FISH RESEARCH PROJECT
OREGON

IMPLEMENTATION OF THE ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM (EMAP) PROTOCOL IN THE JOHN DAY SUBBASIN OF THE COLUMBIA PLATEAU PROVINCE

ANNUAL TECHNICAL REPORT

CONTRACT PERIOD: September 1, 2007 to August 31, 2008

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Objectives

1. Monitor status and trends in steelhead redd abundance and spawners in the John Day River basin.
2. Estimate the distribution of summer steelhead redds and spawners in the John Day River Basin.
3. Provide background data that can be used for:
    a. Stock assessment.
    b. Comparison data for long-term effectiveness monitoring of habitat projects.
    c. Annual estimates of spawner escapement, age structure, SAR, egg-to-smolt survival, smolt-per-redd ratio, and freshwater habitat use.

Accomplishments and Findings

We sampled 52 random, spatially-balanced sites throughout the John Day River basin during the spring (4 March–1 July) of 2008 to determine summer steelhead *Oncorhynchus mykiss* redd abundance. Survey sites encompassed 105 km of an estimated 4,269 km of steelhead spawning and rearing habitat within the basin. During these surveys, 56 redds and 31 live steelhead were observed. Redds were observed at 17 of the 52 sites (33%). Redd and adult steelhead escapement estimates for the basin were 2,277 and 9,260, respectively. Although redd counts were low, this adult steelhead escapement estimate is the greatest since the implementation of the EMAP sampling protocols in 2004 resulting from high fish/redd ratios. Redd counts at annual EMAP sites were the second lowest since 2004, exceeding only 2005. Hatchery steelhead composed 22% (4 of 18) of observed live fish where the presence or absence of an adipose fin clip could be determined. All four of the marked hatchery fish were observed in Service Creek in the Lower Mainstem John Day subbasin. We estimate that of the 9,260 steelhead in the John Day River basin in 2008, 2,037 were of hatchery origin and 7,223 were wild steelhead. High flow events persisted throughout much of the spawning season making redd observations difficult, particularly in the month of May when the majority of redds were observed in previous years.

Management Recommendations

1. Using the current data of steelhead spawning distribution and geographic landscape variables, redefine the sampling universe for *O. mykiss* in the John Day River Basin to improve our knowledge of steelhead spawning distribution.

2. Determine the level of change in the escapement estimate that we would consider to be biologically and statistically significant in order to determine short- and long-term population changes.

3. Increase effort in monitoring freshwater life history strategies and survival rates of key salmonid species in the John Day River Basin. Such information will be valuable in assessing critical limiting factors for key species and provide greater guidance for restoration activities.

4. Continue to manage the John Day River basin exclusively for wild steelhead and determine the extent and distribution of hatchery steelhead in the basin through observations of hatchery fish during the spawning season and compiling information from other sources and projects. Consider using genetic analysis to understand the influence of hatchery stocks and wild strays on John Day River wild summer steelhead stock genetics.

ACKNOWLEDGEMENTS

We would like to acknowledge the assistance and cooperation of the many private landowners throughout the John Day River basin who allowed us access to survey on their property. The cooperation of private landowners and The Confederated Tribes of the Warm Springs Reservation were essential in meeting our project objectives. Additionally, we would also like to thank Tim Unterwegner, Jeff Neal and Chris James for providing much needed guidance and advice regarding steelhead spawning ground surveys. The information they provided was extremely helpful for survey planning and landowner contacts. Furthermore, we would like to acknowledge our field crew members Mikaela Alley, Taira Flute and Barbara McLean for their assistance. This project was funded by the U. S. Department of Energy, Bonneville Power Administration, Environment, Fish, and Wildlife. Project Number: 199801600. Contract Number: 34466.

INTRODUCTION

The John Day River, located in northeastern Oregon, is unique in that it supports one of the last remaining wild populations of summer steelhead *Oncorhynchus mykiss* in the Columbia River Basin with no hatchery supplementation. However, this population remains depressed relative to historic levels. In 1999, the National Marine Fisheries Service (NMFS) listed the Middle Columbia River summer steelhead Distinct Population Segment (DPS), which includes John Day River summer steelhead, as threatened under the Endangered Species Act (ESA). Although numerous habitat protection and rehabilitation projects have been implemented within the John Day River basin to improve steelhead and other salmonid freshwater production and survival, it has been difficult to estimate the effectiveness of these projects without a systematic program in place to collect information on the status, trends, and distribution of salmonids and habitat conditions within the basin. Prior to the inception of this project, population and environmental monitoring of steelhead in the basin consisted of a combination of index surveys and periodic monitoring of some status and trend indicators. While index spawning data is useful in drawing inference about trends in adult steelhead abundance, it is limited in determining the status of steelhead escapement or distribution at the basin-wide scale because survey sites are not randomly selected, and are likely biased towards streams with higher redd densities. A broader approach to the monitoring and evaluation of status and trends in anadromous and resident salmonid populations and their habitats was needed to provide data to effectively support restoration efforts and guide alternative future management actions in the basin.

The Independent Scientific Review Panel (ISRP), in their guidance on monitoring, strongly recommended that the region move away from index surveys and embrace probabilistic sampling for most population and habitat monitoring. To meet the ISRP's recommendation, the structure and methods employed by the Oregon Plan for Salmon and Watersheds Monitoring Program were extended to the John Day basin. This approach incorporates the sampling strategy of the United States Environmental Protection Agency's (EPA's) Environmental Monitoring and Assessment Program (EMAP). The EMAP is a long-term research effort with a statistically based and spatially explicit sampling design. This program applies a rigorous, Tier-2 sampling design to answer key monitoring questions, integrate on-going sampling efforts, and improve agency coordination. EMAP objectives specific to the John Day basin are to determine annual estimates of steelhead spawner escapement, hatchery to wild steelhead stray ratios, and track changes in the status and trends of these estimates over time. In addition, data from on-going projects in the basin, such as smolt monitoring, will be incorporated in future years to develop a more complete picture of status and trends in resources (e.g. life-stage specific survival) not targeted under the EMAP program.

This project provides information as directed under two measures of the Columbia Basin Fish and Wildlife Program. Measure 4.3C specifies that key indicator naturally spawning populations should be monitored to provide detailed stock status information. In addition, measure 7.1C identifies the need for collection of population status, life history, and other data on wild and naturally spawning populations. This project was developed in direct response to the recommendations and needs of regional modeling efforts, the ISRP, the Fish and Wildlife Program, the Oregon Plan for Salmon and Watersheds, and the Columbia Basin Fish and Wildlife Authority Multi-Year Implementation Plan.

METHODS

Study Area

The John Day River basin is located in north central and northeastern Oregon (Figure 1), and is the fourth largest drainage in the state. The basin is bounded by the Columbia River to the north, the Blue Mountains to the east, the Strawberry and Aldrich Mountains to the south, and the Ochoco Mountains to the west. The John Day River originates in the Strawberry Mountains at an elevation near 1,800 m (5,900 ft) and flows approximately 457 km (284 miles) to its mouth, at an elevation of 90 m (295 ft), at river km 349 (river mile 217) of the Columbia River. It is the second longest free-flowing river in the continental United States, and along with the Yakima River it is one of only two major tributaries to the Columbia River managed for wild salmon and steelhead. There are no hydroelectric dams or hatcheries located on the John Day River, although numerous irrigation diversions dot the drainage. Major tributaries flowing into the mainstem John Day River include the North Fork, Middle Fork, and South Fork John Day rivers. The North Fork is the largest tributary, contributing approximately 60% of the flow to the mainstem. The John Day River basin contains 15,455 km (9,603 miles) of stream habitat available for fish, but only 4,602 km (2,859 miles; 30%) are known or assumed to be used for various anadromous salmonid life history stages (spawning, rearing, and migration; Figure 2).

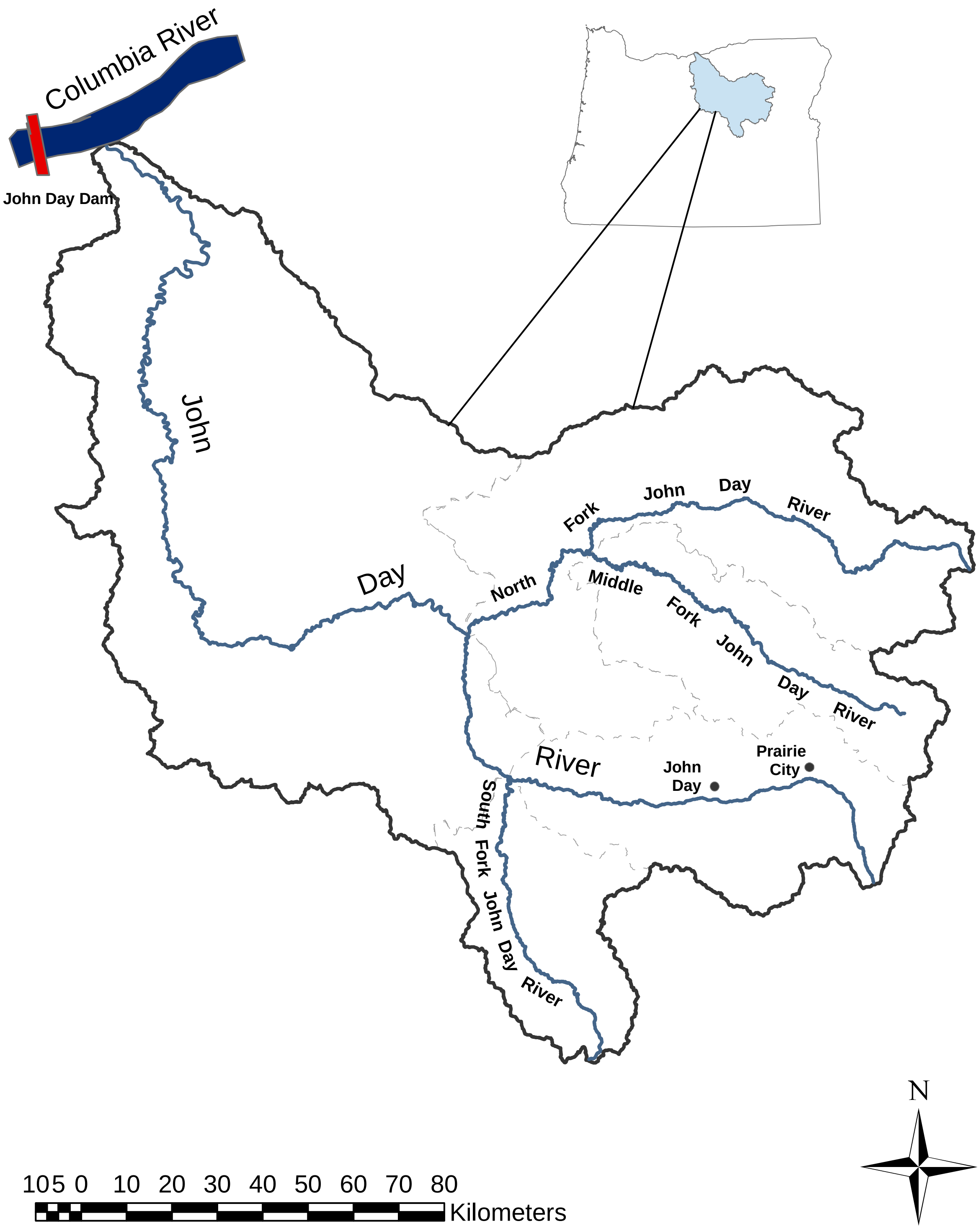

Figure 1. Map of the John Day River basin including the Mainstem John Day River and all three major forks (North Fork, Middle Fork, and South Fork). Dashed grey lines represent subbasin delineations (Lower Mainstem, Upper Mainstem, North Fork, Middle Fork, and South Fork subbasins).

