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

Accomplishments and findings

We conducted 157 surveys in the Upper Grande Ronde River (UGRR) watershed and 100 surveys in the Joseph Creek watershed from 13 March through 18 June 2013 to determine summer steelhead *Oncorhynchus mykiss* redd abundance and adult escapement for these two populations. We sampled 29 random, spatially-balanced sites throughout the UGRR basin encompassing 56.1 km (6.3%) of an estimated 892 km of available steelhead spawning habitat. In Joseph Creek, we surveyed 26 sites encompassing 51.5 km (13.4%) of the 384 km of available spawning habitat. During these surveys we observed 52 steelhead redds and nine live steelhead in the UGRR watershed and 153 redds and 27 live steelhead in the Joseph Creek watershed. We observed five carcasses in the Joseph Creek watershed and one carcass in the UGRR watershed.

On 18.7 km of Deer Creek, 33 redds, 10 live steelhead, and two carcasses were observed during five survey visits. A total of 63 wild-origin adult steelhead were passed above a permanent weir on Deer Creek, resulting in a 1.91 fish:redd ratio for the 2013 spawning season. Using the fish:redd ratio extrapolated from Deer Creek surveys, adult steelhead escapement estimates for the UGRR and Joseph Creek basins were 1,561 (95% C.I.: 800 – 2,323) and 2,197 (95% C.I.: 1,263 – 3,130) 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.

ACKNOWLEDGEMENTS

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 for providing data from weir collections on Catherine Creek 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 Robert Hogg, Marcus Anderson, Celeste Cole, Chelsea Gibson, and Shannon Skinner 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 watersheds support two of the four Major Population Groups (MPG) in the Grande Ronde River basin. 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 the 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 watershed (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 watershed 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 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. Land use is relatively light downstream of Elgin.

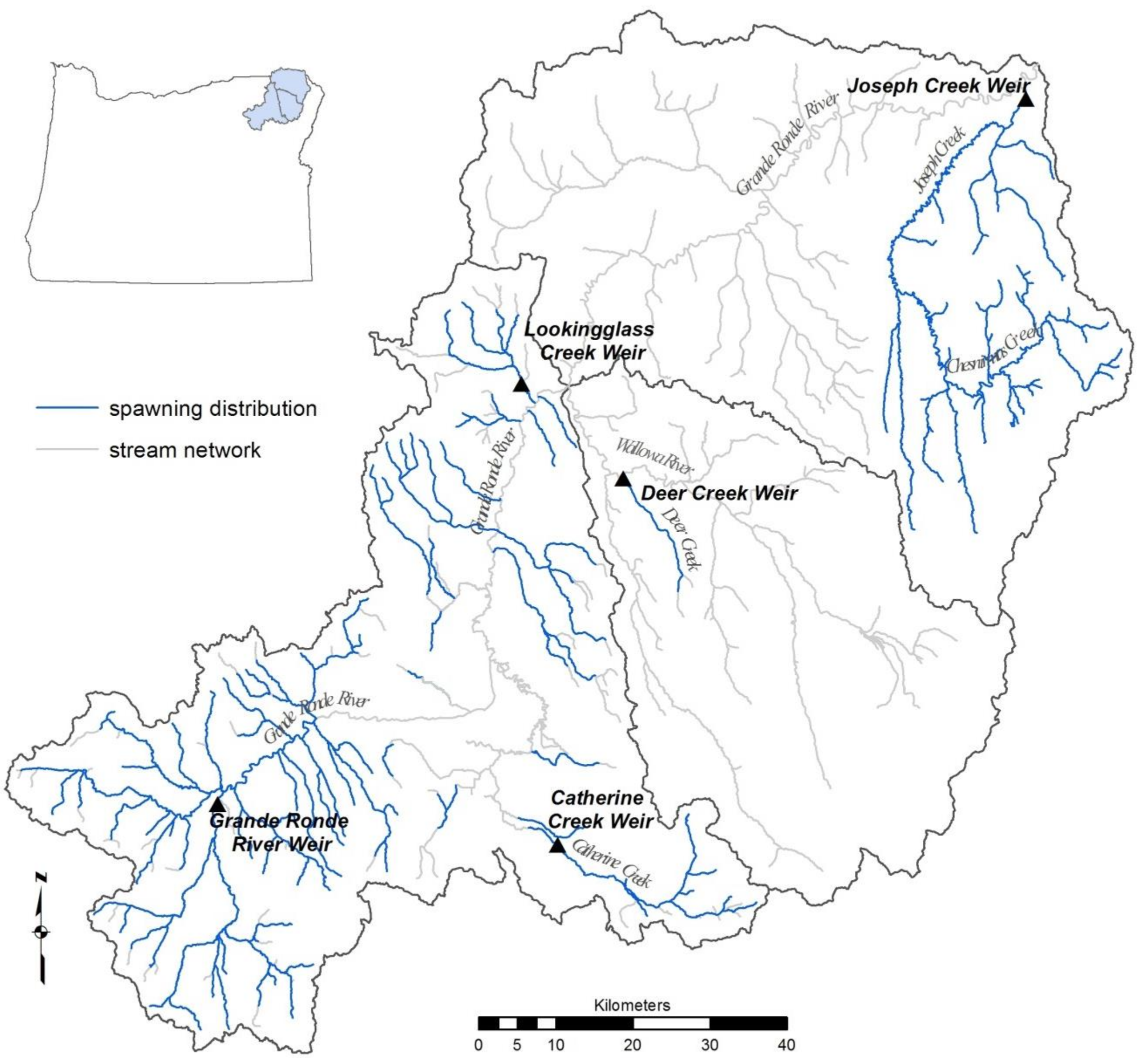

Figure 1. Sampling domains fall within the current spawning distribution of summer steelhead (blue) in Upper Grande Ronde River (UGRR) and Joseph Creek watersheds. Deer Creek and pertinent weir locations are also shown.

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 watershed 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 watershed 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 in 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 but most of lower Joseph Creek flows through federal (US Forest Service) and Nez Perce Tribal property. No significant municipalities exist in the Joseph Creek watershed.

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. 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 spawner abundance (Jacobs et al. 2009). This method follows the Oregon Plan for Salmon and Watersheds Monitoring Program approach (Stevens 2002).

This GRTS design was first implemented in the UGRR in 2008 and recently implemented in 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 sample sites were targeted in the UGRR for this year. Twenty-six 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 watershed. 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 watershed. Therefore, sites were selected as follows:

- 10 sites repeated every year (annual)
- 16 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, 2013. Individual sites were surveyed up to seven 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 Creek, and Deer Creek (Figure 1) were used to evaluate timing of steelhead entering the watersheds 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). 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 (Paul Kucera, NPT, unpublished data).

Discharge and temperature

We attempted to relate redd observations to discharge for the UGRR, Joseph Creek and Deer Creek. We used discharge measurements taken by Oregon Water Resources Department (OWRD) on the mainstem Grande Ronde River (station ID 13318960) by Perry (rkm 263). Unfortunately the Joseph Creek gauge (station ID 35G060, Washington Department of Ecology) lost funding in late 2012, and is no longer operational.

