FISH RESEARCH PROJECT
OREGON

STEELHEAD ESCAPEMENT AND JUVENILE PRODUCTION MONITORING IN THE JOHN DAY BASIN

ANNUAL TECHNICAL REPORT

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INTRODUCTION

The John Day River, located in northeastern Oregon, is unique in that it supports some of the last remaining wild populations of summer steelhead *Oncorhynchus mykiss* in the Columbia River basin with no hatchery supplementation. However, these populations remain 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 the John Day River Major Population Group (MPG), 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 spawning activity, juvenile salmonids, and aquatic 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 spawning surveys and periodic monitoring of some status and trend indicators. While index spawning data are useful in drawing inference about trends in adult steelhead abundance, they are 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, recommended that the region move away from index surveys and embrace probabilistic sampling for most population and habitat monitoring. To meet the ISRP 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 to answer key monitoring questions, integrate on-going sampling efforts, and improve agency coordination. The current program seeks to integrate project objectives focused on summer steelhead spawning metrics, juvenile salmonid metrics, and aquatic habitat conditions. 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 fisheries resources (e.g., life-stage specific survival) not targeted under this program.

This project provides information as directed by two measures of the Columbia River 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.

ADULT STEELHEAD MONITORING OBJECTIVES

1. Monitor status and trend of steelhead spawning distribution and abundance in the John Day River basin.
2. Estimate wild to hatchery stray rates of spawning steelhead in the John Day River basin.

COLUMBIA HABITAT MONITORING PROGRAM (CHaMP) HABITAT MONITORING OBJECTIVE

1. Assess the quality and quantity of stream habitat for salmonids.

JUVENILE FISH MONITORING OBJECTIVES

1. Monitor status and trend of juvenile salmonid abundance in the John Day River basin.
2. Characterize abundance and density of juvenile salmonids at the site and subbasin level.
3. Evaluate relative condition metrics of juvenile *O. mykiss*.

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 351 (river mile 219) 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. Coincidentally, the boundaries of these tributaries also define summer steelhead population boundaries for the John Day River MPG (Carmichael and Taylor 2008). While we acknowledge these population boundaries for summer steelhead, we will refer to the specific boundaries as 'subbasins' to minimize confusion with other population boundaries for various salmonid species reported in this document and co-occuring within the John Day River MPG. The John Day River basin contains 15,455 km of stream habitat available for fish, but only 4,628 km (30%) are known, or assumed, to be used for various anadromous salmonid life history stages (Figure 2). Topography and climate are highly variable with stream temperatures ranging from 0°C (32°F) in the winter to 30°C (86°F) in the summer (Feldhaus 2006; Tattam 2006).

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 boundaries, as well as summer steelhead population delineations (Lower Mainstem, Upper Mainstem, North Fork, Middle Fork, and South Fork).

SPAWNING SAMPLING DOMAIN AND SITE SELECTION

Steelhead spawning survey sites were selected using the EMAP protocol that uses a spatially balanced random sampling design (GRTS; 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 Oregon Department of Fish and Wildlife (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 selected 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 for the 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 ensure an unbiased and spatially balanced selection of sample sites. 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 that 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; Table 1), or the removal of barriers (e.g., road culverts) that previously limited access to habitat. These stream reaches are removed or added into our sample universe accordingly. The current EMAP sample universe includes 4,322 km of stream (Table 1). The universe does not include sections of stream with use types classified as migration or excluded reaches (Table 1).

Table 1. Length of stream reaches (km) in the John Day River basin classified by life history use type and subbasin.

Use Type	LMJDR	NFJDR	MFJDR	UMJDR	SFJDR	Basin Totals
Spawning and Rearing	1,215	1,185	526	588	237	3,750
Rearing and Migration	94	144	40	57	0	335
Migration	292	1	0	0	0	293
Historic Use	18	2	0	9	0	29
Present Use Unknown	0	97	67	20	23	208
Excluded Reaches	69	73	4	0	12	158
TOTAL	1,688	1,502	637	674	272	4,773

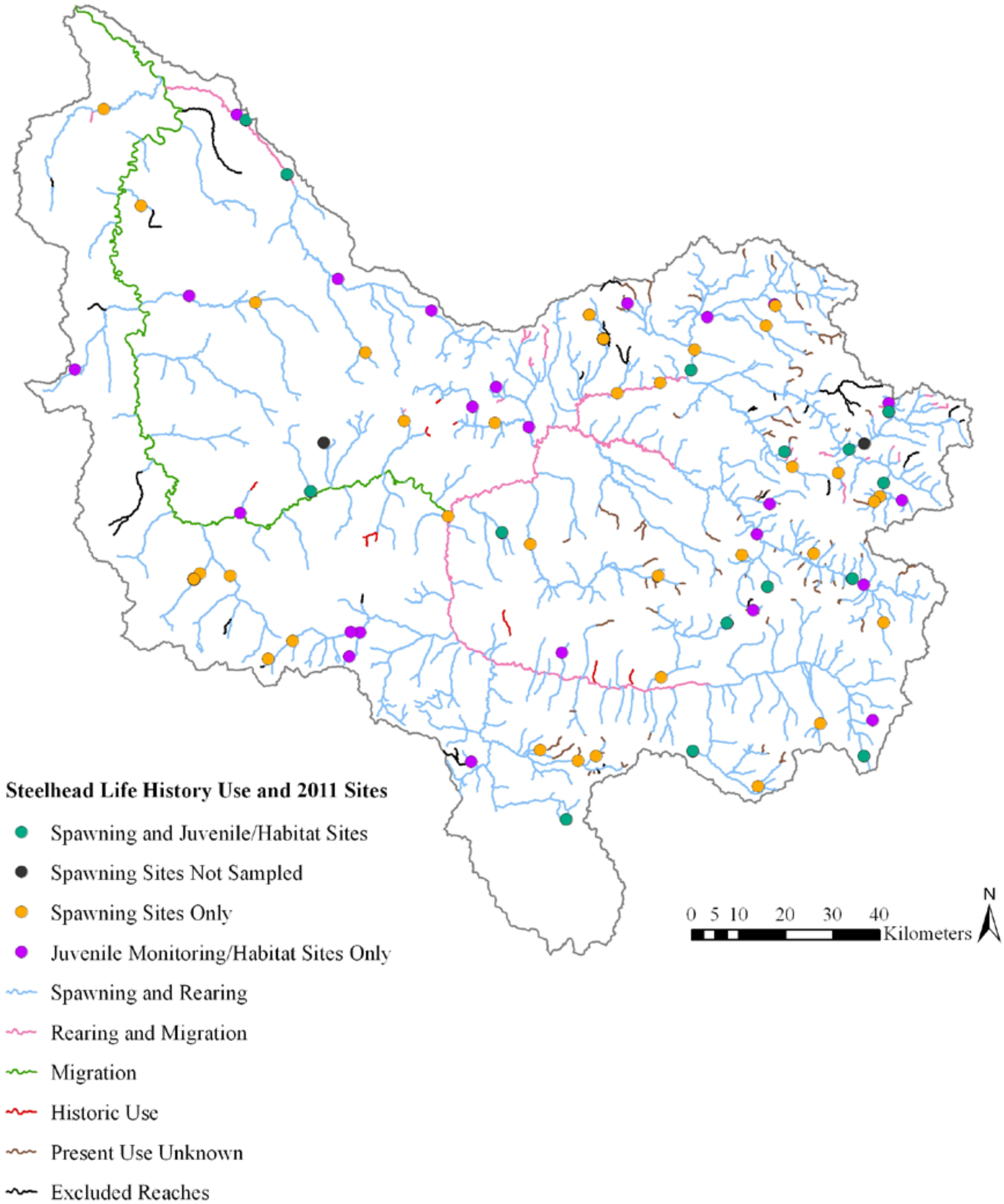

Figure 2. Map of summer steelhead life history use in the John Day River basin and 2011 spawning and juvenile/habitat monitoring sample sites. Spawning sites were surveyed in the spring (March-July) of 2011 for steelhead redds and juvenile salmonid abundance and habitat sites were sampled in the summer (June-September) of 2011.

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 February to July 2011 (Table 2). Individual sites were surveyed as many as six times to quantify the number of redds (spawning nests) 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 sample draw. Surveyors walked each reach and counted all redds, live fish, and carcasses observed. New redds were flagged and their locations were marked with a GPS unit.

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.

