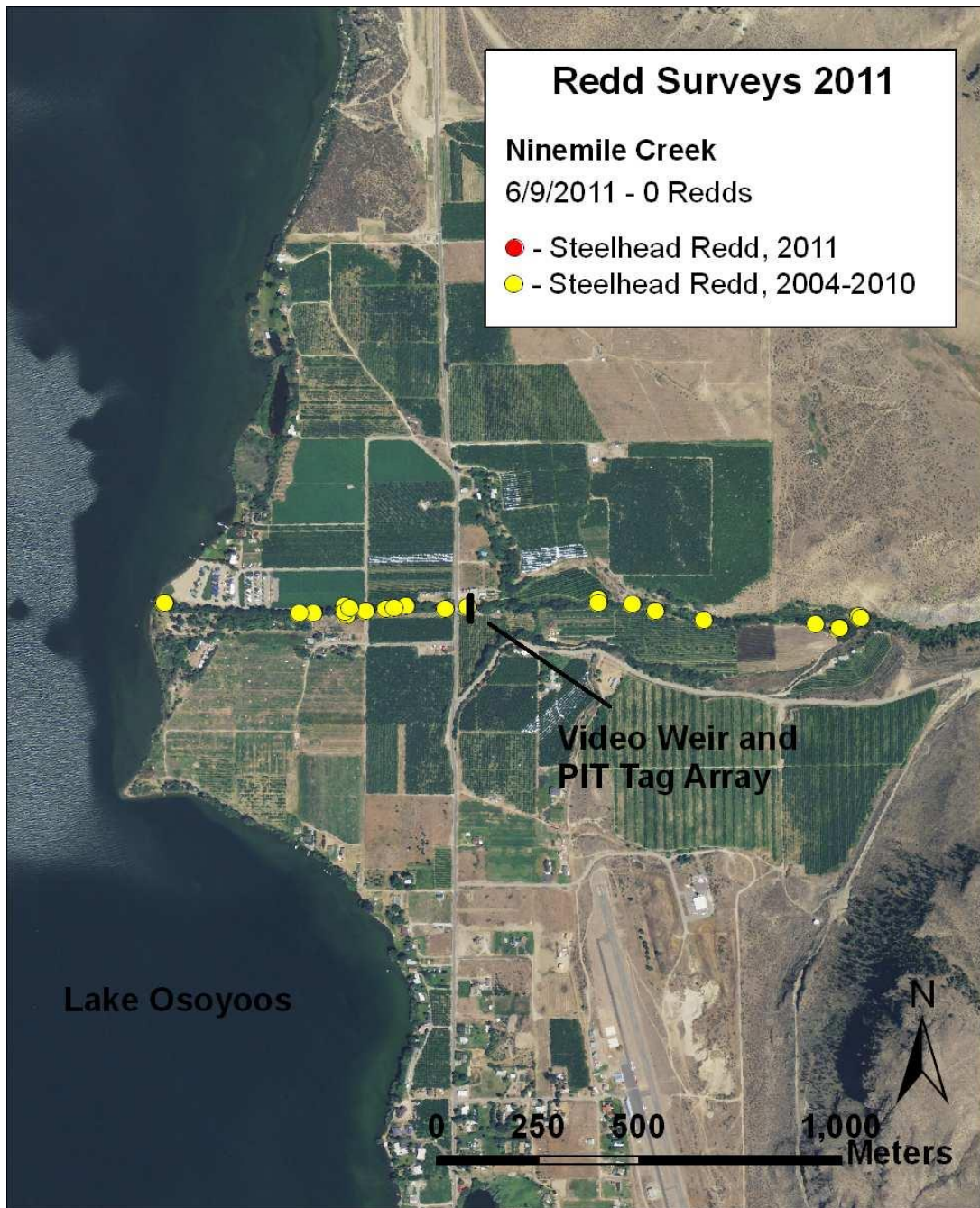


Figure 28. Redd distribution from 2004-2010 for Ninemile Creek. No redds were observed in 2011 below the video weir at RKM 0.7 due to high water runoff.