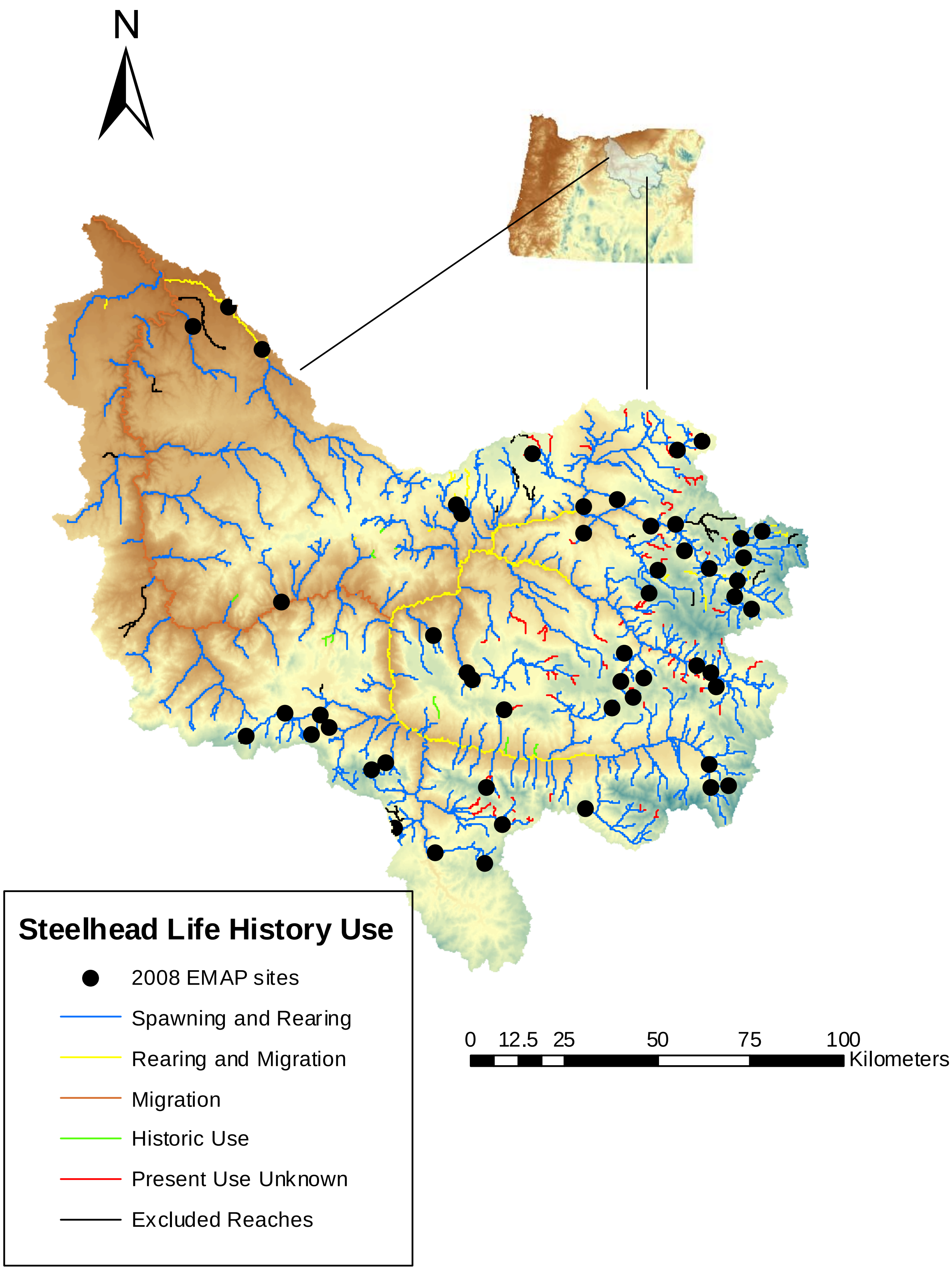

Figure 2. Map of summer steelhead life history use in the John Day River basin and 2008 EMAP sample sites.

Sampling Domain and Site Selection

Sites were selected using the EMAP protocol which uses a spatially balanced random sampling design (Stevens 2002). The sampling universe for EMAP surveys is based on professional knowledge of steelhead life history use in the John Day River basin. This knowledge is derived from ODFW biologists as well as biologists from other natural resource entities, and is currently the best information available concerning the distribution and habitat use of steelhead in the John Day River basin (Figure 2). All reaches upstream of known barriers to anadromous fish passage were eliminated from the sampling universe. Fifty sample sites are targeted each year. In order to balance the needs of status (more random sites) and trend (more repeat sites) monitoring, the following rotating panel design was implemented in the John Day River basin:

- 17 sites repeated every year (annual)
- 16 sites repeated once every four years on a staggered basis (four)
- 17 sites new every year (new)

A Geographic Information System (GIS) incorporating a 1:100,000 digital stream network was used to insure an unbiased and spatially balanced selection of sample site. The GIS site selection process provides geographic coordinates (i.e. latitude and longitude) of each candidate site. From these site coordinates, topographic maps were produced showing the location of each sample point. Landowner contacts were then developed based on county plat maps. With the assistance of ODFW District Biologists, permission was sought from landowners for survey sites. In the field, crews used a handheld Global Positioning System (GPS) to locate the established survey reaches which encompassed the selected EMAP points. Some candidate sites were not sampled due to a lack 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. Every year the EMAP sampling universe is refined based on field observations of previously unknown barriers and other restrictions (e.g. dry streams) that limit fish life history stages (defined as “Excluded Reaches” in Figures 2 and 3), or the removal of barriers (e.g. road culverts) that limited access to habitat. These stream reaches are removed or added into our sampling universe accordingly.

Steelhead Redd Surveys

Steelhead redd surveys based on standard ODFW methods (Susac and Jacobs 1999; Jacobs et al. 2000; Jacobs et al. 2001) were conducted from March to June 2008 (Table 1). 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. Survey reaches were approximately 2 km in length and encompassed the sample point derived from the EMAP sampling design. Surveyors walked upstream from the downstream end of each reach and counted all redds, live fish, and carcasses observed. New redds were flagged and the location marked with a GPS unit (UTM - NAD 27).

During each visit, surveyors recorded the number of new redds and redds that had been identified and flagged during previous surveys. Redd visibility was estimated for redds that were found during previous surveys. Ideally, each site was to be visited by different surveyors

on successive visits, however this was not always logistically possible with the number of personnel available.
Overall redd density (R_D) was estimated by:

$$R_D = \sum_{i=1}^{n} r_i/d_i \qquad (1)$$

where r_i is the number of unique redds observed at site i, d_i is the distance surveyed (km) at site i, and i is the individual sites surveyed. The total number of redds (R_T) occurring throughout the basin was estimated by:

$$R_T = R_D \cdot d_u \qquad (2)$$

where d_u is the total kilometers available to steelhead for spawning and rearing (4,269 km). Steelhead escapement (E_S) was then estimated by:

$$E_S = 4.07 \cdot R_T \qquad (3)$$

where 4.07 is a fish per redd constant. This constant is developed each year from repeat redd surveys of a tributary (Deer Creek) in the Grande Ronde River basin where a known number of adult steelhead are passed above a counting weir (Flesher et al. 2005; Gee et al. 2008; Lance Clarke and Jim Ruzycki, ODFW, unpublished data). This constant or weighting value differs from those previously reported in our recent annual reports in that it now represents a single spawning year, not an average of several consecutive years. Escapement estimates for previous years (2004-2007) have also been updated in this report using their respective single-year values. A locally weighted neighborhood variance estimator (Stevens 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 R statistical software (R Development Core Team 2005).

Steelhead carcasses were examined to obtain population and life history information (age, sex, length, and spawner origin). For all carcasses, surveyors collected scale samples from the key scale area (Nicholas and Van Dyke 1982) for age determination, recorded sex, measured MEPS length (middle of eye to posterior scale), and determined spawner origin (hatchery or wild) by inspecting carcasses for the presence (wild) or absence (hatchery) of an adipose fin. The hatchery : wild fish ratio 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 estimated by multiplying this proportion of hatchery and wild steelhead by our estimate of steelhead escapement.

South Fork John Day River Spawning Subsample

Because of the limited area available for steelhead spawning in the South Fork subbasin, few sites, usually four or less, fall into our sampling frame in any given year. In 2008, we again surveyed 13 additional sites including four sites already in the 2008 sampling frame from the South Fork John Day River subbasin to gather additional spawning data (Figure 4) and to provide an escapement estimate for this subbasin. Subsample sites were determined by selecting the first 13 sites that occurred in the South Fork subbasin from the list of EMAP sample sites. Spawning surveys were conducted as previously outlined in this report and adult steelhead escapement to the South Fork subbasin was estimated using the same equations as noted above except that the distance in the sampling universe (d_u) only encompassed that area within the South Fork subbasin available for steelhead spawning and rearing and upstream of a rotary screw trap operated by Oregon Department of Fish and Wildlife (251 km).

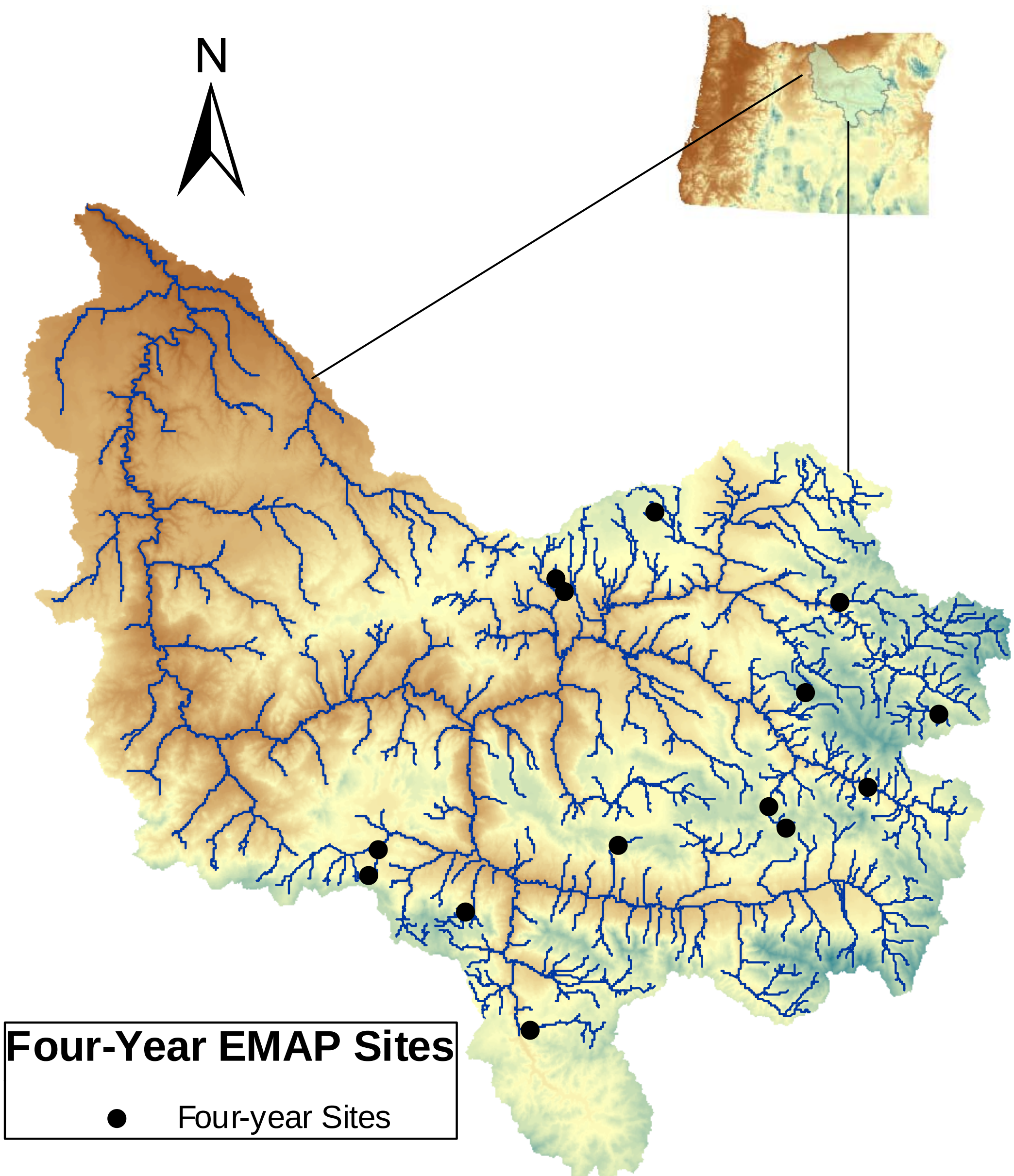

Figure 3. Map of sites in the four year site selection panel.