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 in the sample universe (4,322 km). Steelhead escapement (E_S) was then estimated by:

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

Where c_a is an estimated constant adult steelhead per observable redd (4.75 fish/redd in 2011). This estimate is developed annually 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 (Jim Ruzycki, ODFW, unpublished data). A locally weighted neighborhood variance estimator (Stevens and Olsen 2004), that incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, was used to estimate a 95% confidence interval for 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-to-wild fish ratio was calculated by dividing the total number of adipose-clipped fish by all fish that could be observed for marks (including live fish and carcasses). 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.

Table 2. Stream, site identification number, start and end coordinates, panel type (Annual site = A; South Fork Subsample and EMAP sites = SF), survey distance, and dates for steelhead spawning surveys conducted in the John Day River basin from February to July, 2011.

		Start Coordinates		End Coordinates									
Stream	**Site ID**	**Latitude**	**Longitude**	**Latitude**	**Longitude**	**Panel Type**	**Length (km)**	**1**	**2**	**3**	**4**	**5**	**6**
Lower John Day													
Badger Creek	552	44.5222	-120.0525	44.5114	120.0671	Four4	2	3/30	5/2	5/26	6/27		
Bear Creek	077	44.6543	-120.2981	44.6428	-120.3135	Four4	2	3/24	4/28	5/12	6/27		
Bear Creek	555	44.6428	-120.3135	44.6329	-120.3302	Four4	2	3/24	4/28	5/12	6/27		
Bridge Creek	212	44.6491	-120.2466	44.6380	-120.2318	New8	2	7/11					
Brown Creek	597	45.0733	-119.8759	45.0602	-119.8593	New8	2	3/21	4/11	4/25	5/11	5/25	
Ferry Canyon	068	45.3622	-120.4799	45.3497	-120.4720	Four4	2	2/28	4/11	4/25			
Grass Valley Canyon	079	45.5316	-120.5608	45.5346	-120.5762	Four4	2	2/28	4/11				
Henry Creek	214	44.9286	-119.7526	44.9421	-119.7646	New8	2	3/23	4/4	4/19	5/4	5/18	
Johnson Creek	216	44.7491	-119.6446	44.7524	-119.6654	New8	2	3/22	4/18	5/4	5/19	6/21	
Lake Creek	076	44.8810	-119.9697	44.8940	-119.9791	Four4	2	3/22	4/18	5/4	5/18		
Milk Creek	497	44.4775	-120.1326	44.4654	-120.1417	Replacement (A)	1.8	5/2	5/27				
Rock Creek	006	45.4208	-120.0824	45.4090	-120.0742	Annual	1.9	2/23	5/5				
Rock Creek	009	45.5208	-120.1985	45.5135	-120.1845	Annual	2	2/23	5/5				
Service Creek	011	44.7969	-120.0025	44.8046	-120.0201	Annual	1.8	3/21	4/18	5/4	5/26		
Thirtymile Creek	211	45.1675	-120.1817	45.1636	-120.1617	New8	2	4/25	5/11	5/25			
Middle Fork John Day													
Beaver Creek	210	44.6529	-118.6769	44.6672	-118.6638	New8	2	4/6	4/26	5/4	5/11	5/25	6/15
Clear Creek	215	44.5473	-118.4862	44.5315	-118.4801	New8	2	5/2	5/26	6/7	6/22		
M.F. John Day River	534	44.6215	-118.5789	44.6170	-118.5613	Replacement(A)	1.9	6/30					
W.F. Lick Creek	017	44.6235	-118.7876	44.6060	-118.7896	Annual	2	4/26	5/9	5/24	6/2	6/14	
Whiskey Creek	010	44.6624	-118.8355	44.6671	-118.8563	Annual	1.9	4/11	4/28	5/24			
North Fork John Day													
Battle Creek	535	44.8585	-118.7574	44.8636	-118.7357	Replacement (A)	2	5/10	7/6				
Big Wall Creek	203	44.9298	-119.4935	44.9283	-119.5161	New8	2	3/23	4/12	5/2	5/17	6/21	
Cable Creek	067	45.1193	-118.7940	45.1063	-118.7794	Four4	2	4/28	5/11	5/24	6/8		
Camas Creek	004	45.0219	-118.9871	45.0403	-118.9818	Annual	2.4	6/30					
Camas Creek	205	45.0493	-118.9780	45.0628	-118.9737	New8	2	6/30					
Clear Creek	016	44.7996	-118.4711	44.7826	-118.4688	Annual	2.1	4/26	6/15	6/29	7/27		
Clear Creek	071	44.7698	-118.4634	44.7740	-118.4863	Four4	2	4/26	6/29	7/27			

Table 2. Continued.

Stream	Site ID	Start Coordinates		End Coordinates		Panel Type	Length (km)	1	2	3	4	5	6
		Latitude	Longitude	Latitude	Longitude								
North Fork John Day													
Clear Creek	074	44.7740	-118.4863	44.7606	-118.5004	Four4	2	4/26	6/29	7/27			
Cottonwood Creek	201	44.7106	-119.4303	44.6953	-119.4248	New8	2	5/23	6/22				
Desolation Creek	584	44.8446	-118.7338	44.8343	-118.7157	Replacement (F2)	2	7/6					
Fox Creek	206	44.6294	-119.0826	44.6214	-119.0610	New8	2	6/9					
Gilmore Creek	007	44.7178	-119.5007	44.7067	-119.4926	Annual	1.7	4/12	5/4	5/23			
Granite Creek	490	44.8654	-118.5624	44.8530	-118.5496	Replacement (A)	2.1	7/27					
Hidaway Creek	208	45.1582	-118.7665	45.1445	-118.7526	New8	2	4/28	5/11	5/25	6/8		
Hunter Creek	202	45.0002	-119.0677	45.0104	-119.0867	New8	2	4/5	4/19	5/4			
Lake Creek	595	44.8365	-118.5930	44.8214	-118.5927	New8	2	7/7					
Potamus Creek	209	45.0716	-119.2135	45.0873	-119.2191	Four4	2	5/26	6/7	6/28			
Trout Creek	529	44.9266	-118.4444	44.9387	-118.4554	Replacement (A)	1.9	6/29					
Wilson Creek	553	45.1332	-119.2564	45.1371	-119.2684	Four4	1.1	6/7					
South Fork John Day													
Duncan Creek	596	44.2988	-119.4293	44.2994	-119.4056	New8	2	4/20	6/6	7/12			
Murderers Creek	204	44.2784	-119.3226	44.2772	-119.3047	New8 (SF)	1.7	5/31	6/14	7/13			
S.F. Deer Creek	532	44.1818	-119.3339	44.1657	-119.3383	Replacement (A/SF)	2	5/3	6/1				
Tex Creek	066	44.2791	-119.2677	44.2860	-119.2562	Four4 (SF)	1.7	5/9	5/31	6/14			
Upper John Day													
Beech Creek	078	44.4359	-119.0846	44.4400	-119.0635	Four4	2	6/9	6/22				
John Day River	081	44.2935	-118.5494	44.2766	-118.5423	Four4	2	4/14	4/26	6/15			
M. F. Canyon Creek	217	44.2125	-118.8442	44.2228	-118.8251	New8	2	4/13	4/26	5/9	5/27	6/16	7/5
Tinker Creek	005	44.5371	-118.8998	44.5518	-118.8934	Annual	1.9	4/20	5/2	5/23	5/31		
Vance Creek	015	44.2854	-118.9740	44.2930	-118.9976	Annual	2.1	4/14	4/26	5/9	6/16		
Slide Creek	080	44.3423	-118.6563	44.3256	-118.6630	Four4	2	4/14	5/5	6/16			

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 2011, we again surveyed eight sites in addition to the four sites already in the 2011 sampling frame from the South Fork John Day River subbasin to gather additional spawning data (Figure 3) and to provide an escapement estimate for this subbasin. Subsample sites were determined by selecting the first eight 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 only encompassed stream reaches within the South Fork subbasin available for steelhead spawning and rearing and upstream of a rotary screw trap operated by ODFW (d_u=249 km).