Escapement into British Columbia

From July 2010 through June 2011, 270 summer steelhead were counted on underwater video passing Zosel Dam through the fishways (Table 8). In order to determine the number of steelhead unaccounted for in Lake Osoyoos, the estimated number of spawners that entered Ninemile (36 steelhead) and Tonasket (60 steelhead) Creeks were subtracted from the total number counted at Zosel Dam. These two creeks are located upriver (north) of Zosel Dam, but south of the international border. Therefore, 174 summer steelhead may have passed into habitats beyond Lake Osoyoos.

A total of 62 ad-present summer steelhead were observed at the Zosel Dam video station. The estimated number entering Ninemile (12 ad-present steelhead) and Tonasket (12 ad-present steelhead) Creeks were subtracted from the total, resulting in an estimate of 38 ad-present summer steelhead. Of the total number of summer steelhead unaccounted for in Lake Osoyoos, 21.8% were likely ad-present.

Table 8. The number of adult summer steelhead that passed Zosel Dam by month for the 2011 spawner cohort, July 2010 to June 2011.

Zosel Dam Video Counts			
Month	Ad-Clipped	Ad-Present	Total
July, 2010	0	0	0
August	0	0	0
September	1	0	1
October	0	0	0
November	0	0	0
December	0	0	0
January, 2011	0	0	0
February	0	0	0
March	13	10	23
April	174	37	211
May	20	15	35
June	0	0	0
Total	208	62	270

PIT Tag Detections at VDS-3

Two PIT tagged adult wild steelhead from the Priest Rapids release group were detected at the PIT tag array located at VDS-3, in the mainstem Okanogan River, just north of Osoyoos Lake. Based on those detections, an estimated 24 wild steelhead passed above this point. In addition to the steelhead tagged at Priest Rapids, one additional wild steelhead and three hatchery steelhead were detected at this location. However, those fish were not part of the Priest Rapids release group, and therefore, not expanded into the total escapement estimate.

Bringing it all together

In the United States, summer steelhead are currently listed as “threatened” under the Endangered Species Act in the Upper Columbia River Evolutionary Significant Unit. Detailed percent-wild information for 2011 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 it is difficult to define natal origin through visual observation alone (i.e. intact adipose fin). Values presented in this document represent our best scientific estimate from available information, but the variability surrounding our point estimates is unknown. Thus, high and low estimates are also provided to represent a full range of potential scenarios. A summary of the best available counts and estimates for each reach or sub-watershed throughout the Okanogan River basin are presented in Table 9.

The total escapement estimate for Okanogan River summer steelhead spawners in 2011, based on redd surveys, weir traps, PIT tags, and video data, was likely between 1,479 and 1,687 (Table 10). Since 2005, the number of spawning summer steelhead in the Okanogan River has been growing at a rate of 258 per year (Figure 29). For 2011, the WDFW estimated maximum spawner escapement into the Okanogan River basin at 2,497 summer steelhead (Charles Frady, WDFW, pers. comm.). The WDFW estimate was derived from Wells Dam passage counts, modified by harvest information, and divided into individual subbasins (Methow and Okanogan) through the use of radio telemetry data (English et al. 2001, 2003).

The WDFW escapement estimate for wild steelhead in the Okanogan basin was 338; OBMEP estimated that between 307 and 339 ad-present steelhead likely spawned within the Okanogan River basin in 2011 (Table 11). The range in our estimate of wild steelhead was directly linked to uncertainty in the actual origin of ad-present steelhead. Additionally, inconsistent percentages of ad-present steelhead that utilized individual tributaries (i.e. 85.7% wild for Omak Creek vs. 10.6% for Salmon Creek) complicated percent-wild calculations from redd counts where we had no means of determining local counts. Since 2005, the Okanogan River population of wild steelhead has been increasing by approximately 62 steelhead per year (Figure 30).

Table 9. Estimated number of total and wild spawning steelhead for each sub-watershed or counting location in 2011. The grand total for the entire Okanogan River population is presented with subtotals for tributary and mainstem habitat types in Washington and British Columbia.

