FISH RESEARCH PROJECT
OREGON

STEELHEAD ESCAPEMENT MONITORING IN THE UPPER GRANDE RONDE RIVER AND JOSEPH CREEK BASINS

ANNUAL TECHNICAL REPORT

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Objectives

1. Estimate redd density and spawner escapement of summer steelhead in the Upper Grande Ronde River basin.
2. Estimate redd density and spawner escapement of summer steelhead in the Joseph Creek basin, a tributary to the Lower Grande Ronde River.
3. Estimate spawners:redd ratio above adult weir collection points.

Accomplishments and findings

We conducted 108 surveys in the Upper Grande Ronde River (UGRR) basin and 25 surveys in the Joseph Creek basin from 21 March through 01 June 2017 to determine summer steelhead *Oncorhynchus mykiss* redd abundance and adult escapement for these two populations. We sampled 31 random, spatially-balanced sites throughout the UGRR basin encompassing 64.6 km (7.2%) of an estimated 892 km of available steelhead spawning habitat. In Joseph Creek, we surveyed 25 sites encompassing 51.2 km (13.3%) of the 384 km of available spawning habitat. During these surveys we observed 36 steelhead redds and three live steelhead in the UGRR basin and 61 redds and zero live steelhead in the Joseph Creek basin. We observed zero carcasses in UGRR and Joseph Creek basins.

Using the fish:redd ratio extrapolated from Deer Creek surveys, adult steelhead escapement estimates for the UGRR and Joseph Creek basins were 1,733 (95% C.I.: 1,052–2,415) and 1,610 (95% C.I.: 993–2,228) respectively.

Management recommendations

1. Using the current data of steelhead spawning distribution and geographic landscape variables, refine the sampling universe for the Upper Grande Ronde River and Joseph Creek populations to improve our knowledge of steelhead spawning distribution.
2. Estimate the biologically and statistically significant level of change in steelhead escapement for determining short- and long-term population changes.
3. Improve current methods for standardizing escapement estimates.
4. Manage the Upper Grande Ronde River and Joseph Creek populations exclusively for wild-origin steelhead and determine the extent and distribution of hatchery steelhead in the basin through observations of hatchery fish during the spawning season.

ACKNOWLEDGMENTS

We would like to acknowledge the assistance and cooperation of the many private landowners throughout the area who allowed us access to their property. The cooperation of private landowners was essential in meeting our project objectives. Additionally, we thank the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) for providing data from weir collections on Catherine and Lookingglass creeks and the UGRR. The Nez Perce Tribe provided data from weir collections on Joseph Creek. Further, we would like to acknowledge our field crew members Kirsten Ressel and Dan Ellis for their assistance as well as Jeff Yanke and Kyle Bratcher for their expertise and assistance.

INTRODUCTION

Summer steelhead in the Grande Ronde River basin fall within the Snake River Distinct Population Segment (DPS) and are listed as threatened under the Endangered Species Act (62 FR

43937; August 18, 1997). The Upper Grande Ronde River (UGRR) and Joseph Creek basins support two of the four populations in the Grande Ronde Major Population Group (MPG). These populations are segregated based on topographic, genetic, and behavioral evidence of interactions. Historically, the Grande Ronde River was one of the more significant anadromous fish producing rivers in the Columbia River basin. Despite recovery efforts, these populations remain depressed relative to historic levels.

The goal of this project is to annually evaluate summer steelhead population abundance for the UGRR, and recently Joseph Creek, by conducting surveys of redds and spawning activity. These surveys provide those data needed to estimate adult steelhead escapement, improve our understanding of habitat utilization, and contribute to productivity and survival estimates for these populations.

Study area

The Grande Ronde River flows generally northeast 341 km from its origin in the Elkhorn Mountain range to join the Snake River at river kilometer (rkm) 271, about 32 rkm upstream of Asotin, WA and 793 rkm from the mouth of the Columbia River. The UGRR basin (Figure 1) includes the Grande Ronde River and its tributaries from the headwaters to the confluence with the Wallowa River (rkm 131). Major tributaries of the UGRR include Sheep Creek (rkm 312), Meadow Creek (rkm 290), Catherine Creek (rkm 225), and Lookingglass Creek (rkm 138). The UGRR drains approximately 4,200 km^2 and contains 1,475 km of streams (892 km of anadromous salmonid habitat). Elevations in the basin range from 705 m at the confluence of the Grande Ronde and Wallowa rivers to over 2,646 m in the headwater mountains. Stream physiography in headwater areas is similar to other western, inter-mountain systems, with forested uplands, perched meadows, and high to moderate stream gradients. However, the mid-portion of the UGRR flows through large historic wetland complex (approximately 56 x 24 km at its greatest extent), bounded by a geologic pinch point at the downstream end (Rinehart Gap). The main portion of this valley is extremely flat (stream gradient $<0.1\%$), leading to increased stream sinuosity and decreased water velocity. Gradient increases after the UGRR passes downstream through Rinehart Gap (near the town of Elgin) and enters a canyon-dominated landscape. Land use in the headwaters is a mix of timberlands and cattle grazing, while the main valley is in irrigated crop production. Agricultural land use is relatively light downstream of Elgin.