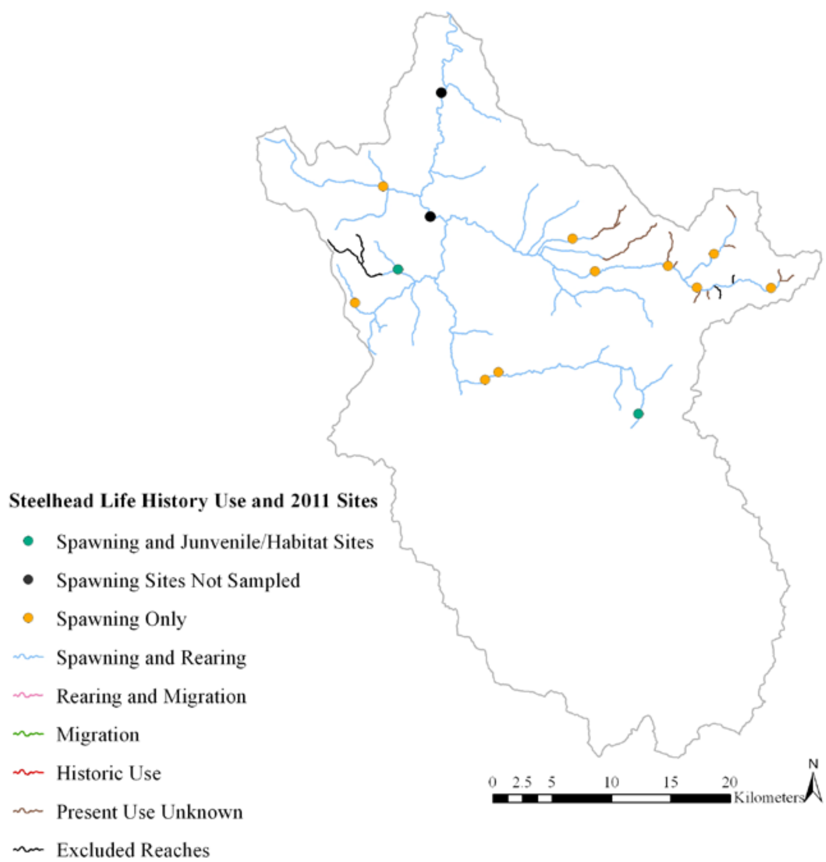

Figure 3. Map of sites selected for subsample spawning surveys and habitat/juvenile monitoring in the South Fork John Day River subbasin in 2011 and steelhead life history use. Spawning and juvenile/habitat sites were surveyed in the spring (March-July) of 2011 for steelhead redds and juvenile salmonid abundance and habitat sites were sampled in the summer (June-September) of 2011.

Table 3. Stream, site identification number, start and end coordinates, panel type (A = Annual site), survey distance, and dates for steelhead spawning surveys conducted in the South Fork John Day River subbasin subsample from March to July, 2011.

		Start Coordinates		End Coordinates							
Stream	**Site ID**	**Latitude**	**Longitude**	**Latitude**	**Longitude**	**Panel Type**	**Length (km)**	**1**	**2**	**3**	**4**
South Fork John Day											
Black Canyon Creek	140	44.3374	-119.5847	44.3410	-119.6061	New4	1.9	3/28	4/13	5/3	5/24
Deer Creek	033	44.1934	-119.4998	44.1968	-119.4797	Four1	2	3/14	3/28	6/20	7/12
Deer Creek	200	44.1934	-119.4997	44.1964	-119.4797	New7	1.9	3/14	3/28	6/20	7/12
Duncan Creek	596	44.2988	-119.4293	44.2994	-119.4056	New8	2.0	4/20	6/6	7/12	
Murderers Creek	161	44.2692	-119.2911	44.2605	-119.2753	New5	1.7	5/9	5/31	6/14	7/13
Murderers Creek	204	44.2784	-119.3226	44.2772	-119.3047	New8	1.7	5/31	6/14	7/13	
Murderers Creek	223	44.2731	-119.4034	44.2741	-119.3820	New9	2	6/1	6/20	7/13	
Murderers Creek	282	44.4226	-119.5407	44.4086	-119.5420	New12	2	5/9	5/31	6/14	
N.F. Wind Creek	097	44.2773	-119.5903	44.2742	-119.6122	New1	1.9	5/3	5/24	6/13	
S.F. Deer Creek	532	44.1818	-119.3339	44.1657	-119.3383	Replacement (A)	2	5/3	6/1		
Tex Creek	066	44.2791	-119.2677	44.2860	-119.2562	Four4	1.7	5/9	5/31	6/14	
Wind Creek	152	44.2448	-119.6191	44.2530	-119.6358	New5	2	5/3	5/24		

Habitat Sampling Domain and Site Selection

Habitat monitoring sites were selected using the CHaMP monitoring design which uses a GRTS based sampling design (Stevens 2002, Stevens and Olsen 2004) with rotating panels (Table 4). The design utilizes four components recommended by the Salmon Monitoring Advisory group (NCEAS 2010):

1) The spatial design, which describes how sites will be selected for monitoring from the spatial domain;
2) The temporal design, which describes sampling frequency and revisit schedule for monitoring sites;
3) The response design, which describes what and how measurements are taken and how site-level metrics are calculated, and
4) The inference design, which describes how indicators are estimated from site-level metrics across a population and time periods.

The sampling universe for CHaMP habitat and fish surveys are based on professional knowledge of steelhead life history use in the John Day River MPG. Forty sample sites are targeted each year. Sites are further divided within the MPG by two strata: land ownership (private or public) and sediment transport classes (i.e. depositional, source, and transport). In order to balance the needs of status (more random sites) and trend (more repeat sites) monitoring, the following rotating panel design was implemented for the basin:

- 21 sites repeated every year (annual)
- 19 sites repeated once every three years on a staggered basis

Table 4. The split panel design used for the CHaMP habitat and juvenile monitoring sites.

	Year								
Panel	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Annual									
Rotating Panel 1									
Rotating Panel 2									
Rotating Panel 3									

CHaMP Habitat Surveys

This report will not cover methods (Bouwes et al. 2011) or results for habitat survey data collection and analysis. However, CHaMP habitat surveys were conducted at each site where juvenile fish monitoring occurred. Information on the CHaMP habitat protocols, results, and data analyses will be reported at the program level for CHaMP (www.champmonitoring.org).

Juvenile Salmonid Surveys

Mark-recapture surveys were conducted from June to September 2011 (Table 5) to enumerate fish abundance in survey reaches. Survey reaches ranged from 120 – 400 meters depending on the average bankfull width derived during CHaMP habitat surveys. Sample reaches were closed with block nets (4.1 mm mesh) at both the downstream and upstream extents, if possible.

Fish were captured using various capture methods depending on habitat type and complexity. In pools, either a snorkeler or backpack electrofisher (Smith-Root LR20 or LR24) were employed to "herd" fish into a bag seine (3.7 m wide 1.2 m deep, with a 4.1 mm mesh) held in the thalweg of the pool. In riffles less than 40 cm deep, we used spot electrofishing and dip-netting techniques. In deeper riffles (>40 cm), we herded juvenile salmonids into a bag seine, the same seine used in pools, either by snorkeling or electrofishing. In runs, we deployed both herding and spot electrofishing methods. All sampling proceeded in an upstream direction through the reach. After the initial 'mark' pass, a second 'recapture' pass was made approximately 3- to 24-hours later to enumerate marked and unmarked fish in the reach (Rosenberger and Dunham 2005; Temple and Pearsons 2006). Once captured, fish were placed in aerated buckets and transferred to instream live-boxes until processing.

During processing, juvenile salmonids were anesthetized in a diluted bath of tricaine methanesulfonate (MS-222; 70% stock solution) to reduce handling stress during processing. Once anesthetized, fish were marked with an upper caudal fin clip, or recorded as a recapture if previously marked, measured for fork length (FL) to the nearest millimeter, and weighed to the nearest tenth of a gram on each capture occasion. After processing, juvenile salmonids were allowed to recover in a dark, well aerated container or in in-stream live boxes until able to maintain equilibrium before being released within the sampling reach. Additionally, all non-target species (i.e. suckers, shiners, dace, etc.) were enumerated at each pass, but immediately released upstream of sampling.

Juvenile Data Analyses

Binomial encounter histories were developed for each individual based on capture data, where a fish was coded as either captured, 1, or un-captured, 0, during the mark and recapture runs, respectively. We used program CAPTURE (White et al. 1982) to estimate abundance and 95% Confidence Intervals (CI) for salmonid species at each site and subbasin using the grouped individual encounter histories. Within program CAPTURE, we used the closed M_t model from Chao (1989) which allows capture probability to vary among sampling periods, but must remain constant among individuals for each period. Site level fish density was calculated as:

$$D_i=N_i/d_i \tag{4}$$

where D_i is fish density (fish/linear m) at site i, N_i is the estimated abundance at site $_i$, and d_i is the linear stream length (m) sampled at site i. Fish density within each subbasin was calculated as:

$$D_{n=}N_n/d_n \qquad (5)$$

where D_n is fish density (fish/linear m) in subbasin n, N_n is the estimated abundance in subbasin n, and d_n is the total linear stream length (m) sampled within basin n.