Discharge was determined for Deer Creek using paired pressure sensors (Onset Corp., HOBO Water Level Logger, P/N U20-001-01) located directly upstream of the Big Canyon Weir facility. A standpipe was installed streamside, and connected to stream flow via a buried pipe. Both pressure sensors were suspended inside the standpipe in fixed locations, one under the water's surface, and one well above. Both sensors recorded external pressure (i.e. atmospheric) hourly. The difference in pressure between the two sensors directly relates to water depth. Calculating the difference in pressure (*P*) for each measurement allowed us to track water depth (indirectly) throughout the year. We also developed a stream flow rating curve at the same locale by measuring discharge (Hach Flow Meter) multiple times, at different discharge levels. Linear regression between the observed discharge and the pressure difference from the two sensors generated our rating curve. Discharge (Q, ft^3/s) was estimated for the rest of the year with this rating curve (see formula below).

$$Q_i = (31.5 * P_i) - 61.8 \quad (1)$$

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 ran 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, 2013.

Site ID	Stream	Survey Frequency	Stream Classification	Survey Distance (km)	GRTS point		Downstream point of survey		Upstream point of survey	
					Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
018904	Spring Creek	Annual	Transport	2.06	45.3393	-118.2893	45.3381	-118.2861	45.3472	-118.3073
059352	Clark Creek	Annual	Depositional	1.86	45.5155	-117.8297	45.5150	-117.8289	45.5002	-117.8199
079752	Grande Ronde River	Annual	Depositional	1.95	45.1834	-118.3883	45.1933	-118.3952	45.1793	-118.3894
101102	Phillips Creek	Annual	Depositional	1.95	45.5671	-117.9746	45.5669	-117.9732	45.5697	-117.9937
101560	Meadow Creek	Annual	Transport	1.87	45.2832	-118.6023	45.2832	-118.6022	45.2924	-118.6122
118408	West Chicken Creek	Annual	Source	2.07	45.0318	-118.4057	45.0445	-118.4039	45.0268	-118.4036
120904	Burnt Corral Creek	Annual	Source	1.91	45.1807	-118.5073	45.1843	-118.4997	45.1740	-118.5165
125832	Meadow Creek	Annual	Depositional	1.89	45.2637	-118.5514	45.2714	-118.5333	45.2636	-118.5515
147928	Five Points Creek	Annual	Depositional	1.98	45.4047	-118.2170	45.4034	-118.2228	45.4107	-118.2018
177134	East Phillips Creek	Annual	Source	1.97	45.6280	-118.0615	45.6230	-118.0722	45.6345	-118.0557
075502	Phillips Creek	Once	Transport	2.00	45.5891	-118.0336	45.5816	-118.0244	45.5942	-118.0413
094088	Meadow Creek	Once	Depositional	2.09	45.2369	-118.4400	45.2449	-118.4234	45.2370	-118.4405
117208	South Fork Spring Creek	Once	Transport	2.04	45.3451	-118.3046	45.3456	-118.3021	45.3346	-118.3195
141832	North Fork Catherine Creek	Once	Depositional	1.97	45.1380	-117.6235	45.1303	-117.6316	45.1447	-117.6208
010424	Dark Canyon Creek	Panel 3	Transport	2.10	45.3652	-118.3936	45.3576	-118.3960	45.3753	-118.3902
025816	West Fork Ladd Creek	Panel 3	Transport	1.07	45.2536	-118.0238	45.2540	-118.0245	45.2457	-118.0186
051964	Catherine Creek	Panel 3	Depositional	2.17	45.1507	-117.7365	45.1521	-117.7444	45.1429	-117.7234
084462	Lookingglass Creek	Panel 3	Depositional	1.56	45.7416	-117.8687	45.7362	-117.8631	45.7474	-117.8712
095704	Beaver Creek	Panel 3	Transport	1.96	45.1825	-118.2324	45.1826	-118.2331	45.1714	-118.2179
102024	East Sheep Creek	Panel 3	Source	1.95	45.0127	-118.4511	45.0165	-118.4724	45.0128	-118.4508
130904	Little Whiskey Creek	Panel 3	Source	1.78	45.2821	-118.2135	45.2891	-118.2191	45.2751	-118.2091
131128	Clark Creek	Panel 3	Source	1.94	45.4310	-117.7590	45.4372	-117.7748	45.4278	-117.7549
139144	Meadow Creek	Panel 3	Depositional	1.92	45.2405	-118.4626	45.2404	-118.4623	45.2472	-118.4797
157422	Phillips Creek	Panel 3	Transport	1.98	45.5721	-118.0093	45.5727	-118.0060	45.5814	-118.0244
000094	Fly Creek	Panel 3*	Transport	2.01	45.1248	-118.4520	45.1367	-118.4477	45.1208	-118.4540
000161	South Fork Catherine Creek	Panel 3*	Source	1.97	45.1043	-117.5648	45.1051	-117.5830	45.1068	-117.5608
000213	Meadow Creek	Panel 3*	Depositional	1.97	45.2641	-118.3952	45.2659	-118.3902	45.2567	-118.4060
013882	Peet Creek	Panel 3*	Source	2.12	45.2610	-118.6152	45.2776	-118.6160	45.2601	-118.6146
252730	Meadow Creek	Panel 3*	Depositional	1.98	45.2566	-118.4061	45.2566	-118.4061	45.2451	-118.4232

*CHaMP annual sites integrated into the steelhead draw.

Table 2. Steelhead spawning ground survey characteristics, location and stream classification for sites in the Joseph Creek basin, 2013.

Site ID	Stream	Survey Frequency	Stream Classification	Survey Distance (km)	GRTS Point		Downstream point of survey		Upstream point of survey	
					Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
002175	Crow Creek	Annual	Transport	2.04	45.7033	-117.1550	45.7056	-117.1516	45.6902	-117.1503
051026	Unnamed trib to Alder Creek	Annual	Source	1.60	45.6945	-117.0136	45.7044	-117.0217	45.6939	-117.0126
112130	Devils Run Creek	Annual	Source	2.02	45.7842	-116.9856	45.7801	-116.9842	45.7826	-116.9690
141826	Basin Creek	Annual	Source	2.26	45.9138	-117.0579	45.9323	-117.0575	45.9128	-117.0573
167426	Chesnimnus Creek	Annual	Depositional	2.05	45.7536	-117.0031	45.7507	-117.0188	45.7550	-116.9973
169810	Chesnimnus Creek	Annual	Transport	2.03	45.6978	-116.9229	45.6975	-116.9228	45.7128	-116.9101
301570	Cottonwood Creek	Annual	Source	1.65	45.9375	-117.0616	45.9430	-117.0590	45.9325	-117.0534
389247	Chesnimnus Creek	Annual	Depositional	1.70	45.7053	-117.1373	45.7051	-117.1361	45.6984	-117.1210
493394	Salmon Creek	Annual	Transport	1.90	45.7092	-117.0513	45.7188	-117.0522	45.7048	-117.0492
515586	Chesnimnus Creek	Annual	Depositional	2.06	45.7331	-117.0400	45.7318	-117.0496	45.7370	-117.0317
007682	Joseph Creek	Panel 2	Depositional	1.93	45.7595	-117.1718	45.7688	-117.1757	45.7583	-117.1738
022018	Cottonwood Creek	Panel 2	Source	1.95	45.8593	-116.9798	45.8594	-116.9788	45.8448	-116.9681
061375	Swamp Creek	Panel 2	Transport	2.00	45.7711	-117.2332	45.7840	-117.2290	45.7682	-117.2331
062978	Chesnimnus Creek	Panel 2	Transport	1.75	45.7278	-116.9510	45.7394	-116.9622	45.7275	-116.9497
103938	Unnamed trib to Billy Creek	Panel 2	Source	1.91	45.8349	-117.0215	45.8316	-117.0190	45.8464	-117.0294
120658	Crow Creek	Panel 2	Transport	2.06	45.6350	-117.1435	45.6420	-117.1427	45.6265	-117.1381
155138	Joseph Creek	Panel 2	Depositional	2.07	45.7341	-117.1615	45.7424	-117.1653	45.7333	-117.1598
157522	Chesnimnus Creek	Panel 2	Depositional	2.28	45.6977	-117.1200	45.6980	-117.1196	45.7026	-117.1017
187906	Peavine Creek	Panel 2	Source	2.17	45.7534	-117.0831	45.7363	-117.0836	45.7551	-117.0832
227263	Davis Creek	Panel 2	Transport	2.15	45.7051	-117.2581	45.7067	-117.2570	45.6883	-117.2606
231250	Salmon Creek	Panel 2	Transport	2.02	45.6981	-117.0499	45.7039	-117.0485	45.6870	-117.0533
265730	TNT Gulch	Panel 2	Source	2.09	45.7698	-116.9270	45.7706	-116.9267	45.7538	-116.9190
310786	Chesnimnus Creek	Panel 2	Depositional	1.90	45.7095	-117.0932	45.7031	-117.1010	45.7093	-117.0912
408066	Summit Creek	Panel 2	Source	1.83	45.7939	-116.9475	45.7779	-116.9491	45.7937	-116.9468
510466	Broady Creek	Panel 2	Source	2.15	45.9013	-117.0930	45.9184	-117.0935	45.9005	-117.0919
527618	Horse Creek	Panel 2	Source	1.92	45.9758	-116.9886	45.9842	-117.0057	45.9760	-116.9869