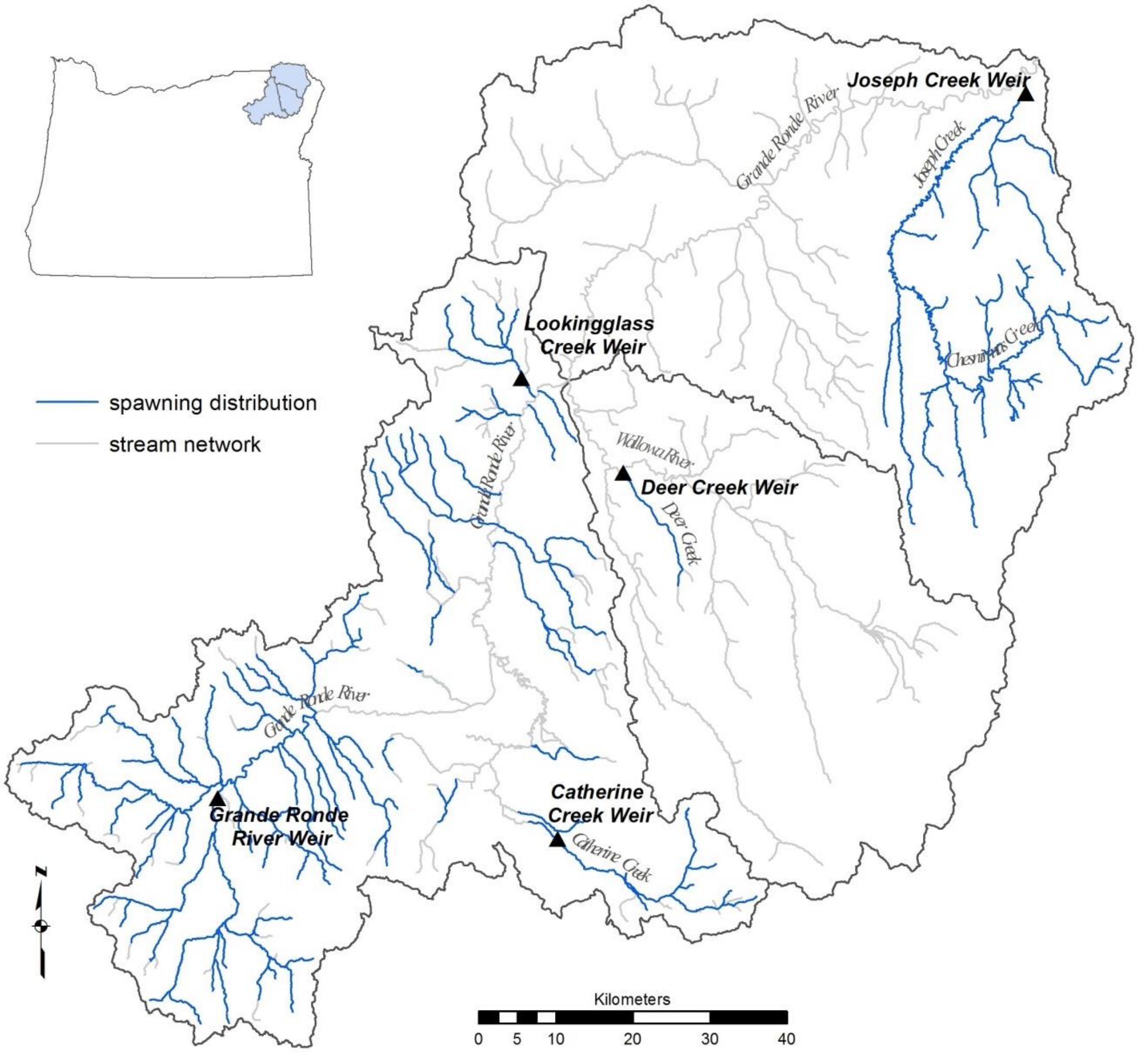

Figure 1. Sampling domains (blue) fall within the current spawning distribution of summer steelhead in Upper Grande Ronde River (UGRR) and Joseph Creek basins. Deer Creek and weir locations are also shown.

Joseph Creek is the most downstream tributary of the Grande Ronde River, entering approximately 7 km upstream of its mouth. Joseph Creek and its tributaries drain 1,420 km^2 originating on a plateau north of the upper Wallowa River valley, and flowing generally north into Washington (Wallace 2011). The Joseph Creek basin contains 536 km of streams, 384 km of which are estimated to be part of steelhead spawning distribution (Figure 1). Major tributaries include Crow and Chesnimnus creeks (which meet forming Joseph Creek at rkm 79), Swamp Creek (rkm 54), and Cottonwood Creek (rkm 7). Elevations in the basin are substantially lower than the UGRR basin, and range from 273 m at its confluence with the lower Grande Ronde River to around 1,673 m in the headwater areas. Physiography within the drainage is a mixture of hills and valleys at the upstream end, and canyonlands in the downstream portion (Figure 1). Land use is primarily cattle grazing in the upper reaches, especially upstream of the origin of

Joseph Creek. Some grazing occurs in the lower reaches and tributaries; however, most of lower Joseph Creek flows through federal (US Forest Service) and Nez Perce Tribal property. No significant municipalities exist in the Joseph Creek basin.

Deer Creek flows north from its origin in the Wallowa Mountains until reaching the Wallowa River at rkm 18. It is a narrow, elongated drainage, covering 79 km^2 with elevations ranging from 2,259 m to 787 m. Approximately 18.7 km of stream are considered anadromous fish spawning habitat, and all 18.7 km are surveyed annually. A concrete fish acclimation facility (Big Canyon), with a permanent weir, is located approximately 0.25 km from the mouth of Deer Creek. All wild-origin adult steelhead captured at Big Canyon were marked with an opercle punch and passed above the weir during their spawning migrations. The known number of adult steelhead allowed into the spawning areas enables us to determine the adult fish:redd ratio for extrapolation to the larger UGRR and Joseph Creek populations (Flesher et al. 2005; Gee et al. 2008; James Ruzycki, ODFW, unpublished data). Land use is almost entirely timberlands upstream of the permanent weir.

METHODS

Sampling domain and site selection

Steelhead were monitored using a probabilistic sampling approach that incorporates a sample-site selection procedure created for the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP). The Generalized Random Tessellation Stratified (GRTS) design achieves a spatially balanced distribution of sites selected at random from the available spawning habitat to extrapolate an estimate of redd, and therefore, spawner abundance (Jacobs et al. 2009). This method follows the Oregon Plan for Salmon and Basins Monitoring Program approach (Stevens 2002).

This GRTS design was first implemented in the UGRR in 2008 and 2012 for Joseph Creek. Sample sites were limited to the current steelhead spawning distribution, which was defined by redd and fish counts from previous spawning ground surveys and barriers identified during habitat surveys for summer steelhead. This information is annually updated to include newly identified barriers as well as new reaches of spawning habitat. All reaches upstream of known barriers to anadromous fish passage were eliminated from the potential sampling area. Thirty-one sample sites were targeted in the UGRR for this year. Twenty-five sample sites were targeted in the Joseph Creek basin for this year.

Beginning in 2012, a new survey design implementing sites selected from the Columbia Habitat and Monitoring Program (CHaMP) was integrated into the legacy design that includes the following components for the UGRR:

- 10 sites repeated every year (annual)
- 10 sites repeated once every 3 years on a staggered basis
- 5 sites from UGRR CHaMP frame to be repeated once every 3 years.
- 5 sites new every year (once-only)

Under the new survey design, stream segments were stratified into three classifications (source, transport, and depositional) and sites were evenly distributed among those three strata (logistics allowing). Stream segments were classified using Geographical Information System

(GIS) by several attributes including valley width, stream gradient and bankfull width (Tim Beechie, unpublished data). In stratifying the sampling universe, we attempted to identify and isolate areas of habitat differentially utilized for spawning, thereby increasing the precision of future adult escapement estimates.

There were no sites in the Joseph Creek basin integrated from CHaMP because the program is not implemented in that basin. Additionally, GRTS-selected sites were not stratified by stream classification. The initial GRTS draw (2012) was stratified similarly to UGRR, but resulted in significant site clustering in depositional stream reaches. We removed the stratification to promote wider distribution of sites within the basin. Therefore, sites were selected as follows:

- 10 sites repeated every year (annual)
- 15 sites repeated once every 3 years on a staggered basis

Incorporating a 1:100,000 digital stream network, GIS was used to insure an unbiased and spatially balanced selection of sample sites. The GIS site selection process generated geographic coordinates (i.e. latitude and longitude) for each candidate site (Table 1). A two-kilometer reach was established encompassing each candidate site. Topographic maps were produced showing the downstream and upstream ends of each survey reach along with the included GRTS sample point. In the field, crews used a handheld Global Positioning System (GPS) to locate the established survey reaches. Some candidate sites were not sampled due to denial of permission from private landowners or because sites were located upstream of previously unknown fish passage barriers. In such events, replacement sites were drawn from a pre-selected list of over-sample sites.

Steelhead redd surveys

Steelhead redd surveys were based on standard ODFW methods (Susac and Jacobs 1999; Jacobs et al. 2000; Jacobs et al. 2001) and were conducted from March through June 2017. Individual sites were surveyed up to six times to quantify the number of redds constructed at each site, with approximately two week intervals between successive surveys to account for the temporal variation in spawning activity. Generally, surveyors walked upstream from the bottom of each sample reach and counted all redds, live fish, and dead fish observed. In some cases the larger streams were surveyed in a downstream direction for safety.

New redds were flagged and locations were marked with a handheld GPS unit. During each visit, surveyors recorded the number of new redds as well as previously identified flagged redds. Redd visibility was rated 0 for newly discovered redds and ranged from 1 (clearly visible) to 5 (no longer visible) for previously observed redds. To reduce bias of surveyor observations, surveyors were rotated through sites and partners if logistics allowed.

Steelhead carcasses were examined to obtain population and life history information by recording fork length (mm), MEPS (middle of the eye to posterior scale) length (mm), sex, egg retention (females), and origin determined by presence (wild) or absence (hatchery) of an adipose fin. For all carcasses, surveyors also collected scale samples from the key scale area (Nicholas and Van Dyke 1982) for age determination. Additional details of the survey protocol can be downloaded from the PNAMP, Monitoring Methods website (https://www.monitoringmethods.org/Protocol/Details/757).