We used Fulton's condition factor (K) to index the relative condition of juvenile steelhead ≥100 mm FL. Fulton's condition factor (K) was estimated by:

$$K = ((W/ FL^3) * 100,000) \qquad (6)$$

where W is weight in g and FL is fork length in mm. We conducted a one-way Analysis of Variance (ANOVA) to test for differences in condition factors of juvenile *O. mykiss* between subbasins (LMJDR, MFJDR, NFJDR, SFJDR, UMJDR). To isolate any differences among subbasins, we used Tukey's Test for multiple comparisons between groups.

We assessed age structure of each population of juvenile *O. mykiss* based on length frequency histograms in order to evaluate age at length information.

Table 5. Site identification number, stream, subbasin, survey length, panel type, strata, and start and end coordinates for juvenile salmonid mark-recapture surveys conducted in the John Day River basin from June – September 2011.

						Start		*End*	
Site ID	Stream	Subbasin	Panel	Strata	Survey Length (m)	Latitude	Longitude	Latitude	Longitude
CBW05583-022570	Rowe Creek	LMJDR	Annual	Transport	120	44.7584	-120.2042	44.7593	-120.2045
CBW05583-032138	Mountain Creek	LMJDR	Three1	Transport	200	44.5299	-119.9087	44.5290	-119.9105
CBW05583-401098	Rock Creek	LMJDR	Three1	Transport	120	45.1453	-119.6838	45.1446	-119.6828
OJD03458-000006	Rock Creek	LMJDR	Annual	Depositional	240	45.4086	-120.0739	45.4068	-120.0721
OJD03458-000009	Rock Creek	LMJDR	Annual	Depositional	200	45.5133	-120.1852	45.5127	-120.1831
OJD03458-000011	Service Creek	LMJDR	Annual	Source	120	44.7971	-120.0079	44.7970	-120.0093
OJD03458-000025	Mountain Creek	LMJDR	Three1	Depositional	160	44.5283	-119.8837	44.5276	-119.8841
OJD03458-000029	Fort Creek	LMJDR	Three1	Source	120	44.4830	-119.9134	44.4831	-119.9142
OJD03458-000082	Thirtymile Creek	LMJDR	Three1	Depositional	160	45.1763	-120.3410	45.1750	-120.3403
OJD03458-000514	Big Pine Hollow	LMJDR	Annual	Transport	120	45.0347	-120.6498	45.0344	-120.6512
OJD03458-000539	Rock Creek	LMJDR	Three1	Depositional	160	45.2078	-119.9364	45.2081	-119.9352
OJD03458-000557	Rock Creek	LMJDR	Three1	Depositional	200	45.5241	-120.2089	45.5225	-120.2082
CBW05583-518642	Deadwood Creek	MFJDR	Three1	Transport	120	44.7640	-118.7788	44.7641	-118.7778
OJD03458-000017	West Fork Lick Creek	MFJDR	Annual	Source	120	44.6059	-118.7899	44.6050	-118.7894
OJD03458-000147	Middle Fork John Day River	MFJDR	Annual	Depositional	400	44.7069	-118.8148	44.7050	-118.8119
OJD03458-000505	Camp Creek	MFJDR	Three1	Source	120	44.5609	-118.8292	44.5603	-118.8282
OJD03458-000534	Middle Fork John Day River	MFJDR	Three1	Depositional	160	44.6173	-118.5616	44.6164	-118.5612
OJD03458-000536	Vinegar Creek	MFJDR	Annual	Transport	160	44.6046	-118.5303	44.6055	-118.5291
CBW05583-013642	Little Wall Creek	NFJDR	Three1	Transport	120	44.5976	-119.3072	44.5981	-119.3068
CBW05583-021738	Unnamed trib to Trout Creek	NFJDR	Annual	Transport	120	44.9529	-118.4516	44.9528	-118.4525
CBW05583-241210	Hidaway Creek	NFJDR	Three1	Transport	120	45.1468	-118.7547	45.1463	-118.7534
OJD03458-000004	Camas Creek	NFJDR	Annual	Depositional	240	45.0221	-118.9862	45.0241	-118.9848
OJD03458-000007	Gilmore Creek	NFJDR	Annual	Source	120	44.7178	-119.5005	44.7174	-119.4996
OJD03458-000016	Clear Creek	NFJDR	Annual	Depositional	200	44.7998	-118.4710	44.7982	-118.4726
OJD03458-000019	Tribble Creek	NFJDR	Annual	Transport	120	45.1545	-119.1528	45.1550	-119.1533
OJD03458-000085	Wall Creek	NFJDR	Annual	Depositional	160	44.9186	-119.4237	44.9200	-119.4241
OJD03458-000132	Wilson Creek	NFJDR	Three1	Transport	120	44.9595	-119.5757	44.9602	-119.5767
OJD03458-000490	Granite Creek	NFJDR	Annual	Depositional	360	44.8651	-118.5626	44.8625	-118.5607
OJD03458-000496	Beaver Creek	NFJDR	Annual	Transport	120	44.7653	-118.4235	44.7651	-118.4225
OJD03458-000520	Pine Creek	NFJDR	Annual	Transport	120	45.1257	-118.9349	45.1251	-118.9362

Table 5. Continued

						Start		*End*	
Site ID	Stream	Subbasin	Panel	Strata	Survey Length (m)	Latitude	Longitude	Latitude	Longitude
OJD03458-000529	Trout Creek	NFJDR	Annual	Source	120	44.9361	-118.4521	44.9367	-118.4532
OJD03458-000535	Battle Creek	NFJDR	Three1	Source	120	44.8640	-118.7356	44.8638	-118.7342
OJD03458-000553	Potamus Creek	NFJDR	Three1	Source	120	45.1322	-119.2553	45.1330	-119.2558
OJD03458-000097	North Fork Wind Creek	SFJDR	Three1	Source	120	44.2766	-119.5897	44.2774	-119.5960
OJD03458-000152	Wind Creek	SFJDR	Three1	Transport	120	44.2515	-119.6350	44.2521	-119.6359
OJD03458-000532	South Fork Deer Creek	SFJDR	Three1	Source	120	44.1652	-119.3385	44.1643	-119.3384
OJD03458-000005	Tinker Creek	UMJDR	Annual	Source	120	44.5371	-118.8999	44.5377	-118.8988
OJD03458-000013	Rail Creek	UMJDR	Annual	Source	120	44.3445	-118.5153	44.3446	-118.5141
OJD03458-000015	Vance Creek	UMJDR	Annual	Source	120	44.2928	-118.9967	44.2930	-118.9978
OJD03458-000081	John Day River	UMJDR	Three1	Source	120	44.2765	-118.5424	44.2756	-118.5413
OJD03458-000116	Cummings Creek	UMJDR	Three1	Source	120	44.4817	-118.3468	44.4826	-118.3466

RESULTS

STEELHEAD REDDS AND ESCAPEMENT

In the basin-wide sample, we observed 53 steelhead redds while surveying 96 km of stream, approximately 2.2% of an estimated 4,322 km of steelhead spawning and rearing habitat within the John Day River basin (Table 6). This resulted in a redd density of 0.55 redds/km. By expansion, an estimated 2,386 observable redds were constructed within the John Day River basin by an estimated 11,334 spawners (Table 7; Figure 4). The Middle Fork subbasin had the highest density of redds with 1.12 redds/km, followed by the Lower Mainstem with 0.92 redds/km, the Upper Mainstem with 0.58 redds/km, the South Fork with 0.41 redds/km, and the North Fork with 0.13 redds/km (Table 8). Approximately 55% of sites surveyed in 2011 had no detected spawning activity (Table 6; Figure 5). We observed redds at 60% of sites within the Lower Mainstem, 80% in the Middle Fork, 75% in the South Fork, 26% in the North Fork, and 17% in the Upper Mainstem, (Table 6; Figure 5). We observed redds at 41% of annual sites in 2011 (Table 9). Granite (site 490), Gilmore (site 7), and Battle (site 535) creeks are the only annual sites where we observed redds during only one year, every other site where redds were observed have contained redds in multiple years (Table 9). We observed redds at 29% of sites in the four-year panel in 2011 (Table 10).