RESULTS

Sampling domain and site selection

We surveyed 29 sites on the UGRR (Figure 2) encompassing 56.1 km of an estimated 892 km (6.3 %) available steelhead spawning habitat (Table 1). One additional site was never surveyed due to persistent high discharge and was not included in our calculations. Stream classification for the 29 sites was distributed as evenly as possible while retaining previously-surveyed sites: eight sites in source classification, nine in transport, and 12 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. Available spawning habitat was estimated at 897 km at the beginning of 2013 season, but we removed 5.2 km from Wright Slough, Ordell Ditch, and Conley Creek after determining this section of stream had extremely low gradient and little to no gravel available for spawning.

Twenty-six sites were surveyed in Joseph Creek and tributaries (Figure 3), encompassing 51.5 km of an estimated 384 km (13.4 %) available spawning habitat (Table 2), all of which were above the weir. Stream classification for the 26 sites was random with eleven sites in source classification, eight in transport, and seven in depositional.

We conducted five surveys on Deer Creek encompassing 18.7 km of what is believed to be all available 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 157 surveys in the UGRR basin in 2013, with a mean interval of 14.1 d between surveys. A total of 52 steelhead redds were observed at 15 of the 29 sites (Table 3). Redds were not evenly distributed among stream classifications: only two redds (4%) were found in source areas, 19 (37%) in transport, and 31 (59%) in depositional reaches. A total of nine, live adult steelhead were observed at four sites (Table 5) while one dead steelhead was found in Meadow Creek. No adipose-clipped hatchery fish were observed during our surveys.

A total of 100 surveys were completed in the Joseph Creek watershed. We found 153 steelhead redds at 16 of the 26 sites (Table 4). More redds were found in the depositional stream classification (n=74, 48%), than source or transport reaches (n=53 (35%) and 26 (17%) respectively). Water clarity was more challenging in Joseph Creek than UGRR, and surveys had a mean interval of 20.4 d once conditions allowed for access. Twenty-seven live, adult steelhead were seen at eight of the sites (Table 6), while five dead, adult steelhead were found at four sites (Table 7). No adipose-clipped hatchery fish were observed during our surveys.

We observed 33 redds on our visits to Deer Creek, 21 (63.6 %) of which were discovered in the lower 9.6 km. Two dead steelhead were also observed (Table 7). No adipose-clipped hatchery fish were observed during our surveys.

Spawning timing

Based on our redd observations, onset of spawn timing was similar between the surveyed watersheds. We observed the first redds on 26 March in the UGRR and Joseph Creek basins (Figure 4) and 28 March in Deer Creek (Figure 5). The last redds were observed on 13 June in the UGRR, 30 May in Deer Creek, and 13 June in Joseph Creek. By the third survey on 15 April, 33% of the total redds were observed on Deer Creek. By 6 May, 56% of the total redds in the UGRR basin were observed. By 15 May, 50% of the total redds in the Joseph Creek basin were observed. Although onset of redd building was similar among basins, peak redd observations occurred slightly later in Joseph Creek than UGRR (Figure 4), which is similar to the pattern observed in 2012 (Dobos et al. 2012). Most redds in the UGRR basin were first observed during the descending hydrographs of early May to late June (Figure 4). The five visits to Deer Creek coincided with low discharge periods (Figure 5).

Weir Counts

The Catherine Creek, Lookingglass Creek, and the Grande Ronde River weirs were operable 21 February, 1 March, and 6 March respectively. During the spring of 2013, 157 wild and two hatchery adult steelhead were passed at the Lookingglass Creek weir, 171 wild adult steelhead at the Catherine Creek weir, and 28 wild adult steelhead at the Grande Ronde River weir (Table 8). The first adult steelhead were passed on 11 March at the Lookingglass Creek weir and 18 March at the Catherine Creek and the Grande Ronde River weirs. The last fish were passed on 6 May at the Grande Ronde River and 10 June at Lookingglass Creek and Catherine Creek (CTUIR, unpublished data). The Grande Ronde River weir was removed on 7 June due to high water temperatures and was reinstalled on 11 June. The Catherine Creek, Lookingglass Creek, and the Grande Ronde River weirs were removed 31 July, 11 September, and 18 June respectively.

Adult steelhead were captured at the weir operated by Nez Perce Tribe (NPT) near the mouth of Joseph Creek and all fish (wild- and hatchery-origin) were passed above the weir to spawn naturally. High flows, ice and debris rendered the trap inoperable for 17 days during the months of February through April. The first adult steelhead were passed 9 February and the last was passed 25 May. During the spring of 2013, 1640 wild adult steelhead and 34 hatchery adult steelhead were passed above the weir (Table 8., Paul Kucera, NPT, unpublished data).

At the Deer Creek weir, 63 adult wild-origin steelhead were passed upstream to spawn naturally (Table 8). The weir was installed and operating 13 February trapping the first fish on 15 March. The weir was removed 29 May, 12 days after the last wild-origin fish was passed.

Estimating escapement

A fish:redd ratio of 1.91 (63/33) was generated using the number of fish passed above the weir at Deer Creek and the number of redds observed there in 2013. Using this ratio and a single weight value for all stream classifications (30.8), **1,553 adult steelhead (95% C.I.: 796 – 2,310)** escaped into the UGRR watershed and naturally spawned (Table 9; Figure 6). No adipose-clipped hatchery fish were observed during surveys on the UGRR. Using this same method with a weight value of 14.9, **2,197 adult steelhead (95% C.I.: 1,263 – 3,130)** escaped into the Joseph Creek watershed (Table 9; Figure 6). No adipose-clipped hatchery fish were observed during surveys on Joseph Creek.

Stratifying surveys by stream classification reduced the escapement estimate for UGRR by about 29%. Using the weight values for each strata, source (56.6), transport (27.0), and depositional (16.4), we estimated that **1,101 (95% CI, 616 – 1,585)** adult steelhead for the UGRR population (Table 10). For Joseph Creek estimates changed little: using the weight values for each strata, source (14.5), transport (14.3), and depositional (15.8), we estimated that **2,241 (95% CI, 1,306 – 3,175)** adult steelhead returned to spawn (Table 11).

