Colville Tribes, Fish & Wildlife Department

2020 Okanogan Subbasin Steelhead Spawning Abundance and Distribution

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Executive Summary

The Okanogan Basin Monitoring and Evaluation Program (OBMEP) monitored summer steelhead (*Oncorhynchus mykiss*) spawner abundance and distribution within the Okanogan River subbasin from 2005 through 2020. Monitoring has been conducted through a combination of redd surveys, underwater video counts, and Passive Integrated Transponder (PIT) tag detections. In 2020, it was estimated that 374 summer steelhead (114 hatchery origin and 260 natural origin) spawned in the Okanogan subbasin in 2020. That number is the lowest total return since the monitoring project began in 2005 (Table 2), continuing a similar trend for the past three years. Over the past 16 years of monitoring (2005 through 2020), the average number of adult steelhead spawners in the Okanogan subbasin was 1,472 (geomean = 1,247). The average number of natural-origin spawning steelhead was 287 (geomean = 250). Spawning estimates were also compared with recovery goals, as outlined by the Interior Columbia Basin Technical Recovery Team (ICBTRT). The Upper Columbia Spring Chinook and Steelhead Recovery Plan states 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). Although the proportion of natural-origin steelhead spawning in the Okanogan River subbasin has slightly trended upward since data collection began in 2005, the minimum abundance threshold for ESA-recovery for natural origin spawners in the combined transboundary population was not reached.

The proportion of hatchery origin spawners (pHOS) from 2005 through 2013 averaged 0.85, but the average pHOS decreased to 0.66 from 2014 through 2020. In fact, the 0.31 pHOS recorded in 2020 was the lowest proportion of hatchery spawners recorded to date. The abundance of hatchery steelhead has been variable, ranging from a low of 114 in 2020 up to 2,768 in 2010. Spawning occurred throughout the mainstem Okanogan River, but was concentrated in distinct areas that contained suitable water velocities and substrates. The highest concentration of steelhead spawning has been documented below Zosel Dam on the Okanogan River and in braided island sections of the lower Similkameen River. The release location of juvenile hatchery steelhead likely influences the spatial distribution of spawning adults. Hatchery releases occur in Omak, Salmon, Antoine and Aeneas Creeks and the Similkameen River.

On years when spring runoff takes place after peak spawning is completed, redd surveys can provide a reasonable depiction of steelhead spawning distribution and an estimate of escapement. Defining the physical location of redds informs managers about which, and to what extent, habitats are being used for spawning and allow for tracking of spatial status and trends through time. However, conducting redd surveys on years with early runoff is not always effective due to poor water clarity. Since OBMEP began collecting steelhead spawning data in 2005, the importance of not relying solely on redd surveys for abundance estimates has become evident. Implementation of Upper Columbia Basin-wide PIT tag interrogation systems (Project # 2010-034-00), coupled with the representative marking of returning adults at Priest Rapids Dam, provides managers an additional means to estimate abundance for years with poor survey conditions. Data from instream PIT arrays also helps validate redd survey efficiency, describes spatial distribution, timing of migration, and the extent of upstream spawning where previously unknown. These efforts allow managers to more accurately describe the spatial extent of spawning in tributaries, monitor effectiveness of barrier removal projects, and better define escapement estimates.

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1.0 Introduction

Within the Upper Columbia River Basin, the furthest upstream and northern-most extent of currently accessible anadromous habitat is found in the Okanogan River. Summer steelhead (*Oncorhynchus mykiss*) are listed as threatened in the Upper Columbia Evolutionarily Significant Unit (ESU) under the Endangered Species Act (ESA) (NMFS 2009). To recover this ESU requires that all four populations (Wenatchee, Entiat, Methow, 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. 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 and revised in 2007 (Arterburn et al. 2007). In addition to redd surveys, we used a combination of adult weir traps, Passive Integrated Transponder (PIT) tag arrays, and underwater video counting to improve escapement estimates and coordinate with other on-going data collection efforts. In cooperation with the Washington Department of Fish and Wildlife (WDFW), OBMEP expanded the use of instream PIT tag arrays to enhance the monitoring of adult summer steelhead use of small tributaries to the Okanogan River.

This document builds upon knowledge and information gained from preceding years' surveys. A 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:

https://www.okanoganmonitoring.org/Reports/SteelheadSpawningSurveys

2.0 Methods

OBMEP - Adult Abundance - Redd Surveys v1.0 (ID:192)
https://www.monitoringresources.org/Document/Protocol/Details/192
OBMEP - Adult Abundance - Adult Weir and Video Array (ID:6)
https://www.monitoringresources.org/Document/Protocol/Details/6
OBMEP – Adult Abundance – Analysis v1.0 (ID:2125)
https://www.monitoringresources.org/Document/Protocol/Details/2125
Upper Columbia River ESU Steelhead Stock Assessment (2010-034-00) v1.0 (ID:235)
https://www.monitoringresources.org/Document/Protocol/Details/235

The Okanogan River flows from the northern headwaters near Vernon, BC to the confluence with the Columbia River near Brewster, WA (Figure 1). Counts of summer steelhead spawning occurred downstream of anadromous fish migration barriers in the mainstem Okanogan River and its tributaries accessible to anadromous fish within the United States (Arterburn et al. 2007, Walsh and Long 2006) following the OBMEP redd survey protocol. The area of the Okanogan River downstream from Chiliwist Creek has very low gradient and 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. Mainstem and tributary redd survey reaches are listed in Table 1. Redd surveys were supplemented with adult weir traps, instream PIT tag arrays, and underwater video counts at locations where habitat was too extensive or when access could not be arranged with private landowners.

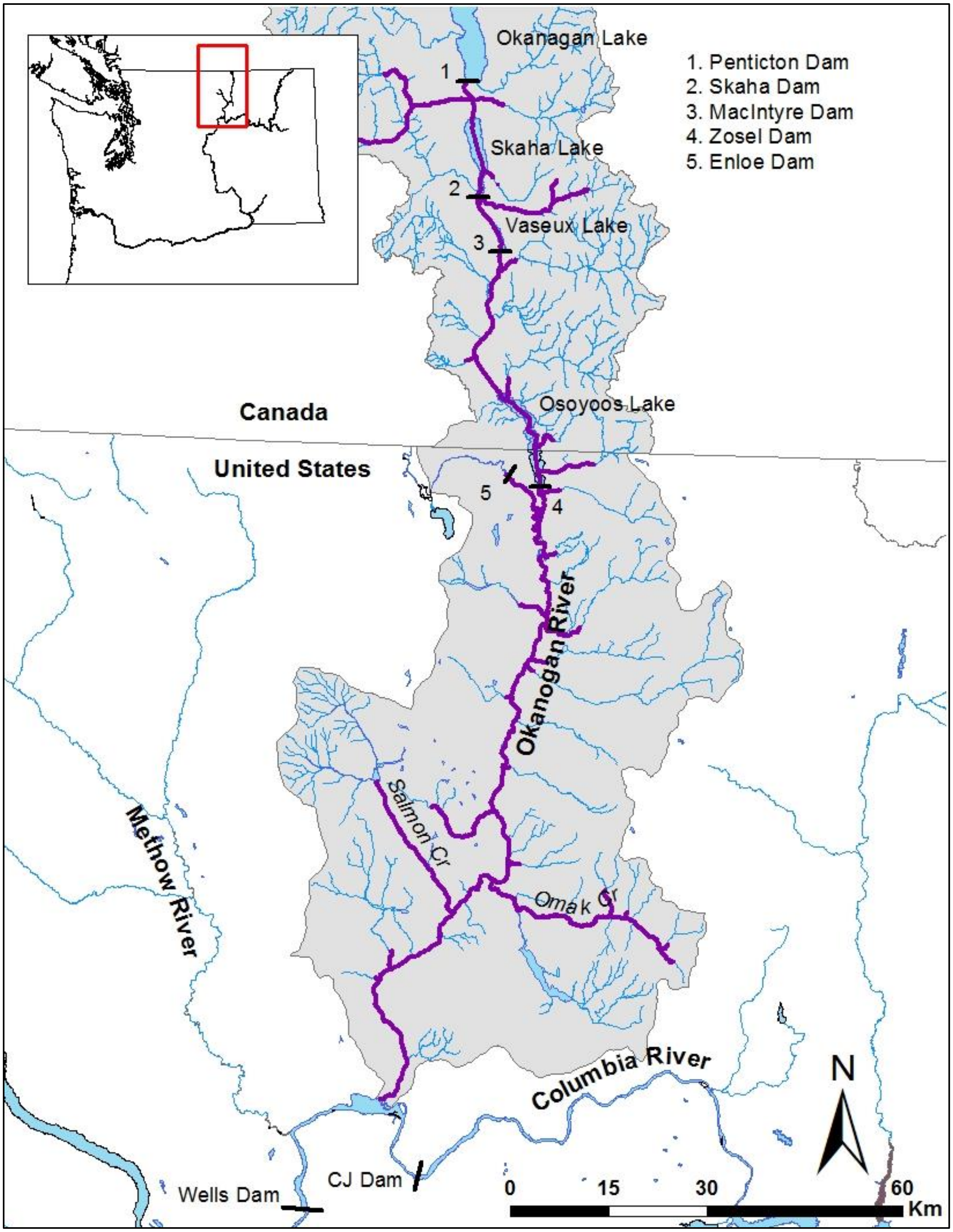

Figure 1. Study area, the Okanogan River subbasin in north-central Washington State and southern British Columbia. Stream segments shaded in purple represent habitat currently accessible to anadromous fish.

The Okanogan River was divided into seven survey reaches and the Similkameen River was surveyed as two reaches. Survey reaches were determined by access points along the river and outlined in Table 1. Discharge data, air and water temperature, and local knowledge of fish movements collected from previous years were used 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 foot catarafts. Small tributaries were surveyed on foot, walking in an upstream direction, and are typically attempted three times to document spatial distribution of spawning across the entire steelhead spawning period.

Table 1. Okanogan subbasin steelhead redd survey reaches.

Redd Survey Reach	Location and Description	Reach Length (km)
Okanogan River 1	Okanogan River at Loup Loup Creek (26.7) to Salmon Creek (41.4)	14.7
Okanogan River 2	Okanogan River at Salmon Creek (41.4) to the office (52.3)	10.9
Okanogan River 3	Okanogan River at the office (52.3) to Riverside (66.1)	13.8
Okanogan River 4	Okanogan River at Riverside (66.1) to Janis Bridge (84.6)	18.5
Okanogan River 5	Okanogan River at Janis Bridge (84.6) to Tonasket Park (91.4)	6.8
Okanogan River 6	Ok. R. at Horseshoe Lake (112.4) to confluence with Similk. R. (119.5)	7.1
Okanogan River 7	Okanogan River at Similk. R. confluence (119.5) to Zosel Dam (127.0)	7.5
Similkameen River 1	Similkameen/Okanogan Confluence (0) to sewer plant (6.6)	6.6
Similkameen River 2	Similkameen from sewer plant (6.6) Enloe Dam (14.6)	8.0

Geographic position of redds were collected with a Trimble GeoXT™ GPS unit and downloaded into GPS Pathfinder® after each survey. Waypoints were reviewed and differentially corrected. To avoid recounting, flagging was tied to bushes or trees 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.

Abundance of steelhead spawning within survey reaches were then converted to Hydrologic Unit Code (HUC), which adds to consistency within other approaches. HUCs also directly correspond to the Diagnostic Units (DU) used in habitat modeling within the mainstem Okanogan River (Figure 2). Each unique tributary to the Okanogan River also represent individual HUCs.

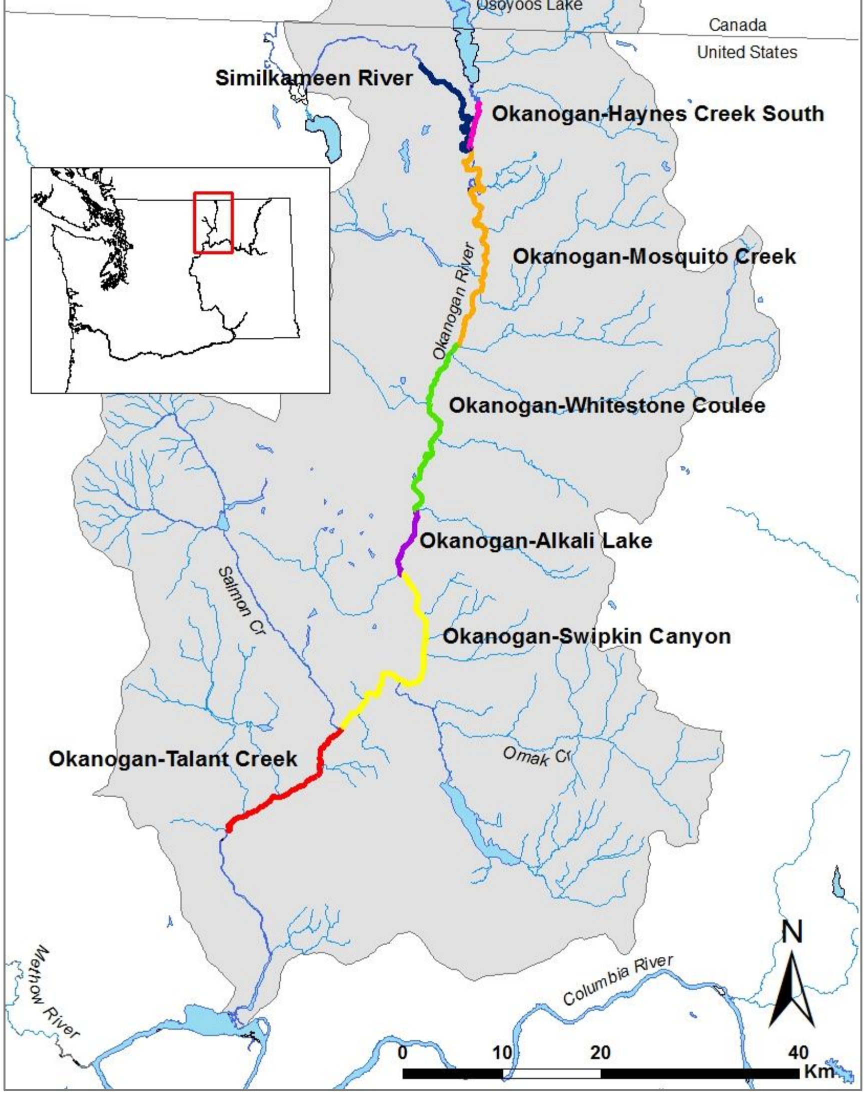

Figure 2. Mainstem Okanogan and Similkameen Rivers Hydraulic Unit Codes and diagnostic unit reaches.

2.1 Sex Ratio and Number of Fish Per Redd

OBMEP employed a method that has been used by the Washington Department of Fish and Wildlife (WDFW) in the Upper Columbia Basin to extrapolate escapement estimates from redd counts using the sex ratio of fish collected randomly throughout the run at Priest Rapids Dam. A sample of 792 summer steelhead, including 421 natural-origin and 371 hatchery fish were captured, marked, and sexed during the 2019 upstream migration by WDFW personnel (Ben Truscott, WDFW, pers. comm.). The proportion of female to male steelhead was similar for natural-origin (0.668:0.332) and hatchery fish (0.644:0.356), which rendered a combined 0.657:0.343. Rounded, that sex ratio of one female per 0.52 males or 1.52 fish per redd (FPR) was used to expand redd counts into steelhead spawning estimates for the subbasin. All calculations using sex ratio multipliers assume that each female will produce only one redd.

2.2 PIT Tag Expansion Estimates

Throughout the spring of 2020, permanent and seasonal PIT tag arrays were operated near the mouth of all tributaries to the Okanogan River known to contain steelhead spawning. The CCT works in conjunction with the WDFW (the lead investigator on project number 2010-034-00), to operate and maintain PIT tag detection sites in the Okanogan subbasin, along with data collection and management of those datasets. Any expanded PIT tag estimates presented in this document should be considered preliminary estimates as data analyses are currently in progress for the entire Upper Columbia for multiple years of the project. Final analyses of these data will be reported under project number 2010-034-00.

Population estimates derived from PIT tag detections were calculated following the protocol developed by Murdoch et al. 2011. In the 2020 brood year, a representative sample of upstream migrating steelhead were captured at Priest Rapids Dam (PRD) from July through November, 2019. All fish were scanned for hatchery marks, sexed and marked with a PIT tag unless previously tagged. A portion of the total run, approximately 21.31% of hatchery and 21.31% of natural-origin steelhead, were included in this sample group (Ben Truscott, WDFW, pers. comm.). These mark-rates were used to expand the number of detections into escapement estimates for tributaries with PIT tag arrays. For example, if six hatchery and two natural-origin steelhead from the PRD sample group were detected at an instream PIT array in a given creek in the Okanogan subbasin, the escapement estimate would be 28 hatchery steelhead (28=6/0.2131) and 9 natural-origin steelhead (9=2/0.2131). This method assumes that marked fish are representative of unmarked fish. Given relatively few detections at many locations (particularly at smaller tributaries) escapement estimate confidence bounds derived from PIT tag detections may be quite wide. In addition to fish tagged at Priest Rapids, adult steelhead may have also received PIT tags at other locations e.g., out-migrating juveniles, adults returning to Bonneville Dam, Wells Dam, among others. However, it is unknown how representative those fish are to the run at large. Therefore, only PIT tags from the PRD release group, project 2010-034-00, were used to estimate steelhead escapement.

3.0 Okanogan Subbasin Summer Steelhead Spawning Estimates

Based on expanded redd counts and PIT tag detections from project 2010-034-00, it was estimated that 374 summer steelhead (114 hatchery origin and 260 natural origin) spawned in the Okanogan subbasin in 2020. That number is the lowest total return since the monitoring project began in 2005 (Table 2), continuing a similar trend for the past three years. Over the past 16 years of monitoring (2005 through 2020), the average number of adult steelhead spawners in the Okanogan subbasin was 1,472 (geomean = 1,247). The average number of natural-origin spawning steelhead was 287 (geomean = 250). Although the proportion of natural-origin steelhead spawning in the Okanogan River subbasin has slightly trended upward since data collection began in 2005 (Figure 3), the minimum abundance threshold for natural-origin spawners was not reached.

The proportion of hatchery origin spawners (pHOS) from 2005 through 2013 averaged 0.85, but the average pHOS decreased to 0.66 from 2014 through 2020. In fact, the 0.31 pHOS recorded in 2020 was the lowest proportion of hatchery spawners recorded to date. The abundance of hatchery steelhead has been variable, ranging from a low of 114 in 2020 up to 2,768 in 2010. A summary of the estimated number of adult steelhead spawners, distributed by mainstem survey reach and individual tributaries, are presented in Table 3. Detailed results for unique tributaries and mainstem reaches are further detailed in sections 3.1 to 3.3 of this document.

Table 2. Okanogan subbasin summer steelhead spawner abundance estimates, 2005–2020.

Year	Total	Hatchery Steelhead	Natural-Origin Steelhead	Natural-Origin 12-yr geomean
2005	1,226	1,080	146	
2006	899	702	197	
2007	1,268	1,116	152	
2008	1,386	1,161	225	
2009	2,133	1,921	212	
2010	3,496	2,768	728	
2011	1,674	1,341	333	
2012	2,802	2,475	327	
2013	1,937	1,687	250	
2014	1,356	838	518	
2015	1,461	1,009	452	
2016	1,566	1,175	391	292
2017	1,044	929	115	286
2018	453	333	120	274
2019	473	306	167	277
2020	374	114	260	280
Average	1,472	1,185	287	280

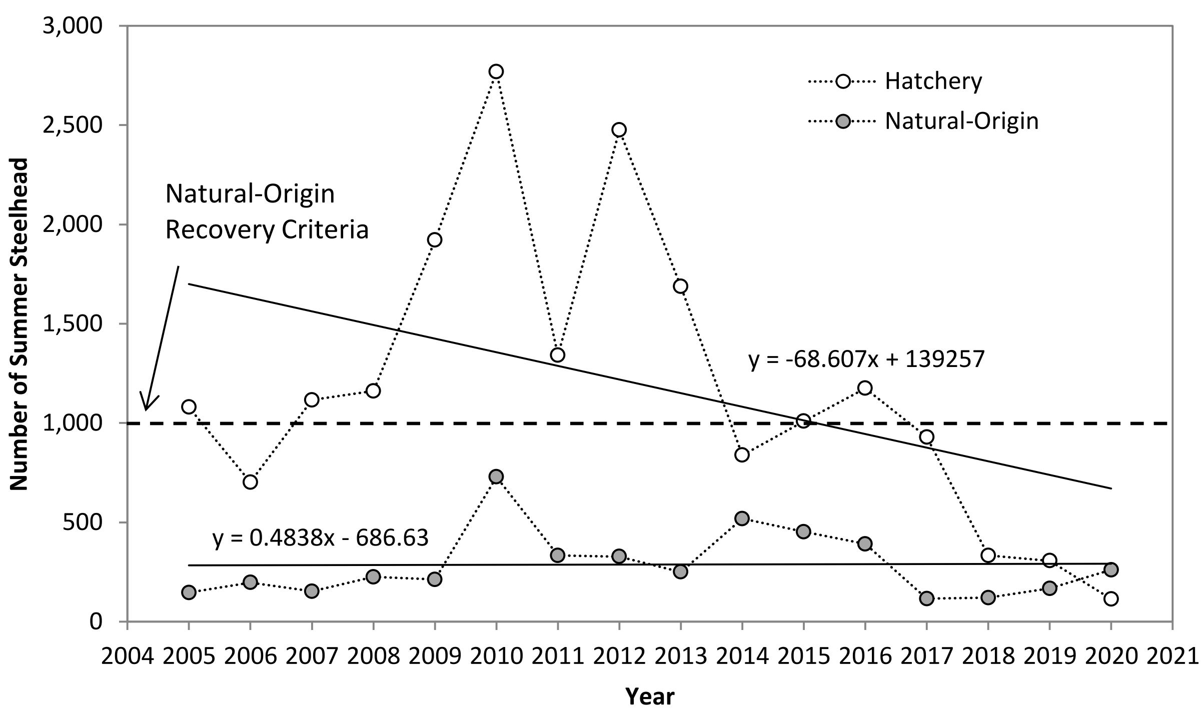

Figure 3. Trend in the estimated number of summer steelhead spawning in the Okanogan River subbasin, 2005–2020.

Table 3. Estimated number of hatchery and natural-origin steelhead spawning for each sub-watershed or assessment unit in 2020 compared with long-term averages.

Category	Location/HUC	2020 natural-origin spawner abundance	Average # of natural-origin spawners 2005–2019	2020 hatchery spawner abundance	Average # of hatchery spawners 2005–2019
WA Mainstem	Okanogan-Davis Canyon	0	*0*	0	*0*
WA Mainstem	Okanogan-Talant Creek	0	*1*	0	*11*
WA Mainstem	Okanogan-Swipkin Canyon	2	*5*	2	*48*
WA Mainstem	Okanogan-Alkali Lake	2	*3*	2	*28*
WA Mainstem	Okanogan-Whitestone Coulee	3	*6*	2	*60*
WA Mainstem	Okanogan-Mosquito Creek	1	*1*	1	*14*
WA Mainstem	Okanogan-Haynes Creek South	1	*40*	1	*346*
WA Mainstem	Similkameen River	9	*24*	9	*205*
WA Tributary	Loup Loup Creek	14	*10*	5	*34*
WA Tributary	Salmon Creek	61	*34*	14	*111*
WA Tributary	Omak Creek	52	*66*	9	*151*
WA Tributary	Wanacut Creek	1	*0*	0	*3*
WA Tributary	Johnson Creek	0	*6*	0	*21*
WA Tributary	Tunk Creek	19	*9*	33	*28*
WA Tributary	Aeneas Creek	0	*0*	3	*3*
WA Tributary	Bonaparte Creek	14	*29*	2	*61*
WA Tributary	Antoine Creek	28	*4*	2	*9*
WA Tributary	Wild Horse Spring Creek	5	*8*	0	*36*
WA Tributary	Tonasket Creek	19	*7*	19	*21*
WA Tributary	Ninemile Creek	5	*7*	5	*16*
Area	Washington State Mainstem	18	*80*	17	*712*
Area	Washington State Tributaries	218	*180*	92	*494*
Area	British Columbia	24	*25* [a]	5	*13* [a]

[a] Average from British Columbia only contain data from 2013-2019.