Table 6. Total number of steelhead redds, redd density, hatchery, unknown, and wild origin live and dead steelhead observed during John Day River basin EMAP spawning surveys in 2011.

				Live				Dead			
Stream	**Site ID**	**Redds**	**Redds/km**	**Hatchery**	**Unknown**	**Wild**	**Total Live**	**Hatchery**	**Unknown**	**Wild**	**Total Dead**
Lower Mainstem John Day											
Badger Creek	552	1	0.50	0	1	1	2	0	0	1	1
Bear Creek	077	4	2.00	0	1	0	1	0	1	2	3
Bear Creek	555	2	1.00	0	1	1	2	0	0	2	2
Bridge Creek	212	0	0.00	0	0	0	0	0	0	0	0
Brown Creek	597	1	0.50	0	0	1	1	0	0	0	0
Ferry Canyon	068	0	0.00	0	0	0	0	0	0	0	0
Grass Valley Canyon	079	0	0.00	0	0	0	0	0	0	0	0
Henry Creek	214	0	0.00	0	1	5	6	0	0	0	0
Johnson Creek	216	8	4.00	1	5	12	18	0	0	2	2
Lake Creek	076	0	0.00	0	2	5	7	0	0	0	0
Milk Creek	497	0	0.00	0	0	0	0	0	0	0	0
Rock Creek	006	1	0.53	0	2	0	2	0	0	0	0
Rock Creek	009	3	1.50	0	1	0	1	0	0	0	0
Service Creek	011	1	0.56	1	6	3	10	1	1	1	3
Thirtymile Creek	211	6	3.00	0	0	0	0	0	0	1	1
Total		**27**	**0.92**	**2**	**20**	**28**	**50**	**1**	**2**	**9**	**12**
Middle Fork John Day											
Beaver Creek	210	5	2.50	0	1	3	4	0	0	1	1
Clear Creek	215	3	1.50	0	0	1	1	0	0	0	0
W.F. Lick Creek	017	2	1.00	0	1	5	6	0	0	0	0
Whiskey Creek	010	1	0.53	0	0	0	0	0	0	0	0
Total		**11**	**1.39**	**0**	**2**	**9**	**11**	**0**	**0**	**1**	**1**

Table 6. Continued.

Stream	Site ID	Redds	Redds/km	Live				Dead			
				Hatchery	Unknown	Wild	Total Live	Hatchery	Unknown	Wild	Total Dead
North Fork John Day											
Battle Creek	535	1	0.50	0	0	1	1	0	0	0	0
Big Wall Creek	203	1	0.50	0	3	0	3	0	0	0	0
Cable Creek	067	0	0.00	0	2	4	6	0	0	0	0
Camas Creek	004	0	0.00	0	0	0	0	0	0	0	0
Camas Creek	205	0	0.00	0	0	0	0	0	0	0	0
Clear Creek	071	0	0.00	0	0	0	0	0	0	0	0
Clear Creek	074	0	0.00	0	0	0	0	0	0	0	0
Clear Creek	016	0	0.00	0	0	0	0	0	0	0	0
Cottonwood Creek	201	0	0.00	0	0	0	0	0	0	1	1
Desolation Creek	584	0	0.00	0	0	0	0	0	0	0	0
Fox Creek	206	1	0.50	0	0	0	0	0	0	0	0
Gilmore Creek	007	1	0.59	0	2	0	2	0	0	0	0
Granite Creek	490	0	0.00	0	0	0	0	0	0	0	0
Hidaway Creek	208	0	0.00	0	1	0	1	0	0	0	0
Hunter Creek	202	0	0.00	0	0	3	3	0	0	0	0
Lake Creek	595	0	0.00	0	0	0	0	0	0	0	0
Potamus Creek	209	1	0.50	0	0	0	0	0	0	0	0
Trout Creek	529	0	0.00	0	0	0	0	0	0	0	0
Wilson Creek	553	0	0.00	0	0	0	0	0	0	0	0
Total		**5**	**0.13**	**0**	**8**	**8**	**16**	**0**	**0**	**1**	**1**

Table 6. Continued.

Stream	Site ID	Redds	Redds/km	Live				Dead			
				Hatchery	Unknown	Wild	Total Live	Hatchery	Unknown	Wild	Total Dead
South Fork John Day											
Duncan Creek	596	1	0.50	0	1	1	2	0	0	0	0
Murderers Creek	204	1	0.59	0	0	2	2	0	0	0	0
S.F. Deer Creek	532	0	0.00	0	0	0	0	0	0	0	0
Tex Creek	066	1	0.59	0	0	0	0	0	0	0	0
Total		**3**	**0.41**	**0**	**1**	**3**	**4**	**0**	**1**	**0**	**1**
Upper Mainstem John Day											
Beech Creek	078	0	0.00	0	0	0	0	0	0	0	0
John Day River	081	0	0.00	0	0	0	0	0	0	0	0
M.F. Canyon Creek	217	7	3.50	0	7	5	12	0	0	0	0
Tinker Creek	005	0	0.00	0	0	0	0	0	0	0	0
Vance Creek	015	0	0.00	0	2	4	6	0	0	0	0
Slide Creek	080	0	0.00	0	0	0	0	0	0	0	0
Total		**7**	**0.58**	**0**	**9**	**9**	**18**	**0**	**0**	**0**	**0**
Basin Total		**53**	**0.55**	**2**	**40**	**57**	**99**	**1**	**2**	**11**	**14**

Table 7. Distance surveyed, number of unique redds observed, redd density (redds/km), estimated total number of redds, fish per redd estimate from Deer Creek (Grande Ronde River basin), and spawning escapement estimate with 95% C.I. for the John Day River basin from 2004 to 2011.

Year	km	Redds	Density	Total Redds	Fish/Redd	Escapement	95% Lower	95% Upper
2004	94.7	66	0.7	3,071	1.46	4,484	1,657	7,310
2005	101.2	39	0.39	1,681	2.2	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	56	0.53	2,277	4.07	9,260	4,742	13,775
2009	98.6	44	0.45	1,934	3.81	7,368	3,642	11,099
2010	96.9	155	1.6	6,914	1.59	11,027	4,628	17,434
2011	96.0	53	0.55	2,386	4.75	11,334	6,565	16,103

Table 8. Total redds observed, redd density (redds/km), and live fish observed throughout the John Day River basin (JDR) and by subbasin (LMJDR: Lower Mainstem; UMJDR: Upper Mainstem; NFJDR: North Fork; MFJDR: Middle Fork; SFJDR: South Fork) from 2004 to 2011.

	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
2009	44	0.45	37	21	0.82	13	10	0.70	11	7	0.20	9	6	0.33	4	0	0.00	0
2010	155	1.60	301	110	4.19	258	1	0.08	9	14	0.35	19	29	2.00	9	1	0.26	6
2011	53	0.55	99	27	0.92	50	7	0.58	18	5	0.13	16	11	1.12	11	3	0.41	4

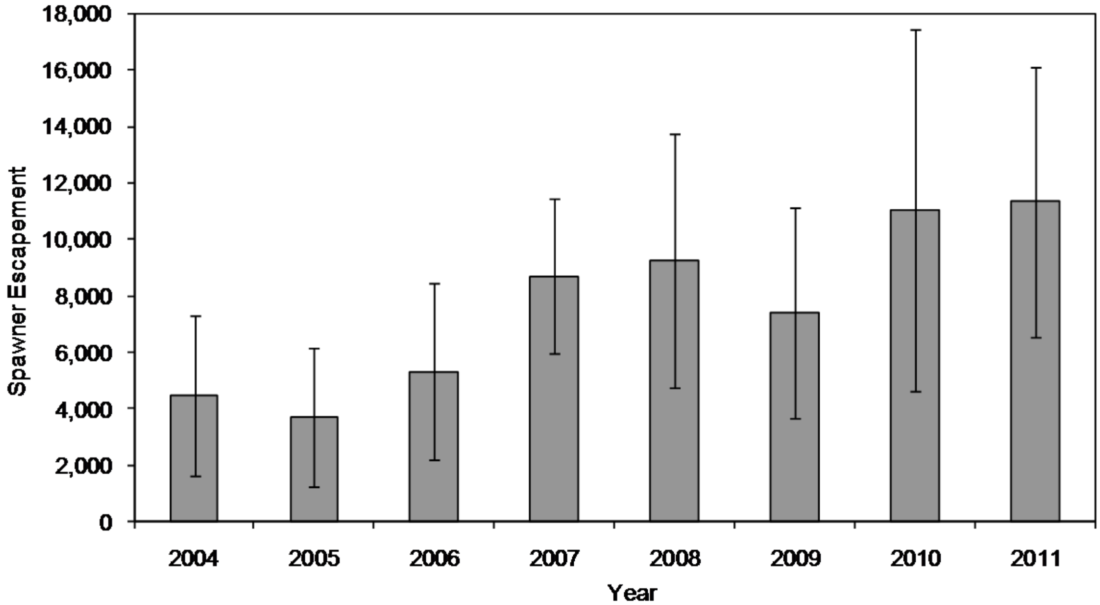

Figure 4. Annual adult steelhead spawner escapement estimates for the John Day River basin from 2004 to 2011. Error bars indicate 95% confidence intervals.