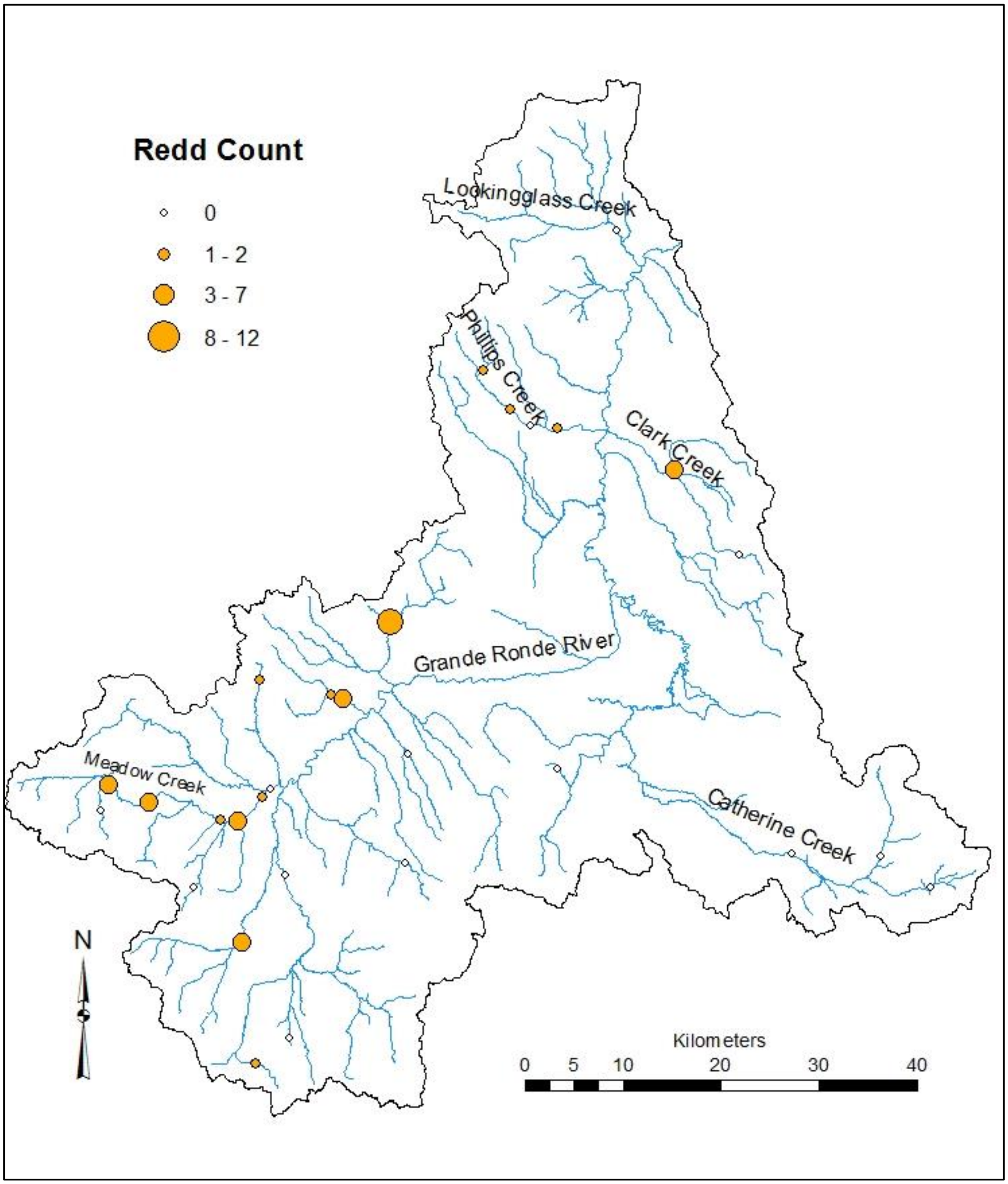

Figure 2. Map of the Upper Grande Ronde River watershed showing count of redds observed at each site in 2013.

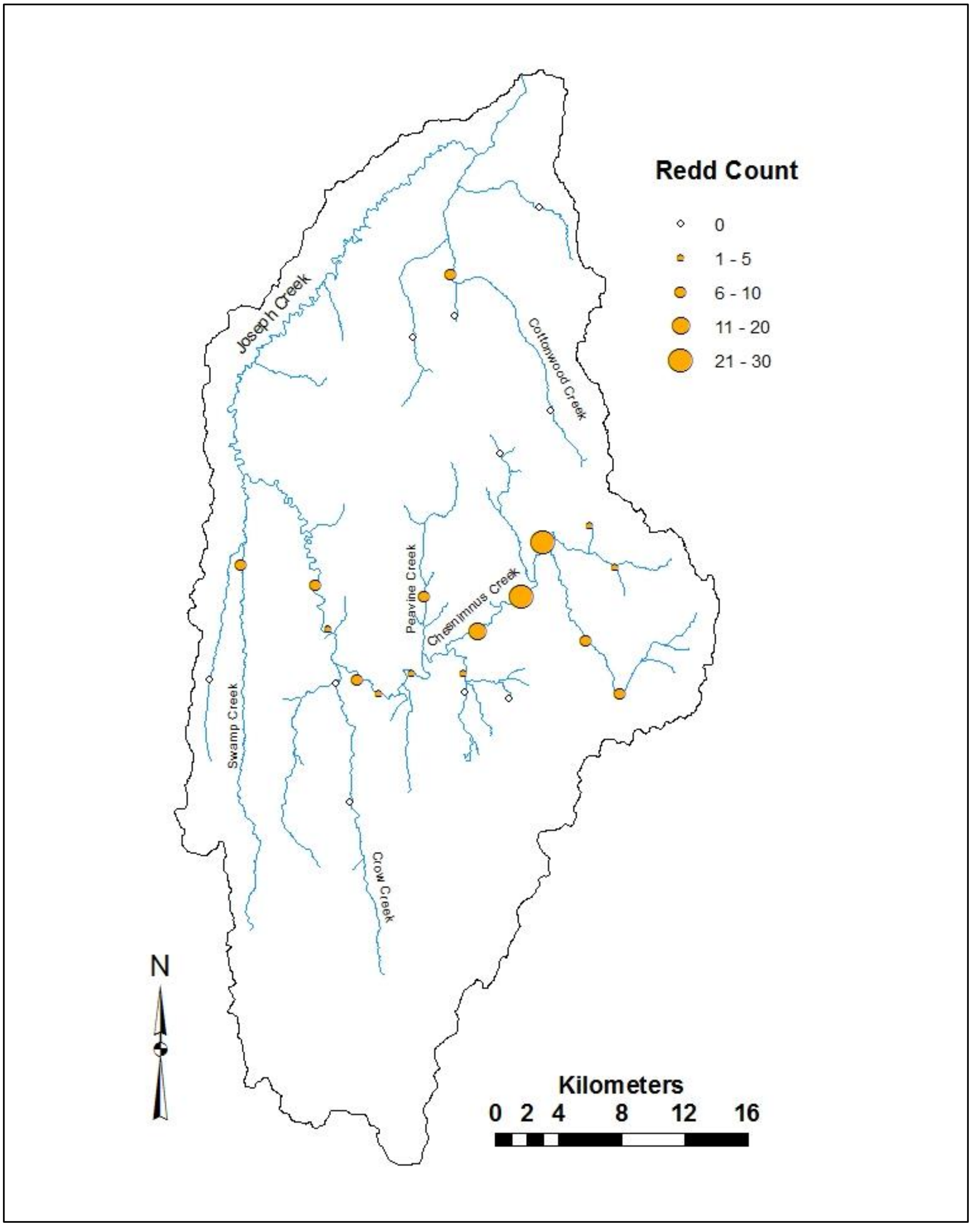

Figure 3. Map of the Joseph Creek watershed showing count of redds observed at each site in 2013.