3.1 Steelhead Spawning Estimates: Okanogan and Similkameen River Mainstem

Compared with extremely large runoff years in 2017 and 2018, and a lower runoff year in 2019, the general discharge pattern for the mainstem Okanogan River in the spring of 2020 was slightly above historical averages (Figure 4). Discharge rates in the Similkameen River increased in mid-April and remained high through July, at which time spawning had long since concluded and steelhead redds were indistinguishable. For reference, locations of redds marked during previous years surveys (2005–2016) on the mainstem Okanogan and Similkameen Rivers are shown in Figures 5–11.

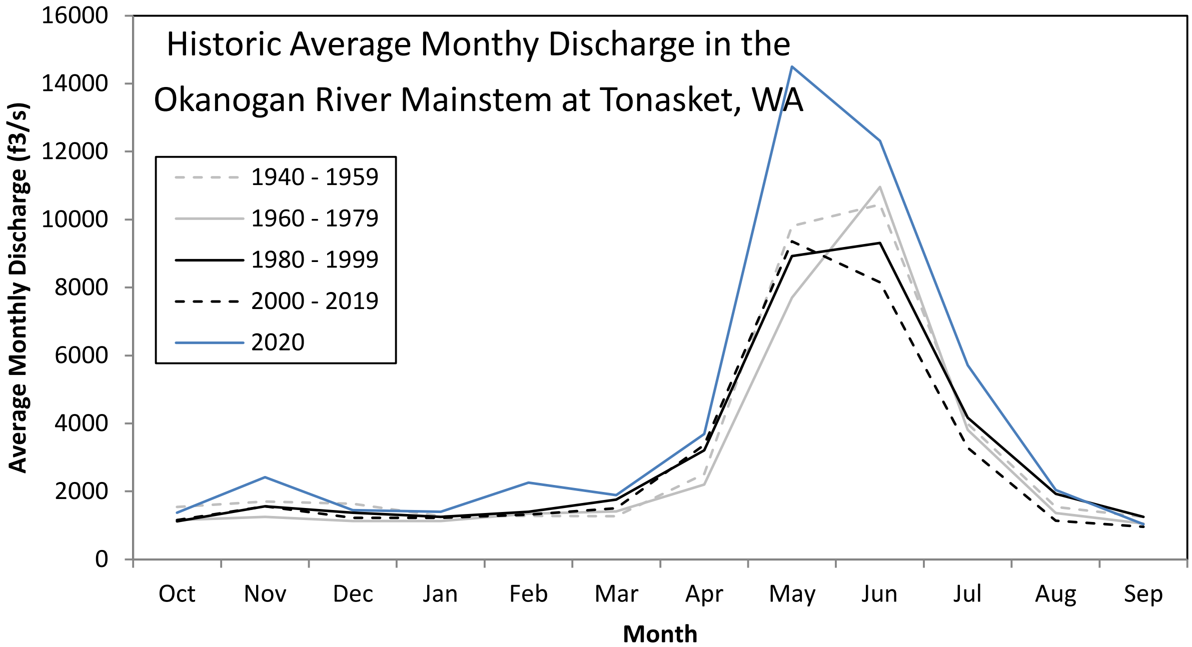

Figure 4. Average monthly discharge of the Okanogan River at Tonasket, WA (USGS Station 12445000, Okanogan River near Tonasket, WA).

Mainstem redd surveys were made complicated in 2020 by lockdown restrictions stemming from COVID-19 in the early months of the year. Limitations on multiple people in work vehicles made running long shuttles for rafting survey reaches difficult if not impossible. Additionally, runoff from the Similkameen River began in mid-April and created turbid water conditions. Reach O7 on the upper Okanogan River has hosted the most numbers of spawners in previous years. Because that survey reach is relatively short, transportation back to the top of the reach had multiple options other than riding within a vehicle together. Staff could also request temporary reductions in flow from Zosel Dam from the operators so that successful surveys could be completed. Two passes of redd surveys were completed on Okanogan River survey Reach O7 (located immediately below Zosel dam) during a peak and post-peak timeframe. Surveys occurred on April 7 (0 redds found) and April 23 (1 redd) (Figure 11). This 1 redd could be expanded by the fish per redd value of 1.52 to equal approximetly 2 fish.

Although redd surveys were unable to capture the complete distribution of spawning activity in the rest of the mainstem Okanogan and Similkameen Rivers, an estimate of mainstem spawning by reach was calculated as follows:

The total number of natural-origin and hatchery steelhead that spawned in the mainstem Okanogan River in 2020 can be estimated using the proportion of PRD marked fish only detected at the lower Okanogan River PIT array (OKL) i.e. entered the Okanogan River, but did not enter a tributary stream. This rendered a total of 18 natural-origin and 17 hatchery steelhead. Removing the 2 fish accounted for in survey Reach O7 left a remainder of 17 natural-origin and 16 hatchery steelhead. We then estimated spatial distribution of steelhead spawning in 2020 based on previous years surveys when complete mainstem redd surveys occurred. Proportional distribution of spawning by survey reach is listed in Table 4 column A for the period of 2005–2011.

To estimate how many fish spawned in each survey reach, the remaining mainstem spawning estimates for natural-origin (17) and hatchery steelhead (16) were multiplied by the historical proportion of spawning recorded in each reach. This calculation assumes no change in the spatial distribution of spawning between the reference period (2005–2011) and in years when redd surveys could not be conducted due to turbid water conditions. Specific calculations are outlined below in Table 4.

Table 4. Modeled estimate of mainstem steelhead spawning in 2020.

Mainstem Survey Reach	A. Avg. Proportion of Mainstem Spawning by Reach (2005-2011)[a]	B. Natural-Origin Steelhead (B=A*17)	C. Hatchery Steelhead (C=A*16)	D. Total Estimate (D=B+C)
Okanogan River 1	0.029	0	0	0
Okanogan River 2	0.107	2	2	4
Okanogan River 3	0.023	0	0	0
Okanogan River 4	0.091	2	2	4
Okanogan River 5	0.148	3	2	5
Okanogan River 6	0.039	1	1	2
Okanogan River 7	NA	NA	NA	NA
Similkameen River 1	0.321	5	5	10
Similkameen River 2	0.241	4	4	8
Mainstem Total	1	17	16	33

[a] Does not include Okanogan River Reach O7, where physical redd surveys were conducted in 2020.

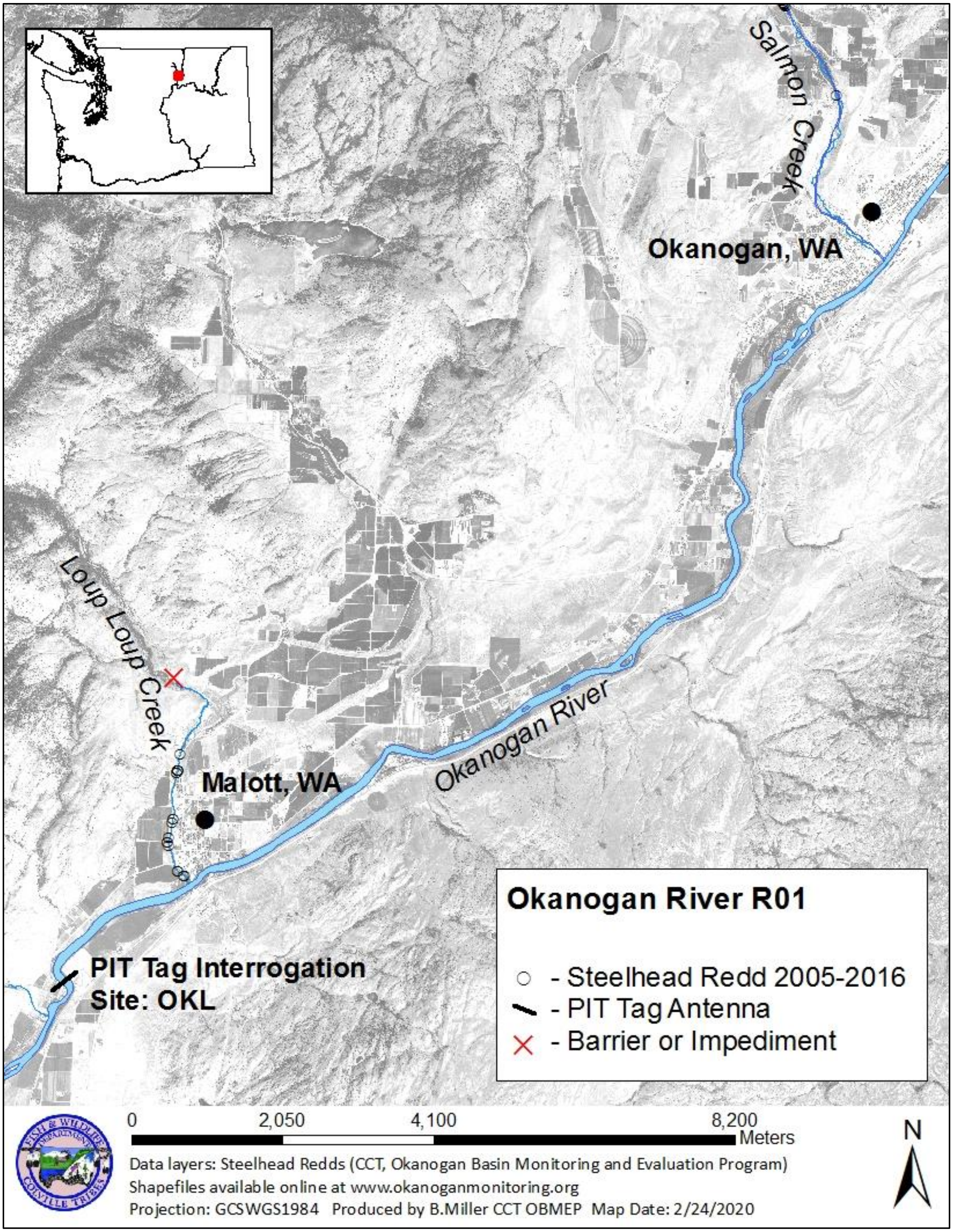

Figure 5. Spatial distribution of summer steelhead redds documented in Okanogan River survey reach RO1, from Salmon Creek to Loup Loup Creek.

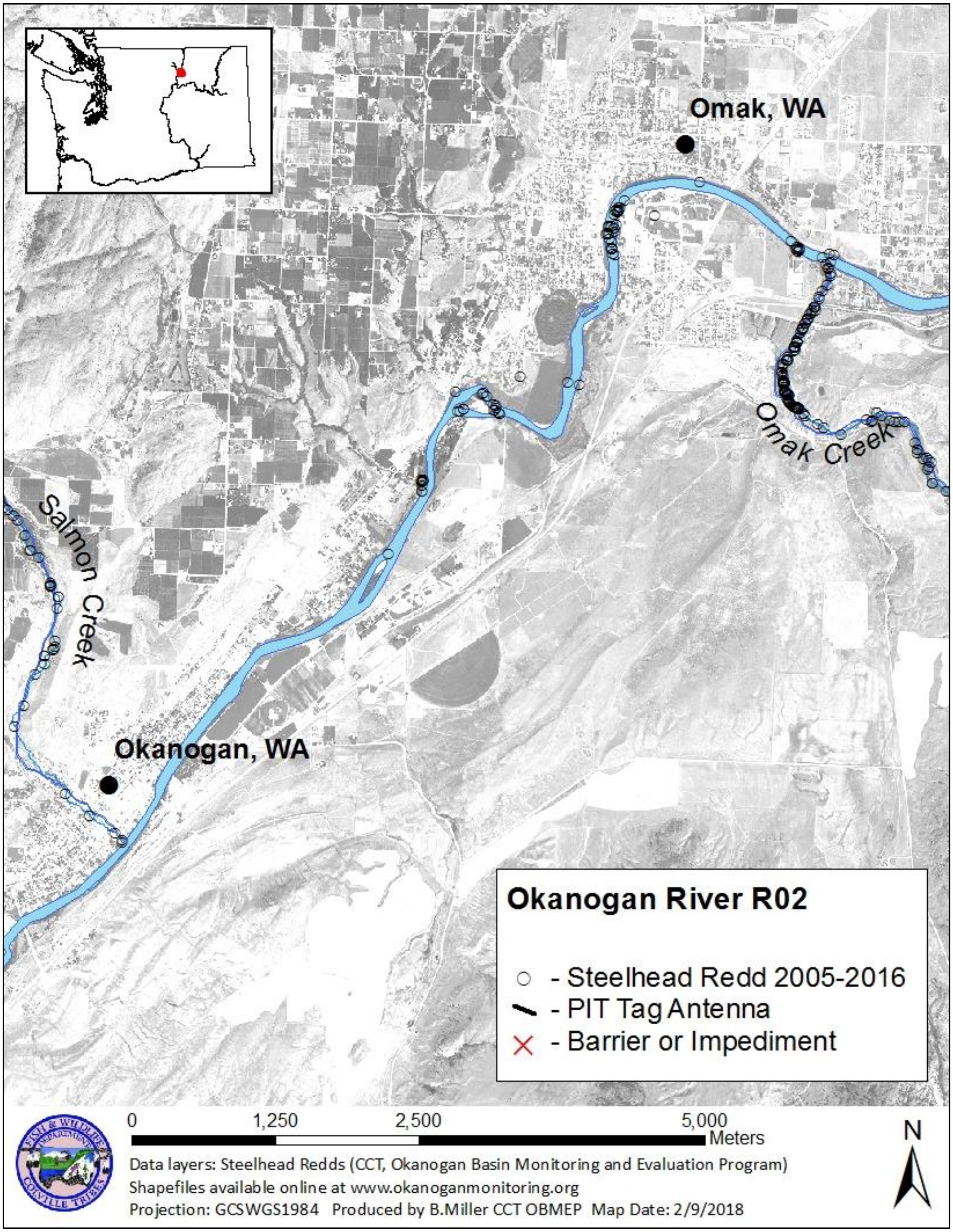

Figure 6. Spatial distribution of summer steelhead redds documented in Okanogan River survey reach RO2, from Omak Creek to Salmon Creek.

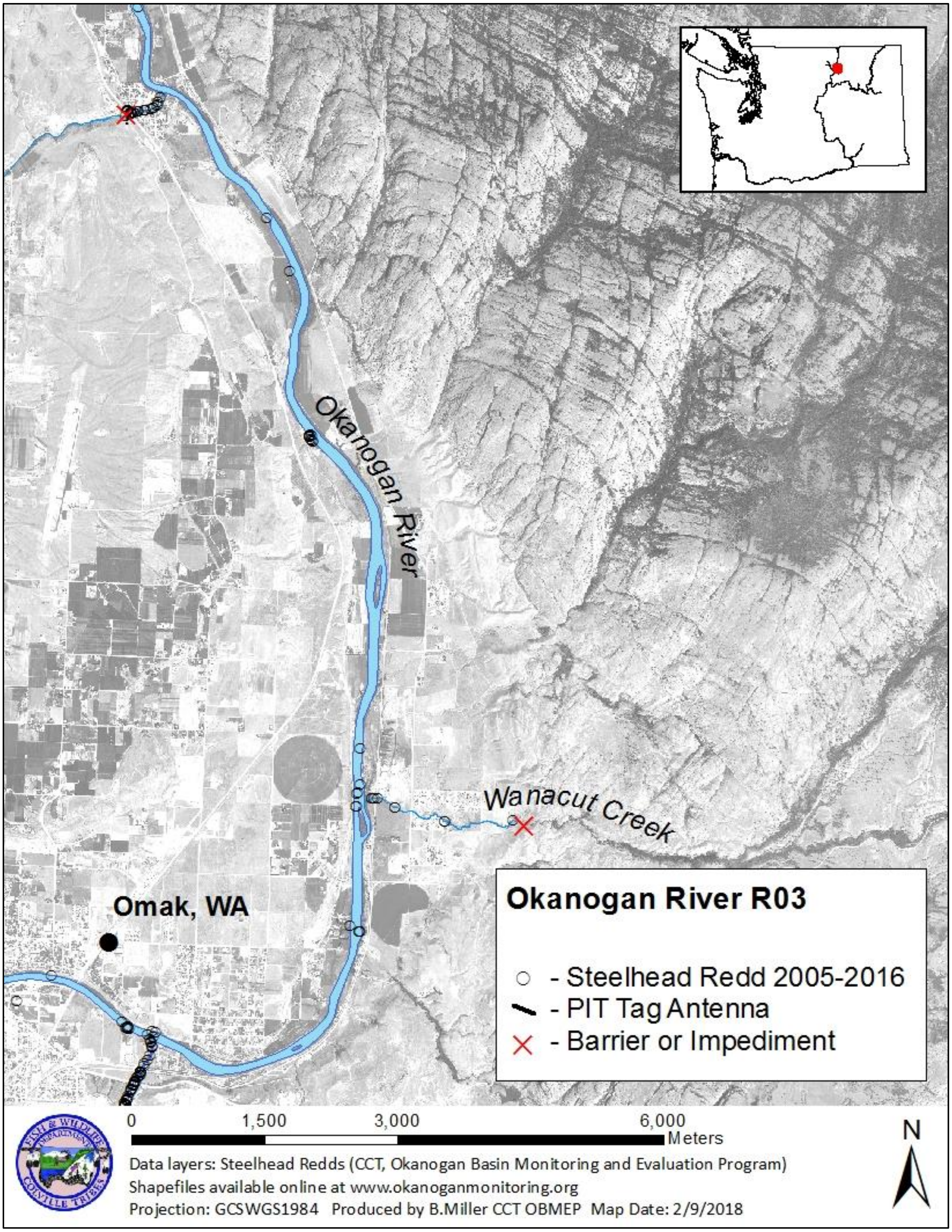

Figure 7. Spatial distribution of summer steelhead redds documented in Okanogan River survey reach RO3, from Johnson Creek to Omak Creek.

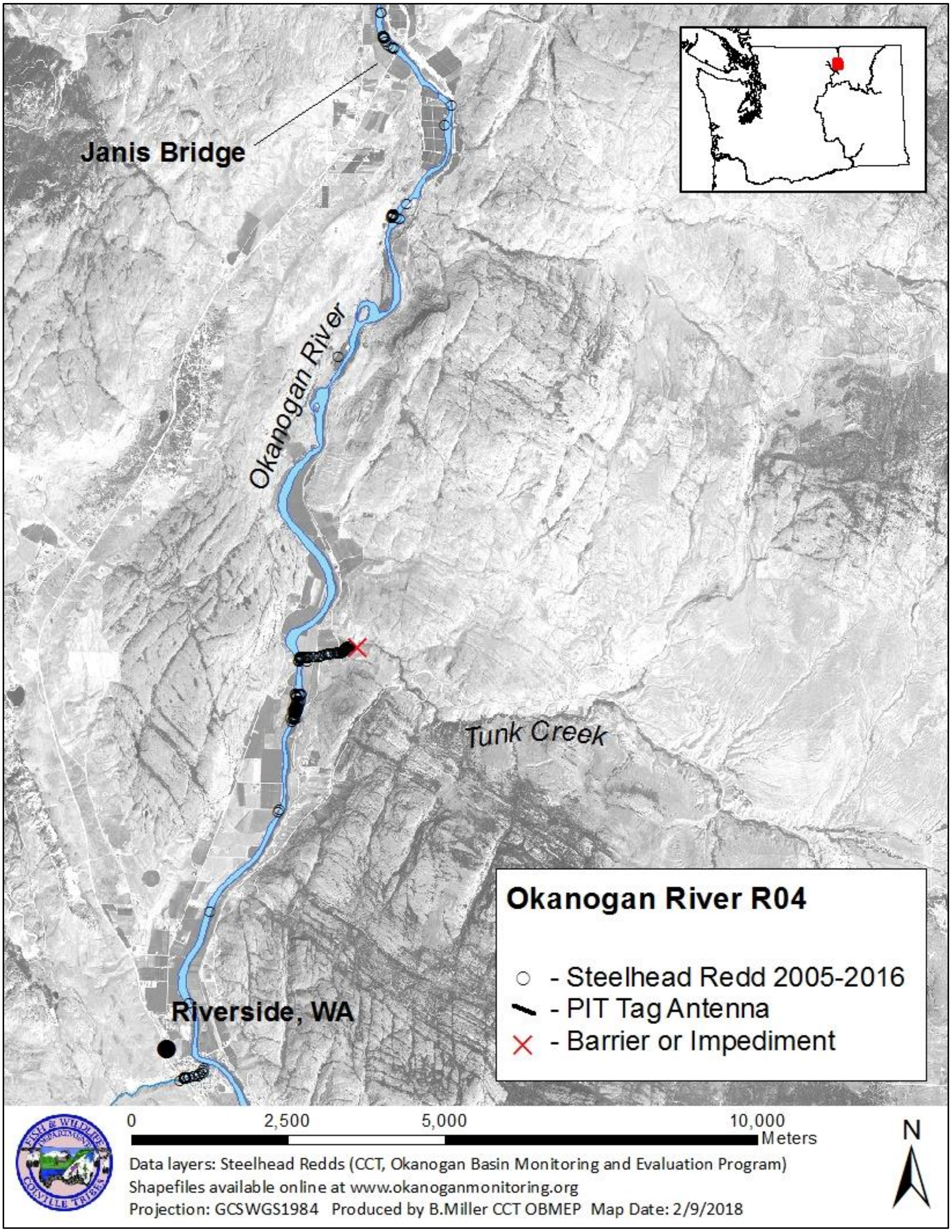

Figure 8. Spatial distribution of summer steelhead redds documented in Okanogan River survey reach RO4, from Janis Bridge to Johnson Creek.

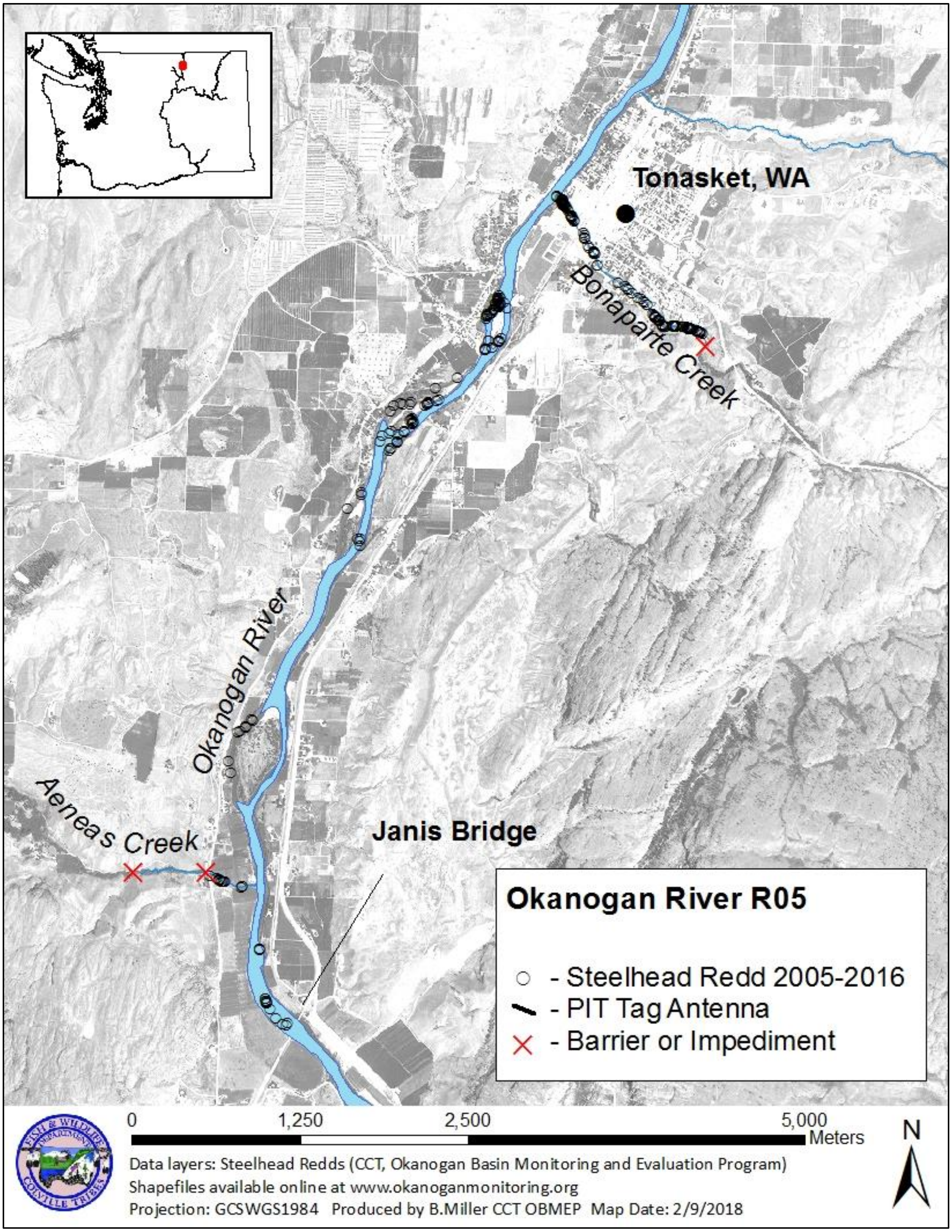

Figure 9. Spatial distribution of summer steelhead redds documented in Okanogan River survey reach RO5, from the Tonasket boat launch to Janis Bridge.