Spawning timing

Weir Counts

Five weirs located on the UGRR, Joseph, and Deer creeks (Figure 1) were used to evaluate timing of steelhead entering the basins prior to spawning. The UGRR weirs, operated by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), are located on the mainstem Grande Ronde River (rkm 291), Catherine Creek (rkm 32), and Lookingglass Creek (rkm 3; Figure 1). The weir on Deer Creek, operated by ODFW, is located 0.25 rkm upstream of its confluence with the Wallowa River. Wild adult steelhead trapped at the Deer Creek weir were marked with an opercle punch and released upstream of the weir to spawn naturally. All wild and hatchery-origin adult steelhead were passed above the UGRR weirs to spawn naturally.

The Nez Perce Tribe (NPT) operates the weir on Joseph Creek just upstream of its confluence with the Grande Ronde River. All adult steelhead (wild- and hatchery-origin) were captured and passed above the weir unmarked to spawn naturally (John Robbins, NPT, unpublished data).

Discharge and temperature

We attempted to relate redd observations to discharge for the UGRR. We used discharge measurements taken by Oregon Water Resources Department (OWRD) on the mainstem Grande Ronde River (station ID 13318960) by Perry (rkm 263).

Estimating escapement

A locally weighted neighborhood variance estimator (Stevens and Olsen 2004), which incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, was used to estimate a 95% confidence interval of the escapement estimate using SP Survey for R statistical software (R Development Core Team 2005). The statistical test was run both with a single weighting value for the total spawning distribution and broken into a matrix of three strata by classification (source, transport, depositional) with weighting values depending on distance and number of surveys for each category (3).

Total escapement of adult steelhead (E_s) was determined by summing the product of the weight value (W), number of redds observed/km surveyed at each site (*i*), and fish:redd ratio determined from Deer Creek Surveys as:

$$E_s = \sum_{i=1}^{n} W_s \left(\frac{\text{Redds}}{\text{km}}\right)_i \left(\frac{\text{Fish}}{\text{Redd}}\right) \quad (2)$$

Weight equals the distance of available spawning habitat in km (determined from GIS layer) divided by the number of sites surveyed as:

$$W = \left(\frac{km\ avail.}{no.sites}\right) \quad (3)$$

The proportion of hatchery to wild-origin steelhead was calculated by dividing the total number of fin marked fish by all fish that could be observed for marks (live fish only). The number of hatchery fish straying to the basin was then estimated by multiplying this proportion of hatchery and wild-origin steelhead by our estimate of steelhead escapement.

Table 1. Steelhead spawning ground survey characteristics, location and stream classification for sites in the UGRR basin, 2017.

Site ID	Stream	Panel	Stream Classification	Survey Distance (km)	Upstream Latitude	Upstream Longitude	Downstream Latitude	Downstream Longitude
CBW05583-092986	Fly Creek	Rotating Panel 1	Depositional	2.00	45.19485	-118.40394	45.21035	-118.39661
CBW05583-149594	Dark Canyon Creek	Rotating Panel 1	Source	2.13	45.31116	-118.40149	45.29690	-118.39020
CBW05583-275866	Meadow Creek	Rotating Panel 1	Transport	2.02	45.29375	-118.64419	45.29290	-118.62310
CBW05583-288410	Little Indian Creek	Rotating Panel 1	Source	2.15	45.40623	-117.80780	45.41245	-117.82674
CBW05583-316330	South Fork Catherine Creek	Rotating Panel 1	Source	2.07	45.10406	-117.59151	45.10050	-117.61070
CBW05583-514458	Spring Creek	Rotating Panel 1	Transport	2.18	45.39553	-118.37275	45.37863	-118.36143
ORW03446-010760	North Fork Catherine Creek	Once-Only	Depositional	2.09	45.14622	-117.61948	45.13051	-117.63087
ORW03446-018904	Spring Creek	Annual	Transport	2.39	45.34725	-118.30746	45.33805	-118.28613
ORW03446-023512	Whiskey Creek	Once-Only	Source	1.97	45.207699	-118.19236	45.222665	-118.20230
ORW03446-030904	McCoy Creek	Rotating Panel 1	Transport	2.48	45.34114	-118.57480	45.34883	-118.57478
ORW03446-047598	Rysdam Creek	Rotating Panel 1	Transport	2.16	45.67330	-117.83508	45.69180	-117.84420
ORW03446-048088	Clark Creek	Rotating Panel 1	Source	2.12	45.48189	-117.80455	45.470188	-117.79619
ORW03446-058968	Five Points Creek	Once-Only	Transport	1.98	45.44351	-118.16766	45.42788	-118.15953
ORW03446-059352	Clark Creek	Annual	Depositional	1.84	45.50022	-117.82016	45.51500	-117.82889
ORW03446-079752	Grande Ronde River	Annual	Depositional	1.99	45.17928	-118.38901	45.19349	-118.39461
ORW03446-083672	Dark Canyon	Once-Only	Transport	2.01	45.28883	-118.38253	45.27197	-118.38200
ORW03446-092488	Waucup Creek	Once-Only	Source	1.94	45.27777	-118.64571	45.28772	-118.62801
ORW03446-101102	Phillips Creek	Annual	Depositional	2.30	45.56971	-117.97455	45.56694	-117.97325
ORW03446-101560	Meadow Creek	Annual	Transport	1.97	45.29236	-118.60224	45.28316	-118.60224
ORW03446-102872	Dry Creek	Rotating Panel 1	Transport	2.07	45.37706	-118.301	45.37043	-118.283
ORW03446-104942	Little Lookingglass Creek	Rotating Panel 1	Depositional	2.08	45.76708	-117.88725	45.75352	-117.87833
ORW03446-118152	Limber Jim Creek	Once-Only	Transport	1.99	45.10594	-118.32930	45.09017	-118.33704
ORW03446-118408	West Chicken Creek	Annual	Source	1.95	45.02682	-118.40393	45.04449	-118.40388
ORW03446-120904	Burnt Corral Creek	Annual	Source	2.13	45.17401	-118.51665	45.18431	-118.49966
ORW03446-125832	Meadow Creek	Annual	Depositional	2.17	45.26362	-118.55152	45.27139	-118.53327
ORW03446-137736	Catherine Creek	Once-Only	Depositional	1.94	45.11989	-117.64801	45.11403	-117.66942
ORW03446-143240	Tybow Creek	Rotating Panel 1	Source	2.01	45.23198	-118.21973	45.21452	-118.46785
ORW03446-147928	Five Points Creek	Annual	Depositional	2.36	45.41072	-118.20183	45.40341	-118.22276
ORW03446-163672	Whiskey Creek	Rotating Panel 1	Source	1.97	45.27012	-118.21989	45.28722	-118.21865
ORW03446-165614	Phillips Creek	Once-Only	Source	2.02	45.62511	-118.07182	45.60941	-118.06078
ORW03446-177134	East Phillips Creek	Annual	Source	2.20	45.63454	-118.05567	45.62304	-118.07222

Table 2. Steelhead spawning ground survey characteristics, location and stream classification for sites in the Joseph Creek basin, 2017.