Table 3. Completion dates and general results for surveys in the Upper Grande Ronde River watershed and Deer Creek, 2013.

Site ID	Stream	No. of surveys completed	Mean no. of days between surveys	Redd count	1st Survey Date	2nd Survey Date	3rd Survey Date	4th Survey Date	5th Survey Date	6th Survey Date	7th Survey Date
000094	Fly Creek	6	12.6	4	4/9/2013	4/22/2013	5/6/2013	5/14/2013	5/29/2013	6/11/2013	
000161	South Fork Catherine Creek	2	16.0	0	5/21/2013	6/6/2013					
000213	Meadow Creek	6	15.4	0	3/25/2013	4/16/2013	4/29/2013	5/14/2013	5/28/2013	6/10/2013	
010424	Dark Canyon	4	12.0	1	4/22/2013	5/7/2013	5/16/2013	5/28/2013			
013882	Peet Creek	5	14.0	0	4/2/2013	4/18/2013	4/30/2013	5/15/2013	5/28/2013		
018904	Spring Creek	7	13.0	3	3/26/2013	4/5/2013	4/22/2013	5/7/2013	5/20/2013	6/3/2013	6/12/2013
025816	West Fork Ladd Creek	6	13.6	0	3/13/2013	3/26/2013	4/9/2013	4/23/2013	5/8/2013	5/20/2013	
051964	Catherine Creek	5	17.8	0	3/27/2013	4/17/2013	5/1/2013	5/21/2013	6/6/2013		
059352	Clark Creek	7	14.0	4	3/26/2013	4/8/2013	4/23/2013	5/8/2013	5/21/2013	6/3/2013	6/18/2013
075502	Phillips Creek	7	12.8	2	4/1/2013	4/12/2013	4/24/2013	5/7/2013	5/20/2013	6/3/2013	6/17/2013
079752	Grande Ronde River	5	19.3	0	3/27/2013	4/18/2013	4/30/2013	5/30/2013	6/12/2013		
084462	Lookingglass Creek	5	19.3	0	3/27/2013	4/15/2013	5/1/2013	5/31/2013	6/12/2013		
094088	Meadow Creek	6	15.4	6	3/25/2013	4/16/2013	4/29/2013	5/14/2013	5/28/2013	6/10/2013	
095704	Beaver Creek	2	10.0	0	5/30/2013	6/9/2013					
101102	Phillips Creek	7	13.8	1	3/26/2013	4/9/2013	4/23/2013	5/7/2013	5/20/2013	6/3/2013	6/17/2013
101560	Meadow Creek	6	12.4	7	4/9/2013	4/25/2013	5/6/2013	5/15/2013	5/28/2013	6/10/2013	
102024	East Sheep Creek	5	12.5	1	4/22/2013	5/2/2013	5/13/2013	5/29/2013	6/11/2013		
117208	South Fork Spring Creek	5	13.8	2	3/26/2013	4/5/2013	4/22/2013	5/7/2013	5/20/2013		
118408	West Chicken Creek	6	14.2	0	4/1/2013	4/22/2013	5/2/2013	5/13/2013	5/29/2013	6/11/2013	
120904	Burnt Corral Creek	5	10.8	0	4/1/2013	4/11/2013	4/25/2013	5/6/2013	5/14/2013		
125832	Meadow Creek	7	12.5	5	3/27/2013	4/18/2013	4/30/2013	5/6/2013	5/15/2013	5/28/2013	6/10/2013
130904	Little Whiskey Creek	6	14.0	0	3/25/2013	4/8/2013	4/22/2013	5/7/2013	5/20/2013	6/3/2013	
131128	Clark Creek	3	15.0	0	5/8/2013	5/21/2013	6/7/2013				
139144	Meadow Creek	7	12.8	1	3/25/2013	4/12/2013	4/25/2013	5/6/2013	5/14/2013	5/28/2013	6/10/2013
141832	North Fork Catherine Creek	4	16.7	0	4/17/2013	5/1/2013	5/21/2013	6/6/2013			
147928	Five Points Creek	5	14.5	12	4/16/2013	4/29/2013	5/13/2013	5/29/2013	6/13/2013		
157422	Phillips Creek	7	12.8	0	4/1/2013	4/12/2013	4/24/2013	5/7/2013	5/20/2013	6/3/2013	6/17/2013
177134	East Phillips Creek	5	13.8	1	4/23/2013	5/7/2013	5/20/2013	6/3/2013	6/17/2013		
252730	Meadow Creek	6	15.4	2	3/25/2013	4/16/2013	4/29/2013	5/14/2013	5/28/2013	6/10/2013	
N/A	Deer Creek	5	15.8	33	3/28/2013	4/15/2013	4/29/2013	5/22/2013	5/30/2013		

Table 4. Completion dates and general results for surveys in the Joseph Creek watershed, 2013.

Site ID	Stream	No. of surveys completed	Mean no. of days between surveys	Redd count	1st Survey Date	2nd Survey Date	3rd Survey Date	4th Survey Date	5th Survey Date
002175	Crow Creek	4	16.3	0	4/3/2013	4/24/2013	5/7/2013	5/22/2013	
007682	Joseph Creek	5	21.0	10	4/18/2013	5/9/2013	5/20/2013	5/30/2013	6/11/2013
022018	Cottonwood Creek	2	63.0	0	4/10/2013	6/12/2013			
051026	Unnamed trib to Alder Creek	4	14.0	0	4/2/2013	4/12/2013	5/1/2013	5/14/2013	
061375	Swamp Creek	2	40.0	8	4/25/2013	6/4/2013			
062978	Chesnimnus Creek	4	15.7	7	4/17/2013	5/2/2013	5/15/2013	6/3/2013	
103938	Unnamed trib to Billy Creek	4	13.7	0	4/23/2013	5/8/2013	5/16/2013	6/3/2013	
112130	Devils Run Creek	3	34.5	30	4/5/2013	4/24/2013	6/13/2013		
120658	Crow Creek	4	14.0	0	4/4/2013	4/24/2013	5/7/2013	5/16/2013	
141826	Basin Creek	4	16.0	0	3/26/2013	4/9/2013	4/29/2013	5/13/2013	
155138	Joseph Creek	5	13.5	4	4/18/2013	5/7/2013	5/20/2013	5/30/2013	6/11/2013
157522	Chesnimnus Creek	4	16.0	4	4/16/2013	5/6/2013	5/20/2013	6/3/2013	
167426	Chesnimnus Creek	4	16.3	25	4/17/2013	5/2/2013	5/22/2013	6/5/2013	
169810	Chesnimnus Creek	4	27.0	8	4/5/2013	5/2/2013	5/15/2013	5/30/2013	
187906	Peavine Creek	5	15.5	9	3/28/2013	4/12/2013	4/24/2013	5/10/2013	5/29/2013
227263	Davis Creek	3	18.5	0	4/3/2013	4/23/2013	5/10/2013		
231250	Salmon Creek	4	15.3	0	3/29/2013	4/8/2013	5/1/2013	5/14/2013	
265730	TNT Gulch	3	17.0	3	4/24/2013	5/8/2013	5/28/2013		
301570	Cottonwood Creek	5	19.0	10	3/26/2013	4/9/2013	4/29/2013	5/13/2013	6/10/2013
310786	Chesnimnus Creek	4	16.7	3	4/16/2013	5/6/2013	5/20/2013	6/5/2013	
389247	Chesnimnus Creek	4	16.0	10	4/16/2013	5/6/2013	5/16/2013	6/3/2013	
408066	Summit Creek	4	18.0	1	4/4/2013	4/24/2013	5/9/2013	5/28/2013	
493394	Salmon Creek	5	16.5	3	3/29/2013	4/8/2013	5/1/2013	5/14/2013	5/29/2013
510466	Broady Creek	2	21.0	0	4/30/2013	5/21/2013			
515586	Chesnimnus Creek	4	19.0	18	4/17/2013	5/2/2013	5/28/2013	6/13/2013	
527618	Horse Creek	4	16.0	0	3/27/2013	4/9/2013	4/29/2013	5/14/2013	