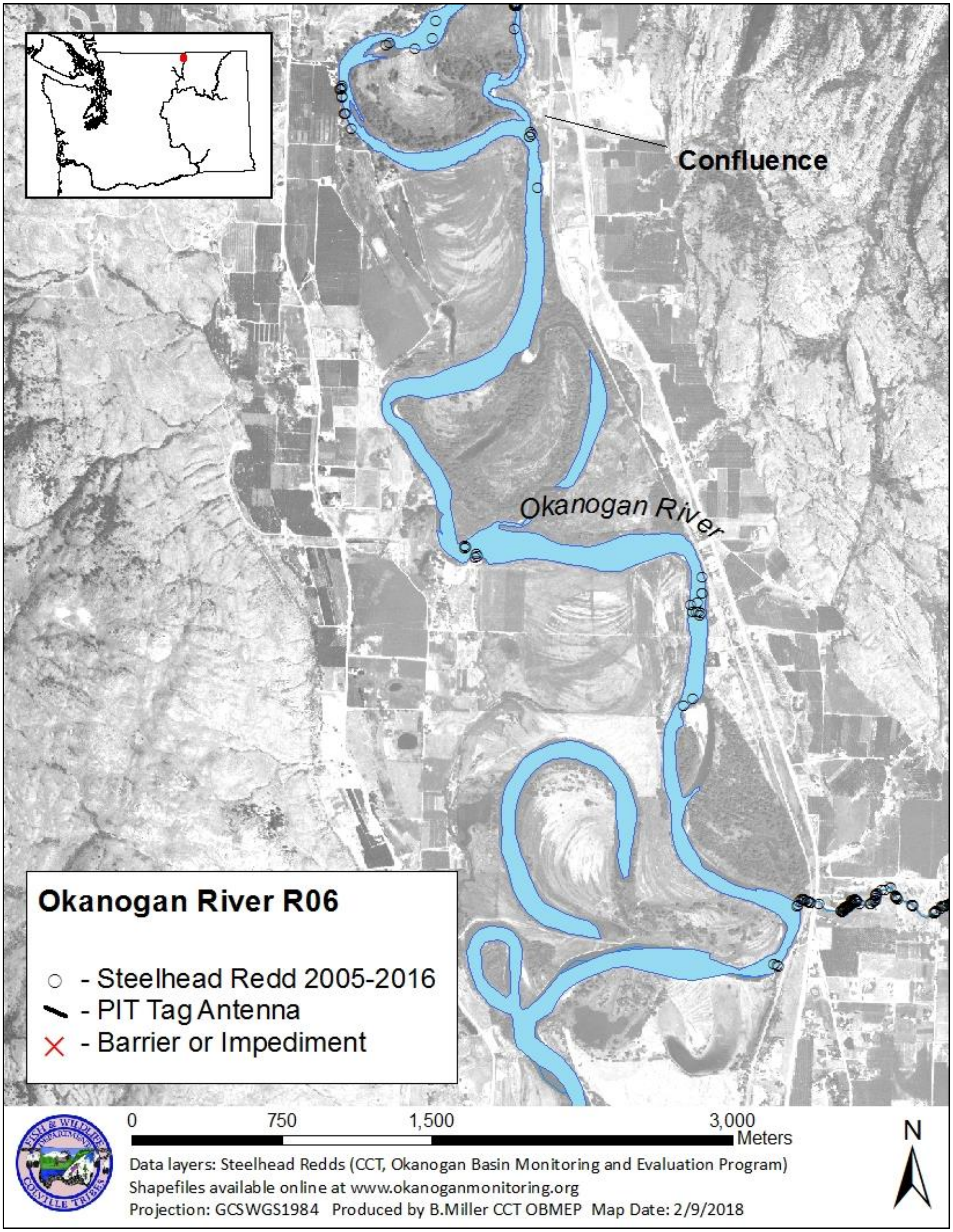

Figure 10. Spatial distribution of summer steelhead redds documented in Okanogan River survey reach RO6, from the confluence of the Similkameen and Okanogan Rivers to Horseshoe Lake.

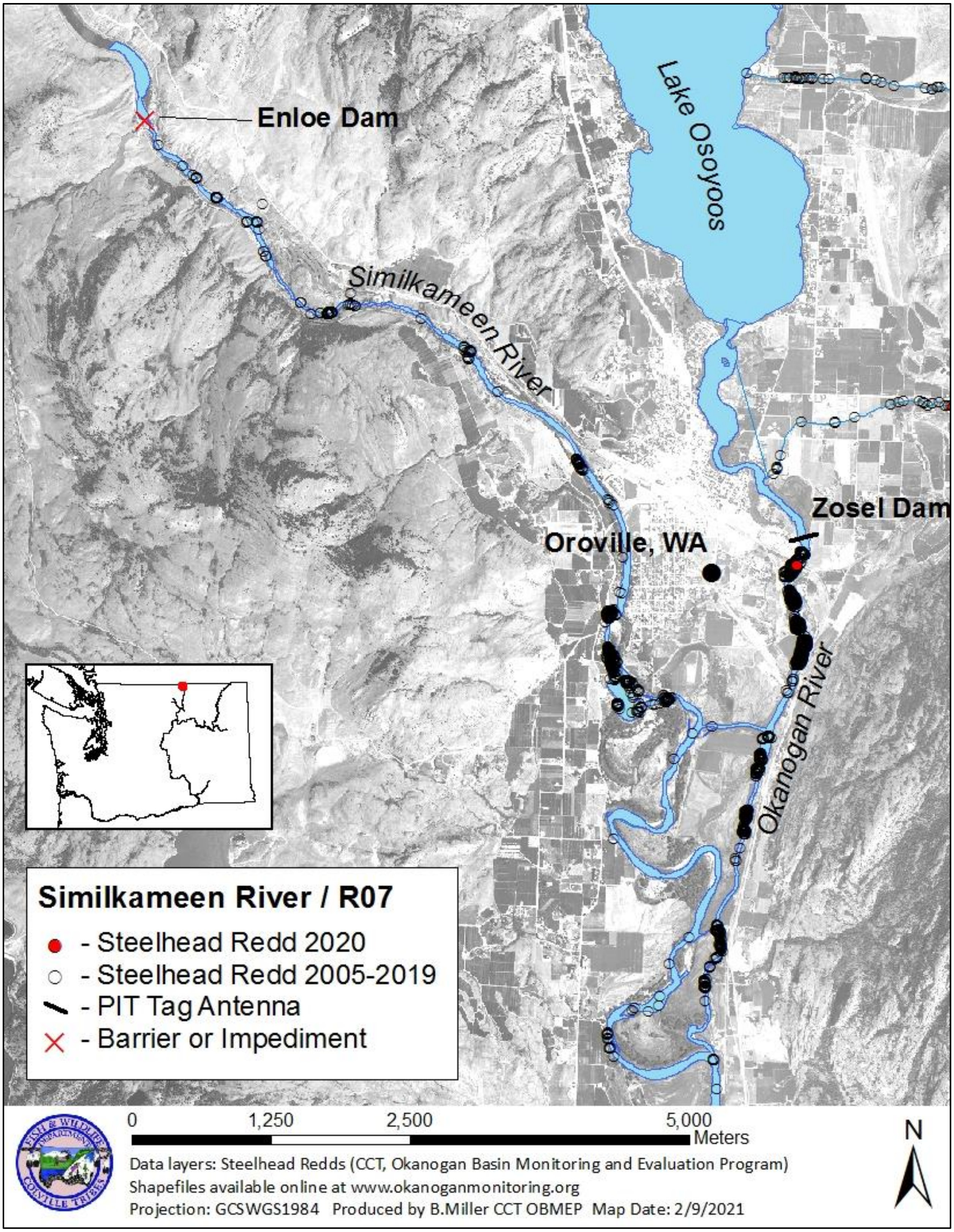

Figure 11. Spatial distribution of summer steelhead redds documented in the Similkameen River, from Enloe Dam to the confluence, and in Okanogan River survey reach RO7, from Zosel Dam to the confluence.

3.2 Steelhead Spawning Estimates: Tributaries to the Okanogan River

Tributary redd surveys were also occasionally affected by high flows and turbid water conditions (Figure 12) from an early runoff period, which began mid-April in most tributaries (Figure 13 and 14). For reference, peak steelhead spawning typically occurs around April 15th. Because redd surveys in 2020 focused primarily on obtaining spatial distribution of spawning in each subwatershed, most subwatershed steelhead spawning estimates were determined from PIT tag detections under project #2010-034-00.

In the following sections, we present a summary of spawning estimates for steelhead in tributaries to the Okanogan River, along with spatial distribution information. Detailed maps are presented in the following sections for each tributary which outline distribution of historic observations from 2005–2020. GIS shapefiles of documented steelhead redds can be downloaded at: www.okanoganmonitoring.org

Figure 12. Staff performing steelhead redd surveys during spring 2020.

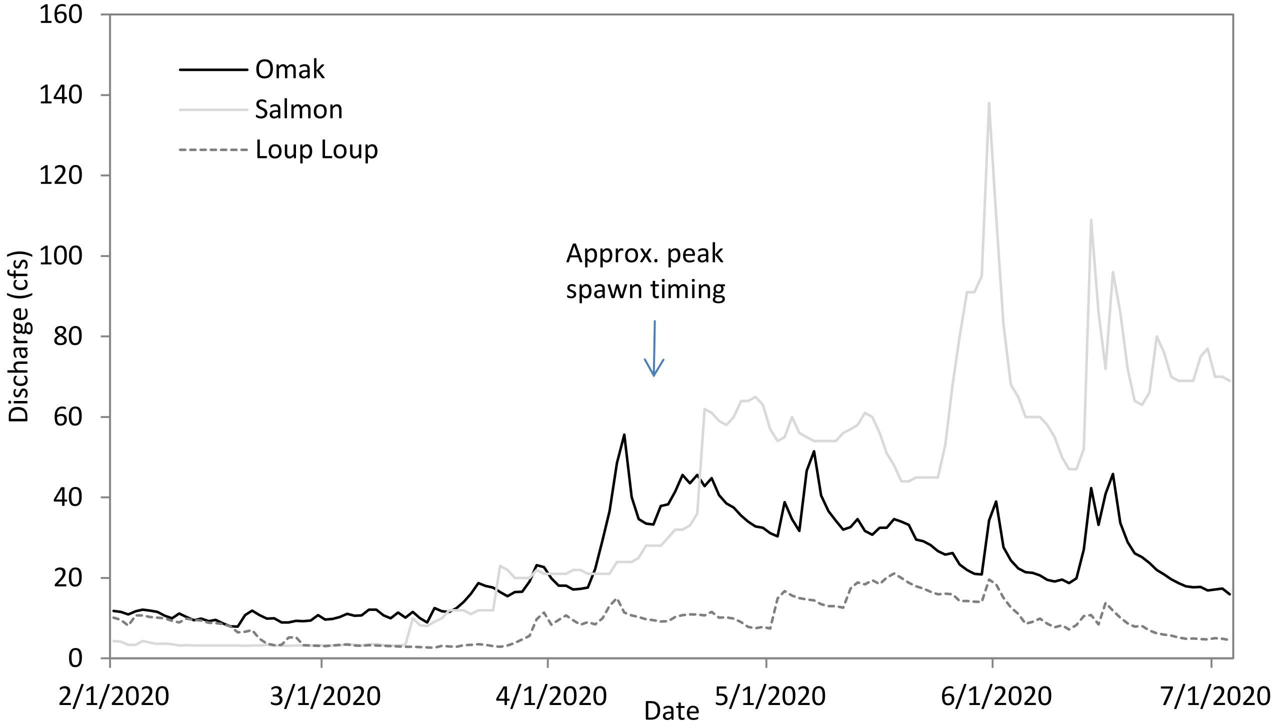

Figure 13. 2020 discharge in three tributaries in the southern Okanogan subbasin in Washington State.

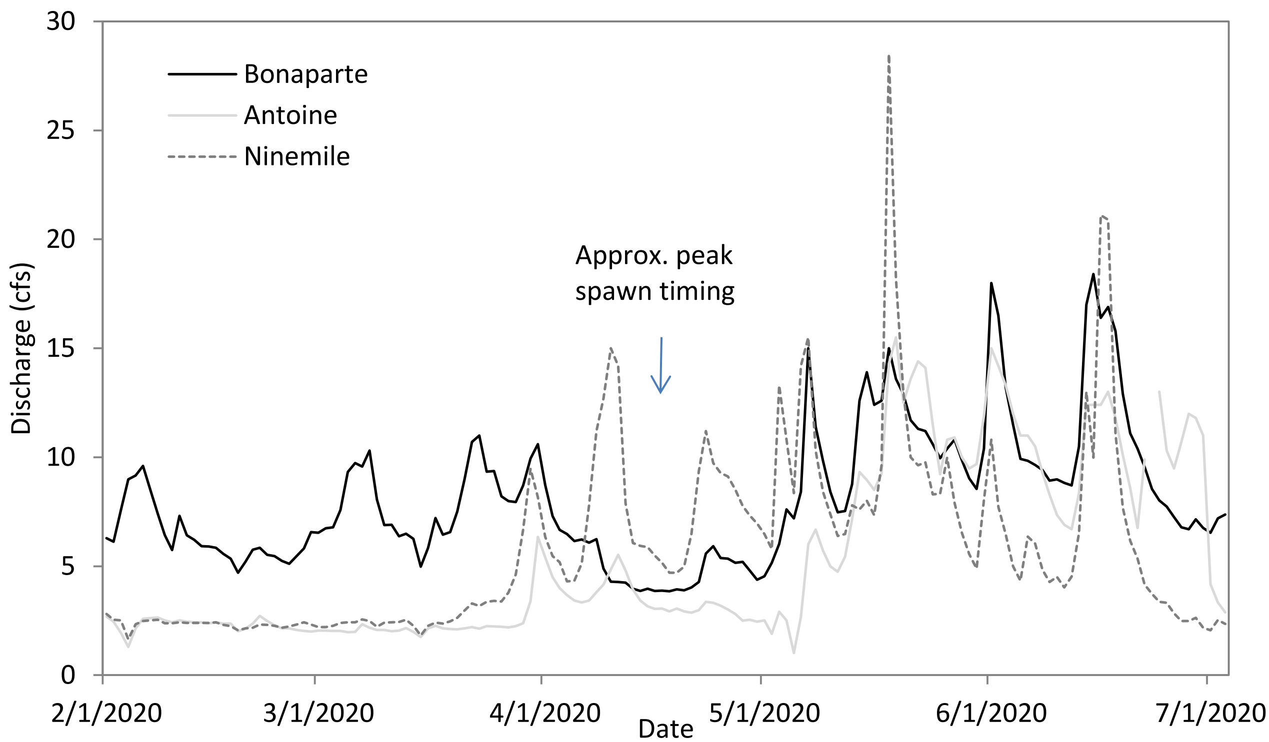

Figure 14. 2020 discharge in three tributaries in the northern Okanogan subbasin in Washington State.

3.2.1 Loup Loup Creek

Loup Loup Creek is a tributary that enters the Okanogan River at river kilometer (RKM) 24, in the town of Malott, WA. The lower sections of the creek frequently went dry during mid-summer, until 2010, when the point of diversion was transferred to the Okanogan River and the irrigation diversion on Loup Loup Creek was removed. PIT tag interrogation site LLC consists of three pass-over HDPE antennas configured in three separate rows near the mouth of the creek.

The instream PIT tag interrogation site LLC was operational throughout the spring of 2020 and detected one hatchery and three natural origin steelhead from the Priest Rapids Dam (PRD) mark group. When those tags were expanded by the mark rate of .2131, a total estimated 5 hatchery and 14 natural origin steelhead likely spawned in Loup Loup Creek in 2020. Three PIT tags not from the PRD mark group were also detected in the creek, 2 hatchery and 1 of unknown origin. Long term trends in steelhead spawning escapement for Loup Loup Creek are shown in Figure 15.

All of the property along the banks of Loup Loup Creek, from the confluence with the Okanogan to the falls (Figure 16, assumed steelhead distribution), is under private landownership. In previous years, surveyors would knock on doors to obtain access permissions for redd surveys; however, in April of 2020 with the early COVID-19 restrictions in place, this could not take place. We relied solely on PIT tag expansion for the 2020 spawner estimates. Redds documented in previous years (2005-2019) are shown in Figure 16 for reference.

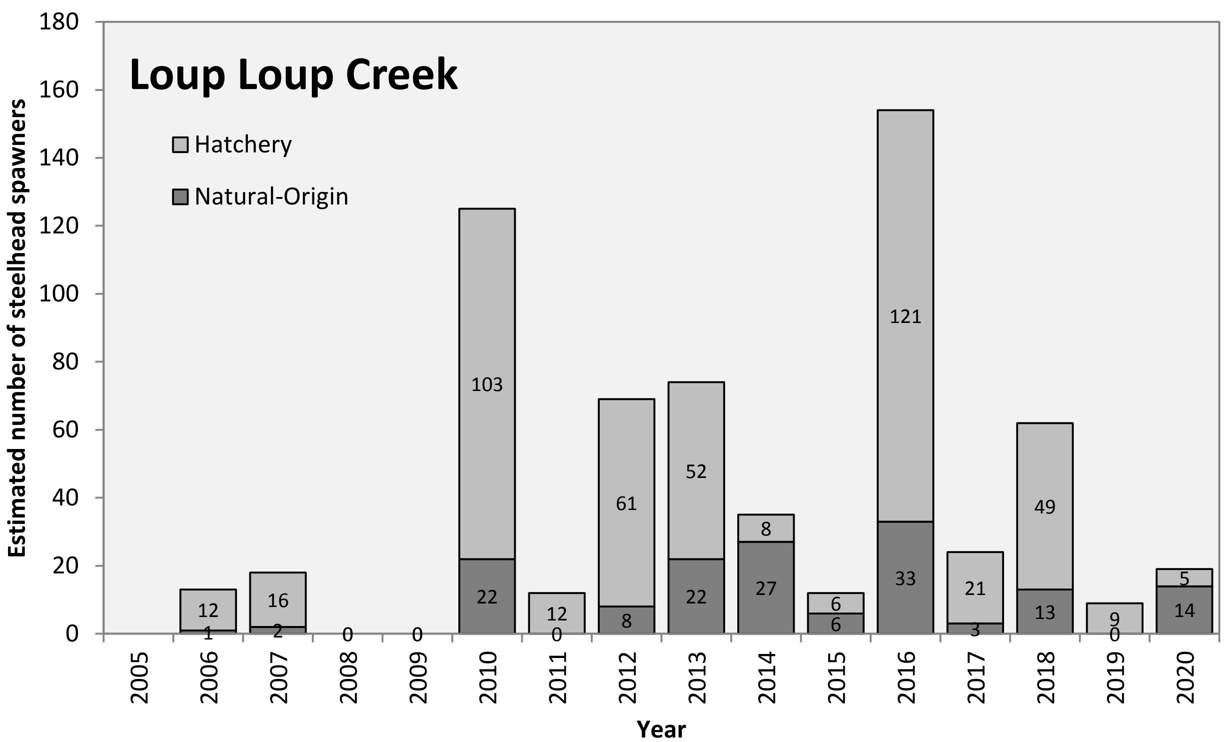

Figure 15. Trend in the number of steelhead spawners in Loup Loup Creek.

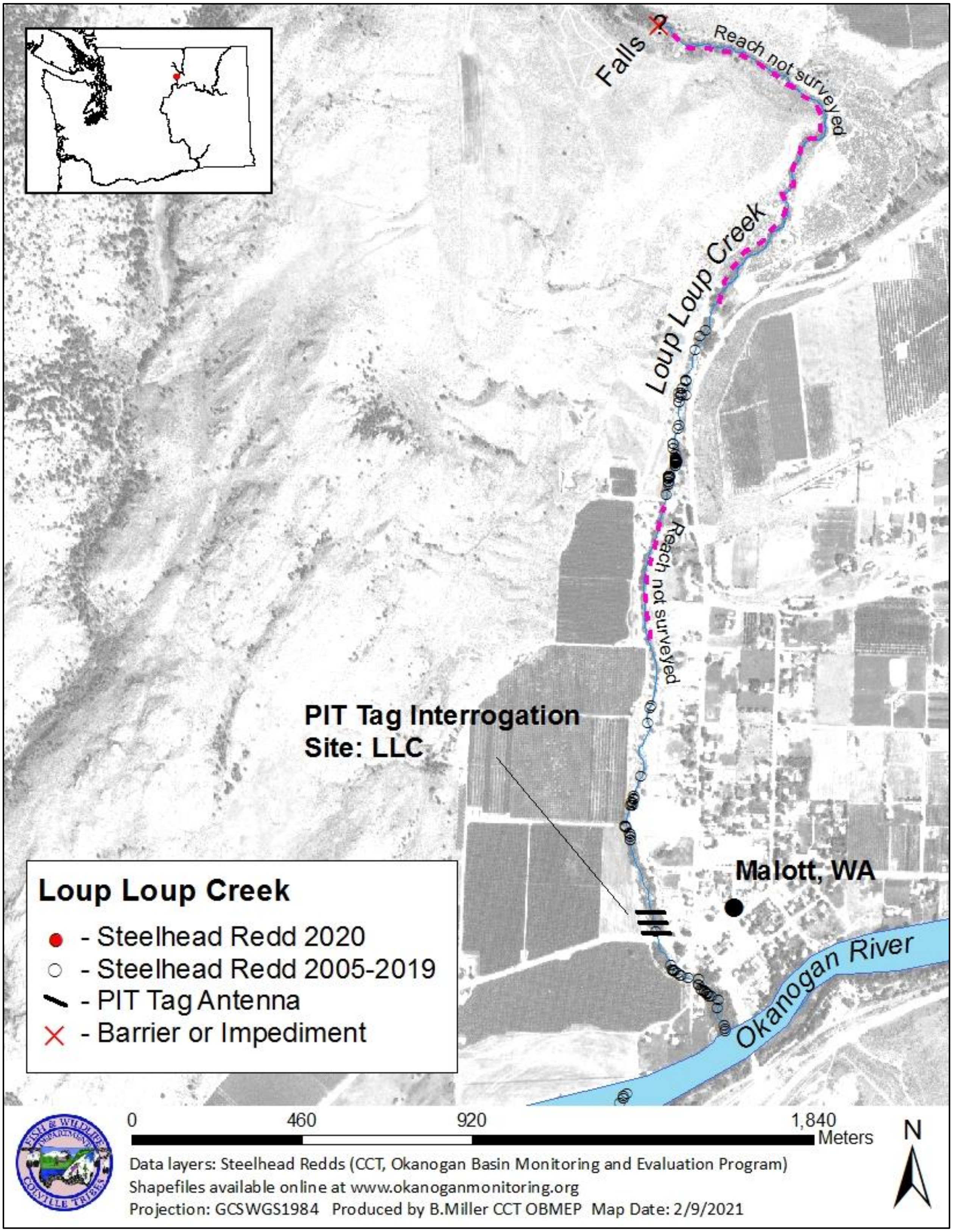

Figure 16. Spatial distribution of historical summer steelhead redds documented in Loup Loup Creek.