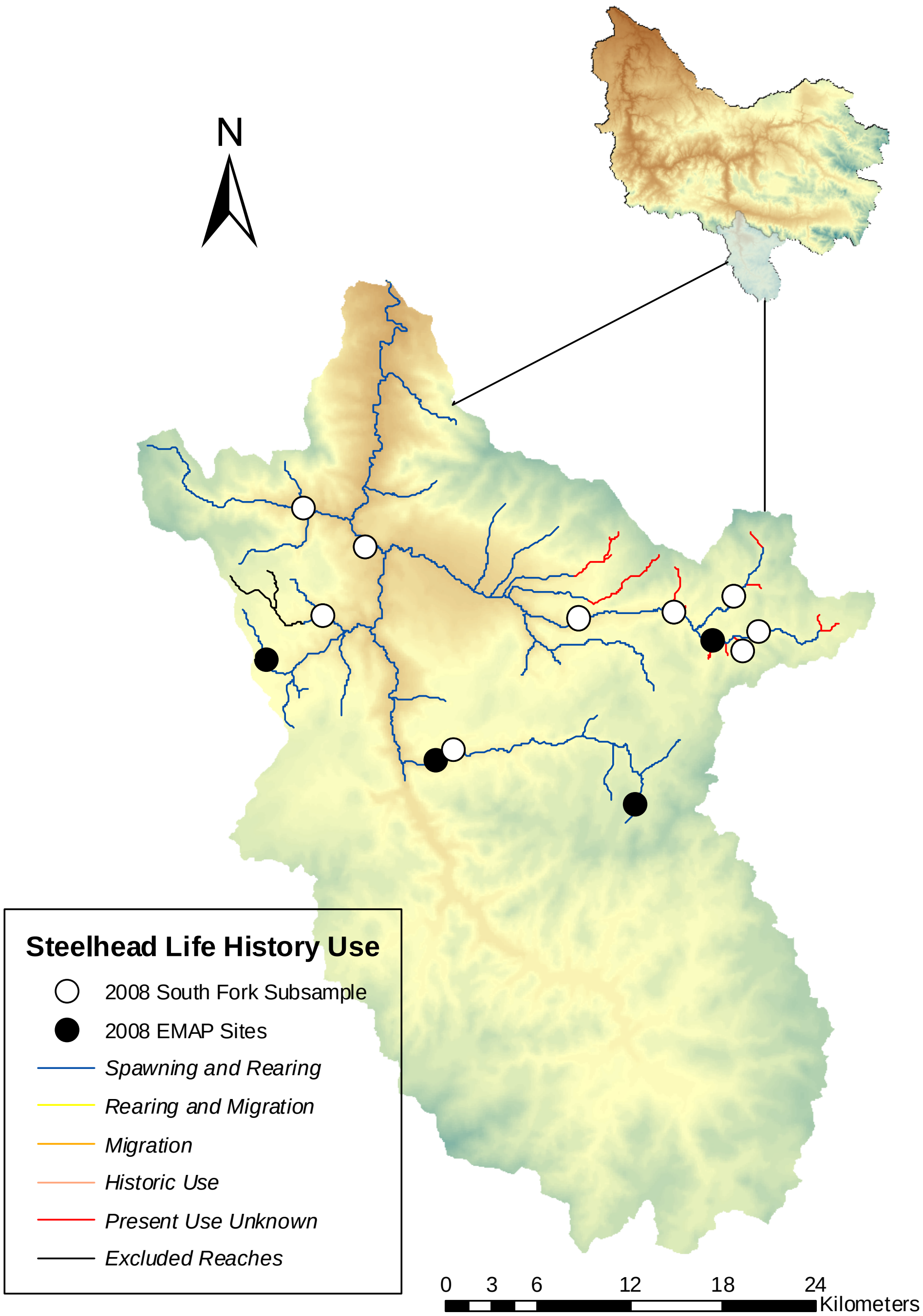

Figure 4 . Map of sites selected for sub-sample spawning surveys in the South Fork John Day River subbasin in 2008. Black circles denote sites incorporated from the basin-wide sampling frame and white circles denote sites selected for subbasin sampling.

Table 1. Stream, site identification number, start and end coordinates (UTM-NAD27), panel type, number of visits, survey distance, and dates for steelhead spawning surveys conducted in the John Day River basin from March to July, 2008. LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin.

Subbasin		UTM	Starting Coordinates		Ending Coordinates		Panel	Distance	Survey Dates					
Stream	Site ID	Zone	Easting	Northing	Easting	Northing	Type	(km)	1	2	3	4	5	6
LMJDR														
Cottonwood	162	11	0285764	4918305	0284188	4918990	New5	2.0	5/30	6/4				
Cottonwood	503	11	0288027	4920926	0287110	4920493	Four1	2.0	5/29	6/4				
Fort Creek	29	11	0270092	4930151	0268527	4929426	Four1	1.9	4/16	4/29	6/10			
Hay Creek	577	10	0709900	5038944	0710384	5037338	Oversample	2.0	3/6	3/18	4/8	4/24		
Milk Creek	497	10	0728121	4928713	0727445	4927348	Annual	1.7	5/19					
Mountain Creek	154	11	0263199	4934157	0261703	4935104	New5	2.0	3/24	4/21	6/10			
Mountain Creek	25	11	0271014	4934518	0269306	4934617	Four1	2.0	3/25	4/8	4/21	6/10		
Pine Hollow	550	11	0274823	4930697	0273118	4931109	Replaced	2.0	3/25	4/8	4/29			
Rock Creek	6	10	0728344	5033646	0729031	5032360	Annual	2.0	3/20	4/2	4/9	4/23	5/7	5/21
Rock Creek	9	10	0718867	5044432	0719995	5043658	Annual	2.0	3/4	4/2	4/9	4/23	5/7	5/21
Service Creek	11	10	0737165	4964565	0735738	4965368	Annual	1.8	3/6	3/19	3/24	4/1	4/8	4/15
UMJDR														
Belshaw Creek	20	11	0319857	4933418	0321683	4933945	Four1	2.0	5/13	5/22	6/9			
Buck Cabin Creek	576	11	0316087	4914475	0314791	4913345	Oversample	2.0	3/19					
John Day River	573	11	0374560	4910692	0375183	4908789	Oversample	2.0	4/16	4/29	5/14	5/28	6/18	
John Day River	158	11	0374522	4916735	0374395	4914934	New5	2.0	4/16	4/29	6/18	7/1		
Rail Creek	13	11	0377482	4910520	0379322	4911070	Annual	2.0	6/18					
Tinker Creek	5	11	0349136	4933091	0349678	4934711	Annual	2.0	4/14	4/28	5/5	5/15	5/28	
Vance Creek	15	11	0342565	4905270	0340702	4906162	Annual	2.1	3/26	4/30	5/28			
Belshaw Creek	20	11	0319857	4933418	0321683	4933945	Four1	2.0	5/13	5/22	6/9			
MFJDR														
Camp Creek	31	11	0351676	4940140	0351681	4938227	Four1	2.2	4/15	5/14	5/23	6/5	6/18	
Camp Creek	505	11	0353203	4936565	0354865	4935566	Four1	2.0	5/12	5/23	6/2	6/18		
Davis Creek	575	11	0378457	4938660	0377048	4937325	Oversample	2.0	4/11	4/18	4/30	5/6	5/16	
Indian Creek	500	11	0358392	4964009	0360132	4963147	Four1	2.0	5/28	6/9	6/20			
MF John Day	534	11	0374803	4941921	0376194	4941394	Annual	2.0	4/1	4/10	6/10	6/25		
MF John Day	27	11	0371970	4943356	0373457	4942863	Four1	1.8	3/25	4/10	6/11	6/24		
WF Lick Creek	17	11	0358255	4942481	0358053	4940539	Annual	2.0	4/9	5/13	6/4	6/17		
Whisky Creek	10	11	0354555	4946886	0352921	4947447	Annual	2.0	4/17	5/14	5/22			

Table 1. Continued.

Subbasin Stream	Site ID	UTM Zone	Starting Coordinates		Ending Coordinates		Panel Type	Distance (km)	Survey Dates					
			Easting	Northing	Easting	Northing			1	2	3	4	5	6
SFJDR														
Deer Creek	33	11	0300296	4896200	0301918	4896522	Four1	2.0	3/27	4/10	5/8	5/14	5/28	
Murderers Creek	161	11	0317209	4904133	0318443	4903132	New5	2.0	5/15	5/27				
SF Deer Creek	532	11	0313523	4894513	0313118	4892743	Annual	2.0	5/8	5/21				
Wind Creek	152	11	0290945	4902199	0289644	4903154	New5	2.0	4/28	5/6				
NFJDR														
Basin Creek	165	11	0371172	4975685	0370339	4974022	New5	2.0	6/17					
Battle Creek	535	11	0361217	4968533	0362942	4969070	Annual	2.0	6/10					
Bear Creek	21	11	0310600	4987630	0309918	4989125	Four1	2.0	4/22	5/12				
Beaver Creek	496	11	0387483	4957651	0388736	4957251	Four1	2.0	6/13					
Big Creek	498	11	0368342	4981443	0370010	4981349	Four1	1.9	4/7	6/30				
Bridge Creek	564	11	0351335	4989516	0353023	4988761	Oversample	2.0	5/15					
Camas Creek	569	11	0374521	5003474	0376472	5003209	Oversample	2.0	3/20	4/10	5/2	5/22		
Camas Creek	4	11	0343517	4987110	0343984	4989146	Annual	2.3	3/31	6/17				
Clear Creek	16	11	0383722	4961548	0383865	4959655	Annual	2.1	6/9	6/19				
Cottonwood	156	11	0310275	4944663	0311484	4943750	New5	2.0	4/9	6/12				
Cottonwood	551	11	0311484	4943750	0312108	4942408	Oversample	2.0	4/9	6/12				
Crane Creek	160	11	0384478	4971505	0386395	4971604	New5	2.0	6/5	6/25				
Gilmore Creek	7	11	0302011	4954449	0302611	4953198	Annual	1.7	4/3	4/23	4/30	6/12		
Granite Creek	490	11	0376641	4968983	0377626	4967590	Annual	2.1	6/9					
Granite Creek	565	11	0382720	4966066	0384177	4965384	Oversample	2.0	6/9	6/19				
North Trail Creek	570	11	0390819	4977151	0391392	4978666	Oversample	2.0	6/4	6/19	7/3			
Otter Creek	30	11	0361486	4981851	0361420	4980761	Four1	1.2	4/14					
Swale Creek	28	11	0310185	4985340	0311481	4986425	Four1	2.1	5/12	5/20	6/11			
Tribble Creek	19	11	0331035	5001276	0330024	5002793	Four1	2.1	5/15					
Trout Creek	529	11	0386082	4975613	0385234	4976978	Annual	2.0	6/16					
Warm Spring	164	11	0369579	5000916	0369753	4998999	New5	2.0	4/10	5/21	6/4			
WF Meadow	163	11	0343583	4980108	0342694	4978548	New5	2.0	4/1	4/23	4/29	5/5	5/14	

RESULTS

Steelhead Redds and Escapement

We observed 56 steelhead redds while surveying 105 km of an estimated 4,269 km of steelhead spawning and rearing habitat within the John Day River basin during 2008 (Table 2). This results in a redd density of 0.53 redds/km. By expansion, an estimated 2,277 observable redds were constructed within the John Day River basin in 2008 by an estimated 9,260 spawners (Table 3). Of all subbasins, the Lower Mainstem had the highest density of redds with1.21 redds/km (Table 4; Figure 5) followed by the Middle Fork with 0.50 redds/km (Table 4; Figure 7), the South Fork with 0.38 redds/km (Table 4; Figure 9), the North Fork with 0.37 redds/km (Table 4; Figure 8), and the Upper Mainstem with 0.19 redds/km (Table 4; Figure 6). Approximately 67% of sites surveyed in 2008 had no spawning occurring within the survey reaches (Table 4). We observed redds at 54% of the sites within the Lower Mainstem, 38% in the Middle Fork, 18% in the North Fork, 50% in the South Fork and 28% in the Upper Mainstem subbasins (Table 4).

Redd counts and densities at annual sites were also the lowest since 2005 (Table 5). This trend was also apparent between each subbasin with the exception of the Upper Mainstem which contained a relatively large proportion of redds in 2005 (Figure 11). We observed less than half as many redds at four year samples sites in 2008 compared to 2004 (Table 6). In 2004 we observed redds at 43% of four year sites and in 2008 we observed redds at only 29% of these same sites (Table 6).

Table 2. Total number of steelhead redds, and unmarked (wild), marked (hatchery), and unknown origin live and dead steelhead observed during spawning surveys conducted in the John Day River basin from March to June, 2008.