Table 5. Locations, dates, and characteristics of live steelhead observations in the UGRR watershed, 2013.

Site ID	Stream	Date observed	Fin clip	Origin	Near redd
000213	Meadow Creek	4/16/2013	Unknown	Unknown	No
000213	Meadow Creek	4/16/2013	Unknown	Unknown	No
000213	Meadow Creek	4/16/2013	No	Wild	No
059352	Clark Creek	3/26/2013	No	Wild	No
059352	Clark Creek	3/26/2013	No	Wild	Yes
059352	Clark Creek	3/26/2013	No	Wild	Yes
094088	Meadow Creek	4/29/2013	Unknown	Unknown	No
094088	Meadow Creek	4/29/2013	Unknown	Unknown	No
147928	Five Points Creek	4/16/2013	No	Wild	Yes

Table 6. Locations, dates, and characteristics of live steelhead observations in the Joseph Creek watershed, 2013.

Site ID	Stream	Date observed	Fin clip	Origin	Near redd
112130	Devils Run Creek	4/24/2013	No	Wild	No
155138	Joseph Creek	5/7/2013	Unknown	Unknown	Yes
167426	Chesnimnus Creek	4/17/2013	Unknown	Unknown	No
167426	Chesnimnus Creek	5/2/2013	No	Wild	Yes
187906	Peavine Creek	3/28/2013	Unknown	Unknown	Yes
187906	Peavine Creek	3/28/2013	No	Wild	Yes
187906	Peavine Creek	3/28/2013	No	Wild	No
187906	Peavine Creek	3/28/2013	No	Wild	No
187906	Peavine Creek	3/28/2013	No	Wild	No
265730	TNT Gulch	4/24/2013	Unknown	Unknown	Yes
265730	TNT Gulch	4/24/2013	Unknown	Unknown	Yes
301570	Cottonwood Creek	3/26/2013	Unknown	Unknown	Yes
301570	Cottonwood Creek	3/26/2013	Unknown	Unknown	Yes
301570	Cottonwood Creek	3/26/2013	No	Wild	Yes
301570	Cottonwood Creek	4/9/2013	Unknown	Unknown	Yes
301570	Cottonwood Creek	4/9/2013	Unknown	Unknown	Yes
301570	Cottonwood Creek	4/9/2013	Unknown	Unknown	Yes
301570	Cottonwood Creek	4/9/2013	Unknown	Unknown	No
301570	Cottonwood Creek	4/29/2013	Unknown	Unknown	No
301570	Cottonwood Creek	4/29/2013	Unknown	Unknown	No
301570	Cottonwood Creek	4/29/2013	Unknown	Unknown	No
301570	Cottonwood Creek	5/13/2013	No	Wild	No
389247	Chesnimnus Creek	4/16/2013	Unknown	Unknown	No
515586	Chesnimnus Creek	4/17/2013	No	Wild	No
515586	Chesnimnus Creek	5/2/2013	Unknown	Unknown	Yes
515586	Chesnimnus Creek	5/2/2013	Unknown	Unknown	No
515586	Chesnimnus Creek	5/2/2013	No	Wild	Yes

Table 7. Locations, dates, and characteristics of dead steelhead observations in the UGRR, Joseph and Deer Creek watersheds, 2013.

Site ID	Stream	Date observed	Sex	Fork length	Age Fresh:Salt, Total	Fin Clip	Origin
094088	Meadow Creek	4/16/2013	Unknown	730	NA	Unknown	Unknown
062978	Chesnimnus Creek	5/2/2013	Unknown	672	2:1, 4	No	Wild
112130	Devils Run Creek	6/13/2013	Unknown	NA	NA	Unknown	Unknown
389247	Chesnimnus Creek	5/6/2013	Male	703	NA	No	Wild
389247	Chesnimnus Creek	5/6/2013	Female	608	NA	No	Wild
515586	Chesnimnus Creek	4/17/2013	Female	NA	2:2, 5	No	Wild
NA	Deer Creek	4/29/2013	Male	768	Unk:2, Unk	No	Wild
NA	Deer Creek	5/22/2013	Male	725	3:2, 6	No	Wild

Table 8. Origin of fish passed above Joseph Creek, UGRR, Catherine Creek, Lookingglass Creek and Deer Creek weirs in 2013.

	Natural Origin	Hatchery Origin	Proportion Hatchery (%)	Total Fish
Joseph Creek	1,640	34	2.2	1,674
UGRR	28	0	0.0	28
Catherine Creek	171	0	0.0	171
Lookingglass Creek	157	2	1.3	159
Deer Creek	63	0	0.0	63

Table 9. Annual results of steelhead spawning ground surveys, 2008−2013. 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	Spawner escapement	SE	95% CI	CI as % of escapement
UGRR basin										
2008	29	1,301	44.9	24	64.2	4.07	2,096	583	±1,142	54.5%
2009	30	1,178	39.3	42	59.9	3.81	3,148	534	±1,047	33.2%
2010	29	934	32.2	109	56.4	1.60	2,876	457	±897	31.2%
2011	28	929	33.2	44	59.5	4.75	3,275	524	±1,028	31.4%
2012	30	897	29.9	70	60.7	3.14	3,261	549	±1,077	33.0%
2013	29	892	30.8	52	56.1	1.91	1,553	386	±757	48.7%
Joseph Creek basin										
2012	30	384	12.8	67	58.4	3.14	1,357	193	±380	28.0%
2013	26	384	14.8	153	51.5	1.91	2,197	476	±934	42.5%

Table 10. Survey characteristics and results, grouped by stream classification type for the UGRR basin, 2013.

Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Redds per km	Spawner escapement	Standard error	Lower 95%CI	Upper 95% CI
Source	8	453	56.6	15.7	2	0.1	110	64	-15	235
Transport	9	243	27.0	17.1	19	1.1	497	151	201	792
Depositional	12	197	16.4	23.3	31	1.3	494	185	131	857
Total	**29**	**892**	**30.8**	**56.1**	**52**	**0.9**	**1,101**	**247**	**616**	**1,585**

Table 11. Survey characteristics and results, grouped by stream classification type for the Joseph Creek basin, 2013.

Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Redds per km	Spawner escapement	Standard error	Lower 95%CI	Upper 95% CI
Source	11	159	14.5	21.6	53	2.5	747	386	-11	1,504
Transport	8	115	14.3	16.0	26	1.6	370	121	134	607
Depositional	7	111	15.8	14.0	74	5.3	1,124	252	631	1,617
Total	**26**	**384**	**14.8**	**51.5**	**153**	**3.0**	**2,241**	**477**	**1,306**	**3,175**

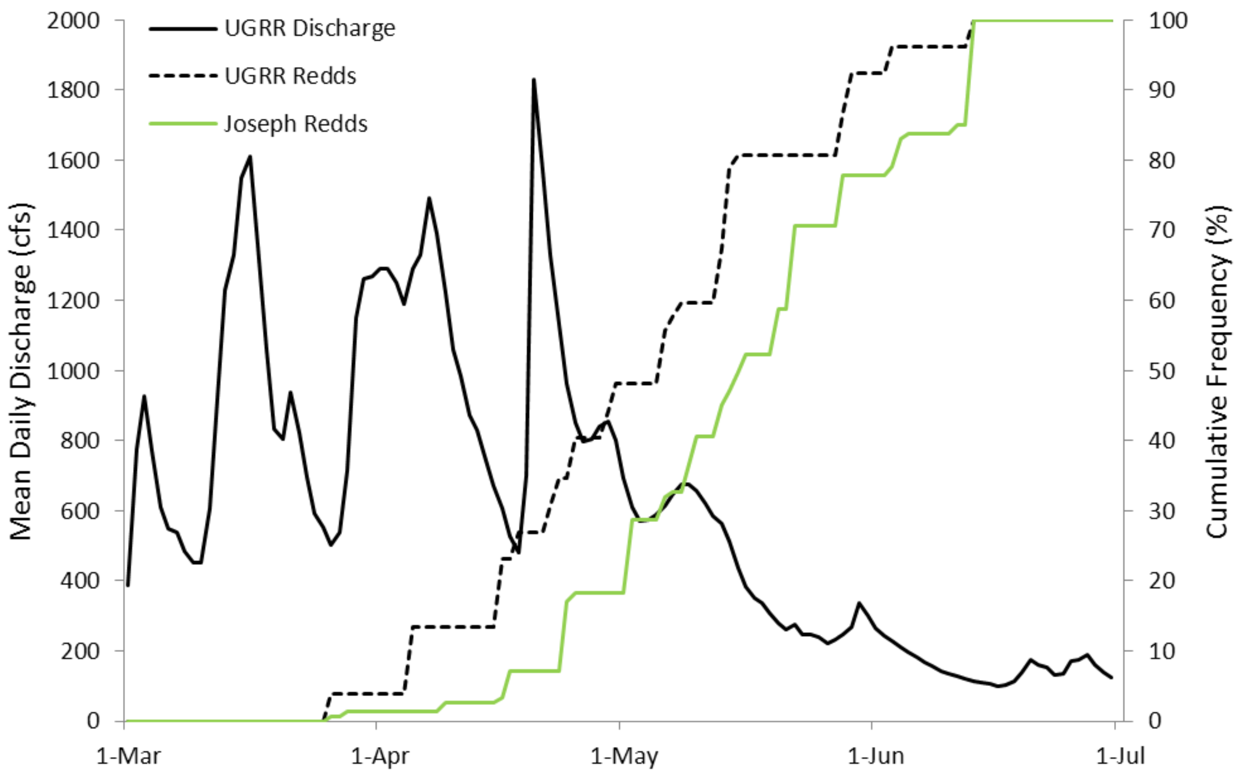

Figure 4. Cumulative frequency of observed redds and mean daily discharge during the spawning period for the UGRR watershed (OWRD station #13318960) in 2013.

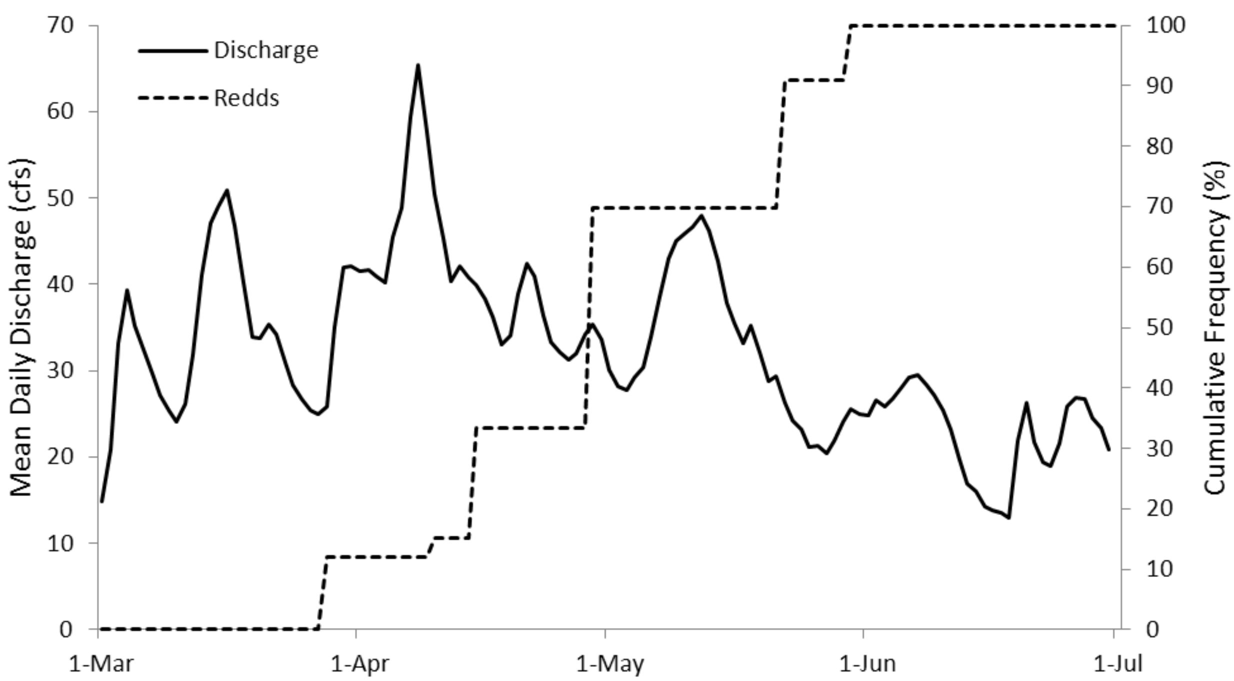

Figure 5. Cumulative frequency of observed redds and mean daily discharge during the spawning period for Deer Creek in 2013.