3.2.2 Salmon Creek

Salmon Creek is a highly managed medium sized tributary, which enters the Okanogan River at RKM 41.3 in the city of Okanogan, WA. Since the early 1900's, the majority of water from Salmon Creek had been diverted for irrigation usage. Resulting in a largely 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 in high water years. These spills typically occurred in mid-May to June, which is after peak spawning for summer steelhead in the Okanogan basin. To provide sufficient water during the migration window of spring-spawning steelhead, the Colville Tribes purchased water from the OID and allowed it to flow down the channel to the Okanogan River. After several years of successful steelhead passage, the Tribes negotiated a long term water lease agreement with the OID. Since 2006, the long term water lease has provided seasonal water for returning adults and outmigrating juvenile salmonids. Further negotiations allowed for continuous flow, year-round since 2019.

A PIT tag interrogation site (SA1) is located 2.9 km upstream from the mouth of Salmon Creek. The instream array consisted of four pass-over HDPE antennas configured in two separate rows. A second PIT tag interrogation site (SA0) is located immediately downstream of the OID diversion dam and consists of five pass-over PVC antennas configured in two separate rows (Figure 18). During the 2020 spawning season, a total of 13 natural-origin and 3 hatchery PIT tagged steelhead from the PRD mark group were detected at the lower SA1 array. All of the tags detected on the upstream site SA0 were detected on SA1, which rendered a detection efficiency estimate of 100% at the downstream detection site. This rendered an expanded total estimate of 75 steelhead (61 natural-origin and 14 hatchery steelhead) spawning in Salmon Creek in 2020.

The lower portion of Salmon Creek is generally owned by the City of Okanogan and we were able to contact other landowners below the diversion for access permissions for redd surveys in the spring of 2020. The creek was surveyed two times from the confluence with the Okanogan River to the irrigation diversion. On April 30, 10 redds were found and one additional redd was found on May 12 (Figure 18). Towards the end of May, discharges became too high to perform walking surveys in the creek (Figure 13). When expanded by 1.52 fish per redd, the 11 redds rendered an estimate of 17 fish spawning in the reach below the diversion.

Although twelve of the 13 natural-origin and all 3 hatchery tagged steelhead were subsequently detected on SA0, we would generally assume that those fish would have spawned above the OID diversion. However, because 17 fish were accounted for below the diversion, it is likely that there appears to be some reluctance to pass the OID diversion. This has been noted in previous years surveys as well. To determine distribution of spawning above and below the diversion, we took the proportion of natural origin fish in the creek (61/75=0.813) and applied that rate to the number of the fish spawning below the diversion, which rendered an estimate of 14 wild and 3 hatchery steelhead. This left an estimated 47 wild and 11 hatchery steelhead spawning above the diversion. For reference, trends in steelhead spawning escapement for Salmon Creek are included in Figure 18.

It is interesting that the number of hatchery steelhead spawners in Salmon Creek has generally been declining in recent years, including the unexpectedly low estimate of 3 in 2019 and 14 in 2020. Between 30,000 and 40,000 hatchery juvenile steelhead are released in the creek each year (Wes Tibbits, CCT, pers. comm.). It is certainly possible that spawning estimates could have been bias low due to error associated with small sample size and few detections. However, because a relatively large proportion of the total adult population (~21.31%) is included in the PRD mark group and interrogation site SA1 had a high detection efficiency in 2019 and 2020 (both ~100%), it is unlikely that significant numbers of hatchery adults were unaccounted for. It is also possible that juvenile hatchery steelhead released in Salmon Creek are not returning to this stream, potentially due to lack of imprinting or insufficient attractant flows in April (typically ~5cfs). Additionally, between 500 and 2,000 hatchery juveniles from the release groups are estimated to residualize in the creek as juveniles annually (OBMEP 2021, Appendix B).

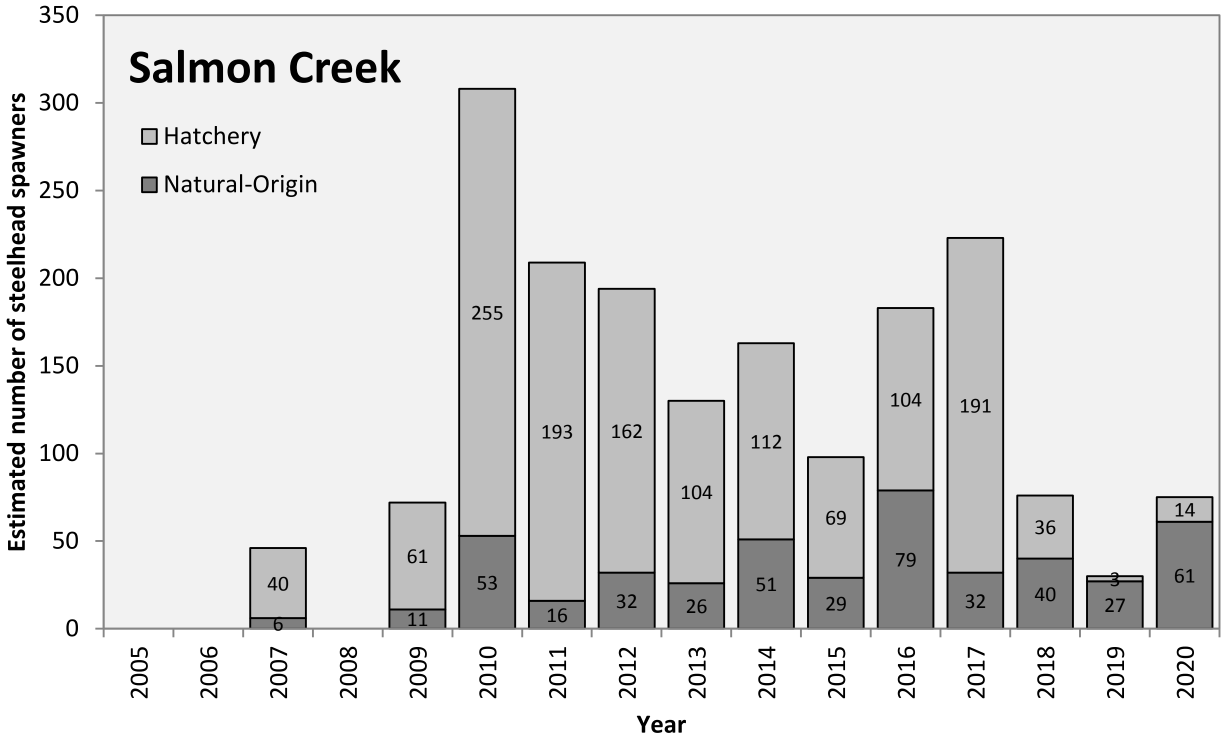

Figure 17. Trend in the number of steelhead spawners in Salmon Creek.

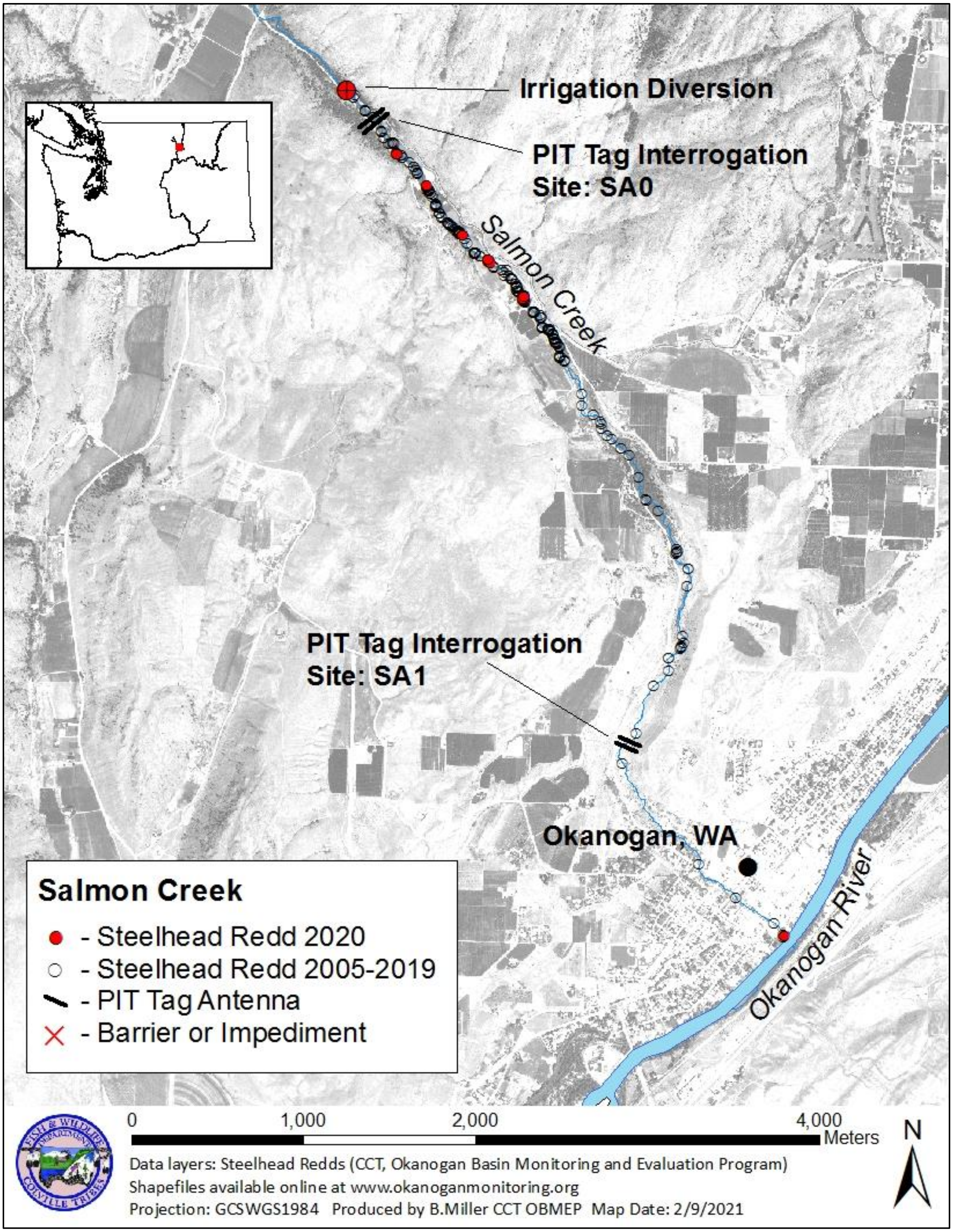

Figure 18. Spatial distribution of historical summer steelhead redds documented in lower Salmon Creek, from the confluence to the irrigation diversion.

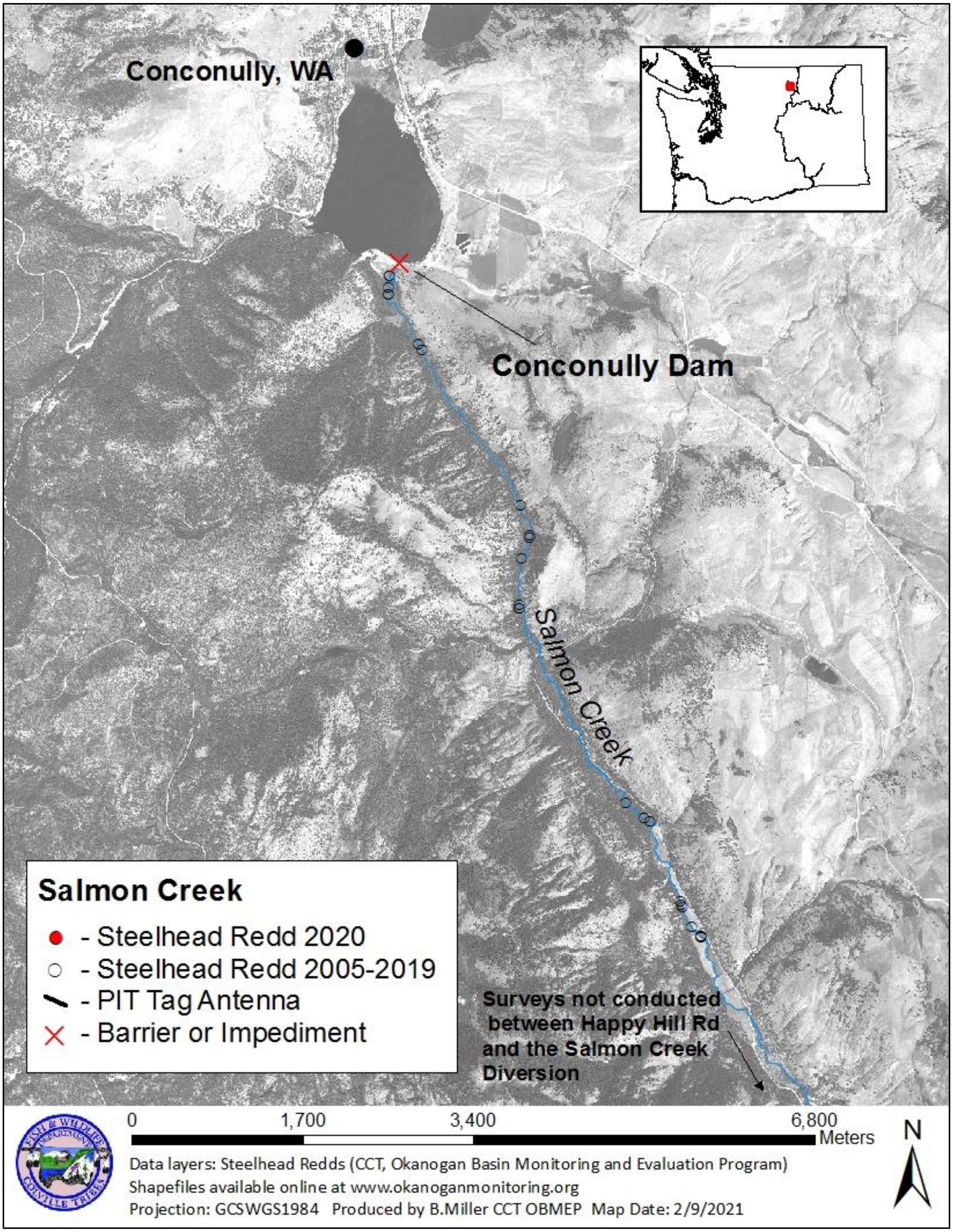

Figure 19. Spatial distribution of summer steelhead redds documented in upper Salmon Creek, below Conconully Dam.

3.2.3 Omak Creek

Omak Creek is characterized as a perennial, medium sized tributary that enters the Okanogan River at RKM 51.5, approximately 1.0 km upstream from the city of Omak, WA. Discharge rates in the creek generally range from a base flow of 2–4 cfs to over 150 cfs during peak runoff. During the base flow period, wetted widths range from approximately 2 to 8 m. A PIT tag interrogation site (OMK) consisted of four pass-over HDPE antennas configured in two separate rows located 0.24 km upstream from the confluence with the Okanogan River. Two additional PIT tag interrogation sites were also operated below (OBF) and above (OMF) Mission Falls to monitor passage rates. Each of these sites consisted of a two pass-over HDPE antennas configured in a single row.

Runoff in Omak Creek began in mid-April and lasted through the end of May. Although water was elevated, clarity was sufficient and two surveys occurred in April below the weir, on the 2nd where three redds were found and on April 29 when two more redds were located. These redds were expanded by 1.52 fish per redd for an estimated 8 total steelhead spawning below the weir. The weir was used to estimate fish spawning above that point. Redd surveys have not been conducted above Mission Falls due to the very few numbers of fish ascending the falls to date and the significant number of stream kilometers above that point.

The total spawning estimate for Omak Creek was estimated based on PIT tag detections and fish handled at the adult weir trap. A total of 13 natural-origin and 6 hatchery steelhead were detected at OMK. We assumed 100% detection efficiency at OMK in 2020 because all tags detected at upstream sites OBF or OMF were detected previously at downstream OMK. Those tags were expanded by the mark rate of 0.2131 for a total number of 61 natural-origin and 28 hatchery steelhead entering the creek. A total of 9 wild and 23 hatchery fish were removed at the weir for broodstock, and 40 natural-origin and 8 hatchery steelhead were passed upstream of the weir. To determine the efficiency of the adult weir trap in 2020, we looked at steelhead that were tagged prior to entering the creek and which were detected at either OBF or OMF, both located above the weir (7 total). Of those seven fish, six were handled at the weir, rendering an estimated 0.86 efficiency across the season (0.86=6/7). The number of fish passed above the weir were expanded by the weir efficiency of 0.86 for a total spawning estimate above the weir of 47 natural-origin and 9 hatchery steelhead. The number of fish spawning below the weir would be the total number of fish entering the creek, minus the number removed at the weir and minus the expanded estimate passed above the weir, for a total of 5 natural-origin and 8 hatchery steelhead (Table 5).

Nine PIT tagged steelhead were detected at OBF (at the base of Mission Falls) before the site was stolen in mid-April. However, a total of 14 fish were detected above Mission Falls in 2020 (13 of natural-origin and 1 hatchery steelhead). These tags were not expanded to unmarked fish because every adult steelhead that was handled and passed upstream of the weir received a PIT tag.

Table 5. Calculations used to estimate the number and distribution of spawning steelhead in Omak Creek in 2020.

Description (Variable)	Natural-origin	Hatchery
A. Total steelhead entering Omak Creek in 2020	61	28
B. Number of steelhead broodstock removed at weir	9	23
C. Number of steelhead passed upstream of weir	40	8
D. Estimated # steelhead spawning above weir (D = C/0.86)	47	9
E. Estimated # steelhead spawning below weir (E = A-B-D)	5	0
F. Number of steelhead above Mission Falls	13	1
G. Total estimated number of SH spawning 2020 (G = D+E)	52	9

It appears that passage through Mission Falls may be confined between certain flow conditions. Because the lower antenna OBF below the falls was stolen in 2020, the passage data and timing of fish detected on the bottom to the top of the falls were incomplete this year. Timing data from 2019 was more compete. Passage through Mission Falls was documented between April 18 and May 20, 2019. Steelhead were first detected at the base of the falls (OBF) on April 1, 2019 (dashed grey line, Figure 20). Passage time was between one and six days as calculated by the time elapsed between the last detection below the falls (OBF) and the first detection above the falls (OMF), a distance of approximately 1200 meters. Stream discharge during passage events was generally 25-50 cfs. The single day passage occurrence on 5/2/2019 was the only female in the group and was recaptured at the Omak Creek weir six days after last detection above Mission Falls.

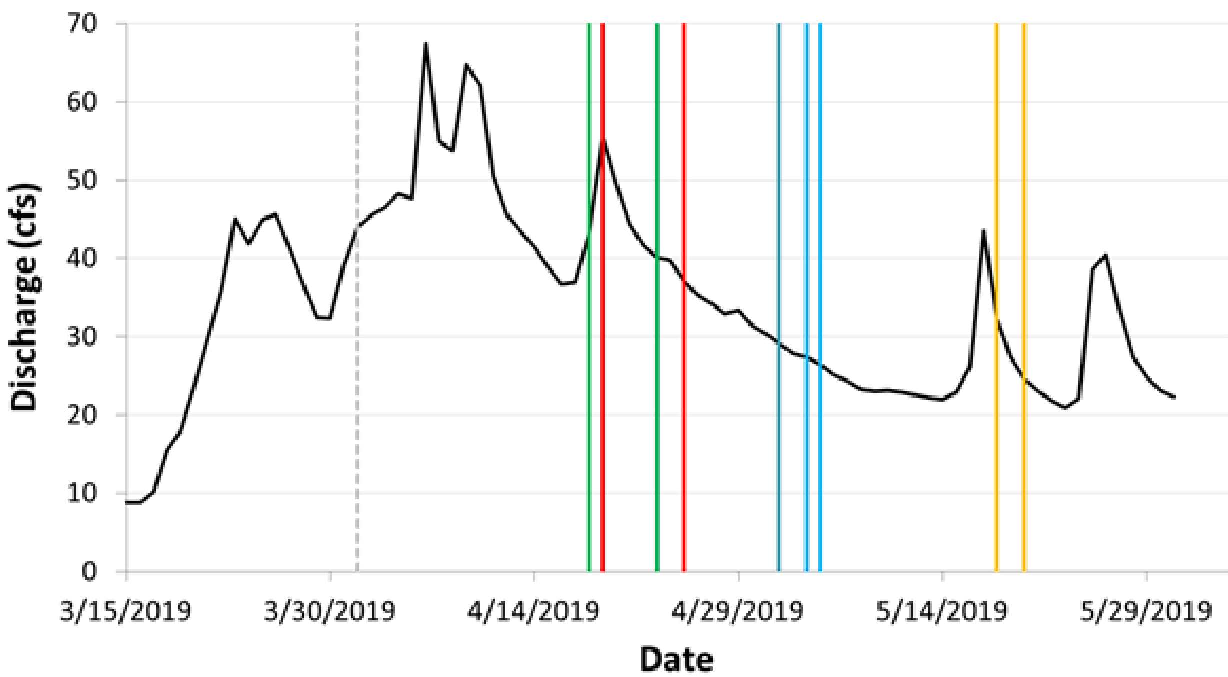

Figure 20. Timing of successful adult steelhead passage events at Mission Falls on Omak Creek 2019. Dashed grey vertical line represents the date of first PIT tag detection below Mission Falls (OBF). Color coded lines are individual fish, with the first sequential color occurrence representing detection below the falls (OBF) and the second occurrence above the falls (OMF). One event occurred in a single day (dark blue line).

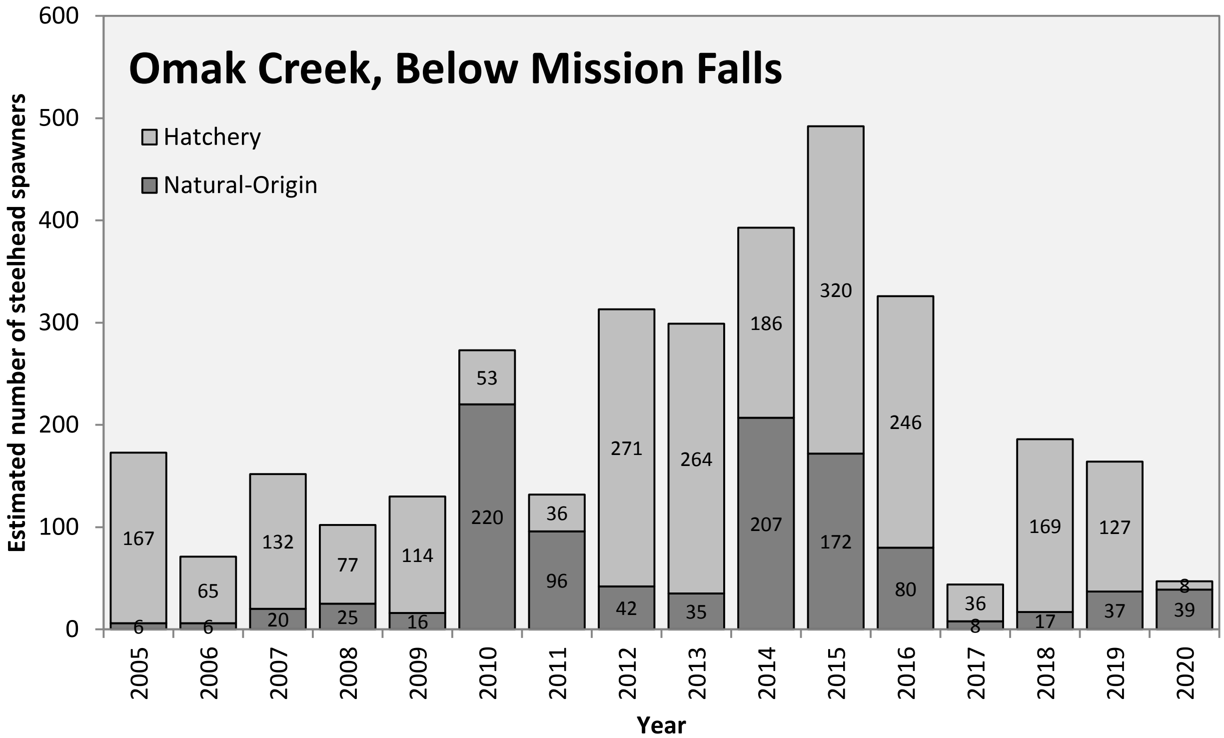

Figure 21. Trend in the number of steelhead spawners in Lower Omak Creek.