Distribution of Steelhead Spawning in the Okanogan Basin, 2011			
Category	Description/location	Estimated Total # Spawners	Estimated Total # Wild
WA Mainstem	Reach O1	3	0
WA Mainstem	Reach O2	16	2
WA Mainstem	Reach O3	0	0
WA Mainstem	Reach O4	14	2
WA Mainstem	Reach O5	15	2
WA Mainstem	Reach O6	3	0
WA Mainstem	Reach O7	471	64
WA Mainstem	Reach S1	189	26
WA Mainstem	Reach S2	138	19
WA Tributary	Loup Loup Creek	12 ^a	0
WA Tributary	Salmon Creek	209 ^a	12 ^a
WA Tributary	Omak Creek	132 ^a	96 ^a
WA Tributary	Wanacut Creek	0	0
WA Tributary	Tunk Creek	56	10
WA Tributary	Bonaparte Creek	12	10
WA Tributary	Antoine Creek	2	0
WA Tributary	Wild Horse Spring Creek	132 ^a	24 ^a
Zosel Dam	Observed Passing Zosel Dam	270	62
WA Tributary	Tonasket Creek	60 ^a	12 ^a
WA Tributary	Ninemile Creek	36 ^a	12 ^a
Subtotals	Adult escapement into WA mainstem	849	115
Subtotals	Adult escapement into WA tributaries	651	176
Subtotals	Adult escapement into BC	174	38
Grand total		1,674	329

^a Total is based on expanded PIT tag detections.

Table 10. Total escapement of summer steelhead for the Okanogan River, since 2005, including combined hatchery and natural-origin summer steelhead estimates.

Okanogan River summer steelhead spawner population trend data				
Year	WDFW escapement estimate ^b	OBMEP spawner survey estimate		
		Low	Estimate	High
2005	2,233	1,147	1,315 ^c	1,482
2006	1,602	779	855 ^c	930
2007	1,921	1,234 ^d	1,266 ^d	1,280 ^d
2008	1,755	1,341	1,386	1,436
2009	2,211	2,020	2,133	2,198
2010	3,920	3,236	3,496	3,596
2011	2,497	1,479	1,674	1,687

^b WDFW restated previous escapement estimates from previous years in 2010.

^c Estimated mainstem reach data rather than empirical data, as in other years.

^d Only a low and high value was reported, so a simple arithmetic mean was computed.