	Site	# of		#Live Fish				# Dead Fish			
Stream	**ID**	**Redds**	**Redds/km**	**Unmarked**	**Marked**	**Unknown**	**Total**	**Unmarked**	**Marked**	**Unknown**	**Total**
LMJDR											
Cottonwood Creek	162	0	0	0	0	0	0	0	0	0	0
Cottonwood Creek	503	0	0	0	0	0	0	0	0	0	0
Fort Creek	29	0	0	0	0	0	0	0	0	0	0
Hay Creek	577	2	1	0	0	0	0	0	0	0	0
Milk Creek	497	0	0	0	0	0	0	0	0	0	0
Mountain Creek	154	1	0.5	0	0	1	1	0	0	0	0
Mountain Creek	25	1	0.5	0	0	0	0	0	0	0	0
Pine Hollow Creek	550	0	0	0	0	0	0	0	0	0	0
Rock Creek	6	6	3	0	0	0	0	0	0	1	1
Rock Creek	9	4	2	0	0	0	0	0	0	0	0
Service Creek	11	12	6.67	3	4	5	12	0	0	0	0
LMJDR TOTAL		**26**	**1.21**	**3**	**4**	**6**	**13**	**0**	**0**	**1**	**1**
UMJDR											
Belshaw Creek	20	0	0	0	0	0	0	0	0	0	0
Buck Cabin Creek	576	0	0	0	0	0	0	0	0	0	0
John Day River	573	1	0.5	0	0	0	0	0	0	0	0
John Day River	158	2	1	1	0	0	1	0	0	0	0
Rail Creek	13	0	0	0	0	0	0	0	0	0	0
Tinker Creek	5	0	0	0	0	0	0	0	0	0	0
Vance Creek	15	0	0	0	0	0	0	0	0	0	0
UMJDR TOTAL		**3**	**0.21**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
NFJDR											
Basin Creek	165	0	0	0	0	0	0	0	0	0	0
Battle Creek	535	0	0	0	0	0	0	0	0	0	0
Bear Creek	21	0	0	0	0	0	0	0	0	0	0
Beaver Creek	496	0	0	0	0	0	0	0	0	0	0
Big Creek	498	0	0	0	0	0	0	0	0	0	0
Bridge Creek	564	0	0	0	0	0	0	0	0	0	0
Camas Creek	569	0	0	0	0	0	0	0	0	0	0
Camas Creek	4	0	0	0	0	0	0	0	0	0	0

Table 2. Continued

Stream	Site ID	# of Redds	Redds/km	#Live Fish Unmarked	#Live Fish Marked	#Live Fish Unknown	#Live Fish Total	# Dead Fish Unmarked	# Dead Fish Marked	# Dead Fish Unknown	# Dead Fish Total
NFJDR (con.)											
Clear Creek	16	0	0	0	0	0	0	0	0	0	0
Cottonwood Creek	156	2	1	0	0	0	0	0	0	0	0
Cottonwood Creek	551	0	0	0	0	0	0	0	0	0	0
Crane Creek	160	0	0	0	0	0	0	0	0	0	0
Gilmore Creek	7	0	0	0	0	0	0	0	0	0	0
Granite Creek	490	0	0	0	0	0	0	0	0	0	0
Granite Creek	565	0	0	0	0	0	0	0	0	0	0
North Trail Creek	570	4	2	1	0	1	2	0	0	0	0
Otter Creek	30	0	0	0	0	0	0	0	0	0	0
Swale Creek	28	1	0.48	2	0	1	3	0	0	0	0
Tribble Creek	19	0	0	0	0	0	0	0	0	0	0
Trout Creek	529	0	0	0	0	0	0	0	0	0	0
Warm Spring Creek	164	0	0	0	0	0	0	0	0	0	0
WF Meadow Brook	163	9	4.5	2	0	2	4	0	0	0	0
NFJDR TOTAL		**16**	**0.37**	**5**	**0**	**4**	**9**	**0**	**0**	**0**	**0**
MFJDR											
Camp Creek	31	0	0	3	0	0	3	0	0	0	0
Camp Creek	505	3	1.5	0	0	0	0	0	0	0	0
Davis Creek	575	4	2	0	0	2	2	0	0	0	0
Indian Creek	500	0	0	0	0	0	0	0	0	0	0
MF John Day River	534	0	0	0	0	0	0	0	0	0	0
MF John Day River	27	0	0	0	0	0	0	0	0	0	0
WF Lick Creek	17	0	0	2	0	1	3	0	0	0	0
Whisky Creek	10	1	0.5	0	0	0	0	0	0	0	0
MFJDR TOTAL		**8**	**0.5**	**5**	**0**	**3**	**8**	**0**	**0**	**0**	**0**
SFJDR											
Deer Creek	33	2	1	0	0	0	0	0	0	0	0
Murderers Creek	161	1	0.5	0	0	0	0	0	0	0	0
SF Deer Creek	532	0	0	0	0	0	0	0	0	0	0
Wind Creek	152	0	0	0	0	0	0	0	0	0	0
SFJDR TOTAL		**3**	**0.38**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
BASIN TOTAL		**56**	**0.54**	**14**	**4**	**13**	**31**	**0**	**0**	**1**	**1**

Table 3. Distance surveyed (km), number of unique redds observed, redd density (redds/km), estimated total number of redds, fish per redd estimate from Deer Creek, and spawner escapement with 95% C.I. for the John Day River basin from 2004 to 2008.

Year	km	Redds	Redds/km	Total redds	Fish/redd	Spawner escapement	95% Lower	95% Upper
2004	94.7	66	0.70	3,071	1.46	4,484	1,657	7,310
2005	101.2	39	0.39	1,681	2.20	3,698	1,261	6,137
2006	90.5	67	0.74	3,202	1.66	5,315	2,189	8,441
2007	99.6	181	1.82	7,758	1.12	8,689	5,939	11,439
2008	105.0	56	0.53	2,277	4.07	9,260	4,742	13,775

Table 4. Total redds observed, redd density (redds/km), and live fish observed throughout the John Day River basin (JDR) and by subbasin (LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin) from 2004 to 2008.

	JDR			LMJDR			UMJDR			NFJDR			MFJDR			SFJDR		
Year	Redds	Density	Fish	Redds	Density	Fish	Redds	Density	Fish	Redds	Density	Fish	Redds	Density	Fish	Redds	Density	Fish
2004	66	0.70	50	38	1.83	35	0	0.00	0	8	0.21	7	17	1.27	0	3	0.35	1
2005	39	0.39	12	8	0.34	6	20	0.75	6	11	0.38	0	0	0.00	0	0	0.00	0
2006	67	0.74	32	29	1.36	18	13	0.73	2	6	0.18	4	19	1.42	8	0	0.00	0
2007	181	1.82	80	91	3.35	53	32	1.50	6	18	0.63	3	25	1.59	5	15	2.21	13
2008	56	0.53	31	26	1.21	13	3	0.19	1	16	0.37	9	8	0.50	8	3	0.38	0

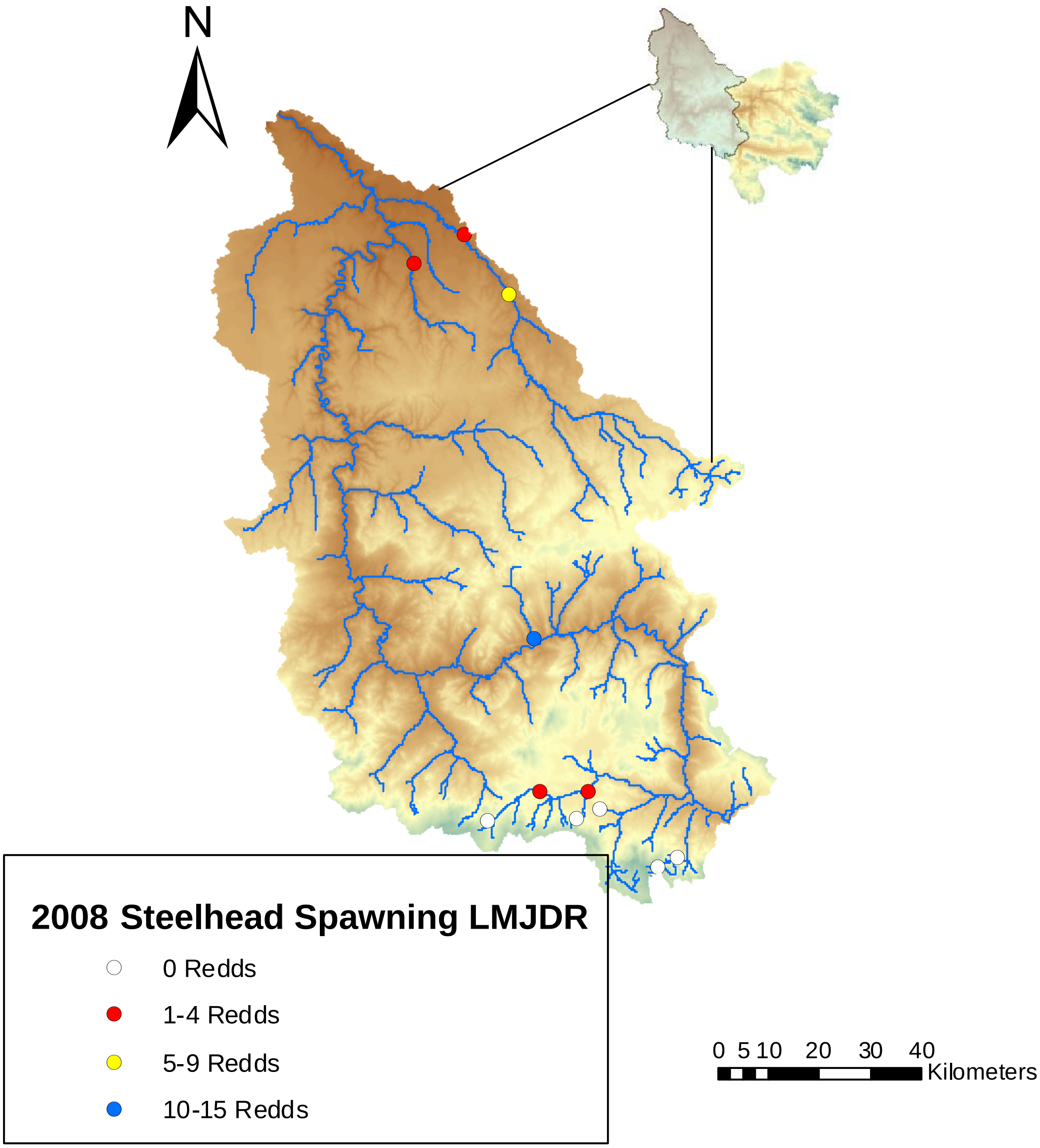

Figure 5. Map of the location and number of redds and observed in the Lower Mainstem John Day River during spawning surveys conducted during the spring of 2008.

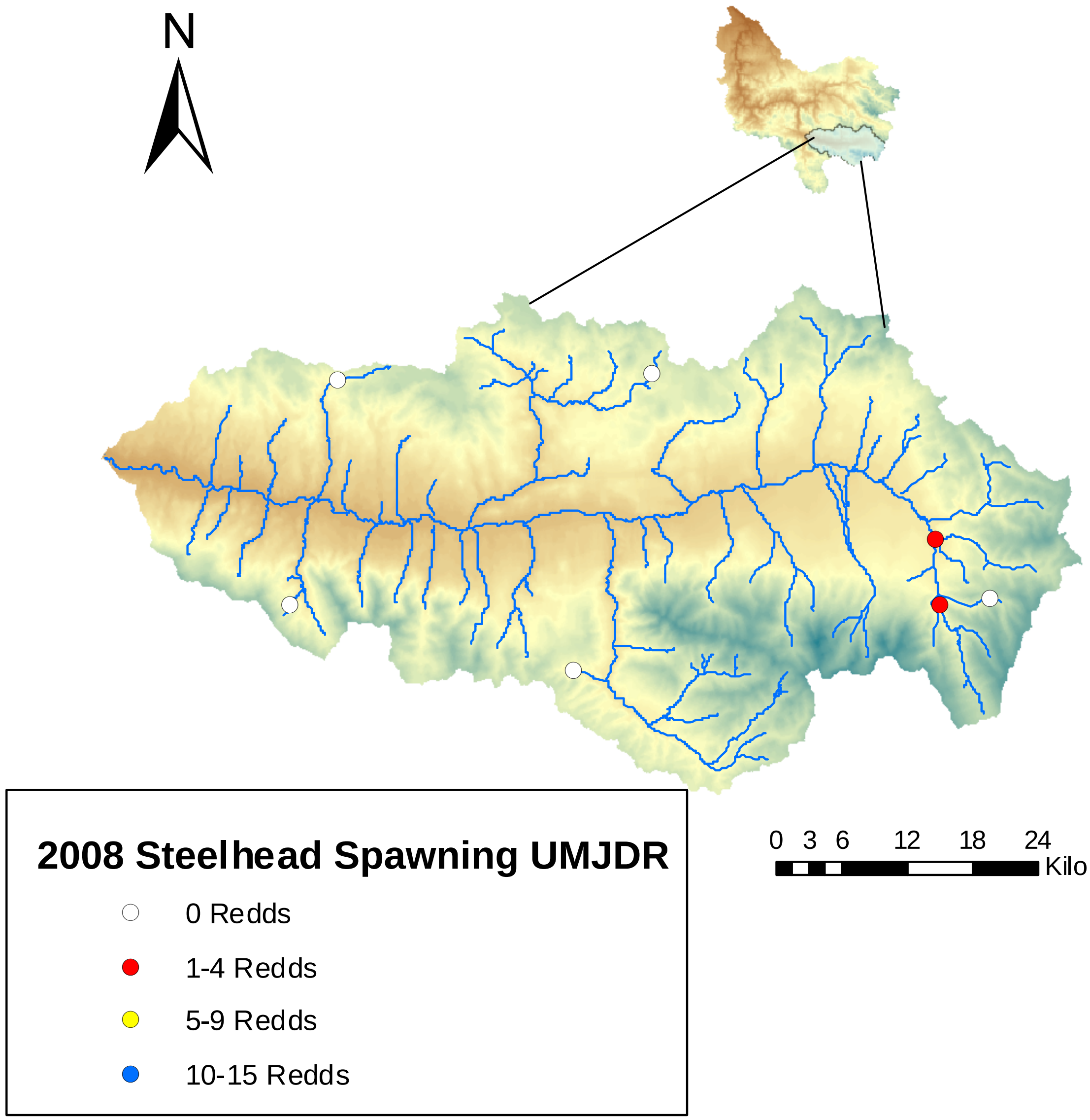

Figure 6. Map of the location and number of redds observed in the Upper Mainstem John Day River during spawning surveys conducted during the spring of 2008.