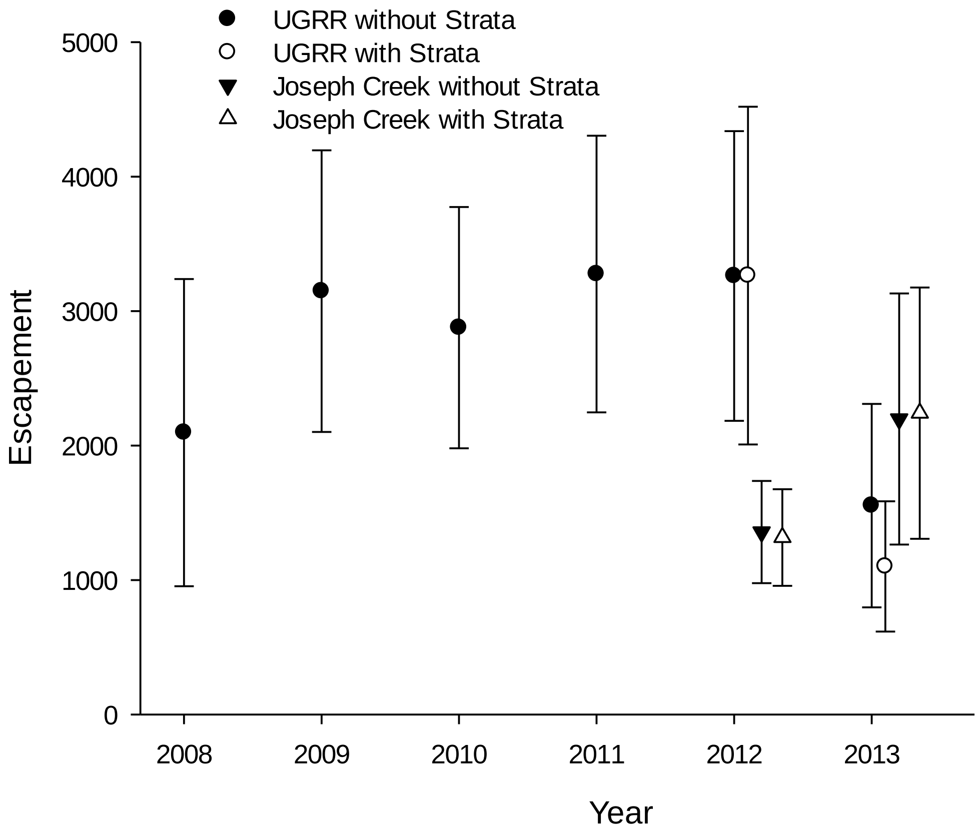

Figure 6. Escapement estimates with 95% confidence intervals for steelhead in the Upper Grande Ronde River watershed using a single weight value, 2008−2013 and using strata weights for the three classifications of stream type for UGRR and Joseph Creek, 2012−2013.

DISCUSSION

Steelhead redd surveys

Water clarity during surveys was marginal to good in both the UGRR and Joseph Creek watersheds throughout most of the season. Water clarity and our ability to observe redds generally improved as the season progressed, especially after April. Restriction of snow to higher elevations, relatively low precipitation, and moderate to low flows in May resulted in early access to most sites and good visibility. Flows were generally higher, and persisted longer in Lookinglass Creek, Deer Creek, Catherine Creek, and other tributaries flowing from the Wallowa Mountains due to their high elevation headwaters. Our protocol indicates that surveys be conducted at two week intervals and we achieved this in the UGRR. Joseph Creek was more challenging as turbidity is generally higher than in the UGGR, and our interval was closer to three weeks than two.

The efficiency of our surveys on larger tributaries (i.e. Lookingglass Creek, Catherine Creek) was poor. Even when able to survey the stream, we were often unable to cross the creek or even walk in the water for significant stretches. This may explain why zero redds were found in all of Lookingglass or Catherine Creek sites, despite hundreds of steelhead being captured at their respective fish weirs (Table 8).

Not surprisingly, seasonal stream discharge appears to play a significant role in our ability to observe steelhead redds. The fish:redd ratio from Deer Creek correlated strongly with the total water volume from UGRR (Figure 7). This suggests that the use of fish:redd is an appropriate method to compensate for our ability to successfully observe redds throughout the basin based on water conditions.

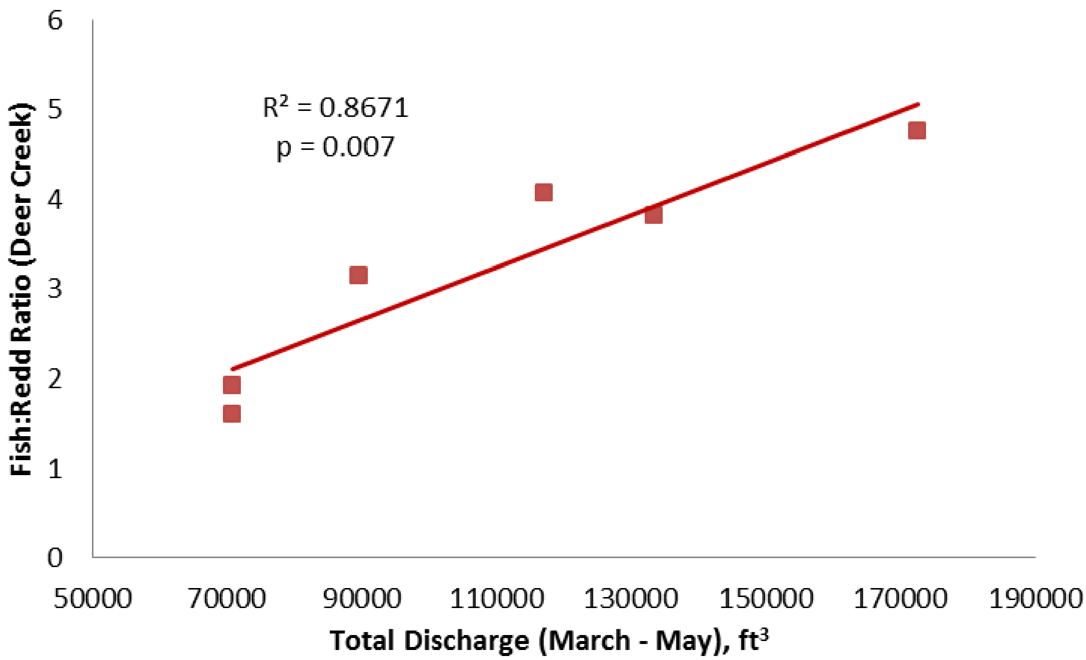

Figure 7. Relationship between total discharge in UGRR (Perry Station) and the fish:redd ratio derived from Deer Creek surveys, 2008−2013.

Spawning timing

Most redds were first observed during descending limbs of the hydrograph. However, this tells us little about the relationship of spawning to stream flow. 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. Deer creek surveys illustrate this point. We were only able to survey during the low water periods between peaks in the hydrograph (Figure 5). However, redds were likely built during the high water periods between surveys. Our surveys cannot determine or estimate when redds were built, limiting our ability to infer a relationship between flow and spawning activities.

Timing of initial redd observations was similar across both basins and in Deer Creek. However, the progression of redd building appeared to be slower in Joseph Creek. This seems counterintuitive, as Joseph Creek is lower in elevation, and generally warmer than UGRR or Deer Creek. We observed a two week lag (early April) between redd building in UGRR and Joseph Creek (Figure 4). This was also observed in 2012 (Dobos et al. 2012), the first year of Joseph Creek surveys. We were unable to determine if this is a real discrepancy in spawn timing, or an inability to effectively survey Joseph Creek tributaries during early April. Surveyors recorded water clarity (scale 1-3) at each survey event, and water clarity did improve substantially in Joseph Creek around April 10th. However, if water clarity/redd visibility was limiting our counts, one would expect a rapid increase in redd counts once water clarity improved. This was not the case, as redd observations climbed steadily after mid-April, but not faster than UGRR or Deer Creek.

Estimating escapement

Population-scale escapement estimates had relatively poor precision for both Joseph Creek and UGRR (95% CI ~45% of the estimate). This is worse than previous years' precision. Confidence intervals have consistently been 30 – 35% of the UGRR escapement estimate since 2009 (Table 9). 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 2013 we observed zero redds at 48% of our UGRR basin sites, and 38% of those in Joseph Creek. 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 second year of attempting to correlate redd locations with stream classifications. Redd observations were highest in depositional reaches for both Joseph Creek (48% of redds) and UGRR (60% of redds) basins. This distribution is similar to Joseph Creek observations in 2012, but far different for UGRR streams (Dobos et al. 2012). 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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