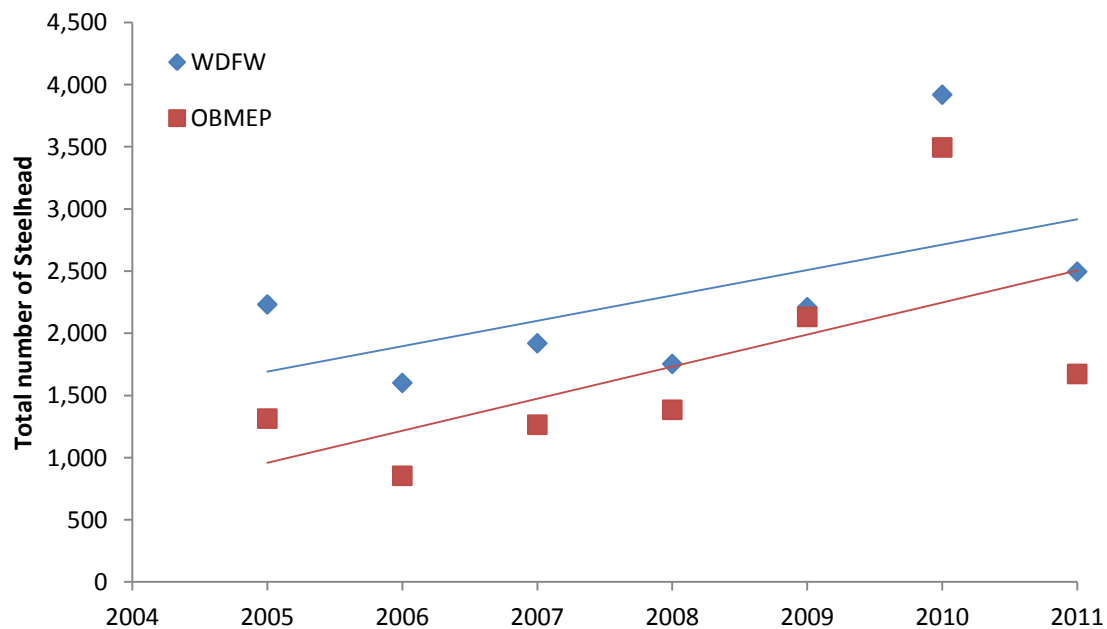


Figure 29. Trend in Okanogan River steelhead spawners, 2005-2011.

Table 11. Natural origin summer steelhead estimates for the Okanogan River, since 2005.

Okanogan River wild summer steelhead spawner population trend data				
Year	WDFW escapement estimate ^e	OBMEP spawner survey estimate		
		Low	Estimate	High
2005	153	143	164 ^f	185
2006	130	127	139 ^f	151
2007	110	148 ^g	152 ^g	155 ^g
2008	227	213	225	266
2009	202	178	212	241
2010	352	630	728	853
2011	338	307	329	339

^e WDFW has restated escapement estimates from previous years in 2010.

^f The Okanogan mainstem percent wild was applied across all reaches.

^g Only a low and high value was reported, so a simple arithmetic mean was computed.

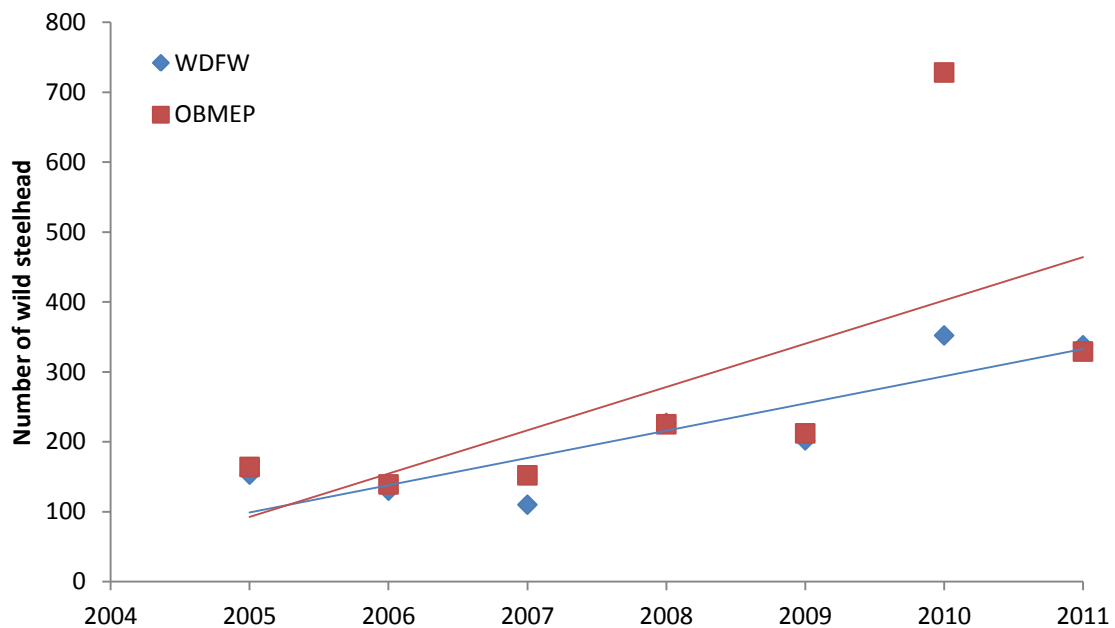


Figure 30. Trend in Okanogan River ad-present steelhead spawners, 2005-2011.