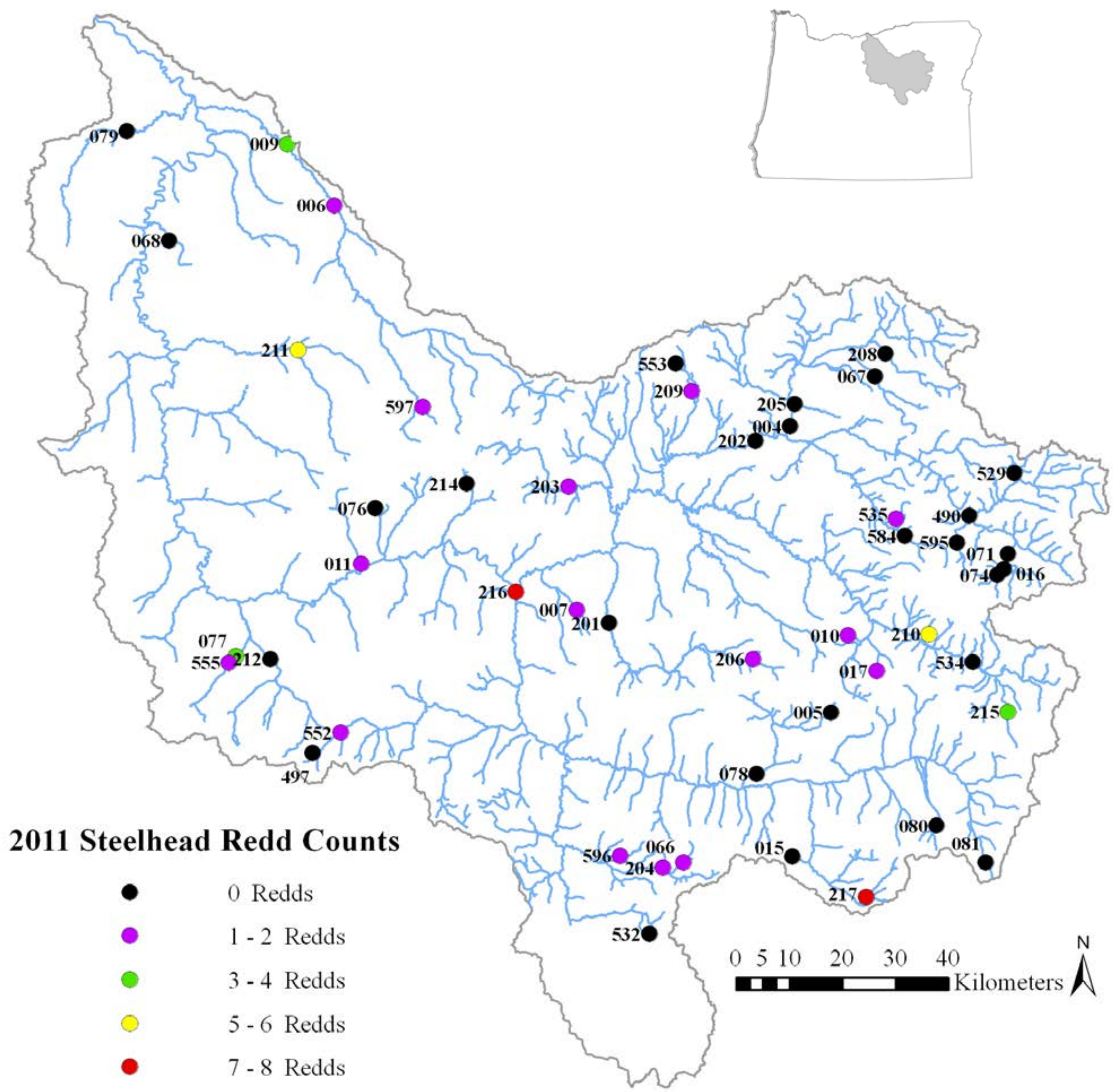

Figure 5. Distribution and number of summer steelhead redds observed in the John Day River basin during spawning surveys conducted in the spring of 2011.

Table 9. Redd observations at annual spawning survey sites in the John Day River basin conducted from 2004 to 2011. 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	Subbasin	2004	2005	2006	2007	2008	2009	2010	2011
Battle Creek	535	NFJDR	N/A	N/A	0	0	0	0	0	1
Camas Creek	4	NFJDR	0	0	0	0	0	0	0	0
Clear Creek	16	NFJDR	3	1	2	2	0	2	1	0
Desolation Creek	584	NFJDR	N/A	N/A	N/A	N/A	N/A	N/A	0	0
Gilmore Creek	7	NFJDR	0	0	0	0	0	0	0	1
Granite Creek	490	NFJDR	0	0	0	1	0	0	0	0
M.F. John Day	534	MFJDR	N/A	N/A	1	6	0	0	0	0
Milk Creek	497	LMJDR	0	0	0	0	0	0	0	0
Rail Creek	13	UMJDR	0	0	0	0	0	N/A	N/A	N/A
Rock Creek	6	LMJDR	3	1	6	7	6	2	5	1
Rock Creek	9	LMJDR	8	2	0	16	4	3	8	3
Rosebush Creek	579	LMJDR	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A
Service Creek	11	LMJDR	17	0	14	16	12	8	14	1
S.F. Deer Creek	532	SFJDR	N/A	N/A	0	0	0	0	0	0
Tinker Creek	5	UMJDR	0	0	0	0	0	0	0	0
Trout Creek	529	NFJDR	N/A	N/A	0	0	0	0	0	0
Vance Creek	15	UMJDR	0	0	0	0	0	0	0	0
W.F. Lick Creek	17	MFJDR	4	0	2	8	0	4	5	2
Whisky Creek	10	MFJDR	0	0	0	0	1	0	0	1
TOTAL			**40**	**10**	**37**	**56**	**25**	**19**	**33**	**10**

Table 10. Redd observations at four-year rotation spawning survey sites in the John Day River basin conducted in the spring of 2007 and 2011. N/A represents sites that were not surveyed because water flows were too high.

Stream	Site ID	Subbasin	2007	2011
Badger Creek	552	LMJD	6	1
Bear Creek	77	LMJD	11	4
Bear Creek	555	LMJD	13	2
Beech Creek	78	UMJD	13	0
Cable Creek	67	NFJD	9	0
Clear Creek	71	NFJD	2	0
Clear Creek	74	NFJD	0	0
Ferry Canyon	68	LMJD	0	0
Grass Valley Canyon	79	LMJD	0	0
John Day River	81	UMJD	0	0
Lake Creek	76	LMJD	4	0
N.F. John Day River	70	NFJD	0	N/A
N.F. John Day River	73	NFJD	0	N/A
Slide Creek	80	UMJD	0	0
Tex Creek	66	SFJD	1	1
Wilson Creek	553	NFJD	0	0
TOTAL			**59**	**8**

SOUTH FORK JOHN DAY RIVER SPAWNING SUBSAMPLE

A total of 18 redds were observed while surveying 22.8 km of steelhead spawning and rearing habitat in the South Fork John Day River subbasin (Table 11; Figure 7). Redd densities at sites in the subbasin varied from zero to 6.84 redds/km (Table 12). Overall, the average redd density was 0.79 redds/km with an estimated total 197 redds constructed in the South Fork above the rotary screw trap (Table 11). We estimate that 934 adult steelhead spawners returned to the South Fork subbasin in 2011 (Table 11, Figure 6). We observed 24 live steelhead in the subsample, 12 of which were of wild origin, 11 were of unknown origin, and one was of hatchery origin (Table 12). The only steelhead carcass found in the South Fork subbasin was of unknown origin and was observed in Black Canyon Creek.