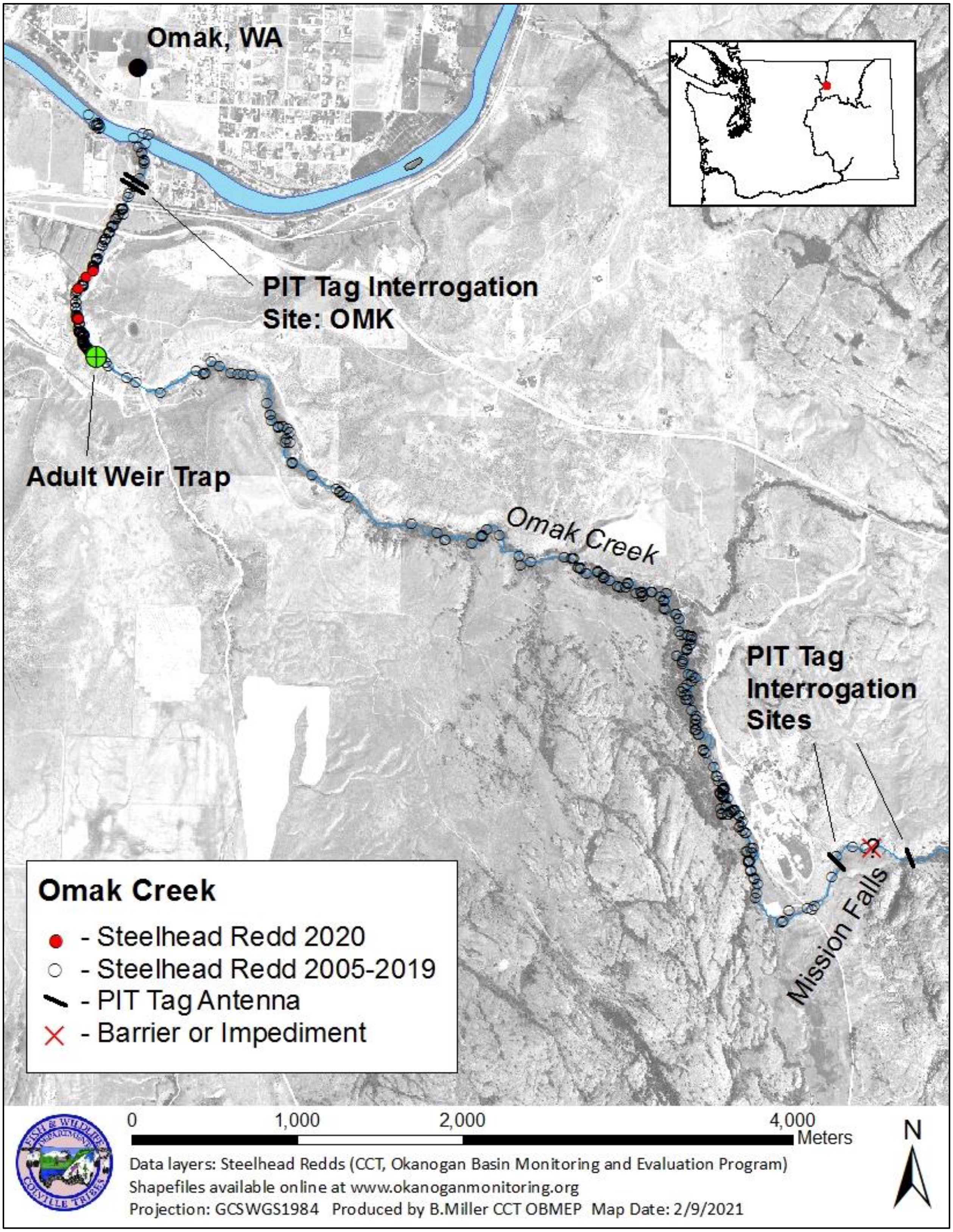

Figure 22. Spatial distribution of historical summer steelhead redds documented in Omak Creek, from the confluence to Mission Falls.

3.2.4 Wanacut Creek

Wanacut Creek is a small stream that joins the Okanogan River at approximately RKM 56, between Omak and Riverside, WA. The 51 km^2 Wanacut Creek drainage stems from Omak Mountain, located on the Colville Reservation. A large natural falls exists a short distance from the confluence with the Okanogan River and the creek frequently flows subsurface in the lower most reaches. A temporary PIT tag interrogation site (WAN) is operated seasonally near the mouth of the creek to record PIT tagged steelhead movements.

No PIT tagged steelhead were detected from the representatively marked PRD group on interrogation site WAN, which would have resulted in a zero spawning estimate. However, one natural-origin PIT tagged steelhead not from the PRD group was detected in mid-April and allocated to Wanacut Creek. Based on this information and our attempt to get the most accurate spawning estimates by subwatershed, we attributed the one natural- and no hatchery steelhead to Wanacut Creek for the 2020 spawning estimate. The lower portion of the creek was dry in early July. Conditions in Wanacut Creek were generally favorable to conduct redd surveys in the spring; although in 2020 with the early COVID-19 restrictions in place, we chose not to survey through the HUD community surrounding the creek. Staff surveyed the lower end of the creek when changing batteries at the PIT tag array, where spawning has been documented in past years, but no redds were found. The location of redds observed in previous years (2005–2019) are shown in Figure 24.

Over the previous 13 years of surveys conducted on Wanacut Creek (2007–2019), seven years had no steelhead spawning and the remaining 6 years had an average of 7 steelhead spawners. The maximum spawning estimate was 12 in 2012 (Figure 23).

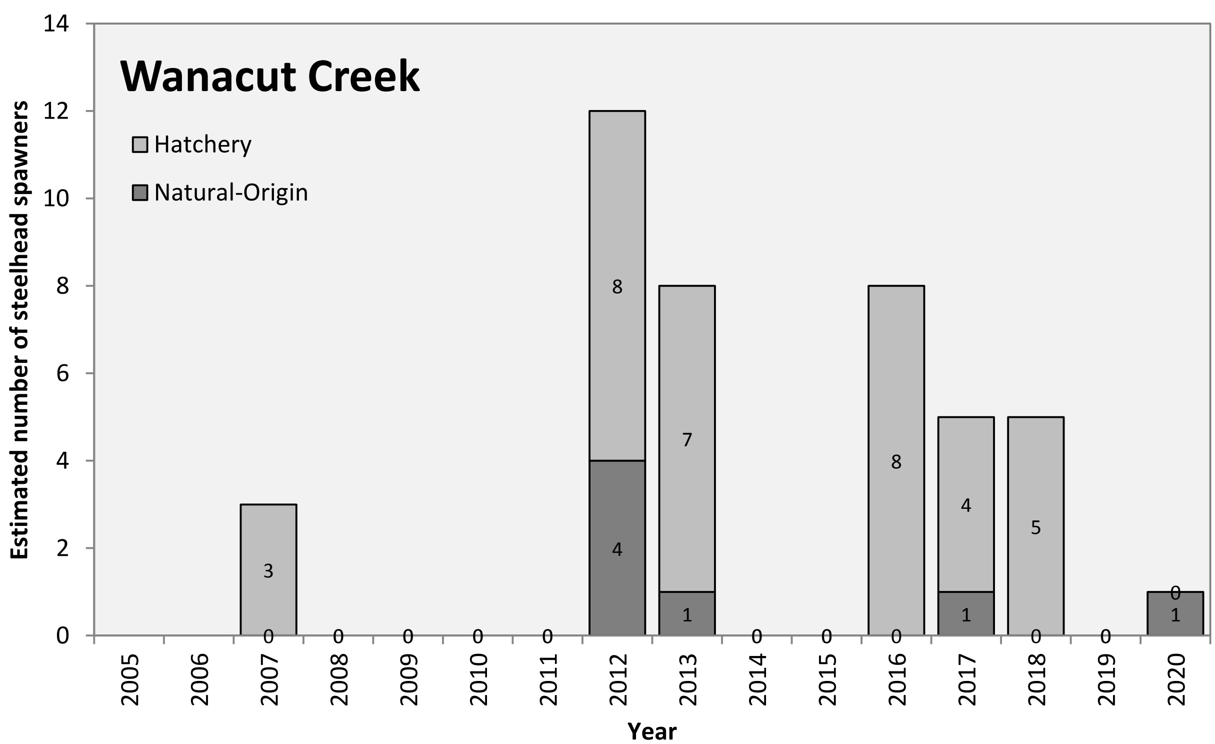

Figure 23. Trend in the number of steelhead spawners in Wanacut Creek.

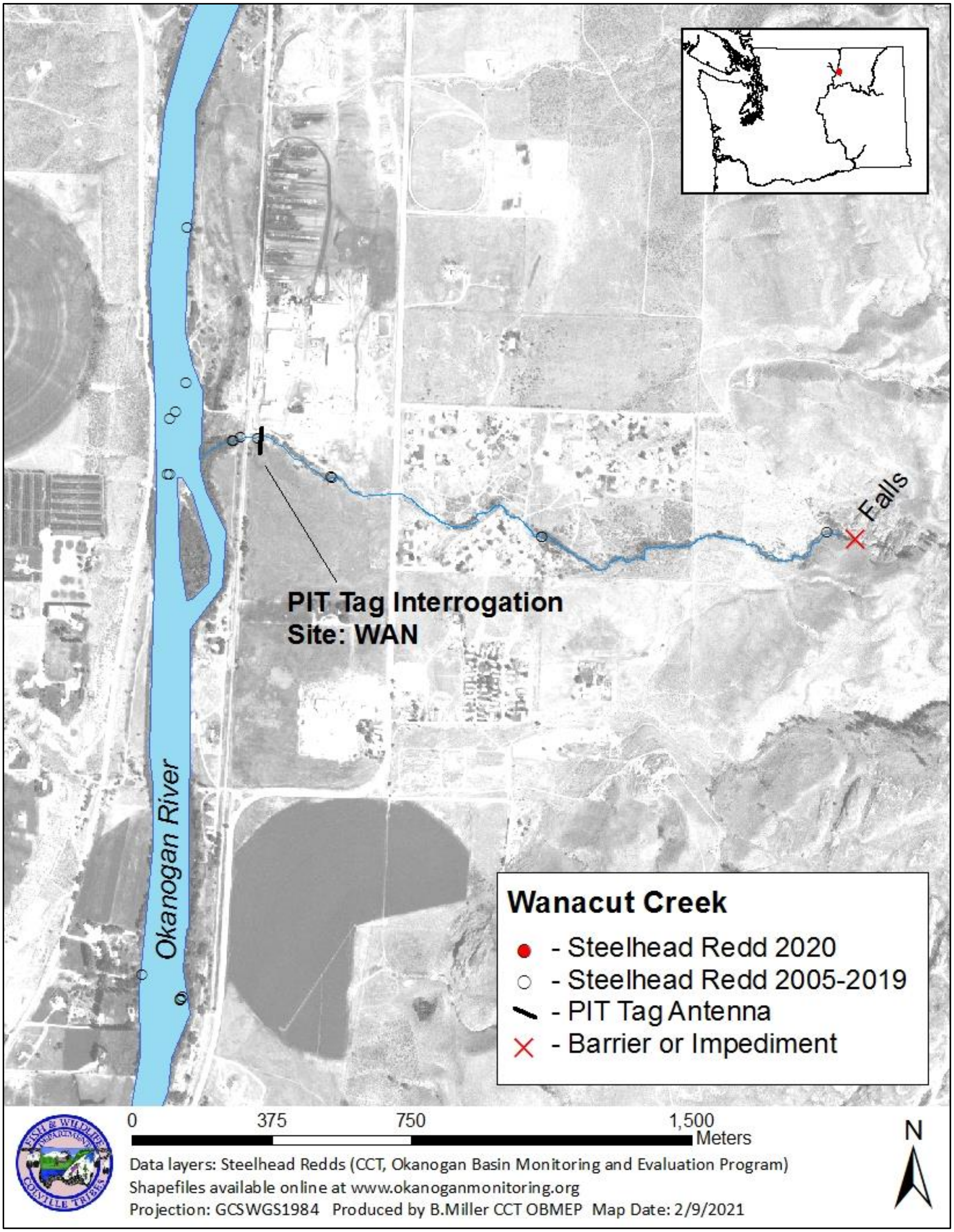

Figure 24. Spatial distribution of historical summer steelhead redds documented in Wanacut Creek.

3.2.5 Johnson Creek

Steelhead surveys have occurred in Johnson Creek since 2012 and two PIT tag arrays were again operated in the creek in 2020. A permanent single pass-through antenna located near the mouth (JOH) and a single temporary pass through antenna above the US 97 culvert. No PIT tagged steelhead were detected at either PIT tag interrogation site in Johnson Creek in 2020, which rendered a total spawning estimate of zero. For reference, trends in steelhead spawning escapement for Johnson Creek are included in Figure 25.

Because the creek flows through the town of Riverside, surveyors needed to obtain permissions from each property owner along the creek. In 2020, we chose not to knock on doors in the early days of COVID-19 lockdowns and therefore must rely on the PIT tag expansion calculations for spawning estimates for Johnson Creek in 2020. The spatial distribution of steelhead spawning in lower Johnson Creek for 2019 and previous years are shown in Figure 26.

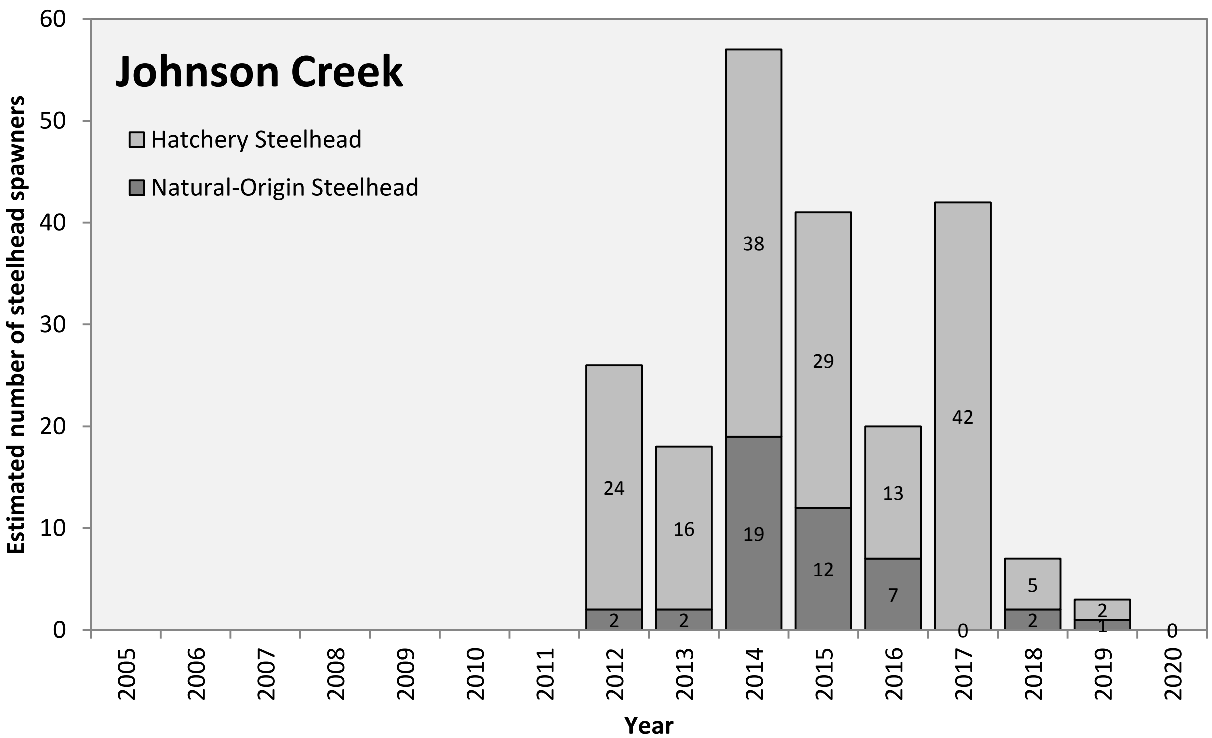

Figure 25. Trend in the number of steelhead spawners in Johnson Creek.

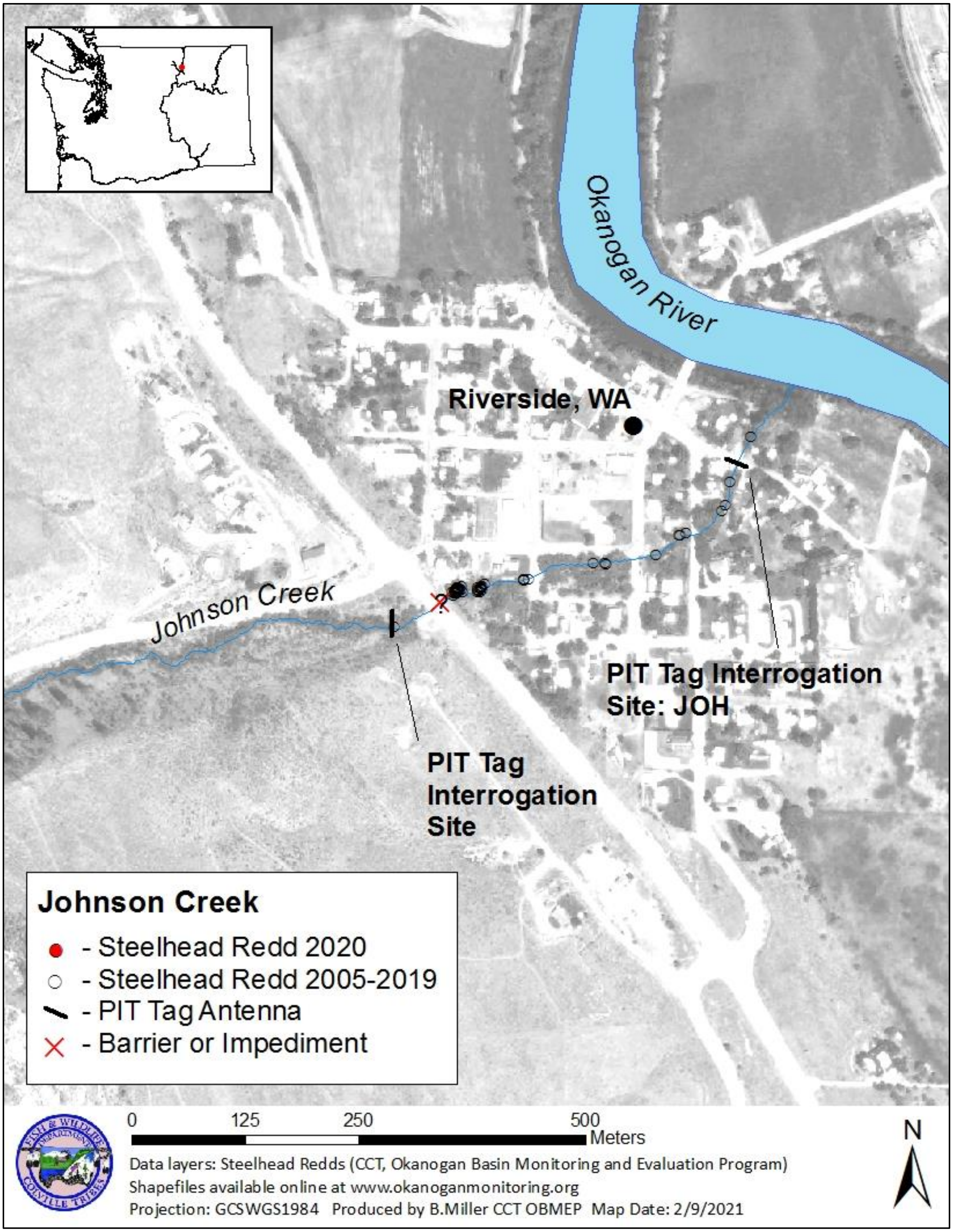

Figure 26. Spatial distribution of summer steelhead redds documented in Johnson Creek, from the confluence to the gabion weir.

3.2.6 Tunk Creek

Tunk Creek is a small tributary that joins the Okanogan River at RKM 72, upstream of Riverside, WA. Although the drainage area of Tunk Creek is approximately 186 km^2, only the lower 1.2 rkm are accessible to anadromous fish, due to a natural falls. The creek frequently flows subsurface in the lower reaches during mid-summer. A temporary PIT tag detection site (TNK) consisting of a single pass-over antenna is installed seasonally near the mouth of the creek.

Conditions in Tunk Creek were generally favorable throughout the spring of 2020 and staff were able to obtain access permissions for a peak spawn redd survey from the mouth to the falls. Eight redds and 5 adult steelhead were seen in the creek. Another redd survey was conducted towards the end of the season on May 26 and an additional 6 redds were found. The 14 redds, when expanded by 1.54 fish per redd rendered 21 steelhead. The majority of steelhead spawning in Tunk Creek occurs in a relatively short reach just downstream of the falls where superimposition is common (Figure 28).

Through the spring of 2020, 4 natural- and 7 hatchery-origin steelhead from the PRD group were detected at site TNK. These fish were expanded by the mark rate to 19 natural- and 33 hatchery-origin, for a total of 52 steelhead. The PIT tag expansion estimate was likely more reliable for a total spawner count due to surveyors likely missing redds due to superimposition, which can be prevalent in the region near the base of the falls (Figure 28).

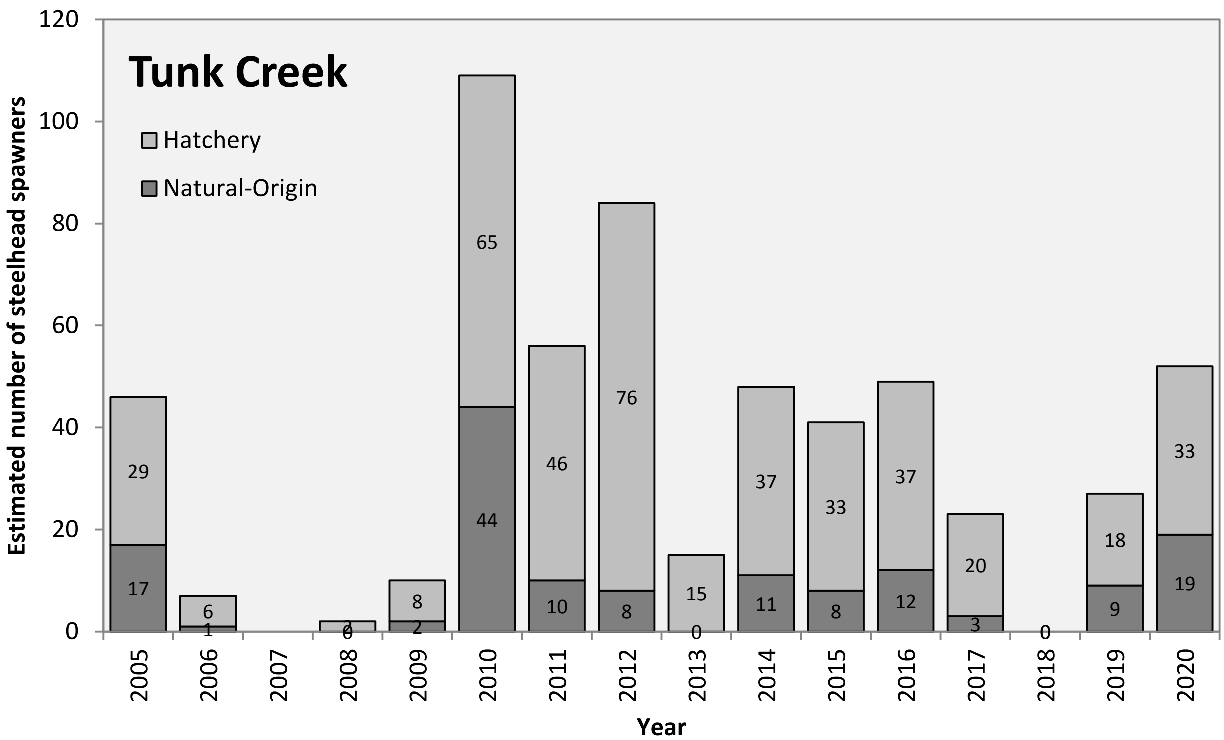

Figure 27. Trend in the number of steelhead spawners in Tunk Creek.