Conclusions

Results from steelhead adult enumeration efforts in the Okanogan basin indicate that the number of spawning steelhead in the Okanogan River continued to increase since the program began collecting data in 2005. Spawning was common throughout the mainstem Okanogan River, although narrowly focused to distinct areas that contained suitable spawning substrates and water velocities. Steelhead spawning was most heavily concentrated below Zosel Dam on the Okanogan River and in braided island sections of the lower Similkameen River. It is likely that distribution of spawning is largely influenced by stocking location because juvenile hatchery steelhead were scatter-planted in Omak Creek, Salmon Creek, and the Similkameen River acclimation site. Steelhead redds were commonly observed near these stocking locations, as well as near Chinook redd mounds and mid-channel islands.

Annual variations of environmental factors can profoundly impact redd distributions in small tributaries to Okanogan River. Changes in spawner distribution within tributaries appear to be driven by the following four factors:

- 1) Discharge and elevation of the Okanogan River
- 2) Discharge of the tributary streams
- 3) Timing of runoff that alters the shape of the hydrograph
- 4) Stocking location of hatchery smolts

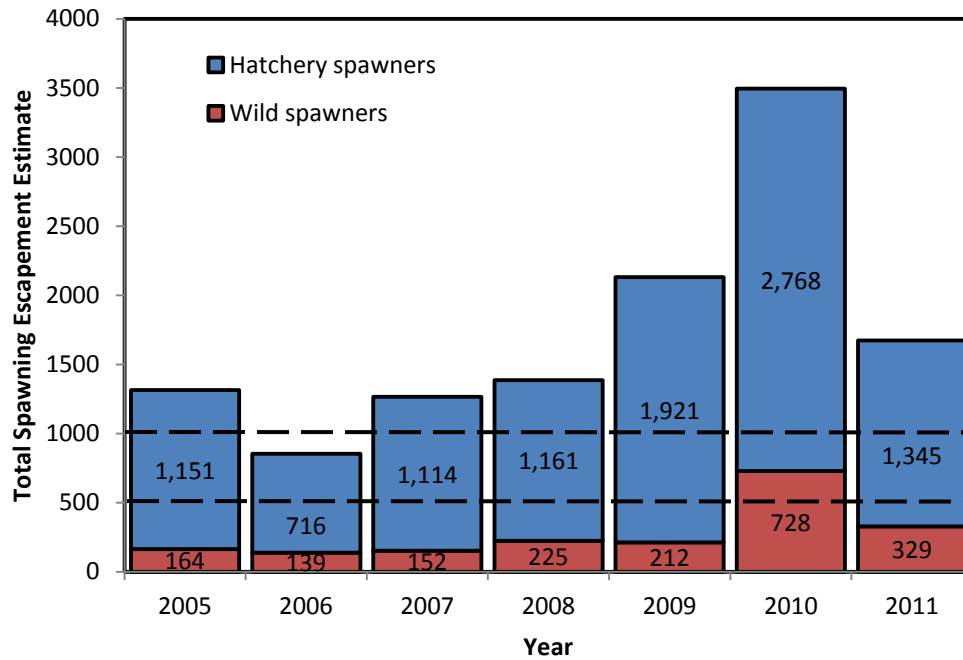
The first three factors are largely based upon natural environmental conditions, which can be altered dramatically by such things as water releases from dams, irrigation withdrawals, and climate change. Years such as 2006, 2008, and 2009 clearly show how low tributary discharge can dramatically alter spawning location and reduce the available tributary habitat for steelhead to utilize. Habitat alterations at the mouths of key spawning tributaries can improve access, provided that sufficient discharge is available. In 2010 and 2011, water availability in the Okanogan River basin was above normal and subsequently, a much larger proportion of steelhead spawned in tributaries than was documented in previous years. Approximately 37% and 38.9% of steelhead were estimated to have spawned in tributaries to the Okanogan in 2010 and 2011, respectively. Summer steelhead that spawn in tributary habitats of the Okanogan River basin are more likely to find suitable environmental conditions and rearing habitats than those spawning in mainstem habitats.