Table 11. Distance surveyed, number of unique redds observed, redd density (redds/km), estimated total number of redds, fish per redd estimate from Deer Creek, and spawning escapement estimate with 95% C.I. for the South Fork John Day River subsample from 2006 to 2011.

Year	km	Redds (n)	Density	Total Redds	Fish/redd	Escapement	95% Lower	95% Upper
2006	25.9	18	0.69	186	1.66	309	145	472
2007	24.2	58	2.4	675	1.12	756	252	1,260
2008	24.2	29	1.2	301	4.07	1,224	624	1,824
2009	25.9	50	1.93	481	3.81	1,833	795	2,867
2010	24.8	27	1.09	271	1.59	432	173	692
2011	22.8	18	0.79	197	4.75	934	0	2,034

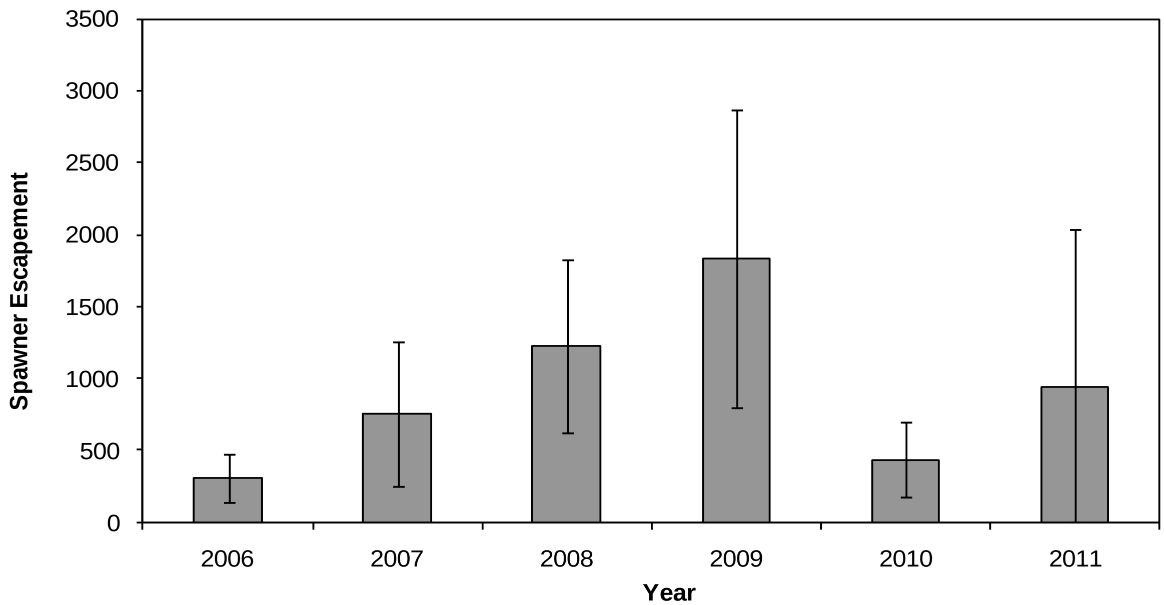

Figure 6. Annual adult steelhead spawner escapement estimates for the South Fork John Day River subsample from 2006 to 2011. Error bars indicate 95% confidence intervals.

Table 12. Total number of steelhead redds, redd density, hatchery, unknown, and wild origin live and dead steelhead observed during South Fork John Day River subsample spawning surveys in 2011.

Stream	Site ID	Redds	Redds/km	Live				Dead			
				Hatchery	Unknown	Wild	Total Live	Hatchery	Unknown	Wild	Total Dead
South Fork John Day River											
Black Canyon Creek	140	13	6.84	1	9	9	19	0	1	0	1
Deer Creek	033	0	0	0	0	0	0	0	0	0	0
Deer Creek	200	0	0.00	0	0	0	0	0	0	0	0
Duncan Creek	596	1	0.50	0	1	1	2	0	0	0	0
Murderers Creek	161	0	0.00	0	0	0	0	0	0	0	0
Murderers Creek	204	1	0.59	0	0	2	2	0	0	0	0
Murderers Creek	223	2	1.00	0	0	0	0	0	0	0	0
Murderers Creek	282	0	0.00	0	0	0	0	0	0	0	0
North Fork Wind Creek	097	0	0.00	0	1	0	1	0	0	0	0
South Fork Deer Creek	532	0	0.00	0	0	0	0	0	0	0	0
Tex Creek	066	1	0.59	0	0	0	0	0	0	0	0
Wind Creek	152	0	0.00	0	0	0	0	0	0	0	0
Total		**18**	**0.79**	**1**	**11**	**12**	**24**	**0**	**1**	**0**	**1**

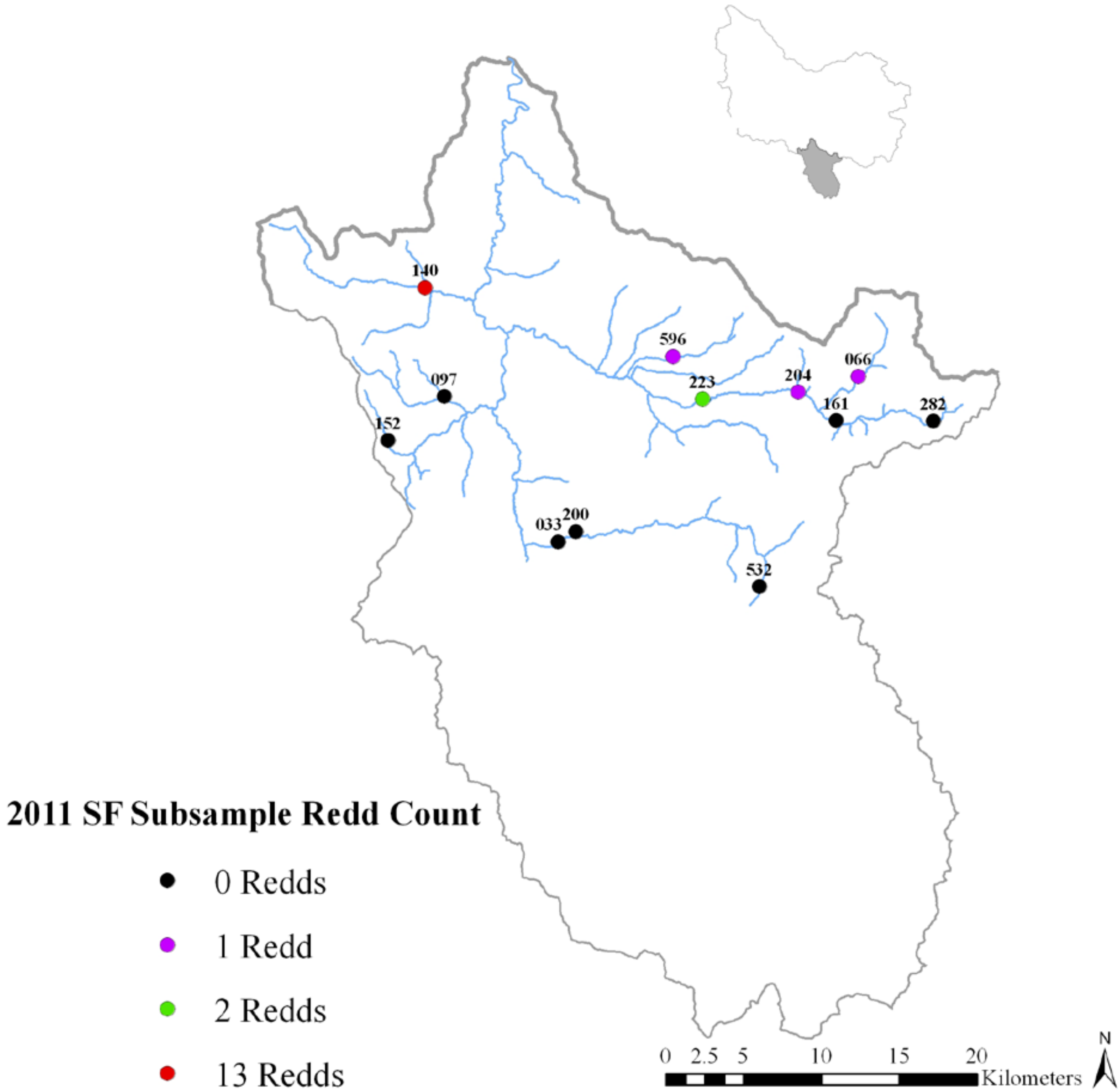

Figure 7. Distribution and number of summer steelhead redds observed in the South Fork John Day River subbasin in 2011.