Site ID	Stream	Panel	Stream Classification	Survey Distance (km)	Upstream Latitude	Upstream Longitude	Downstream Latitude	Downstream Longitude
CBW05583-002175	Crow Creek	Annual	Transport	2.07	45.69023	-117.15030	45.70545	-117.15186
CBW05583-037170	South Fork Chesnimnus Creek	Rotating Panel 3	Source	2.14	45.73462	-116.86890	45.72593	-116.88720
CBW05583-051026	Unnamed trib to Alder	Annual	Source	1.69	45.69084	-117.02180	45.70425	-117.02264
CBW05583-067711	Elk Creek	Rotating Panel 3	Transport	1.68	45.70019	-117.15160	45.70533	-117.15211
CBW05583-112130	Devils Run Creek	Annual	Source	2.02	45.78225	-116.98420	45.78081	-116.98547
CBW05583-141826	Basin Creek	Annual	Source	2.12	45.91900	-117.05750	45.93269	-117.05829
CBW05583-167426	Chesnimnus Creek	Annual	Depositional	2.44	45.75440	-117.01890	45.75067	-117.01907
CBW05583-169810	Chesnimnus Creek	Annual	Transport	2.08	45.71144	-116.92290	45.69759	-116.92303
CBW05583-192639	Crow Creek	Rotating Panel 3	Transport	2.13	45.65243	-117.14310	45.67082	-117.14320
CBW05583-231938	Cottonwood Creek	Rotating Panel 3	Source	2.00	45.88609	-116.98250	45.86799	-116.98250
CBW05583-249983	Elk Creek	Rotating Panel 3	Transport	2.13	45.62962	-117.19590	45.64776	-117.19723
CBW05583-255490	Unnamed trib to Billy Creek	Rotating Panel 3	Source	2.20	45.80279	-117.02100	45.81657	-117.02100
CBW05583-274559	Elk Creek	Rotating Panel 3	Source	2.13	45.64770	-117.18980	45.66401	-117.19043
CBW05583-301570	Cottonwood Creek	Annual	Source	1.88	45.93356	-117.05900	45.94326	-117.05991
CBW05583-339903	Swamp Creek	Rotating Panel 3	Transport	2.12	45.77027	-117.22950	45.71772	-117.22968
CBW05583-389247	Chesnimnus Creek	Annual	Depositional	1.94	45.69840	-117.12100	45.70513	-117.13608
CBW05583-390658	Chesnimnus Creek	Rotating Panel 3	Transport	2.18	45.69719	-116.93390	45.71428	-116.93478
CBW05583-427858	Chesnimnus Creek	Rotating Panel 3	Depositional	2.13	45.70916	-117.09060	45.71297	-117.08470
CBW05583-434111	Swamp Creek	Rotating Panel 3	Depositional	1.96	45.78542	-117.22830	45.80064	-117.22860
CBW05583-436738	Broady Creek	Rotating Panel 3	Source	2.10	45.94505	-117.09620	45.95049	-117.07650
CBW05583-471167	Little Elk Creek	Rotating Panel 3	Source	1.54	45.69495	-117.18440	45.69444	-117.19890
CBW05583-480514	Cottonwood Creek	Rotating Panel 2	Depositional	2.01	45.99712	-117.04960	45.9823	-117.06100
CBW05583-493394	Salmon Creek	Annual	Transport	1.92	45.70401	-117.05220	45.71857	-117.05021
CBW05583-508162	Joseph Creek	Rotating Panel 3	Depositional	2.11	45.79011	-117.17700	45.78396	-117.17970
CBW05583-515586	Chesnimnus Creek	Annual	Depositional	2.40	45.73674	-117.03170	45.73187	-117.05089

RESULTS

Sampling domain and site selection

We surveyed 31 sites in the UGRR encompassing 64.6 km of an estimated 892 km (7.2 %) available steelhead spawning habitat (Table 1). Stream classification for the 31 surveyed sites was distributed evenly (12 sites in source classification, 10 in transport, and nine in depositional). Four sites were located above the Grande Ronde River weir, three above the Catherine Creek weir, and one above the Lookingglass Creek weir.

Twenty-five sites were surveyed in Joseph Creek and tributaries, encompassing 51.2 km of an estimated 384 km (13.3 %) available spawning habitat (Table 2), all of which were above the weir. Stream classification for the 25 sites was random with 10 sites surveyed in source classification, eight in transport, and seven in depositional.

We conducted one survey on Deer Creek encompassing 18.7 km of utilized spawning habitat from the weir to the USFS road 8270 bridge. In previous years, additional surveys were conducted upstream of these 18.7 km and no redds or adult steelhead were observed.

Steelhead redd surveys

We conducted 108 surveys in the UGRR basin in 2017, with a mean interval of 14.3 days between surveys. A total of 36 steelhead redds were observed at 15 of the 31 sites (Table 3). More redds were found in the transport stream classification (n=21, 58%) than source (n=6, 17%) or depositional (n=9, 25%) reaches. A total of three, live adult steelhead were observed in the UGRR (Table 5). All three fish were of unknown origin. No carcasses were found in the UGRR.

A total of 25 surveys were completed in the Joseph Creek basin. We found 61 steelhead redds at 18 of the 25 sites (Table 4). Redds were evenly distributed among stream classifications with 20 (33%) found in depositional, 23 (38%) found in source, and 18 (30%) found in transport reaches. No live adult steelhead or carcasses were found in the Joseph Creek basin.

Spawning timing

We observed the first redds on 28 March in the UGRR basin. The last redd was observed on 30 May in the UGRR basin. By 1 May 53% of the total redds in the UGRR basin were observed. Most redds in the UGRR basin were first observed during the descending hydrographs of early May to mid-June (Figure 5).

Weir Counts

The Catherine Creek weir was operable on 28 February and the Lookingglass Creek and Grande Ronde River weirs were operable 1 March. During the spring of 2017, 147 wild and three hatchery adult steelhead were passed at the Lookingglass Creek weir, 104 wild adult steelhead at the Catherine Creek weir, and two wild adult steelhead at the Grande Ronde River weir (Table 6). The first adult steelhead were passed on 8 March at the Lookingglass Creek, 10 March at Catherine Creek, and 26 April on Grande Ronde River. The last steelhead were passed on 28 April at the Grande Ronde River and 26 May at Lookingglass Creek and 22 May in Catherine Creek (Mike McLean, CTUIR, unpublished data). The Catherine Creek, Lookingglass, and the Grande Ronde River weirs were closed 12 August, 12 September, and 21 June, respectively.

Estimating escapement

Annual steelhead spawning surveys on Deer Creek, a Wallowa River tributary, to determine the relationship between adult steelhead escapement (weir counts) and redd abundance (survey counts) were precluded by high discharge. The Deer Creek weir was installed on 17 February; however, some of the panels were removed on 16 March due to high water. This same day panels were put in place at the intake (~100 meters upstream of the weir) to block fish that escaped into Deer Creek from migrating further upstream. The weir panels were reinstalled on 23 March. During the six day breach at the weir an unknown number of hatchery and wild steelhead passed above the weir and subsequently spawned in Deer Creek. We believe fish spawned both above and below the intake. Therefore, this year only a one survey-pass from the intake to mile post 10 was completed on 5/16/2017 and 5/17/2017 to map the spatial distribution of redds and observe any steelhead carcasses for presence of hatchery origin spawners.

In lieu of the normal multi-pass redd surveys and weir counts, we used the total discharge at the Perry gauge in the Upper Grande Ronde (station #13318960) from March through May to calculate the fish:redd estimate for 2017. The fish:redd ratio from Deer Creek in prior years was significantly correlated with total discharge from the Perry gauge (Figure 2). This suggests that this regression is an appropriate method to estimate the fish:redd when the Deer Creek weir does not function at 100% efficiency.

Using the total discharge from the Perry gauge we estimate a fish:redd ratio of 3.51. Using this ratio and a single weight value for all stream classifications (28.8), 1,733 adult steelhead (95% C.I.: 1,052–2,415) escaped into the UGRR basin and naturally spawned (Table 7; Figure 3). Three steelhead of unknown origin were observed during surveys on the UGRR. Using this same method with a weight value of 15.4, 1,610 adult steelhead (95% C.I.: 993–2,228) escaped into the Joseph Creek basin (Table 7; Figure 4).