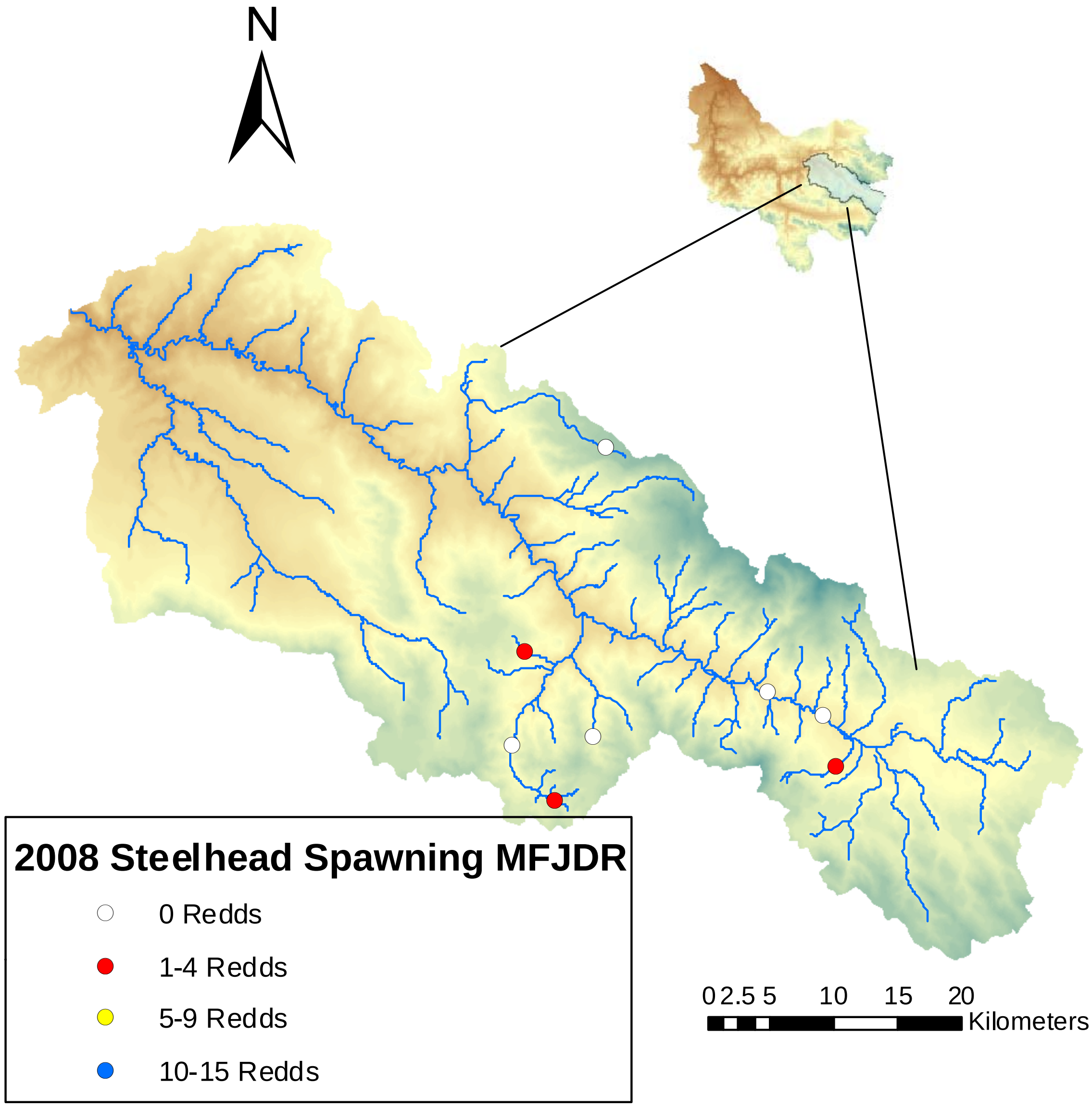

Figure 7. Map of the location and number of redds observed in the Middle Fork John Day River on spawning surveys conducted during the spring of 2008

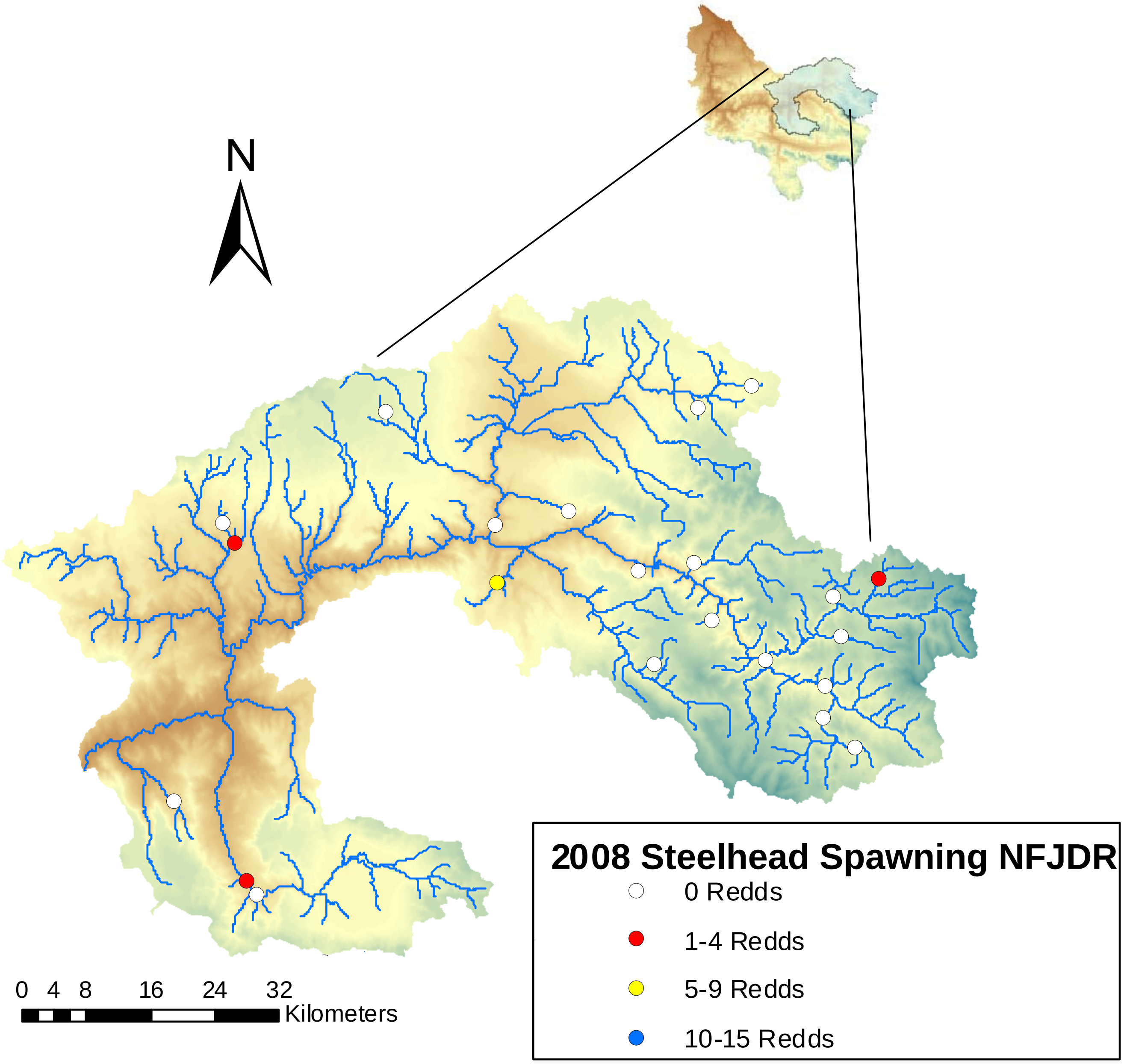

Figure 8. Map of the location and number of redds observed in the North Fork John Day River on spawning surveys conducted during the spring of 2008.

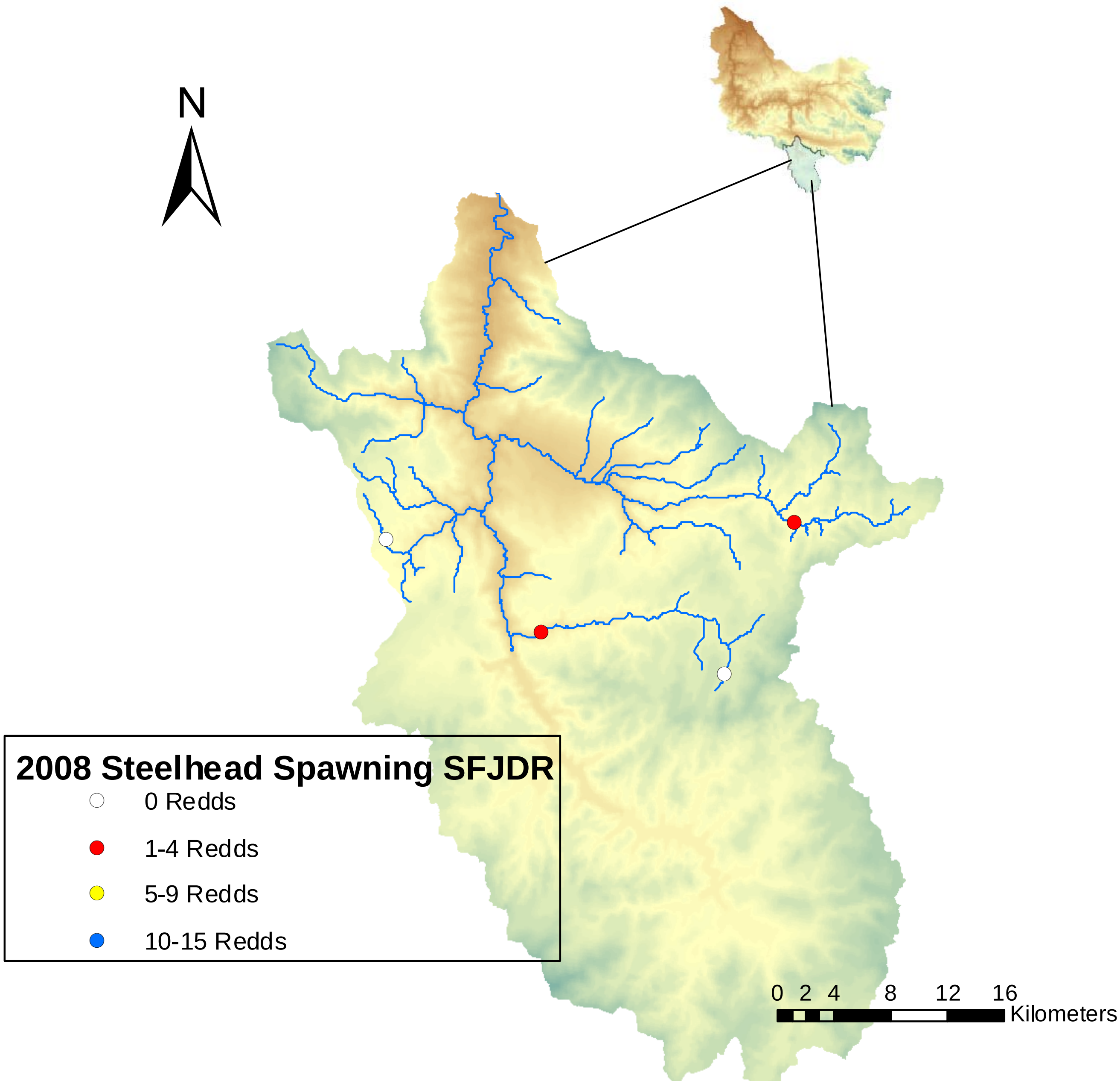

Figure 9. Map of the location and number of redds observed in the South Fork John Day River on spawning surveys conducted in the spring of 2008.