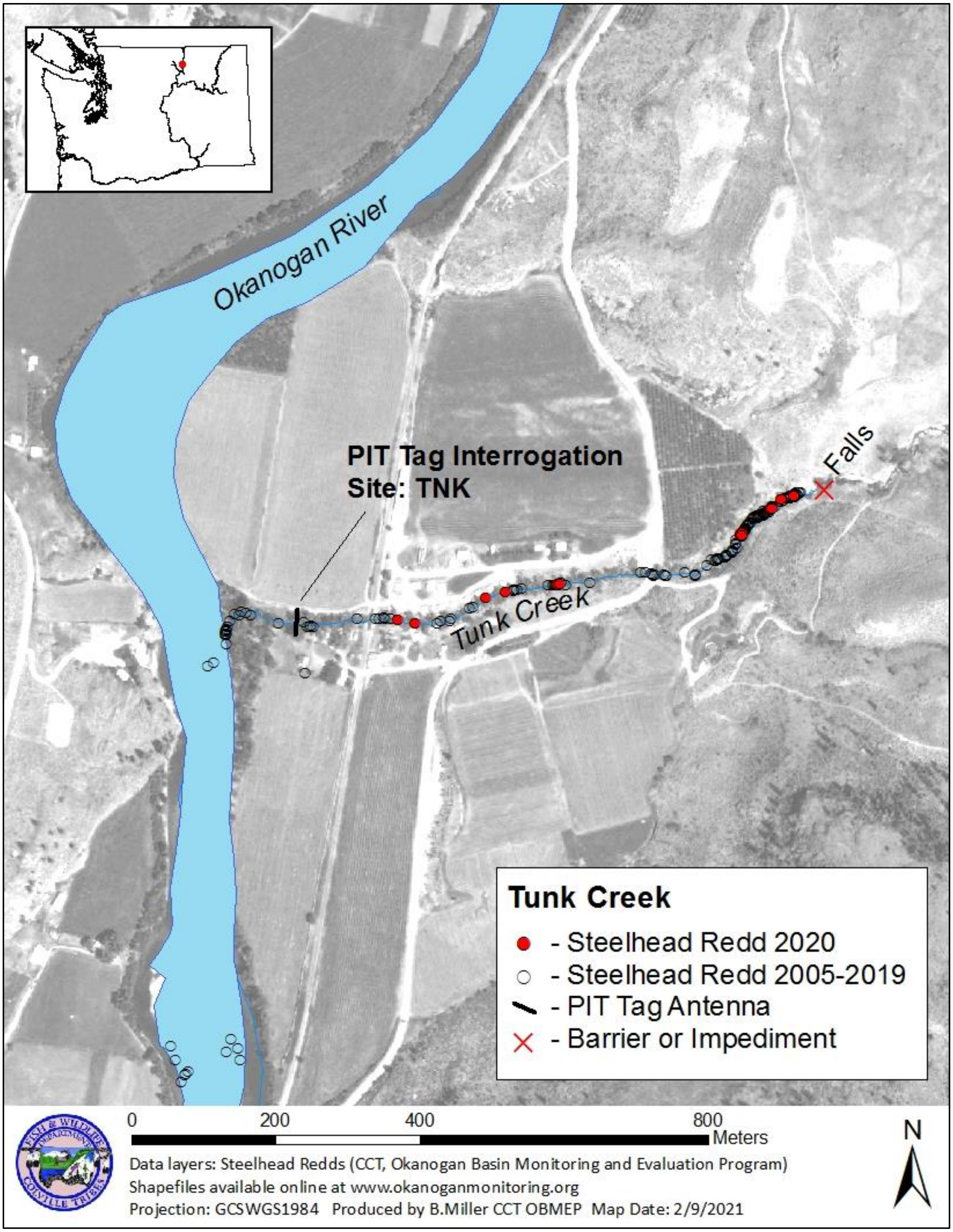

Figure 28. Spatial distribution of historical summer steelhead redds documented in Tunk Creek.

3.2.7 Aeneas Creek

Aeneas Creek is a small creek that enters the Okanogan River just south of the town of Tonasket, WA (RKM 85). The lower section of the creek was impounded with a series of very large beaver dams that were cemented in with calcified clay. In 2012, many of these structures were removed, allowing adult steelhead passage at the mouth of the creek. Although potential passage has not been studied at this location, the total habitat accessible to anadromous fish appears to be limited by a culvert and steep gradient (Figure 30). Two redd surveys were successfully conducted towards the end of the spawning period. Two redds were found on May 13 and 0 new redds were seen on May 26. The two redds, expanded by 1.52 FPR equaled an estimated three steelhead spawning in Aeneas Creek in 2020.

A permanent PIT tag detection site (AEN) consisting of a single pass-through antenna operated near the mouth of the creek to document utilization of the creek by adult steelhead. No PIT tagged steelhead were detected in 2020, resulting a total spawning escapement estimate of zero steelhead. Because two redds were found, we defaulted to the redd survey-based estimate of 3 steelhead. We assumed that these fish were likely of hatchery-origin based on historic hatchery/wild data from Aeneas Creek (Figure 29).

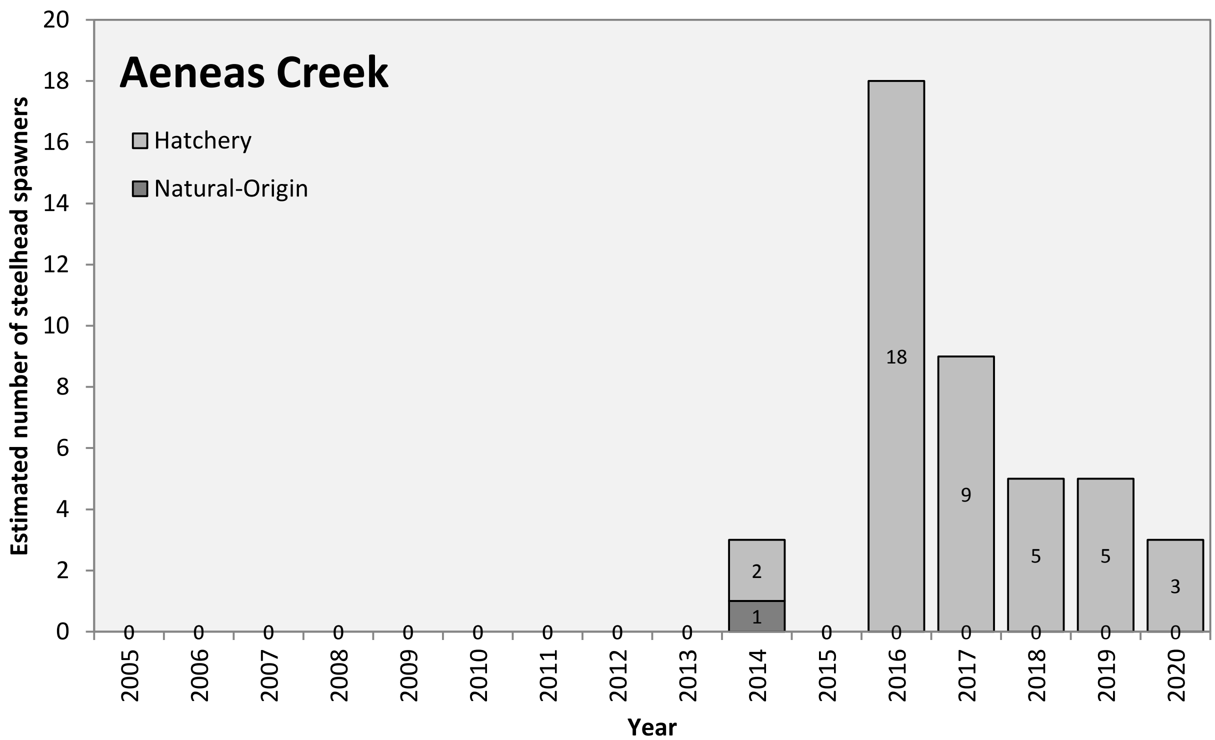

Figure 29. Trend in the number of steelhead spawners in Aeneas Creek.

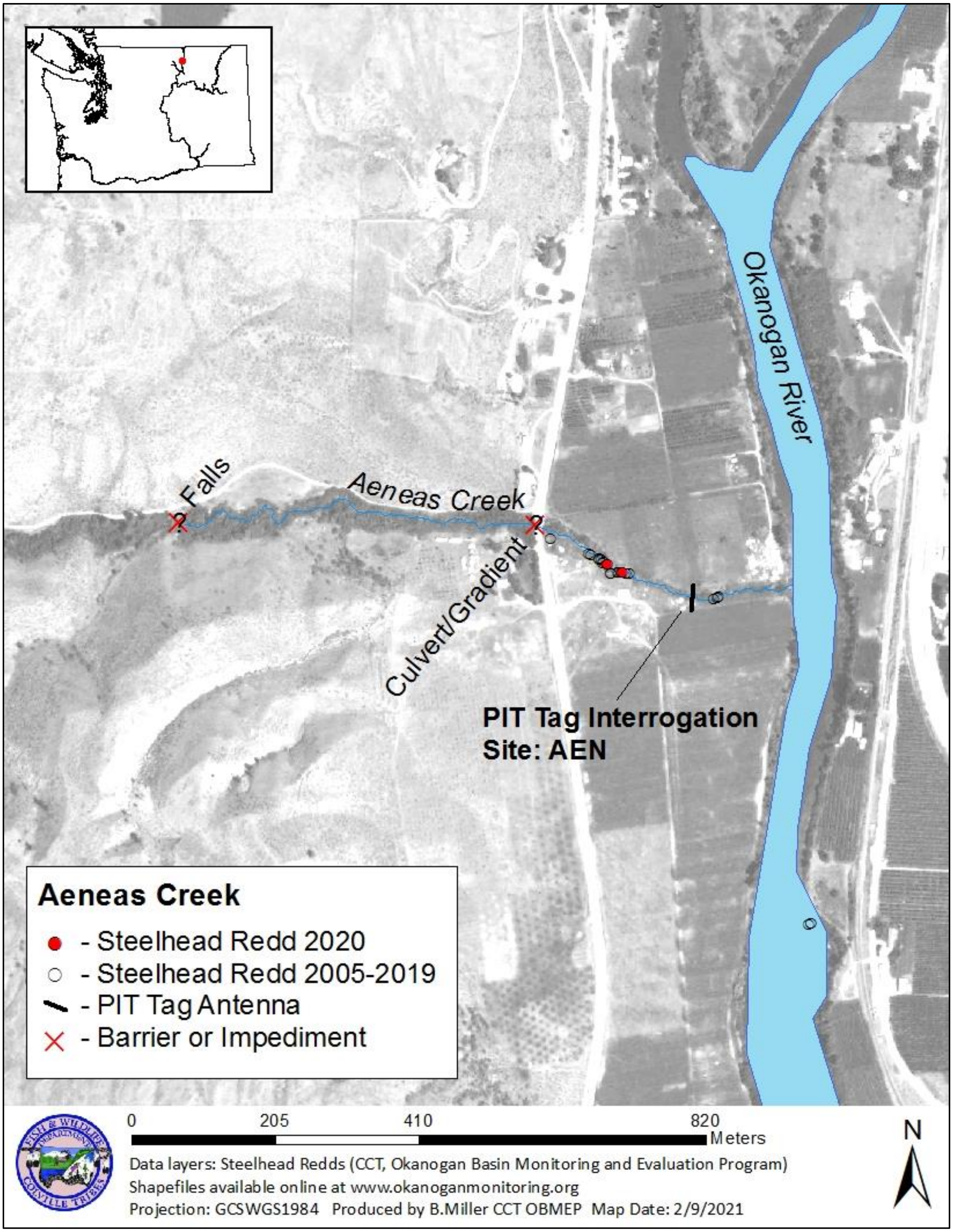

Figure 30. Spatial distribution of historical summer steelhead redds documented in Aeneas Creek.

3.2.8 Bonaparte Creek

Bonaparte Creek flows out of Bonaparte Lake, near Wauconda, WA, and enters the Okanogan River at RKM 91. The Bonaparte Creek watershed has a drainage area of 396 km^2; discharge ranges from 1 cfs during base flow conditions and usually reaches 20–40 cfs during runoff. During summer base flow, wetted widths range from 1.5 m to 3 m. Only 1.6 rkm of stream below a natural falls is accessible to anadromous fish (Figure 32).

A permanent PIT tag interrogation site (BPC) consisting of three pass-over PVC antennas arranged in three separate rows was located just upstream from the confluence with the Okanogan River. Based on 3 natural-origin tag detections from the PRD mark group, the estimated spawning escapement was 14 natural-origin hatchery steelhead in Bonaparte Creek in 2020. Although no hatchery steelhead from the PRD tag group were detected, two other hatchery steelhead were detected at BPC in the spring of 2020. In our attempt to best describe spawning distribution in each subwatershed, these two fish were added for a total spawning estimate of 14 natural-origin and two hatchery steelhead in 2020. For reference, trends in steelhead spawning estimates for Bonaparte Creek are included in Figure 31.

Bonaparte Creek flows through the town of Tonasket, WA. All of the property along the banks of the creek, from the confluence with the Okanogan to the falls (assumed steelhead distribution), is under private landownership. In previous years, surveyors would knock on numerous doors to obtain access permissions for redd surveys. In April of 2020 with the early COVID-19 restrictions in place, this could not take place. We relied solely on PIT tag expansion for the 2020 spawner estimates. Distributions of redds found in previous years surveys (2005-2019) are shown in Figure 32.

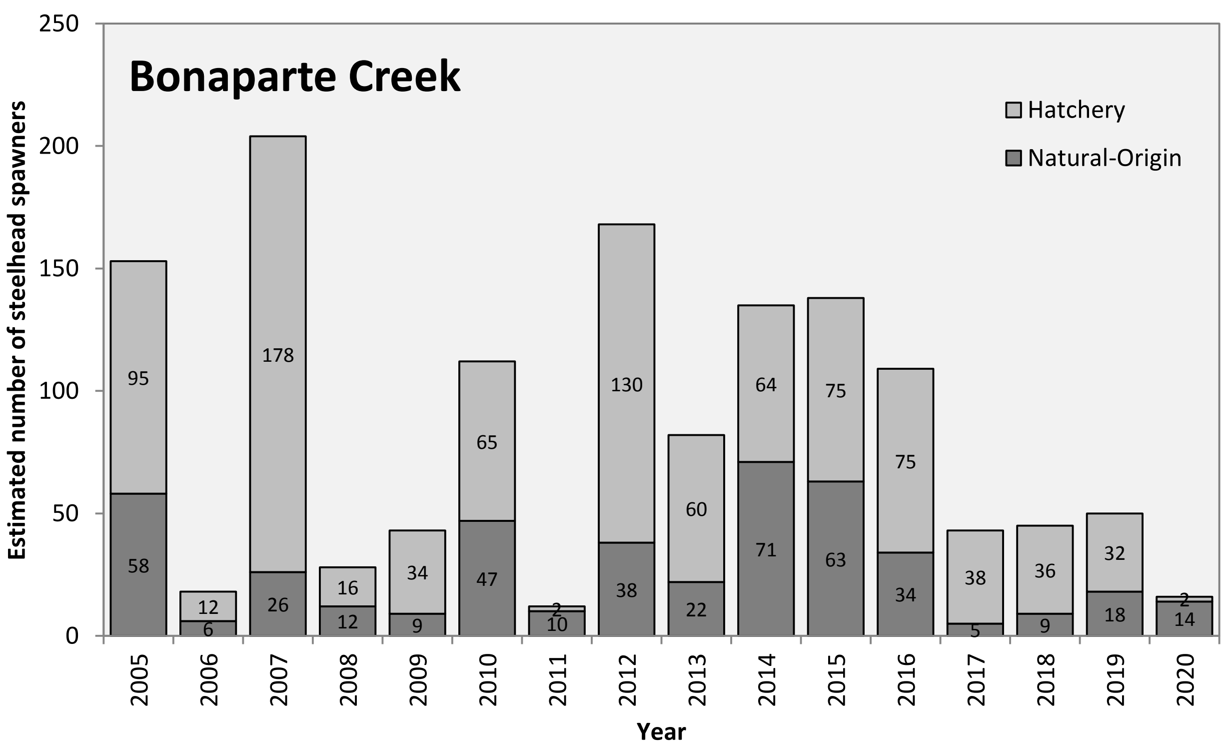

Figure 31. Trend in the number of steelhead spawners in Bonaparte Creek.

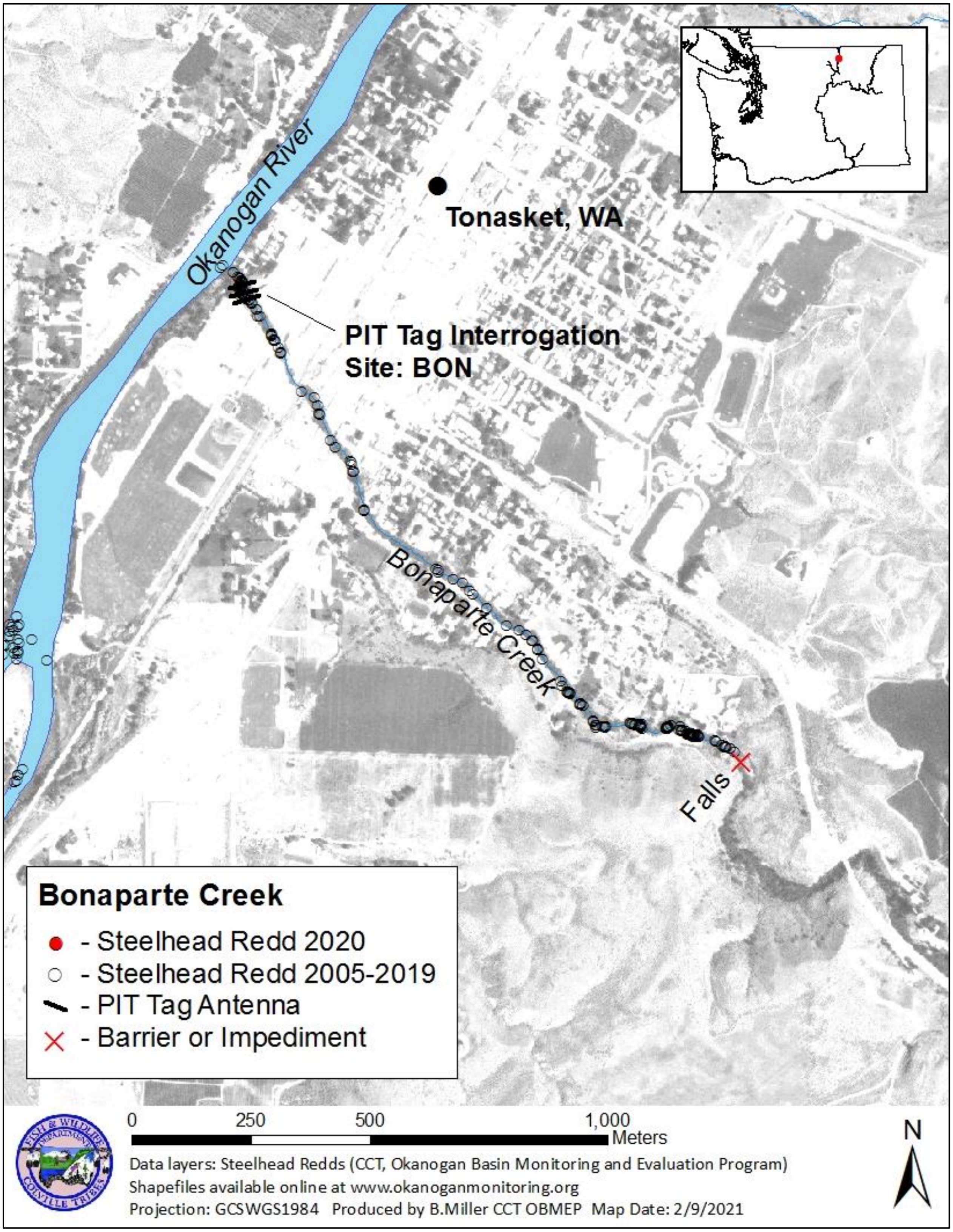

Figure 32. Spatial distribution of historic summer steelhead redds documented in Bonaparte Creek.

3.2.10 Antoine Creek

Steelhead surveys have occurred in the lower portion of Antoine Creek since 2006. The average number of estimated spawners is only five per year from 2006–2015. Utilization by adult steelhead had been relatively limited, potentially due to poor accessibility across the delta at the confluence with the Okanogan River. Additionally, access to Antoine Creek was at least partly impeded by an approximately 6 foot high cut bank falls with a very shallow plunge pool near the confluence with the Okanogan River. Frequently, wood debris piled up in this slot and likely inhibited upstream passage. In late 2015, habitat modifications were completed near the mouth of Antoine Creek, designed to increase passage success for the 2016 spawning period (Keith Kistler, CCT, pers. comm.). Additionally, a small concrete dam was removed in Antoine Creek in the fall of 2013, which opened up an additional 11 rkm of habitat in the upper creek. Since increasing instream flows and removing access barriers, the number of steelhead utilizing Antoine Creek has increased over the past 5 years, compared with prior estimates (Figure 33).

Complete redd surveys occurred in Antoine Creek for the first time in 2018. On April 25th, 2018, surveyors walked upstream from the mouth of the creek through Antoine Valley Ranch and located 15 redds (Figure 34). In 2020, no redds were found in the lower section of the creek and surveys could not be conducted upstream due to lack of access. Six natural-origin and zero hatchery PIT tagged steelhead in the PRD mark group were detected on PIT tag interrogation site ANT in 2020. Those fish were expanded for a total spawning escapement estimate of 28 natural-origin and 0 hatchery steelhead. An additional 2 PIT tagged hatchery steelhead were documented using the creek in the spring of 2020. We added those to the total estimate for a total of 28 natural- and 2 hatchery-origin steelhead in Antoine Creek in 2020.

A temporary PIT tag interrogation site operated on Antoine Valley Ranch for the first time in 2018 was not installed in 2019 or 2020 due to lack of access. In 2018, an estimated 9 natural-origin and 9 hatchery fish passed this upper array, which along with the documented redds, was the first observation of adult steelhead this high in the Antoine Creek watershed. Although spatial distribution was not described in 2020, positions of redds documented in previous years are shown in Figure 34. Two PIT tag antennas will be installed in 2021 on Antoine Valley Ranch, one on the bottom end of the property and one above a large impediment at the upper end of the property now that permissions for access have been secured for long-term monitoring.