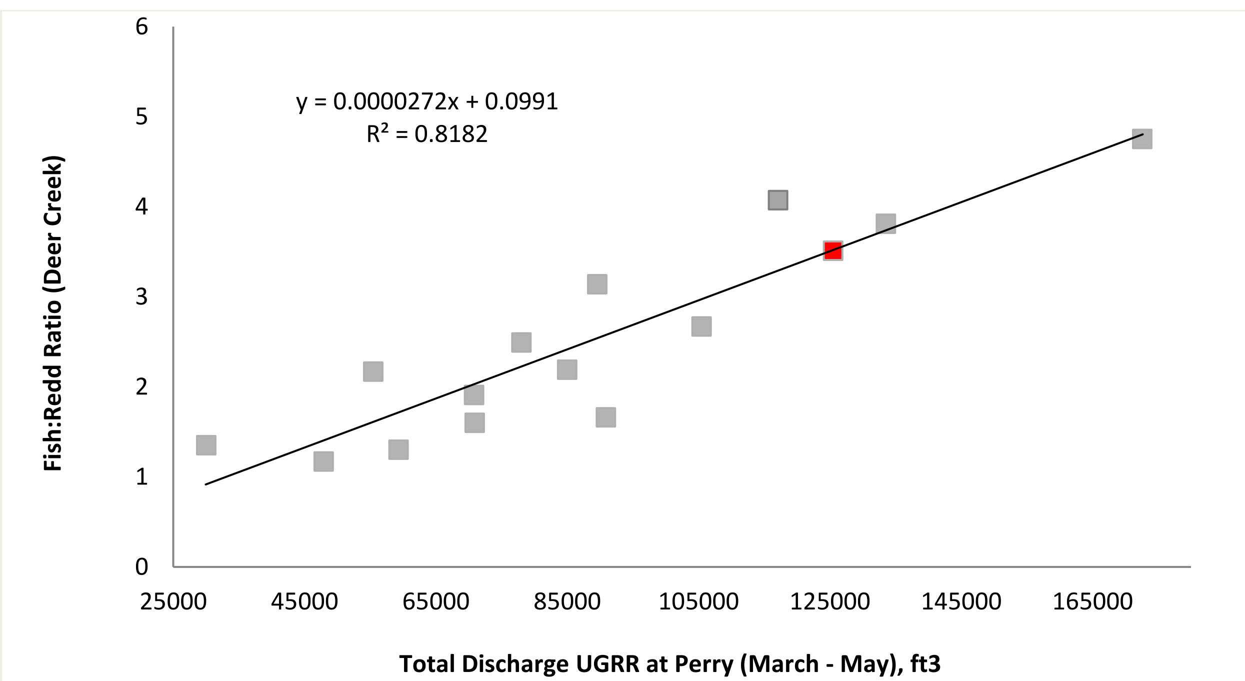

Figure 2. Relationship between total discharge in UGRR (Perry Station) and the fish:redd ratio derived from Deer Creek surveys, 2002 – 2003 and 2005 − 2016. The red point represents the predicted fish:redd for 2017.

Using the weight values for each strata, source (37.75), transport (24.3), and depositional (21.89), we estimated that 1,566 (95% CI, 903-2,229) adult steelhead for the UGRR population (Table 8). For Joseph Creek, using the weight values for each strata, source (15.90), transport (14.38), and depositional (15.86), we estimated that 1,616 (95% CI, 970-2261) adult steelhead returned to spawn (Table 9).

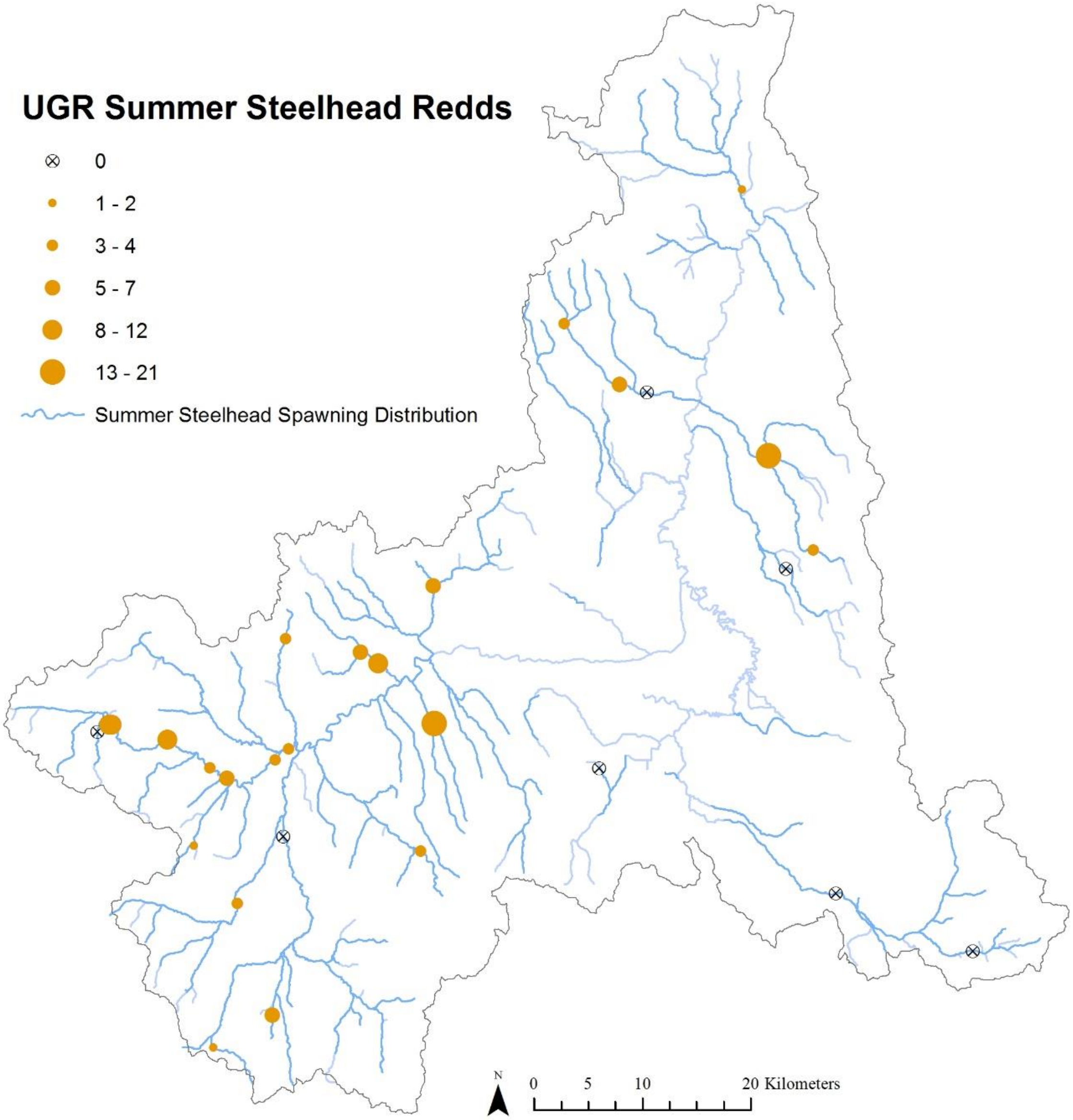

Figure 3. Map of the Upper Grande Ronde River basin displaying count of redds observed at each site in 2017.