Table 5. Redd observations at annual spawning survey sites in the John Day River basin conducted from February to July, 2004–2008. N/A represents sites that were not surveyed during that year but were added later to replace previous annual sites where access was revoked.

Stream	Site ID	Sub-basin	2004	2005	2006	2007	2008
Battle Creek	535	NFJDR	N/A	N/A	0	0	0
Camas Creek	4	NFJDR	0	0	0	0	0
Clear Creek	16	NFJDR	3	1	2	2	0
Gilmore Creek	7	NFJDR	0	0	0	0	0
Granite Creek	490	NFJDR	0	0	0	1	0
M.F. John Day	534	MFJDR	N/A	N/A	1	6	0
Milk Creek	497	LMJDR	0	0	0	0	0
Rail Creek	13	UMJDR	0	0	0	0	0
Rock Creek	6	LMJDR	3	1	6	7	6
Rock Creek	9	LMJDR	8	2	0	16	4
Service Creek	11	LMJDR	17	0	14	16	12
Tinker Creek	5	UMJDR	0	0	0	0	0
Vance Creek	15	UMJDR	0	0	0	0	0
WF Lick Creek	17	MFJDR	4	0	2	8	0
Whisky Creek	10	MFJDR	0	0	0	0	1
Trout Creek	529	NFJDR	N/A	N/A	0	0	0
S.F. Deer Creek	532	SFJDR	N/A	N/A	0	0	0
TOTAL			**40**	**10**	**37**	**56**	**25**

Table 6. Redd observations at four year rotation spawning survey sites in the John Day River basin conducted in the spring of 2004 and 2008.

Stream	Site ID	Sub-basin	2004	2008
Tribble Creek	19	NFJDR	0	0
Belshaw Creek	20	UMJDR	3	0
Bear Creek	21	NFJDR	0	0
Mountain Creek	25	LMJDR	1	1
MF John Day River	27	MFJDR	2	0
Swale Creek	28	NFJDR	0	1
Fort Creek	29	LMJDR	0	0
Camp Creek	31	MFJDR	3	0
Deer Creek	33	SFJDR	3	2
Beaver Creek	496	NFJDR	0	0
Big Creek	498	NFJDR	0	0
Indian Creek	500	MFJDR	0	0
Cottonwood Creek	503	LMJDR	0	0
Camp Creek	505	MFJDR	3	3
TOTAL			**15**	**7**

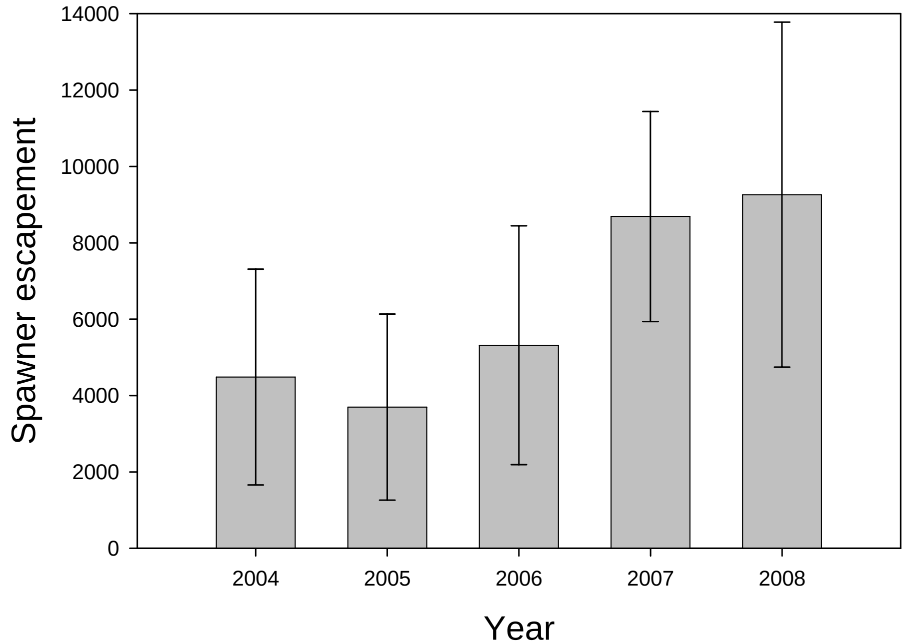

Figure 10. Annual adult steelhead escapement estimates for the John Day River basin from 2004 to 2008. Error bars indicate 95% C.I.

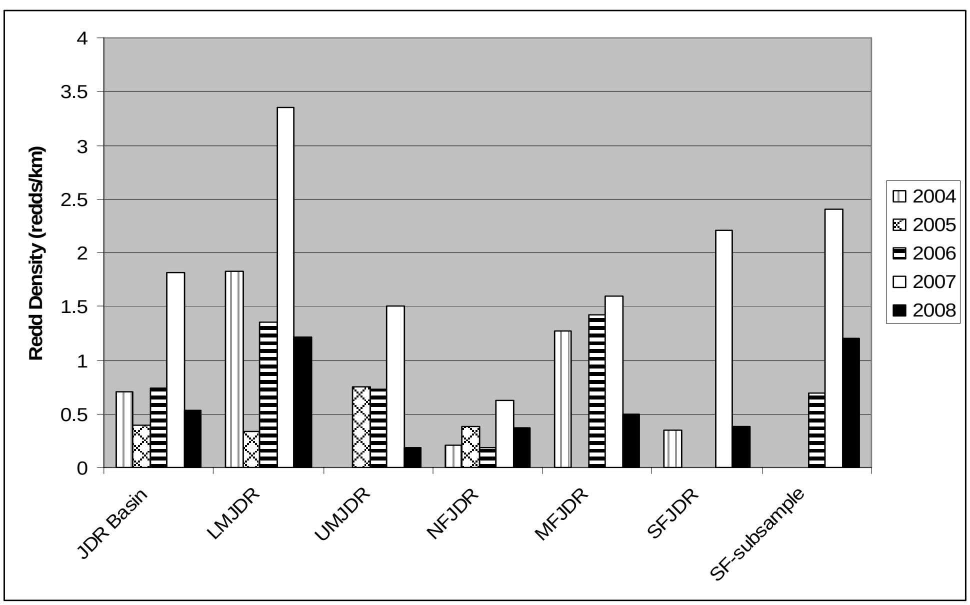

Figure 11. Average redd density (redds/km) observed in the John Day River basin (JDR Basin), Lower Mainstem (LMJDR), Upper Mainstem (UMJDR), North Fork (NFJDR), Middle Fork (MFJDR), and South Fork subbasins (SFJDR) from 2004-2008, and the South Fork subsample (SF-subsample) from 2006 to 2008.

Steelhead Spawning Timing

We observed new steelhead redds from late March to the last week of June, 2008 (Figure 12). Cumulatively, we observed 20% of the total new redds prior to mid April and 80% of the total new redds were observed by late May (Figure 12). A majority of the spawning in the Lower Mainstem subbasin appeared to occur by late April whereas spawning peaked in all other subbasins during mid May, this is consistent with what has been observed in these subbasins since index redd counts were implemented (Tim Unterwegner, personal communication). During the time period from late April to early June we had many high water flow events followed by periods of relatively low discharge due to short intervals of warm weather and greater than average snow pack (Figure 13).

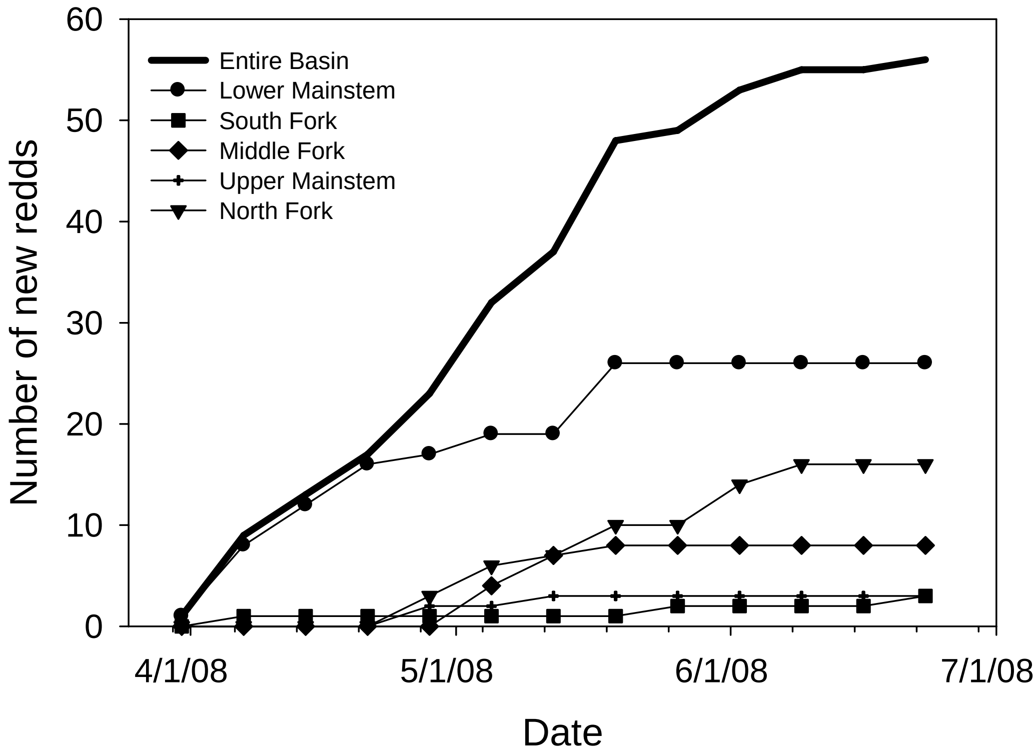

Figure 12. Cumulative number of new steelhead redds observed each week on EMAP spawning surveys during 2008.

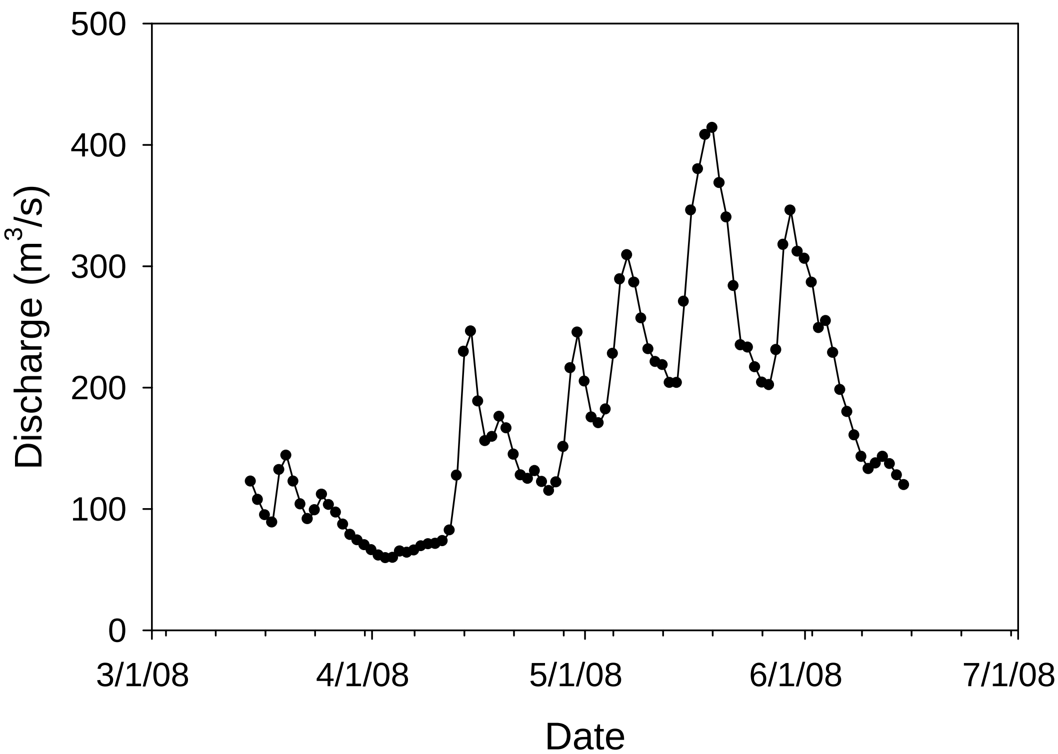

Figure 13. Mean daily discharge (m^3/s) in the John Day River at Service Creek from March 31, 2008 to June 15, 2008.