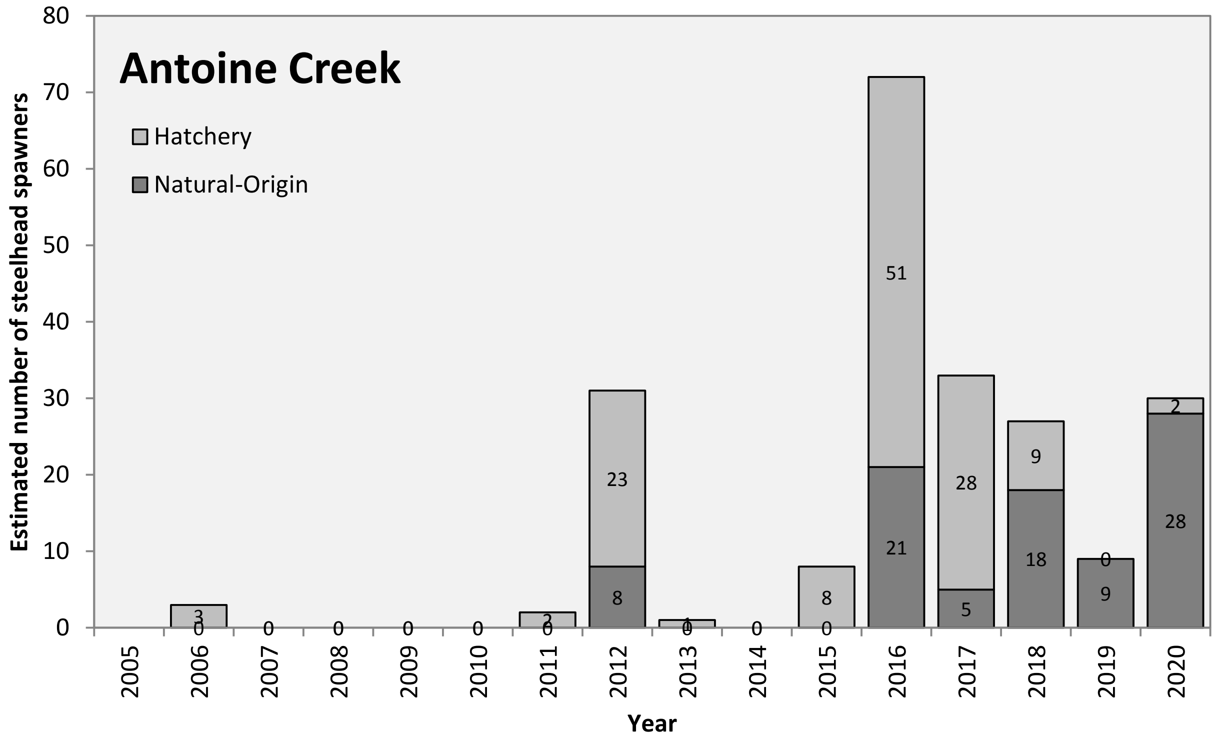

Figure 33. Trend in the number of steelhead spawners in Antoine Creek.

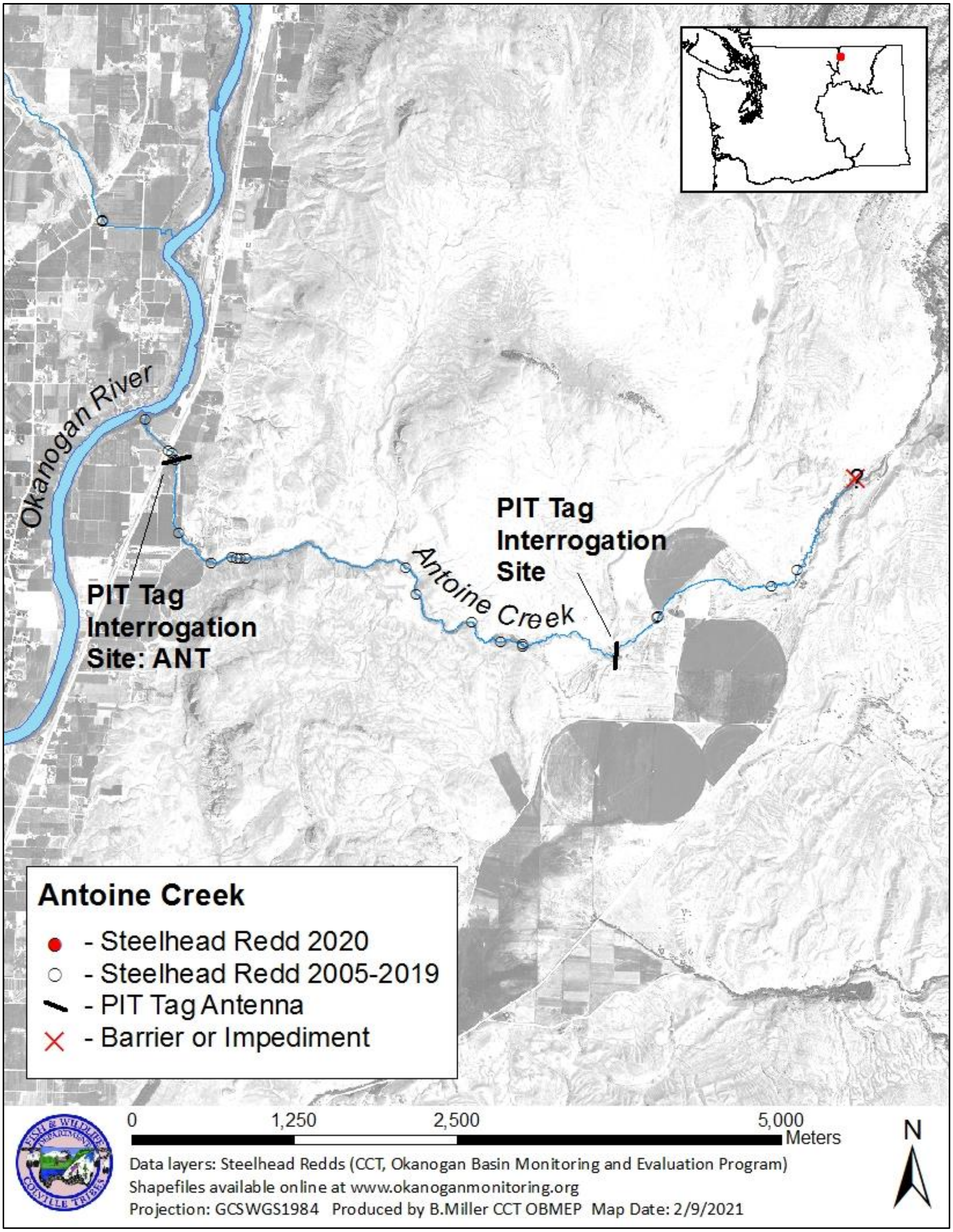

Figure 34. Spatial distribution of summer steelhead redds documented in Antoine Creek.

3.2.11 Wildhorse Spring Creek

Wildhorse Spring Creek is a fairly small watershed that flows off of the west side of Mt. Hull near Oroville, WA. Some years, there is not enough water depth for adult steelhead to access the creek. However, on years where sufficient water flows to allow for adult steelhead access, it is not uncommon for large numbers of fish to utilize this creek for spawning. Surveys have occurred over the previous 15 years (2006–2019). On five of the years (2008, 2009, 2014, 2015, 2018) zero steelhead were estimated to have entered the creek. In the remaining years, an annual average of 87 steelhead spawned in the creek (max=278 in 2012, Figure 35 and 36).

Sufficient flow existed in 2020 to allow adult steelhead passage and one natural-origin steelhead from the PRD mark group was detected on WHS. No hatchery steelhead were detected and the total spawning estimate for 2020 was 5 natural-origin and 0 hatchery steelhead based upon PRD expansion rates. The Colville Tribes Broodstock Acclimation and Monitoring program (BAM) attempted to operate an adult steelhead weir trap in the lower portion of the creek, just above the PIT antenna with no captures, although the weir pickets were removed for much of the runoff. No redds were found below the trap in 2020.

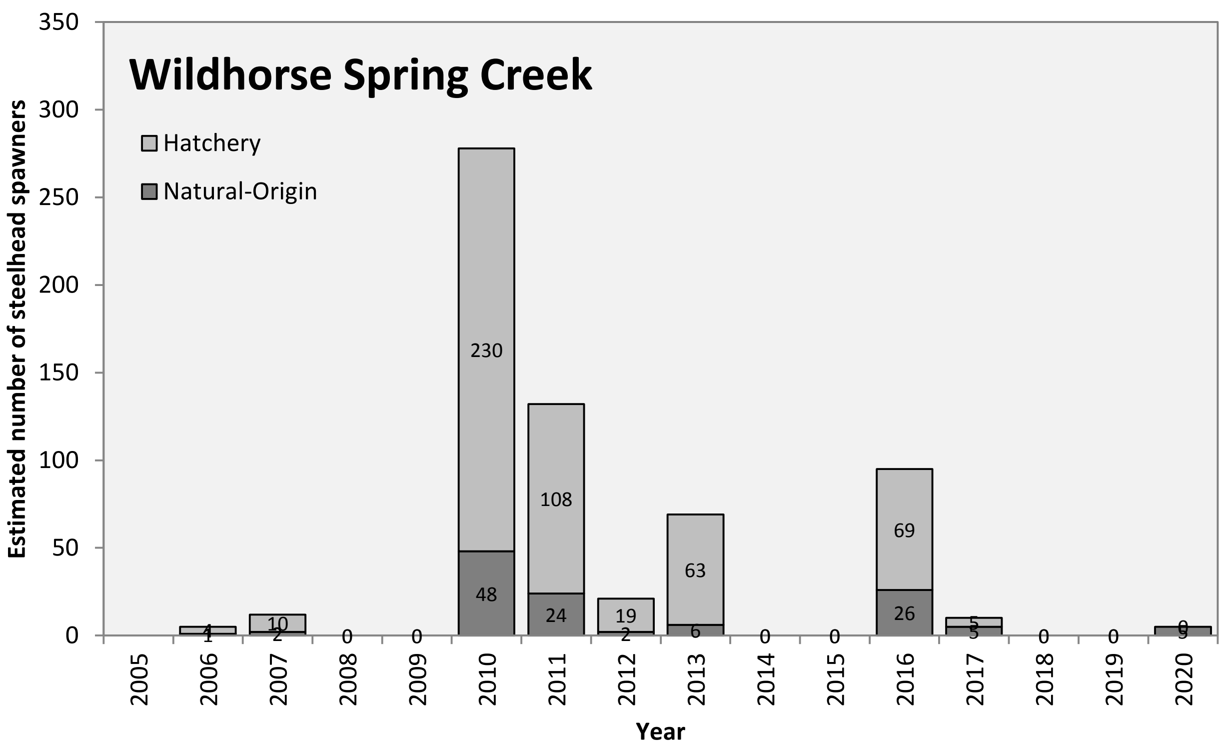

Figure 35. Trend in the number of steelhead spawners in Wildhorse Spring Creek.

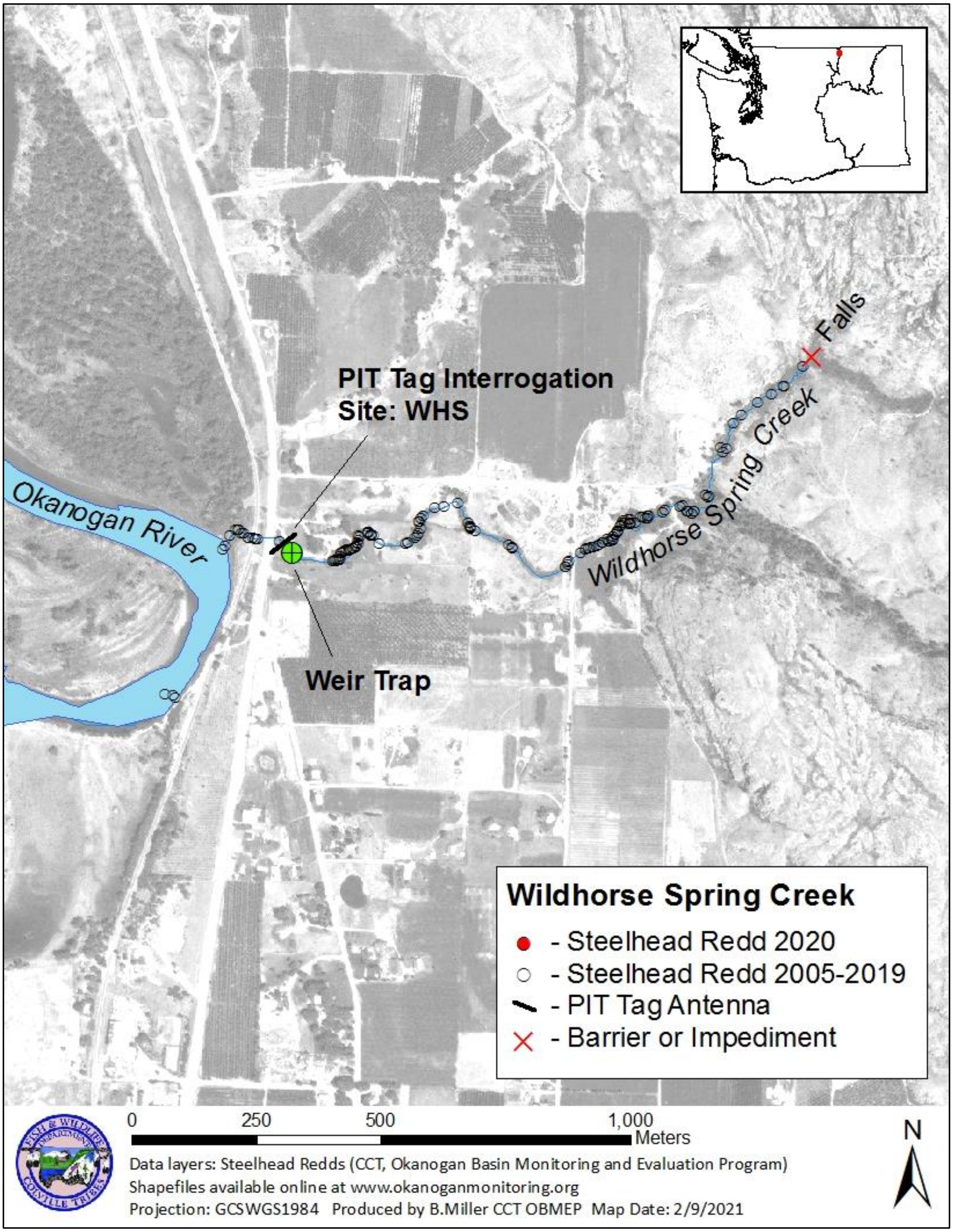

Figure 36. Spatial distribution of summer steelhead redds documented in Wildhorse Spring Creek.

3.2.12 Tonasket Creek

Tonasket Creek enters the Okanogan River at RKM 125, just upstream from Zosel Dam, at the tail end of Lake Osoyoos. The lower reach is known to go dry on an annual basis; however, there is typically some flow in the upper-most reach, below the natural falls (Figure 38). A seasonal PIT tag detection site (TON) consisting of a single pass-through antenna is operated near the confluence of the creek with the Okanogan River.

A total of 4 natural-origin and 4- hatchery steelhead from the PRD mark group were detected at site TON in 2020. This rendered a total spawning estimate of 38 steelhead, 19 natural-origin and 19 hatchery. Walking access was only granted on the upper half of the creek and surveys occurred on April 28 and six redds were found. Another survey was conducted May 11 when two additional redds were found. A final survey was attempted on May 26, but water conditions were turbid. The surveys noted numerous fish at the upper falls and a lot of cleaned gravel. The redd count may have been an under count do to superimposition. The eight redds were expanded by 1.52 FPR to represent 12 steelhead spawners. Because only half of the creek was surveyed and there was likely superimposition, the PIT tag value is the more accurate estimate for total spawners. The lower portion of the creek was dry by July.

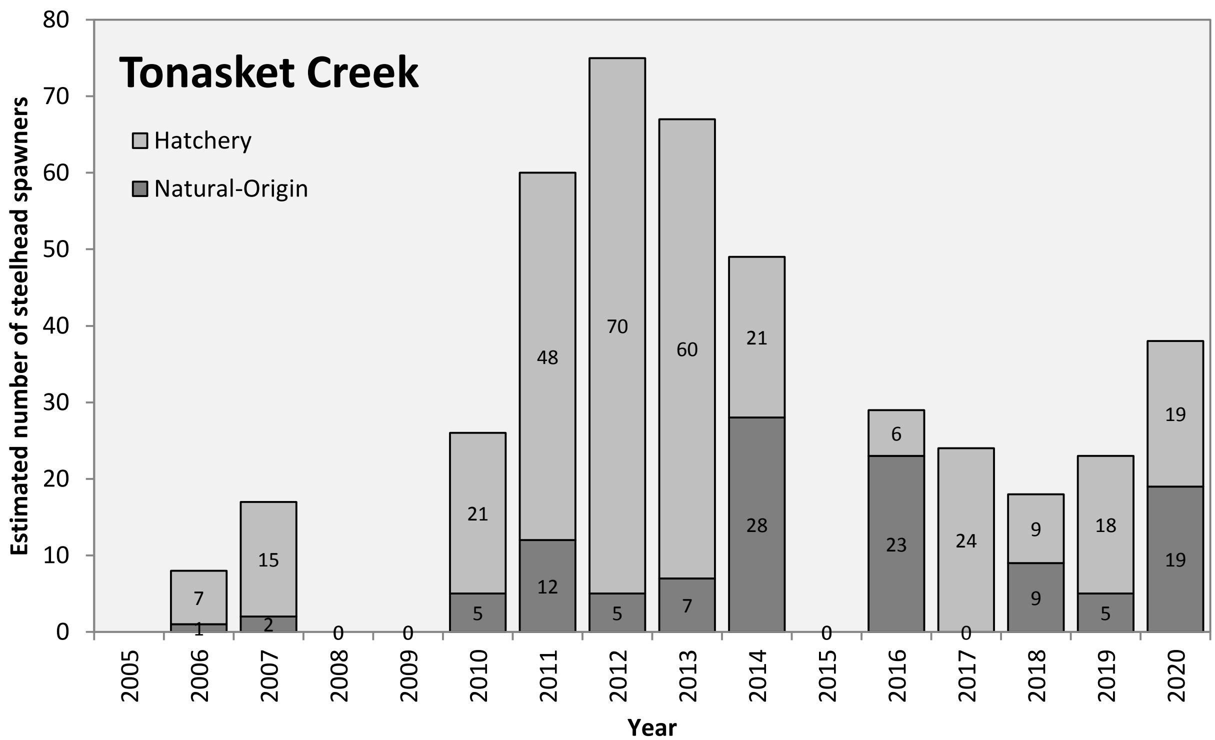

Figure 37. Trend in the number of steelhead spawners in Tonasket Creek.

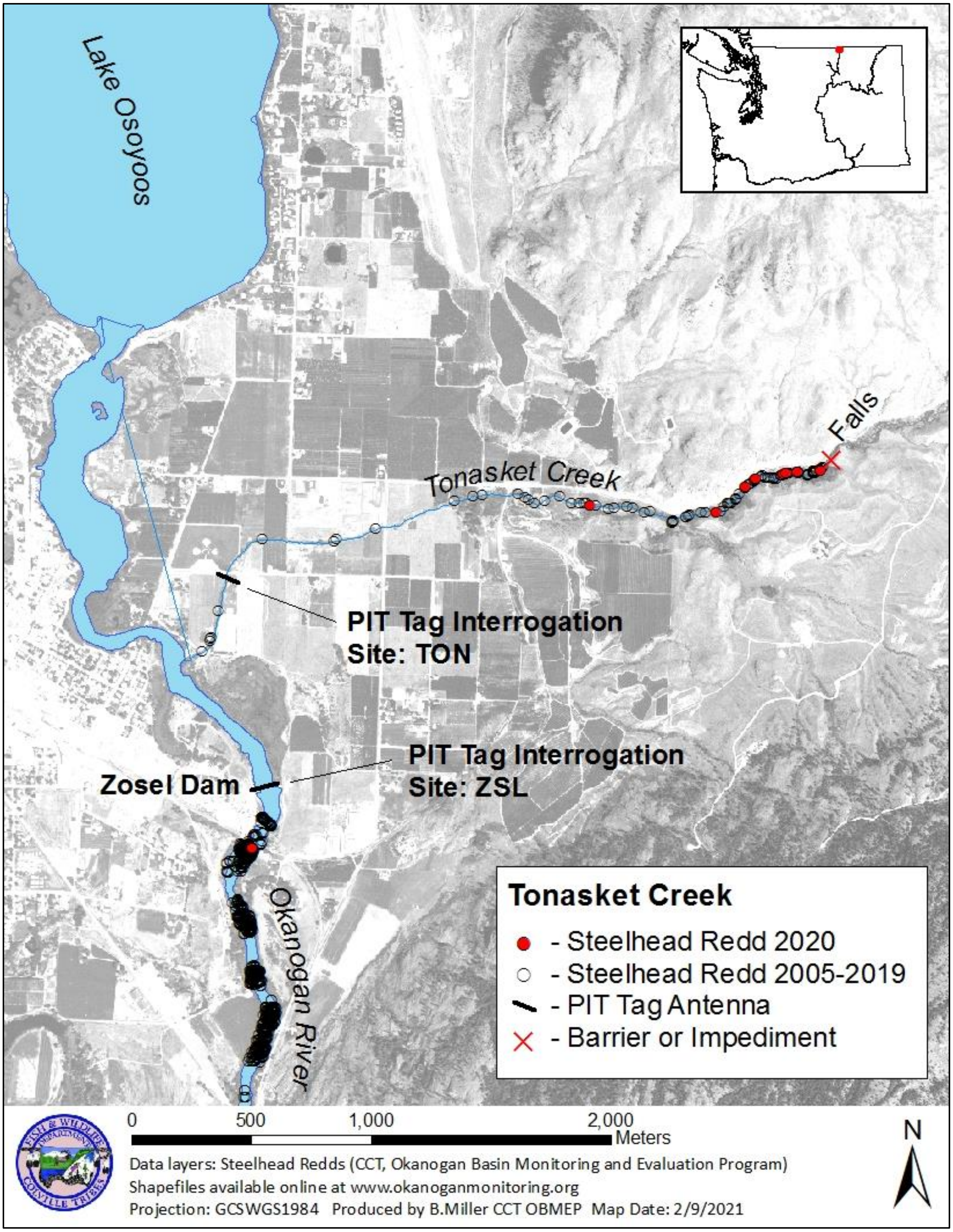

Figure 38. Spatial distribution of historic summer steelhead redds documented in Tonasket Creek.

3.2.13 Ninemile Creek

Ninemile Creek enters the eastside of Osoyoos Lake, just south of the British Columbia border. The creek is known to flow sub-surface annually in the middle reach during the summer, but surface flows are usually present in the upper and lower reach. A permanent PIT tag detection site (NMC) consisting of three pass-through HDPE antennas is located near the mouth of the creek. Based on PIT tag detections in 2020, an estimated 5 natural-origin (1 detection) and 5 hatchery steelhead (1 detection) spawned in Ninemile Creek. The 2020 spawner estimate is similar to the previous 6 years estimates. From 2005–2019, the average number of steelhead in Ninemile creek was 23 (max=77 in 2008, Figure 39). The lower portion of the creek below the PIT array was surveyed in 2020, but no redds were located. Steelhead redds marked in previous survey years are shown in Figure 40 for reference.