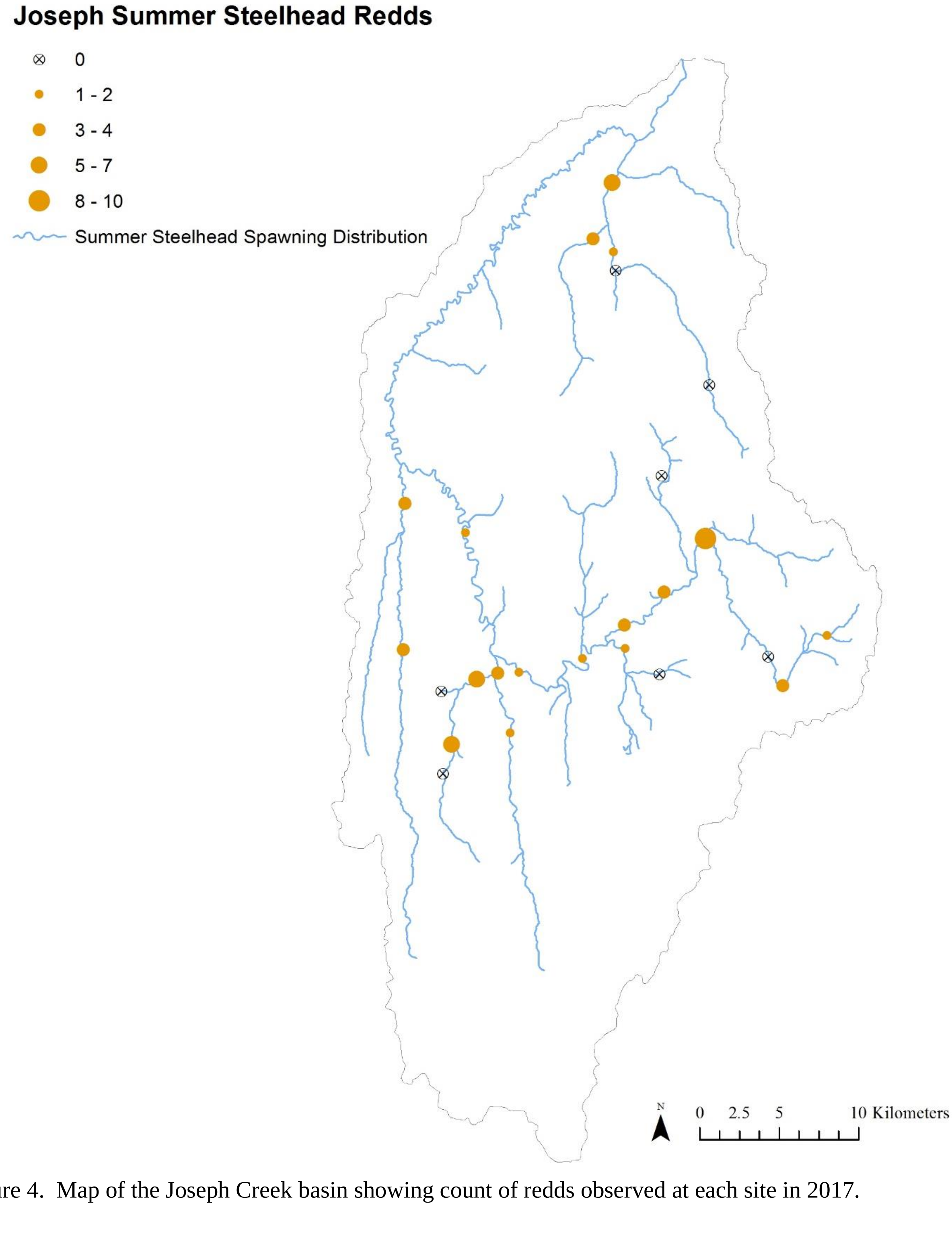

Figure 4. Map of the Joseph Creek basin showing count of redds observed at each site in 2017.

Table 3. Completion dates and general results for redd surveys in the Upper Grande Ronde River basin, 2017.

Short Site ID	Stream	Mean No. days between surveys	Redd Count	1st Survey	2nd Survey	3rd Survey	4th Survey	5th Survey	6th Survey
CBW05583-092986	Fly Creek	16.0	2	4/13/2017	5/4/2017	5/18/2017	5/31/2017		
CBW05583-149594	Dark Canyon Creek	14.0	3	3/21/2017	4/4/2017	4/18/2017	5/2/2017	5/16/2017	5/30/2017
CBW05583-275866	Meadow Creek	14.3	0	4/12/2017	5/1/2017	5/9/2017	5/25/2017		
CBW05583-288410	Little Indian Creek	14.5	0	4/24/2017	5/10/2017	5/23/2017			
CBW05583-316330	South Fork Catherine Creek	N/A	0	5/22/207					
CBW05583-514458	Spring Creek	15.0	7	5/1/2017	5/15/2017	5/31/2017			
ORW03446-010760	North Fork Catherine Creek	26.0	0	4/26/2017	5/22/2017				
ORW03446-018904	Spring Creek	13.8	0	3/28/2017	4/10/2017	4/24/2017	5/8/2017	5/22/2017	
ORW03446-023512	Whiskey Creek	10.5	1	5/11/2017	5/24/2017	6/1/2017			
ORW03446-030904	McCoy Creek	14.3	1	4/17/2017	5/1/2017	5/16/2017	5/30/2017		
ORW03446-047598	Rsydam Creek	14.0	1	4/11/2017	4/27/2017	5/10/2017	5/23/2017		
ORW03446-048088	Clark Creek	N/A	0	5/26/2017					
ORW03446-058968	Five Points Creek	13.0	0	5/11/2017	5/24/2017				
ORW03446-059352	Clark Creek	15.5	0	5/1/2017	5/15/2017	6/1/2017			
ORW03446-079752	Grande Ronde River	N/A	0	5/22/2017					
ORW03446-083672	Dark Canyon Creek	14.0	5	3/21/2017	4/4/2017	4/18/2017	5/2/2017	5/16/2017	5/30/2017
ORW03446-092488	Waucup Creek	14.3	0	4/12/2017	5/1/2017	5/9/2017	5/25/2017		
ORW03446-101102	Phillips Creek	13.8	0	4/5/2017	4/19/2017	5/4/2017	5/15/2017	5/30/2017	
ORW03446-101560	Meadow Creek	14.3	1	4/12/2017	4/26/2017	5/9/2017	5/25/2017		
ORW03446-102872	Dry Creek	14.0	3	4/10/2017	4/24/2017	5/9/2017	5/22/2017		
ORW03446-104942	Little Lookingglass Creek	15.0	0	4/25/2017	5/10/2017				
ORW03446-118152	Limber Jim Creek	13.8	3	3/28/2017	4/13/2017	4/25/2017	5/8/2017	5/22/2017	
ORW03446-118408	West Chicken Creek	13.0	0	4/13/2017	4/25/2017	5/8/2017	5/22/2017		
ORW03446-120904	Burnt Corral Creek	16.3	0	4/3/2017	4/17/2017	5/2/2017	5/22/2017		
ORW03446-125832	Meadow Creek	14.3	1	4/3/2017	4/18/2017	5/3/2017	5/9/2017	5/30/2017	
ORW03446-137736	Catherine Creek	N/A	2	4/25/2017					
ORW03446-143240	Tybow Creek	13.7	0	3/21/2017	4/3/2017	4/17/2017	5/1/2017		
ORW03446-147928	Five Points Creek	6.0	4	5/11/2017	5/17/2017				
ORW03446-163672	Whiskey Creek	13.6	1	3/23/2017	4/4/2017	4/18/2017	5/2/2017	5/16/2017	5/30/2017
ORW03446-165614	Phillips	13.0	1	5/4/2017	5/15/2017	5/30/2017			
ORW03446-177134	East Phillips Creek	13.0	0	5/4/2017	5/15/2017	5/30/2017			

Table 4. Completion dates and general results for surveys in the Joseph Creek basin, 2017.