South Fork John Day River Spawning Subsample

A total of 29 redds were observed while surveying 24.2 km of steelhead spawning and rearing habitat in the South Fork John Day River subbasin (Table 7; Figure 14). Redd densities at sites in the South Fork subbasin varied from zero to 4 redds/km (Table 8). Overall, the average redd density was 1.20 redds/km with an estimated total 301 redds constructed in the South Fork subbasin above the rotary screw trap (Table 8). We estimate that 1,224 adult steelhead spawners returned to the South Fork subbasin during 2008 (Table 8). We observed six live, wild steelhead in Deer Creek (site 200) and three live, wild steelhead in North Fork Wind Creek (site 97). We also observed one wild steelhead carcass in Deer Creek (site 200) and one wild steelhead carcass in Black Canyon Creek (site 140).

Table 7. Total number of steelhead redds observed during subbasin spawning surveys conducted in the South Fork John Day River subbasin from 2006 to 2008.

Stream	Site ID	2006	2007	2008
Black Canyon Creek	140	1	14	2
Charlie Mack Creek	141	0	0	0
Deer Creek	33	1	3	2
Deer Creek	200	5	5	5
Lemon Creek	187	0	0	0
Murderers Creek	161	2	2	1
Murderers Creek	204	2	9	4
Murderers Creek	223	4	21	2
NF Wind Creek	97	0	0	8
SF Deer Creek	532	0	0	0
SF John Day River	175	0	3	2
Tex Creek	66	3	1	3
Wind Creek	152	0	0	0
TOTAL		**18**	**58**	**29**

Table 8. Distance surveyed (km and miles), observed redds, redd density (redds/km and redds/mi), estimated total number of redds, and estimated spawner escapement 95% C.I. for the South Fork John Day River subbasin from 2006 to 2008.

	Distance							95% CL	
Year	**Km**	**Miles**	**Observed Redds**	**Redds/km**	**Redds/mi**	**Total Redds**	**Escapement**	**Lower**	**Upper**
2006	25.9	16.1	18	0.69	1.12	186	309	145	472
2007	24.2	15.0	58	2.40	3.86	675	756	252	1,260
2008	24.2	15.0	29	1.20	1.93	301	1,224	624	1,824

Hatchery:Wild Observations

Hatchery steelhead composed 22% (4 of 18) of live steelhead observed in the John Day River basin in 2008 where the presence (unmarked, presumed wild) or absence (marked, presumed hatchery) of an adipose fin could be determined, however, origin was only determined for 58% of live fish (Table 9). Using the ratio of live clipped : unclipped steelhead (22% and 78%, respectively) observed in the John Day river basin, we estimate that of the 9,260 steelhead in the John Day River basin in 2008, 2,039 were of apparent hatchery origin and 7,221 were wild steelhead. The percentage of live adult hatchery steelhead observed in the John Day river basin has varied from approximately 40% to this year's low of 22% over the past five years (Figure 15). All hatchery steelhead observations during 2008 were in Service Creek (Figure 16).

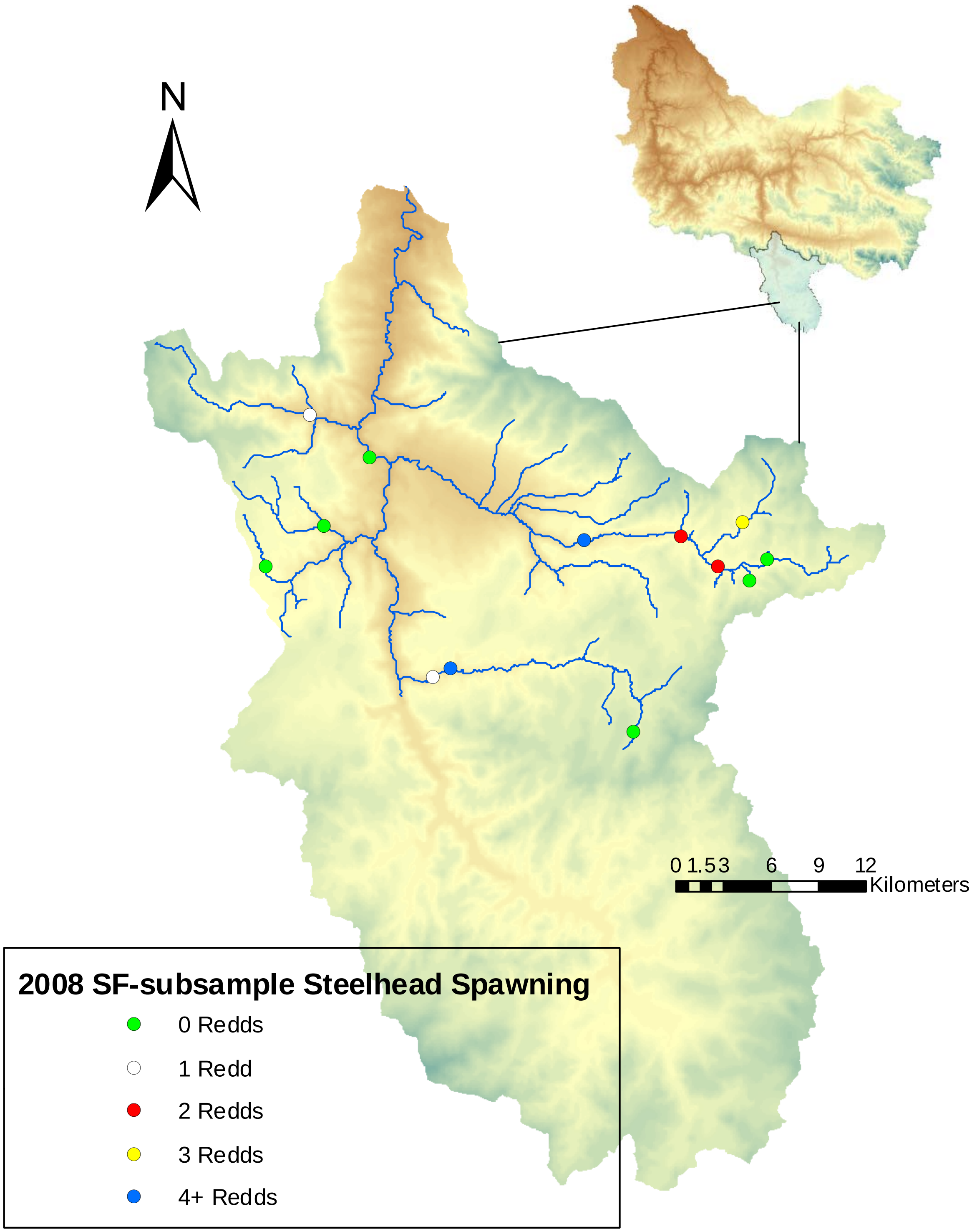

Figure 14. Map of the location and number of redds observed in the South Fork John Day River during subbasin spawning surveys conducted in 2008.

Table 9. Number of live steelhead observed and determined for origin, number and percentage marked and unmarked, and number marked and unmarked steelhead near redds during surveys conducted during 2008. LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin.

Subbasin	# Observed	# Determined	# Marked	% Marked	# Marked Near Redd	# Unmarked	# Unmarked Near Redd
LMJDR	13	7	4	57.1	3	3	1
UMJDR	1	1	0	0.0	0	1	0
NFJDR	9	5	0	0.0	0	5	3
MFJDR	8	5	0	0.0	0	5	0
SFJDR	0	0	0	0.0	0	0	0
BASIN TOTAL	**31**	**18**	**4**	**22.2**	**3**	**14**	**4**

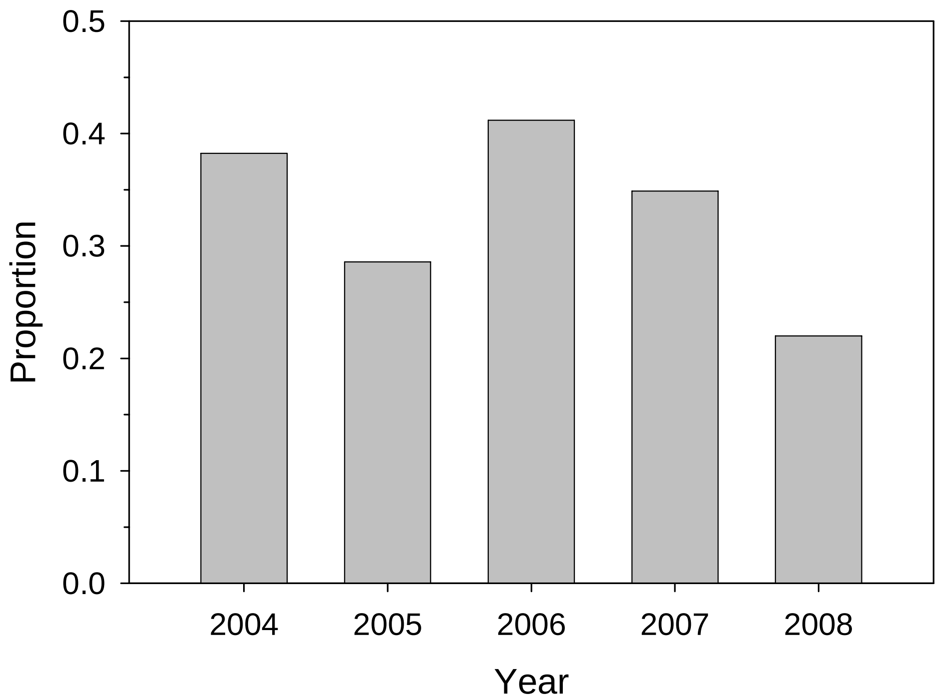

Figure 15. Proportion of steelhead spawners observed during spawning surveys in the John Day River subbasin that were identified as hatchery origin from 2004 to 2008.

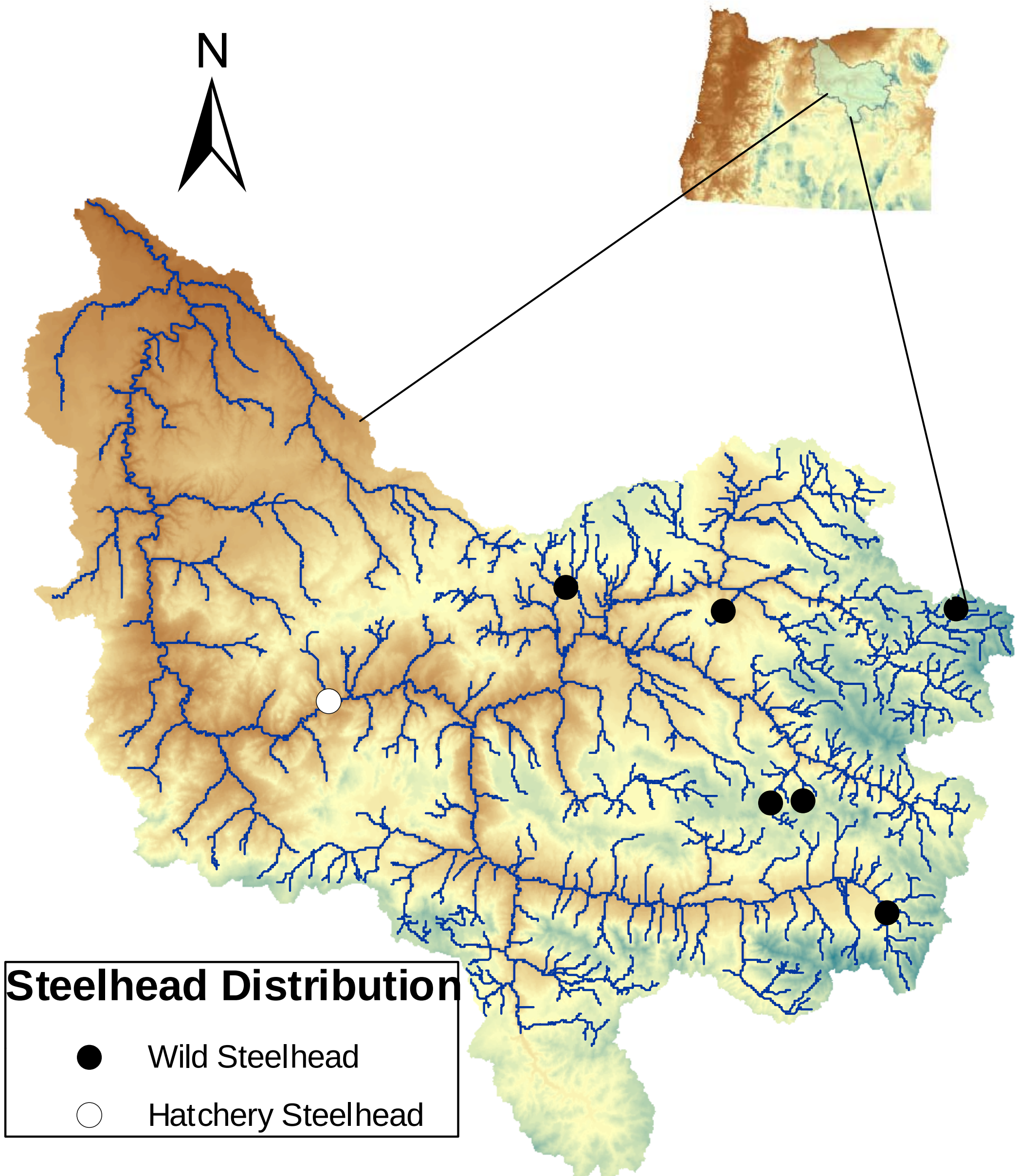

Figure 16. Distribution of live hatchery and wild steelhead observations in the John Day River basin during spawner surveys conducted in the spring of 2008.