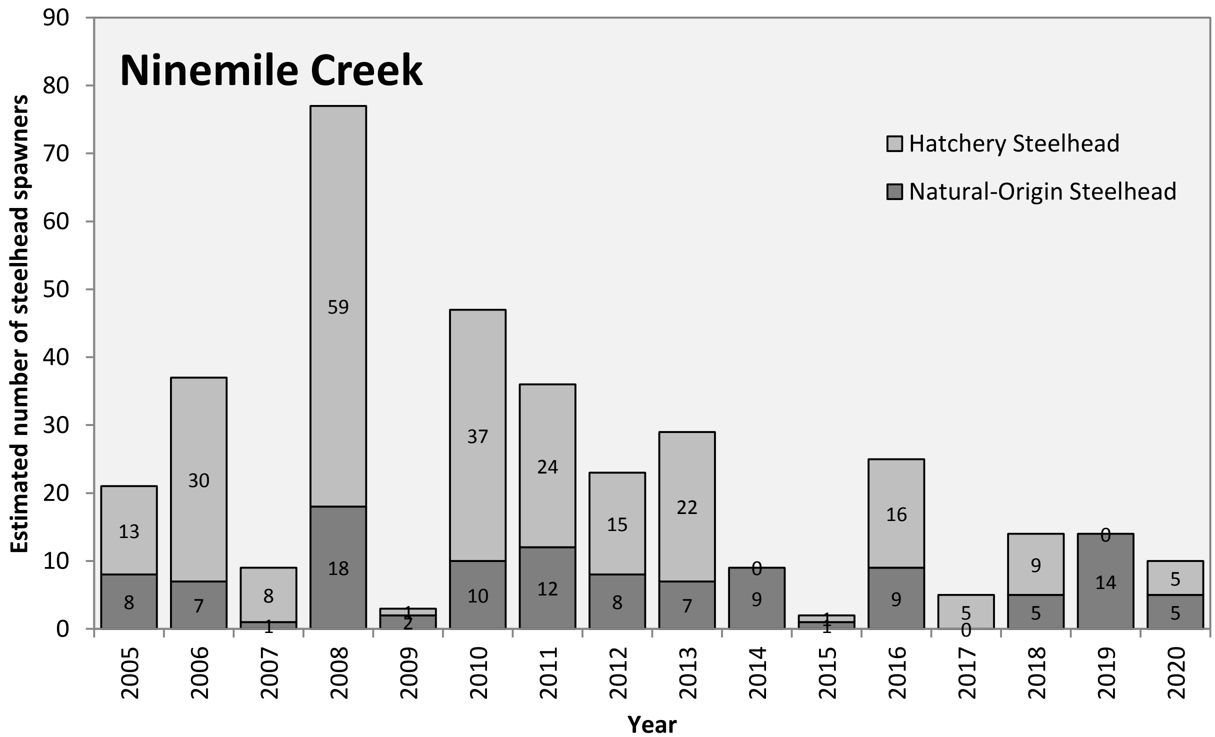

Figure 39. Trend in the number of steelhead spawners in Ninemile Creek.

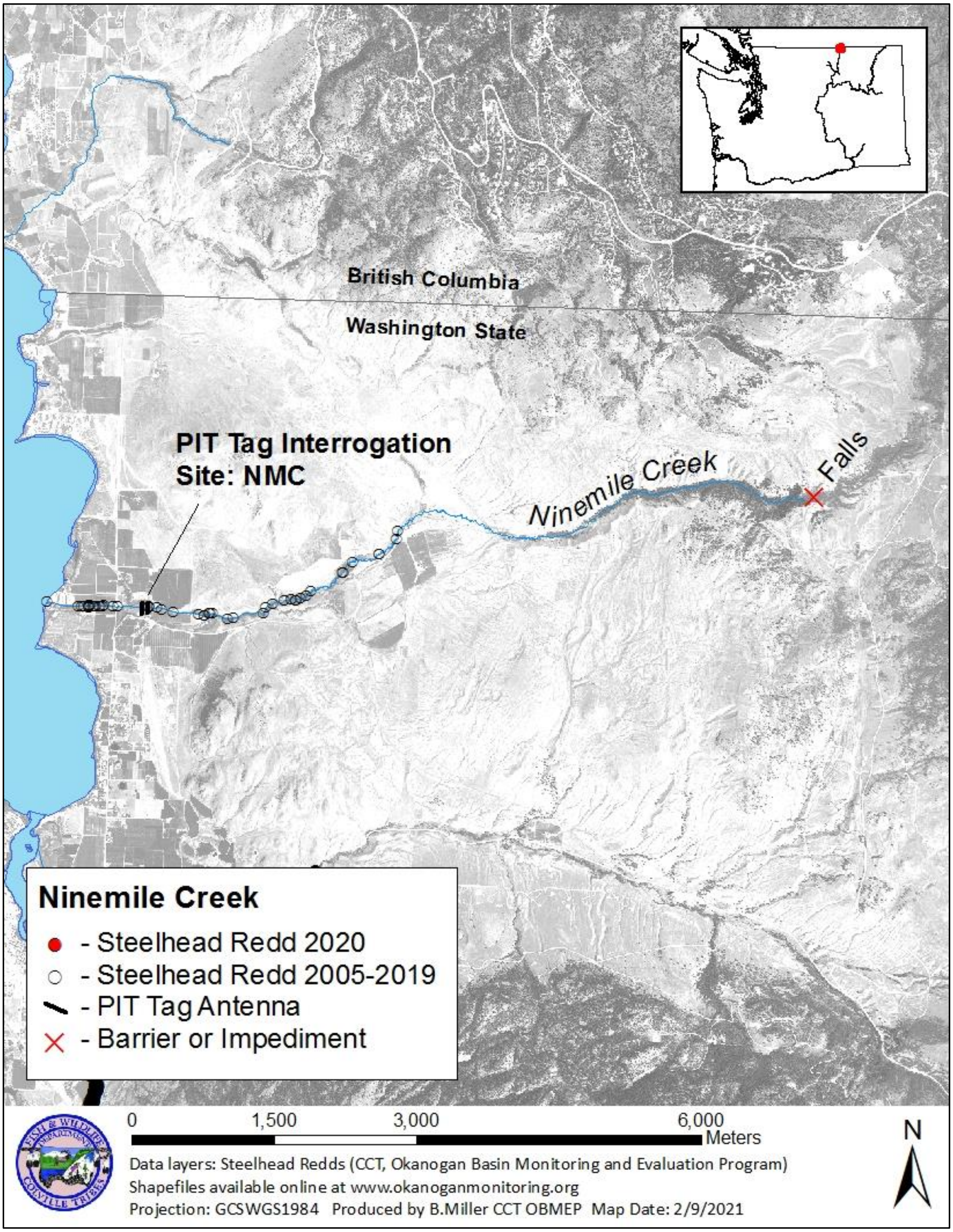

Figure 40. Spatial distribution of historic summer steelhead redds documented in Ninemile Creek.

3.2.14 Foster Creek (located outside the Okanogan subbasin)

Although Foster Creek is not located within the Okanogan subbasin, OBMEP operated a PIT tag detection site (FST) and conducted a post-peak redd surveys in 2020 to further describe the spatial extent of Upper Columbia River steelhead above Wells Dam. During 2020, sufficient water flowed down Foster Creek for adult steelhead to migrate into the upper reaches, past the dam outflow pipe. Foster Creek was surveyed on May 5 from the mouth to the second bridge above the railroad trestle and a total of 10 redds were observed. An additional survey from the mouth to the falls occurred on May 13 and one additional redd was found. The redds were expanded by 1.52 FPR for a total estimate of 17 steelhead.

A total of 4 natural-origin and 1 hatchery PIT tagged steelhead from the PRD mark-group were detected at PIT tag interrogation site FST in 2020. Those tags were expanded to 19 natural-origin and 5 hatchery steelhead spawners. Spatial distribution of redds located during the 2020 survey and on previous years surveys are detailed on Figure 42.

Figure 41. Redd surveys conducted in Foster Creek in 2018.

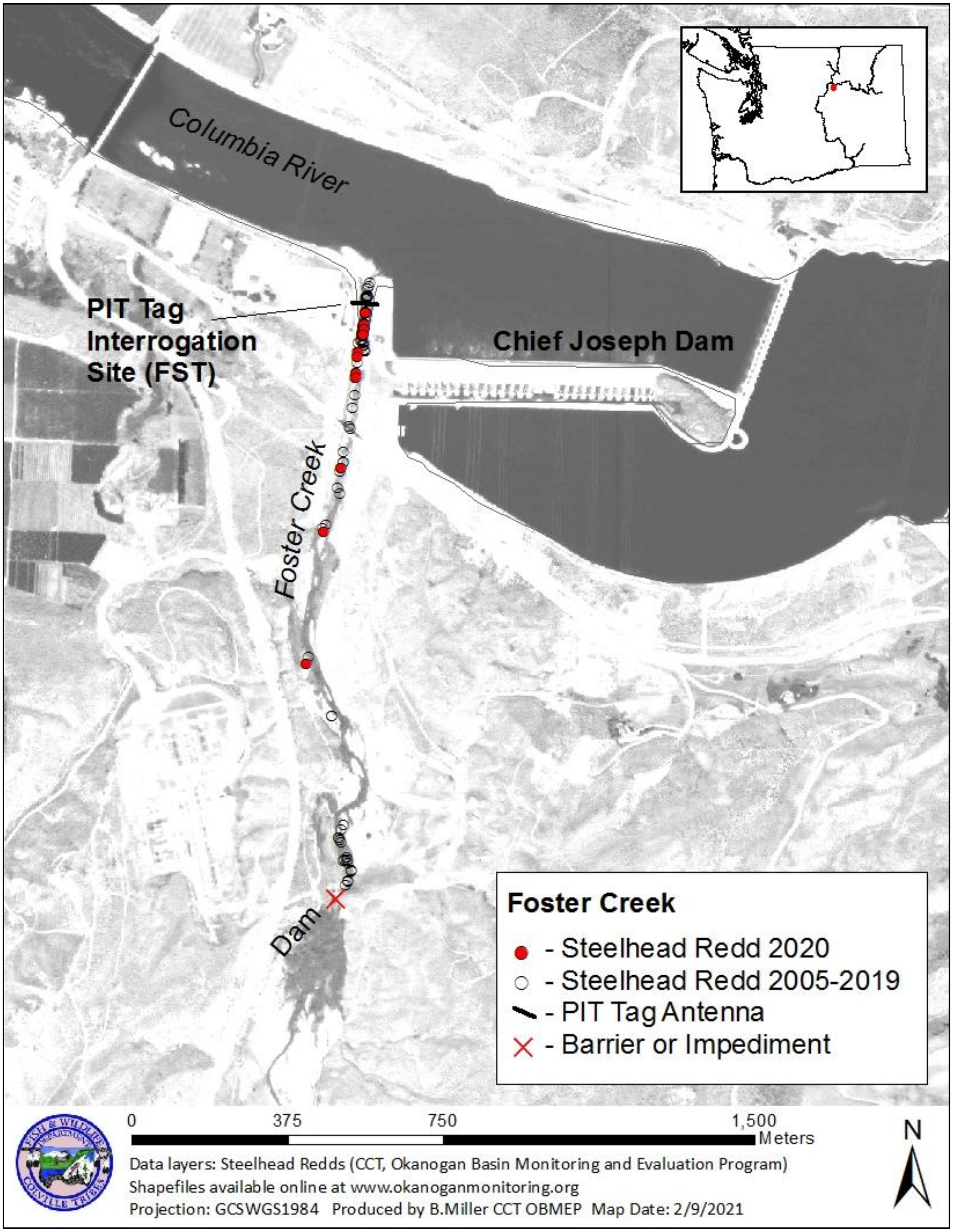

Figure 42. Spatial distribution of summer steelhead redds documented in Foster Creek.

3.3 Zosel Dam and Upstream Locations

Zosel Dam regulates Lake Osoyoos, which extends into the Canadian portion of the subbasin. A vertical-slot fishway provides upstream passage and is equipped with a PIT tag detection array (ZSL). Zosel Dam was constructed in its current state in 1987 with undershot spillways. When these spillway gates are raised to a height of more than 12 inches, fish may be able to ascend through the spillways and bypass the fishway and PIT tag array. Underwater video enumeration of steelhead was discontinued at Zosel Dam in 2015 due to sufficient PIT tag detection sites upstream of that point. The fall back rate at Zosel Dam is currently unknown, but may be relatively large due to the heavily utilized spawning habitat available in Okanogan reach 07.

Three perennial tributaries flow into Lake Osoyoos, two on the Washington State side of the border (Ninemile and Tonasket creeks) and one in British Columbia (akskʷəkʷant (Inkaneep Creek)). Both Ninemile and Tonasket creeks have had PIT tag interrogation sites installed for a number of years; additionally, a permanent PIT tag interrogation site was installed in akskʷəkʷant (Inkaneep Creek) in 2015. Approximately 5 km upstream of Lake Osoyoos, on the q̓awsitkʷ (Okanagan River) mainstem, a permanent instream PIT array spans the entire channel (site OKC situated at Vertical Drop Structure 3) which has been in operation since 2010. Since all salmon migrating upstream of Lake Osoyoos must cross over OKC, it has been a pivotal detection site for enumerating adult salmon abundance and observing migration timing. PIT tag interrogation sites were also installed on three other British Columbia tributaries located further up the subbasin, nʕax̌ʷlqaxʷiya (Vaseux Creek), akłxʷminaʔ (Shingle) and Shuttleworth creeks.

Until 2009, the outlet dam of Vaseux Lake (McIntyre Dam) was the upstream migration barrier for anadromous salmonids. The dam was redesigned in 2009 and currently, the outlet dam of Okanagan Lake at Penticton, BC is the upstream barrier. A dam also exists at the outlet of Skaha Lake (Okanagan Falls, BC), which had a fish ladder installed in 2014. As well, 17 Vertical Drop Structures (VDS) currently exist along the q̓awsitkʷ (Okanagan River) mainstem, 13 between Oliver, BC and Lake Osoyoos, and four between Skaha Lake and Vaseux Lake. The majority of the Canadian portion of the mainstem q̓awsitkʷ (Okanagan River) is characterized as being straightened and channelized. The main British Columbia tributaries to the mainstem q̓awsitkʷ (Okanagan River) include akłxʷminaʔ (Shingle Creek), Ellis Creek, McLean Creek, Shuttleworth Creek, nʕax̌ʷlqaxʷiya (Vaseux Creek), and a number of small perennial streams.

Total spawning estimates for steelhead in British Columbia were calculated the same as in the Washington portion of the subbasin, only using tags from the representitively marked Priest Rapids Dam sample group and expanded by the mark rate of 0.2131. Five tagged steelhead were detected in nʕax̌ʷlqaxʷiya (Vaseux Creek), four of natural-origin and one hatchery steelhead. Those tags were expanded to 19 natural-origin and 5 hatchery steelhead. A total of one PRD marked steelhead (1 natural, 0 hatchery) was only detected on OKC and that tags was expanded to five natural-origin and 0 hatchery steelhead. These fish likely spawned in the mainstem q̓awsitkʷ (Okanagan River), or potentially in another small stream that did not have a PIT antenna in operation, although would be considered rare. All adult steelhead detected on arrays upstream of that point were previously detected on OKC, so we assumed a 100% detection efficiency for this brood-year. No tagged steelhead were detected in in akskʷəkʷant (Inkaneep Creek), Shuttleworth or akłxʷminaʔ, or (Shingle) Creeks. The total spawning estimate in the British Columbia portion of the Okangoan subbasin for 2020 was 24 natural-origin and 5 hatchery steelhead (Table 6). The average number of steelhead spawning upstream of Lake Osoyoos over the last eight years (2013-2020) was 25 natural-origin and 12 hatchery steelhead (Table 7).

Table 6. Brood-year 2020 steelhead detected on PIT tag sites in British Columbia.

Location	Status	Tag Group		
akskʷəkʷant (Inkaneep Creek)		PRD	Other	Total
	Natural-Origin	0	0	0
	Hatchery	0	0	0
	Total	0	0	0
nʕax̌ʷlqaxʷiya (Vaseux Creek)		PRD	Other	Total
	Natural-Origin	4	2	6
	Hatchery	1	1	2
	Total	5	3	8
Shuttleworth Cr		PRD	Other	Total
	Natural-Origin	0	0	0
	Hatchery	0	0	0
	Total	0	0	0
akłxʷminaʔ (Shingle Creek)		PRD	Other	Total
	Natural-Origin	0	0	0
	Hatchery	0	0	0
	Total	0	0	0
Pentincton Channel		PRD	Other	Total
	Natural-Origin	0	0	0
	Hatchery	0	0	0
	Total	0	0	0
OKC Only		PRD	Other	Total
	Natural-Origin	1	1	2
	Hatchery	0	0	0
	Undetermined	0	0	0
	Total	1	1	2

Table 7. Estimated distribution of steelhead spawning in British Columbia based on expanded PIT tag detections from the PRD mark group.

Location	Status	2013	2014	2015	2016	2017	2018	2019	2020	Avg.
akskʷəkʷant (Inkaneep Creek)	Natural-Origin			1	0	0		2	0	1
akskʷəkʷant (Inkaneep Creek)	Hatchery			6	1	5		0	0	2
akskʷəkʷant (Inkaneep Creek)	Total			7	1	5		2	0	3
Shuttleworth Creek	Natural-Origin		0	0	0	0	0	0	0	0
Shuttleworth Creek	Hatchery		0	0	0	0	0	0	0	0
Shuttleworth Creek	Total		0	0	0	0	0	0	0	0
nʕax̌ʷlqaxʷiya (Vaseux Creek)	Natural-Origin						9	9	19	12
nʕax̌ʷlqaxʷiya (Vaseux Creek)	Hatchery						0	9	5	5
nʕax̌ʷlqaxʷiya (Vaseux Creek)	Total						0	18	24	14
akɬxʷminaʔ (Shingle Creek)	Natural-Origin			0	0	0	0	0	0	0
akɬxʷminaʔ (Shingle Creek)	Hatchery			0	0	0	0	0	0	0
akɬxʷminaʔ (Shingle Creek)	Total			0	0	0	0	0	0	0
Mainstem or Other	Natural-Origin	22	23	64	15	10	0	23	5	20
Mainstem or Other	Hatchery	2	16	20	14	5	0	14	0	9
Mainstem or Other	Total	24	39	84	29	15	0	37	5	33
Subtotal BC	Natural-Origin	22	23	65	15	10	9	34	24	25
Subtotal BC	Hatchery	2	16	26	15	10	0	23	5	12
Subtotal BC	Total	24	39	91	30	20	9	57	29	37

4.0 Discussion

OBMEP monitored adult Viable Salmonid Population (VSP) abundance attributes (McElhany et al. 2000) within the subbasin for Okanogan River summer steelhead. In 2020, an estimated 374 summer steelhead (114 hatchery origin and 260 natural origin) spawned in the Okanogan subbasin, which was the lowest total return since the monitoring project began in 2005 (Figure 43), continuing a similar trend for the past three years. Over the past 16 years of monitoring (2005 through 2020), the average number of adult steelhead spawners in the Okanogan subbasin was 1,472 (geomean = 1,247). The average number of natural-origin spawning steelhead was 287 (geomean = 250). Although the proportion of natural-origin steelhead spawning in the Okanogan River subbasin has slightly trended upward since data collection began in 2005, the 12-yr geomean abundance threshold for natural origin spawners (500) has not been reached. In 2020, the highest proportion of natural origin spawners was recorded (0.69). This trend has been improving and should continue to help improve the overall fitness of Okanogan Summer steelhead for several years to come.

Results from steelhead adult enumeration efforts indicate that the number of naturally produced spawning steelhead in the Okanogan River subbasin has slightly increased since data collection began in 2005. Spawning has been documented throughout the mainstem Okanogan River, although narrowly focused to distinct areas that contained suitable spawning substrates and water velocities. Steelhead spawning has been observed to be 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 influenced by stocking location because juvenile hatchery steelhead have been released in the Similkameen River, Omak Creek, and Salmon Creek where large numbers of spawners have been consistently recorded.

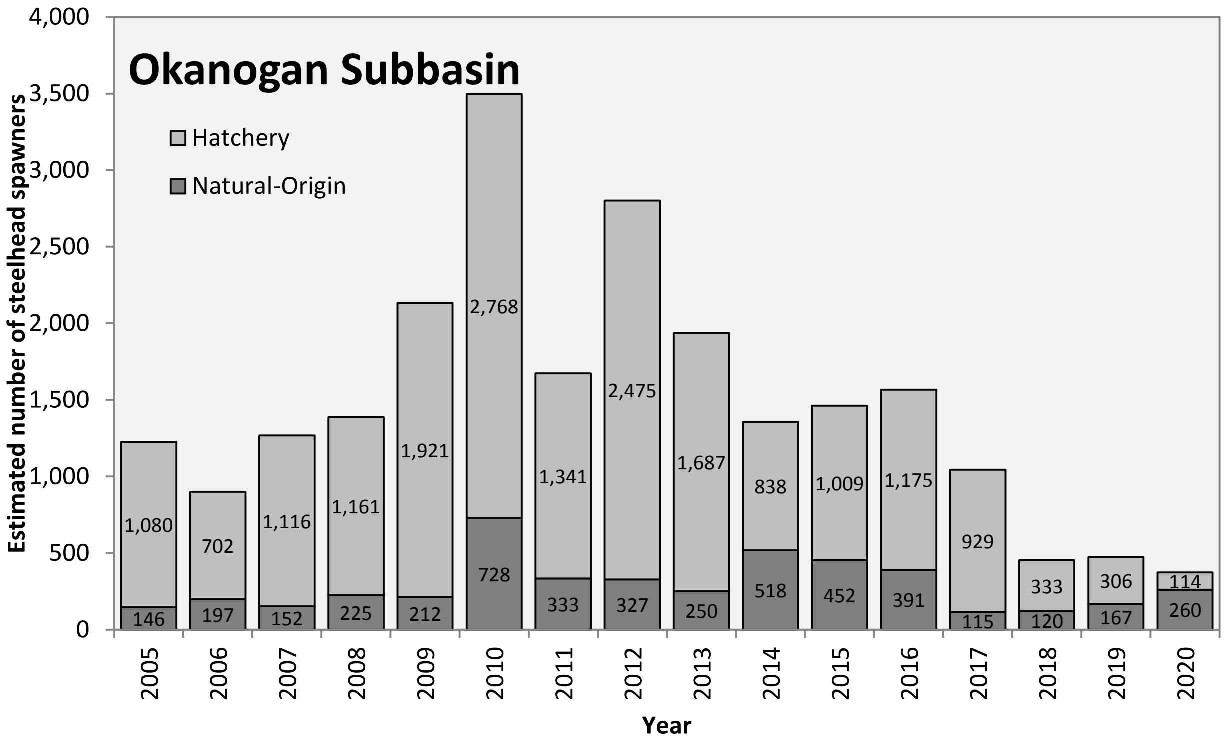

Figure 43. Estimated number of steelhead spawners in the Okanogan subbasin.

Detailed percent-wild information has been provided annually and every attempt has been made to ensure that these estimates are as accurate as stated methods currently allow. 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) on redd surveys and underwater video. Values presented in this document represent our best estimate from available information, but the variability surrounding point estimates are currently undefined.

Large variations in estimates exist in many reaches from year to year, but often, these accurately reflect real-world situations rather than survey bias or calculation error. Small creeks may have extremely low flows for two years, blocking access with no spawning occurring, and then experience a large run of fish the following year when sufficient flows exist (e.g. Loup Loup Creek escapement of 0, 0, and 125 for 2008, 2009, and 2010, respectively). This irregular nature of small scale population data frequently results in data being scattered loosely around a linear trend line. We have made every effort to ensure that the reported values are as accurate as possible, including using multiple data collection methods for validation, comprehensive on-the-ground surveys, and best scientific judgment based on extensive local experience with the subbasin.

Annual variations in physical habitat and environmental factors can profoundly impact redd distributions in small tributaries to the Okanogan River. Changes in summer steelhead spawning 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 in relation to run timing of steelhead, and 4) stocking location of hatchery fish. 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 variations in climate. 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.

The overall outcome of adult steelhead monitoring in the Okanogan subbasin is to guide natural resource managers' decisions to minimize threats to steelhead, choose restoration actions that will have the most positive impact, and set measurable steelhead enhancement objectives to coincide with fiscal investments over multiple jurisdictions. As monitoring efforts proceed, the Okanogan Basin Monitoring and Evaluation Program expects to continually deliver practical status and trend monitoring data and to make those data useful and readily available for use in more comprehensive, broad-scale analyses.

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