Site ID	Stream	No. surveys completed	Mean No. days between surveys	Redd Count	Survey Date
CBW05583-002175	Crow Creek	1	N/A	3	5/24/2017
CBW05583-037170	South Fork Chesnimnus Creek	1	N/A	1	5/18/2017
CBW05583-051026	Unnamed trib to Alder	1	N/A	0	5/24/2017
CBW05583-067711	Elk Creek	1	N/A	6	5/25/2017
CBW05583-112130	Devils Run Creek	1	N/A	10	5/23/2017
CBW05583-141826	Basin Creek	1	N/A	0	5/24/2017
CBW05583-167426	Chesnimnus Creek	1	N/A	4	5/24/2017
CBW05583-169810	Chesnimnus Creek	1	N/A	3	5/18/2017
CBW05583-192639	Crow Creek	1	N/A	1	5/24/2017
CBW05583-231938	Cottonwood Creek	1	N/A	0	5/23/2017
CBW05583-249983	Elk Creek	1	N/A	0	5/18/2017
CBW05583-255490	Unnamed trib to Billy Creek	1	N/A	0	5/16/2017
CBW05583-274559	Elk Creek	1	N/A	7	5/18/2017
CBW05583-301570	Cottonwood Creek	1	N/A	2	5/24/2017
CBW05583-339903	Swamp Creek	1	N/A	3	5/16/2017
CBW05583-389247	Chesnimnus Creek	1	N/A	1	5/24/2017
CBW05583-390658	Chesnimnus Creek	1	N/A	0	5/18/2017
CBW05583-427858	Chesnimnus Creek	1	N/A	2	5/24/2017
CBW05583-434111	Swamp Creek	1	N/A	4	5/25/2017
CBW05583-436738	Broady Creek	1	N/A	3	5/24/2017
CBW05583-471167	Little Elk Creek	1	N/A	0	5/25/2017
CBW05583-480514	Cottonwood Creek	1	N/A	5	5/24/2017
CBW05583-493394	Salmon Creek	1	N/A	2	5/24/2017
CBW05583-508162	Joseph Creek	1	N/A	1	5/25/2017
CBW05583-515586	Chesnimnus Creek	1	N/A	3	5/24/2017

Table 5. Locations, dates, and characteristics of live steelhead observations in the UGRR basin in 2017.

Site ID	Stream	Observation Date	Fin Clip	On/Off Redd
CBW05583-514458	Spring	5/15/2017	Unknown	On
CBW05583-514458	Spring	5/15/2017	Unknown	On
ORW03446-092488	Waucup	4/12/2017	Unknown	Off

Table 6. Origin of fish passed above Joseph Creek, UGRR, Catherine Creek, Lookingglass Creek and Deer Creek weirs in 2017.

	Natural Origin	Hatchery Origin	Proportion Hatchery (%)	Total Fish
Joseph Creek*	N/A	N/A	N/A	N/A
UGRR**	2	0	0	2
Catherine Creek**	104	0	0	104
Lookingglass Creek**	147	3	2%	150
Deer Creek***	N/A	N/A	N/A	N/A

*Clark Watry, Nez Perce Tribe, Department of Fisheries Resources Management, unpublished data, personal communication
**Michael McLean, Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources, Fisheries Program, unpublished data, personal communication
***Michael Flesher, Oregon Department of Fish & Wildlife, La Grande Fish Research, unpublished data, personal communication

Table 7. Annual results of steelhead spawning ground surveys, 2008−2017. Available spawning habitat was refined yearly based on previous surveys.

Year	No. of sites	Spawning habitat (km)	Weight value	Redds observed	Distance surveyed (km)	Fish:redd ratio	Total spawner escapement	95% CI	CI as % of escapement
UGRR basin									
2008	29	1,301	44.9	24	64.2	4.07	2,096	±1,142	54.50%
2009	30	1,178	39.3	42	59.9	3.81	3,148	±1,047	33.20%
2010	29	934	32.2	109	56.4	1.6	2,876	±897	31.20%
2011	28	929	33.2	44	59.5	4.75	3,275	±1,028	31.40%
2012	30	897	29.9	70	60.7	3.14	3,261	±1,077	33.00%
2013	29	892	30.8	52	56.1	1.91	1,553	±757	48.70%
2014	29	892	30.8	65	61.3	2.67	2,512	±974	38.77%
2015	29	892	30.8	246	61.6	1.37	4,837	±1,891	39.09%
2016	29	892	30.8	128	58.2	1.30	2,572	±1,024	39.81%
2017	31	892	28.8	36	64.6	3.51	1,733	±681	39.30%
Joseph Creek basin									
2012	30	384	12.8	67	58.4	3.14	1,357	±380	28.00%
2013	26	384	14.8	153	51.5	1.91	2,197[a]	±934	42.50%
2014	25	384	15.4	130	51.8	2.67	2,522[b]	±778	30.85%
2015	24	384	16	286	48.3	1.37	2,967[c]	±991	33.40%
2016	26	384	14.8	177	52.7	1.30	1,663[d]	±739	44.44%
2017	25	384	15.4	61	51.2	3.51	1,610	±618	38.39%

a. With 2.2% hatchery proportion the total natural spawners is 2,149 (95% CI ±913).
b. With 1.1% hatchery proportion the total natural spawners is 2,494 (95% CI ±769).
c. With 1.8% hatchery proportion the total natural spawners is 2,914 (95% CI ±938).
d. With 4.1% hatchery proportion the total natural spawners is 1,595 (95% CI ±709).

Table 8. Survey characteristics and results, grouped by stream classification type for the UGRR basin, 2017.

Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Redds per km	Spawner escapement	Lower 95% CI	Upper 95% CI
Source	12	453	37.75	24.66	6	0.2	295	39	550
Transport	10	243	24.30	21.24	21	1.0	1013	409	1618
Depositional	9	197	21.89	18.73	9	0.5	425	88	763
Total	**31**	**892**	**83.94**	**64.63**	**36**	**0.56**	**1,566**	**903**	**2,229**

Table 9. Survey characteristics and results, grouped by stream classification type for the Joseph Creek basin, 2017.

Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Redds per km	Spawner escapement	Lower 95%CI	Upper 95% CI
Source	10	159	15.90	19.81	23	1.2	603	73	1,134
Transport	8	115	14.38	16.31	18	1.1	506	203	809
Depositional	7	111	15.86	15.04	20	1.3	501	320	681
Total	**25**	**384**	**46.14**	**51.16**	**61**	**1.2**	**1,616**	**970**	**2,261**

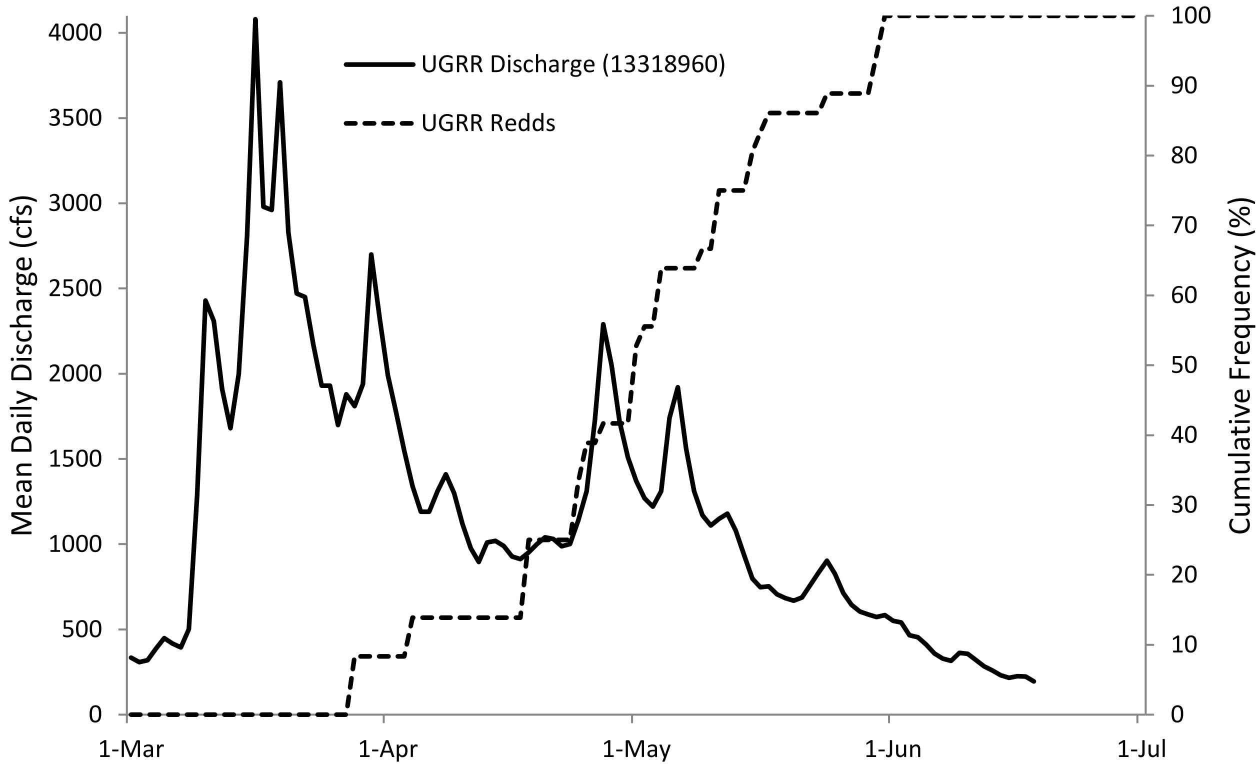

Figure 5. Cumulative frequency of observed redds and mean daily discharge during the spawning period for the UGRR basin (OWRD station #13318960) in 2017.