Spring spawner data provides a reasonable depiction of steelhead spawning distribution and an estimate of minimum spawner abundance; however, determining the origin of returning adults is less objective. Although the abundance of ad-present spawners appears to be increasing in the Okanogan subbasin, the current numbers remain well below recovery goals, as outlined by the Upper Columbia recovery plan (UCSRB 2007) (Figure 31). Accurate and reliable determination of origin is critical for tracking recovery of Upper Columbia summer steelhead within the Okanogan River basin. However, hatchery activities that do not mark all fish in an easily identifiable way complicate origin determinations. It is difficult to conclude if increasing trends in wild fish are a result of more natural production or fewer summer steelhead being marked with an adipose fin clip. In 2010 and 2011, new angling regulations required the retention of all steelhead caught with a clipped adipose fin. The benefits of these regulations may be reduced when not all hatchery fish are properly marked. Evaluation of natural production would be improved in the future by ensuring that all hatchery summer steelhead are marked by the removal of the adipose fin.

PIT tag arrays will be installed again in 2012 at the downstream extent of most tributaries throughout the Okanogan River system. Additionally, returning adults will continue to be implanted with PIT tags at mid-Columbia PUD facilities. Once the basin-wide PIT tag arrays are in place, interrogations of PIT tagged adult steelhead will allow further examination of age, sex, and origin within each sub-watershed. The increasing frequency of PIT tag detections also help to validate redd survey observations, provide an escapement estimate when redd surveys could not be conducted, and further improve our ability to describe habitats used by summer steelhead in the Okanogan subbasin.



A. OBMEP



B. WDFW

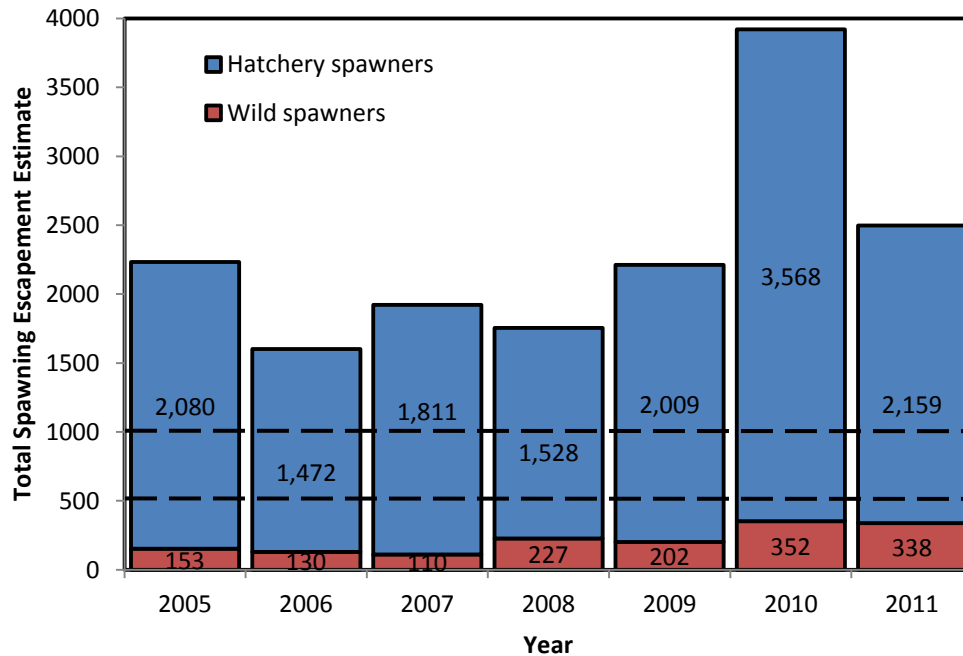


Figure 31. Escapement estimates determined by OBMEP (A) and WDFW (B) compared with steelhead recovery goals, as outlined in the Upper Columbia Spring Chinook and Steelhead Recovery Plan (UCSRB 2007). The Interior Columbia Basin Technical Recovery Team (ICBTRT) determined that 500 naturally produced steelhead adults would meet the minimum abundance recovery criteria within the U.S. portion of the Okanogan subbasin. If the Canadian portion of the subbasin was included, minimum abundance recovery criteria would be 1,000 naturally produced adults (UCSRB 2007).

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