DISCUSSION

Despite poor viewing conditions, the steelhead escapement estimate for the John Day River basin in 2008 was the greatest return since commencing the EMAP monitoring project in the basin in 2004. Redd density estimates were low due to these poor viewing conditions but we correct this sampling artifact by using an annual fish/redd estimate from Deer Creek, a survey with a known adult escapement above a weir. Index surveys in the John Day River basin conducted by Oregon Department of Fish and Wildlife Fish Biologists in 2008 also resulted in below average redd densities (Appendix Figure B). The apparent decrease in spawning in the basin was likely a result of less than optimal surveying conditions in 2008. Snow pack in the John Day basin was above average for the 2008 water year. Cool temperatures early in the spawning season and intermittent warm periods coupled with above average snow pack resulted in high flows and relatively turbid water conditions throughout much of the basin during the survey period.

Steelhead apparently spawned on the descending limb of the hydrograph, similar to spawning observed for other salmonids (Thurow and King 1994; Schmetteriling 2000; Muhlfeld 2002; Holecek and Walters 2007). Multiple periods of alternating high discharge and low discharge may have triggered spawning on these short term decreases in discharge and would have likely resulted in relatively short redd life and visibility. Because the time intervals for the lower water conditions were short it is likely that we would not have observed redds at many sites during these conditions and likely underestimated redd density. In our reference stream on the Grande Ronde River basin, Deer Creek, where a permanent weir is present, low redd visibility and short redd life resulted in the relatively high fish per redd estimate (4.07) compared to when conditions are optimal for redd viewing (~ 1.6 fish/redd; Gee et al. 2008).

We did not observe spawning activity at a large proportion of sites surveyed in 2008. In the past four years, more than 50% of sites surveyed in any given year have been void of any observable spawning activity. Of 17 sites that we survey annually, we also have observed spawning at less than 50% of sites. In 2008 we resampled our first four year panel of surveys which were originally surveyed in 2004. We observed redds at only 50% of the sites for 2004 and 2008 combined. While the steelhead spawning distribution in the John Day River basin is likely variable year to year, our data indicate that over half the sites surveyed in any given year are not being utilized for steelhead spawning and suggests we may not fully understand current steelhead spawning habitat use in the basin. In 2008 an Intensively Monitored Watershed (IMW) project was implemented on the Middle Fork John Day River subbasin which included redd surveys distributed using the EMAP sample design. This project included 30 sample sites within the Middle Fork subbasin, a much higher density than the sampling effort applied to the basin wide EMAP project. Even with the increased sampling intensity, variability for redd and escapement estimates was relatively high (Chris James, personal communication). This suggests that we may not be able to sufficiently detect short term declines in steelhead escapement which may effect our evaluation of restoration efforts and management decisions (Maxell 1999). In order to refine our sampling universe we have removed sites on Otter Creek (Site 30), and Buck Cabin Creek (Site 576) from future sample draws and the stream lengths have been removed from the sampling universe. Otter Creek contains little to no spawning habitat and Buck Cabin Creek has a culvert near the mouth that is a barrier to upstream adult fish passage. Charlie Mack Creek (site 141) and Lemon Creek (187) have also been removed from the South Fork subsample universe because of a lack of suitable spawning habitat. We will continue to refine known spawning distribution through identification of barriers and habitat obviously unsuitable for redd construction due to overriding geomorphic conditions.

Lower Mainstem tributaries account for the majority of redds constructed in any given year suggesting that the Lower Mainstem habitat is an important component of steelhead production within the John Day Basin. Except for 2005 when low water flows limited adult steelhead access to smaller tributaries (Wiley et al. 2005), the Lower Mainstem tributaries have accounted for 47% of redd observations in the basin. With the majority of redds constructed in the Lower Mainstem in any given year, there is significant potential for smolt production in this habitat. Unfortunately, we are unable to effectively monitor this production due to logistical and monetary constraints.

In 2008 we estimated hatchery composition of adult steelhead at 22%, the lowest since we began using the EMAP sample design. Similarly, fewer hatchery strays were observed in other ongoing monitoring projects in the basin during 2008 (Appendix Table A). Visual observations during surveys potentially underestimate the hatchery fish component because of bias towards detecting an adipose fin rather than determining its absence (Susac 2005). Further, not all hatchery fish released in the Columbia River basin have adipose fin clips. All of our hatchery fish observations were from a single sample location, Service Creek, in the lower John Day River. This survey has produced consistent hatchery fish observations through all years. In September 2007 a Passive Integrated Transponder (PIT) tag detection array became operational at McDonald's Ford at river mile 20 in the John Day River. Between September 2007 and June 15, 2008 this array detected 56 adult steelhead. Of these, at least 24 were of hatchery origin and 21 of these fish were transported from the Snake River as smolts (DART 2007).

CONCLUSIONS

To improve our ability to estimate steelhead escapement in the John Day River basin, we need to further refine the current distribution of steelhead spawning habitat. Such refinements will allow us to better determine high priority areas for restoration projects and identify key areas where adequate spawning habitat exists but is not currently being utilized. We currently provide escapement estimates with confidence intervals approximately 50% of the means. Given similar high variance even with increased sampling intensity within the Middle Fork IMW and the South Fork sub sample, increasing sample size alone is not sufficient to reduce sample variance. We believe significant variance arises from the high frequency of reaches with no redds. Refining the current steelhead sampling universe will reduce the number of sample reaches with zero redd counts and thus, decrease our confidence intervals around our escapement estimates. The current methods used for assessing hatchery steelhead stray rates into the John Day River basin are not sufficient for measuring the impact of these strays. Additional effort is needed to measure the relative contributions of hatchery and wild fish to natural production, and the relative productivity of streams with hatchery fish compared to tributaries where they are still absent.

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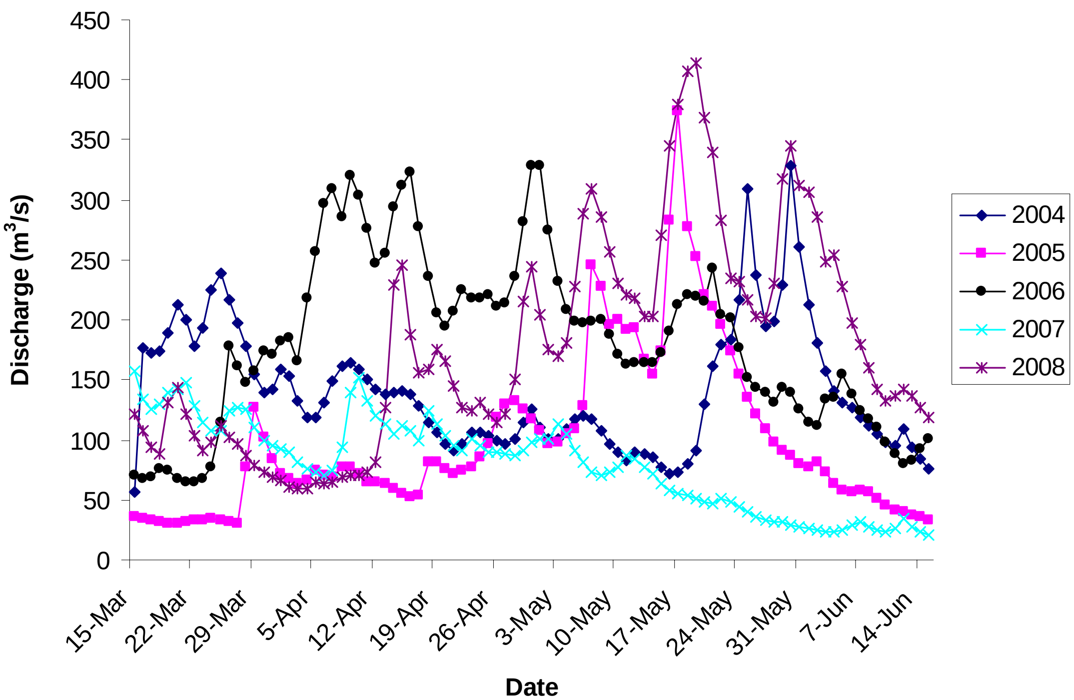
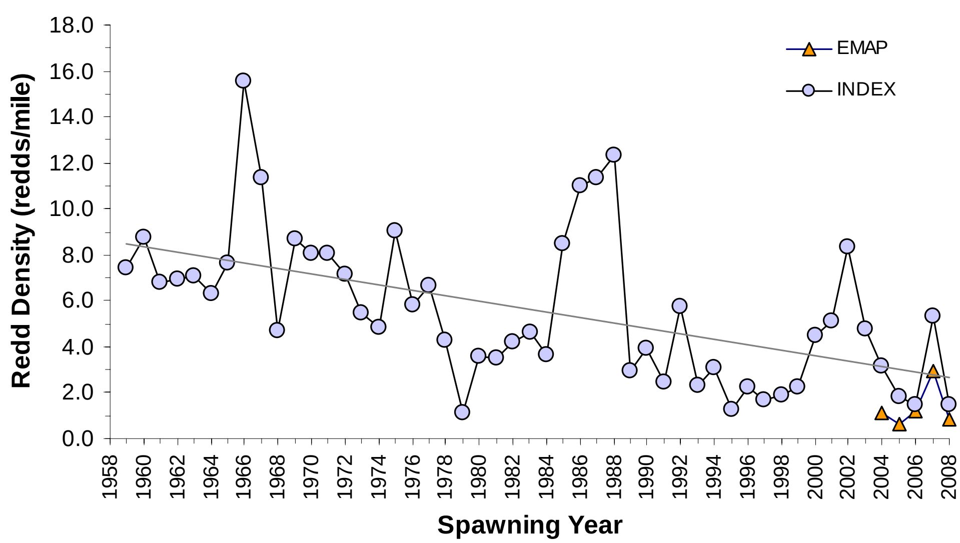
APPENDIX



Appendix Figure A. Mean daily discharge (m^3/s) in the John Day River at Service Creek from March 31 to June 15, 2004 to 2008.



Appendix Figure B. Decline ($P<0.001$) in summer steelhead redd density (redds/mile) observed at index survey sites (circles) sampled by ODFW personnel in the John Day River basin from 1959 to 2008. Redd densities observed at EMAP sites (triangles) are shown for comparison.

Appendix Table A. Recovery year, number of wild steelhead, number of hatchery steelhead, and percent hatchery steelhead observed during index steelhead spawning surveys in the John Day River basin (Tim Unterwegner, unpublished data), seining in the Mainstem John Day River between Kimberly (rkm 298) and Spray (rkm 274), and operation of rotary screw traps in the Middle Fork, South Fork, and Mainstem John Day River. Seining and rotary screw trap data (includes both live fish and carcass observations) were compiled from the John Day Basin Spring Chinook Salmon Escapement and Productivity Monitoring Project (Ruzycki et al. 2002; Carmichael et al. 2002; Wilson et al. 2002; Wilson et al. 2005; Wayne Wilson, unpublished data).

	Index			Spring Chinook Monitoring Project		
Recovery Year	**# of Wild Steelhead**	**# of Hatchery Steelhead**	**% Hatchery Steelhead**	**# of Wild Steelhead**	**# of Hatchery Steelhead**	**% Hatchery Steelhead**
2008	28	2	6.6	19	1	5.0
2007	41	2	4.6	10	0	0.0
2006	22	4	15.4	10	5	33.3
2005	15	1	6.3	8	4	33.3
2004	12	1	7.7	16	6	27.3
2003	27	2	6.9	11	2	15.4
2002	173	16	8.5	20	13	39.4
2001				8	2	20.0
2000				11	1	8.3
TOTAL	318	28	8.81	113	34	23.1