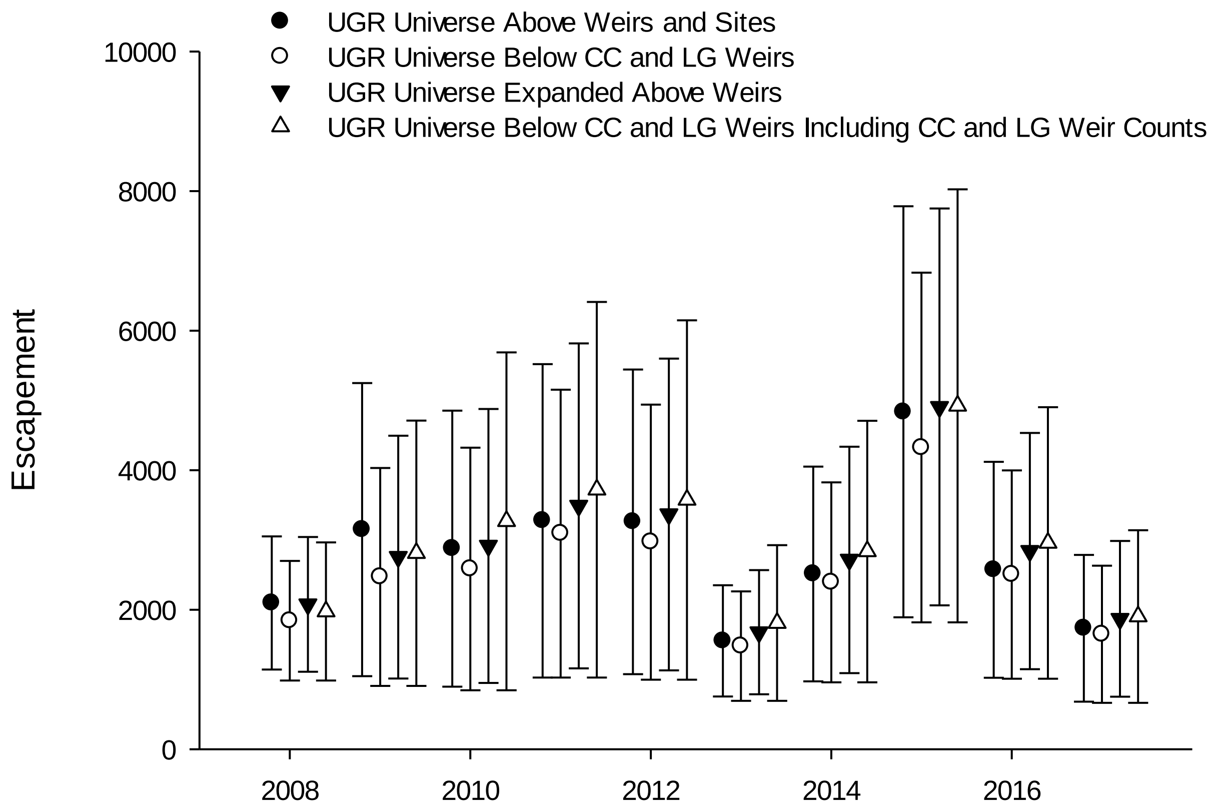

Figure 6.. Escapement estimates with 95% confidence intervals for steelhead in the Upper Grande Ronde River (UGRR) basin using a single weight value, 2008−2017 for available steelhead spawning ground habitat including habitat above Catherine Creek (CC) and Lookingglass Creek (LG) weirs and using a single weight value, 2008-2017 for steelhead spawning habitat not including habitat above Catherine Creek and Lookingglass Creek weirs. Open circles indicate UGRR universe that excludes available habitat above the Catherine Creek and Lookingglass Creek weirs. Closed circles indicate UGRR universe that includes available habitat above Catherine Creek and Lookingglass Creek weirs.

DISCUSSION

Steelhead redd surveys

Viewing conditions were marginal to difficult through most of the season at most sites, though visibility increased in mid-May at some sites. Flows were generally higher, and persisted longer in Lookingglass and Catherine creeks, and other tributaries flowing from the Wallowa Mountains due to their high elevation headwaters. Our protocol indicates that surveys should be conducted at two week intervals, which were achieved in the UGRR at sites not flowing from the Wallowa Mountains.

The efficiency of our surveys on larger tributaries (i.e. Lookingglass and Catherine creeks) was poor. Even when we were able to survey the stream, we were often unable to cross or even walk in the channel for significant stretches. This may explain why no redds were observed in Lookingglass Creek and only two redds were observed in the Catherine Creek drainage, despite hundreds of steelhead being captured at their respective fish weirs (Table 6).

Spawning timing

Most redds were first observed during descending limbs of the hydrograph (Figure 5). However, any relationship of spawning to stream flow may be obscured by artifacts of our sampling technique. Our ability to observe redds is strongly influenced by water clarity, which is generally better on the descending limb of hydrographs than on rising limbs. Even though our observations of redds were during these descending periods, they do not indicate exactly when the redd was made, as redds were likely built during the high water periods between surveys. Our surveys cannot determine or estimate when redds were built (unless we observe fish actively spawning) limiting our ability to infer a relationship between flow and spawning activities.

Estimating escapement

Population-scale escapement estimates had relatively poor precision for both Joseph Creek and UGRR (95% CI ~39% of the estimate). This is similar to last year's precision estimate of ~40% of estimate. Confidence intervals have consistently been 31–55% of the UGRR escapement estimate since 2008 (Table 7). This is despite our refinement of known steelhead spawning distribution, which has been reduced in length by 31% since 2008. It appears that the variable distribution of redds throughout the spawning distribution inflates the confidence intervals. In particular, observations of zero redds substantially increase the confidence interval, and certain streams are not likely to produce redds regardless of the number of adults returning. In 2017, we observed zero redds at 52% of our UGRR basin sites and 28% of our Joseph Creek basin sites. With continued observations of zero redds at some survey sites, it seems unlikely that precision will improve unless some other method of identifying appropriate spawning habitat can be found.

This is our sixth year of attempting to correlate redd locations with stream classifications. Redd observations were highest in transport reaches at UGRR and source reaches in Joseph Creek. There seems to be only minor utility in attempting to relate stream classification generated from landscape level variables to redd locations. Steelhead are likely not choosing appropriate spawning sites at the landscape scale. With the overlap of CHaMP sites and steelhead spawning ground surveys, we are exploring other potential relationships between redd building and small-scale habitat characteristics.

We will continue to define the extent of these identified stream reaches deemed unsuitable for spawning and locate similar reaches when they are selected in our sample draw. As the spawning distribution is refined, precision in our escapement estimates should increase. We will also continue to monitor trends of both methods and relate redd locations to immediate habitat to gain better understanding of how spawning habitat is utilized.

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