HATCHERY:WILD OBSERVATIONS

Hatchery steelhead composed 5% (4 of 81) of steelhead observed in the John Day River basin in 2011 where the presence (unmarked, presumed wild) or absence (marked, presumed hatchery) of an adipose fin could be determined. Origin was determined for 60% of observed steelhead, including live and dead fish (Table 13). However, some fish may have been observed more than once depending on their residency time and our site visit frequency. Using the ratio of clipped-to-unclipped steelhead (5% and 95%, respectively) observed in the John Day River basin, we estimate that of the 11,334 steelhead in the basin in 2011, 560 were of apparent hatchery origin and 10,774 were wild. The percentage of live adult hatchery steelhead observed in the John Day River basin has varied from approximately 8% to 40% over the past seven years (Figure 8). The majority of hatchery observations (81%) were observed in the Lower Mainstem subbasin, a trend that has been consistent since 2004 (Table 13). Wild steelhead were observed at every site where hatchery steelhead were observed (Figure 9). We sampled 15 summer steelhead carcasses in 2011, 8% (1 of 12) were of hatchery origin. Approximately 5% and 0% of fish were of hatchery origin that were observed during ODFW Index spawning surveys and ODFW juvenile salmonid sampling projects, respectively (Appendix Table A1).

Table 13. Live and dead steelhead observed, determined for origin, number marked, percentage marked, and number unmarked during spawning surveys conducted in 2011. LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork Subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin (includes steelhead observed during South Fork subsample surveys).

Subbasin	**# Observed**	**# Determined**	**# Marked**	**% Marked**	**# Unmarked**
Lower John Day	62	40	3	7.5	37
Middle Fork John Day	12	10	0	0.0	10
North Fork John Day	17	9	0	0.0	9
South Fork John Day	25	13	1	7.7	12
Upper John Day	18	9	0	0.0	9
Basin Total	**134**	**81**	**4**	**4.9**	**77**

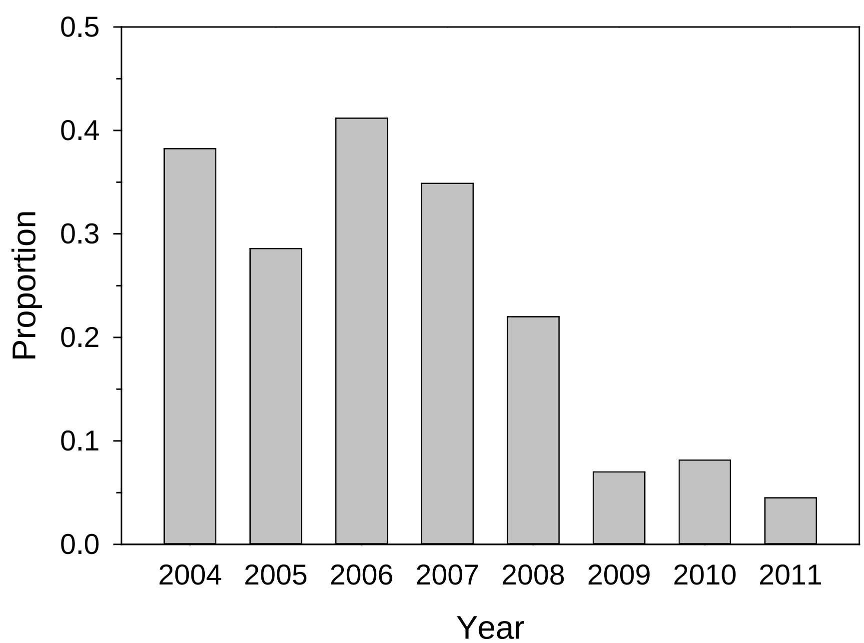

Figure 8. Proportion of steelhead spawners observed during spawning surveys in the John Day River basin that were identified as hatchery origin from 2004 to 2011.

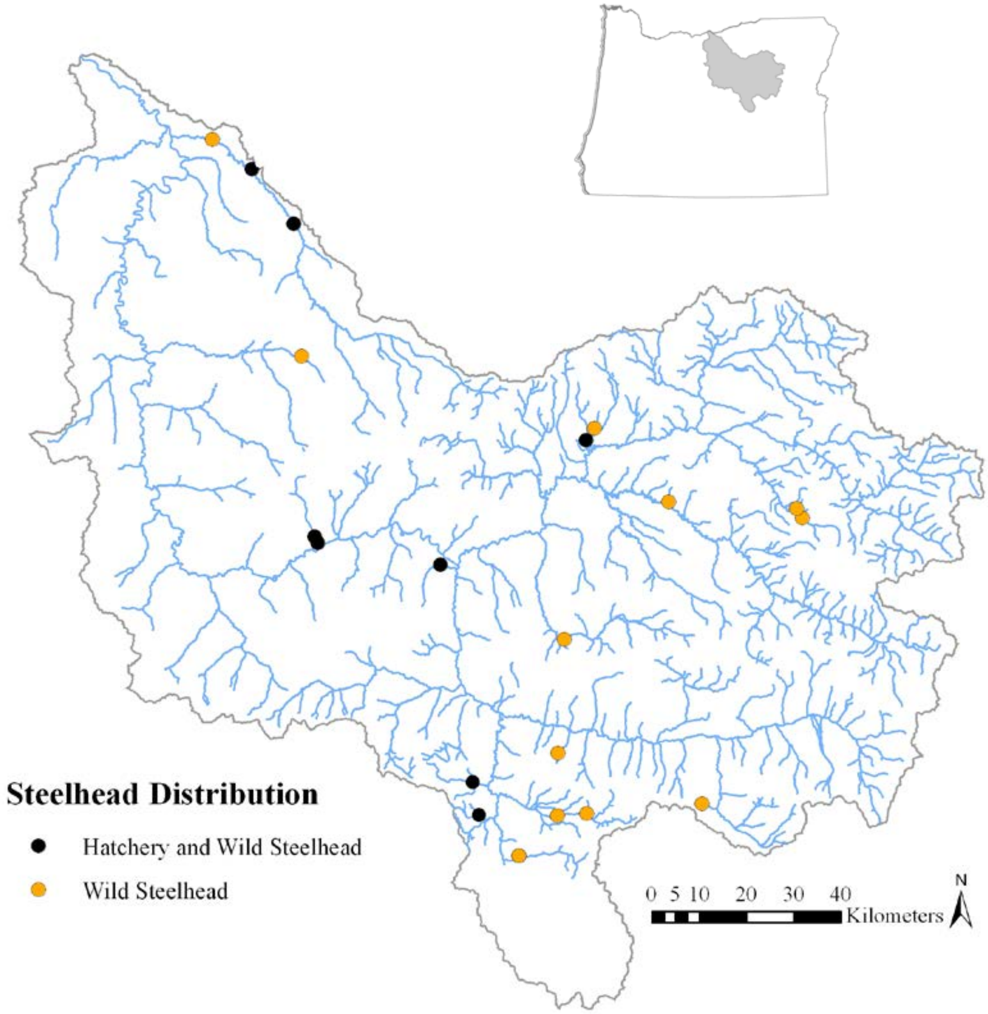

Figure 9. Distribution of hatchery and wild steelhead observations in the John Day River basin during summer steelhead spawning surveys conducted in the spring of 2011 (includes observations in the South Fork subsample).

STEELHEAD SPAWNING TIMING

We observed new steelhead redds from 23 February to 13 July 2011. Observations occurred earliest in the Lower Mainstem and latest in the North Fork and South Fork subbasins (Figure 11), a trend that has been apparent since 2004. The first redd was observed in Rock Creek (site 009) along with the first live steelhead (unknown origin, off redd). Redd observations were similar for March and April, approximately 19% and 25% of the total redds observed, respectively. Surveys conducted in May produced 46% (n=31) of the total redds found in 2011. However, 24 of the 31 redds observed in May were found prior to a large runoff event on 15 May and it was nine days later until another redd was observed (Figure 12).

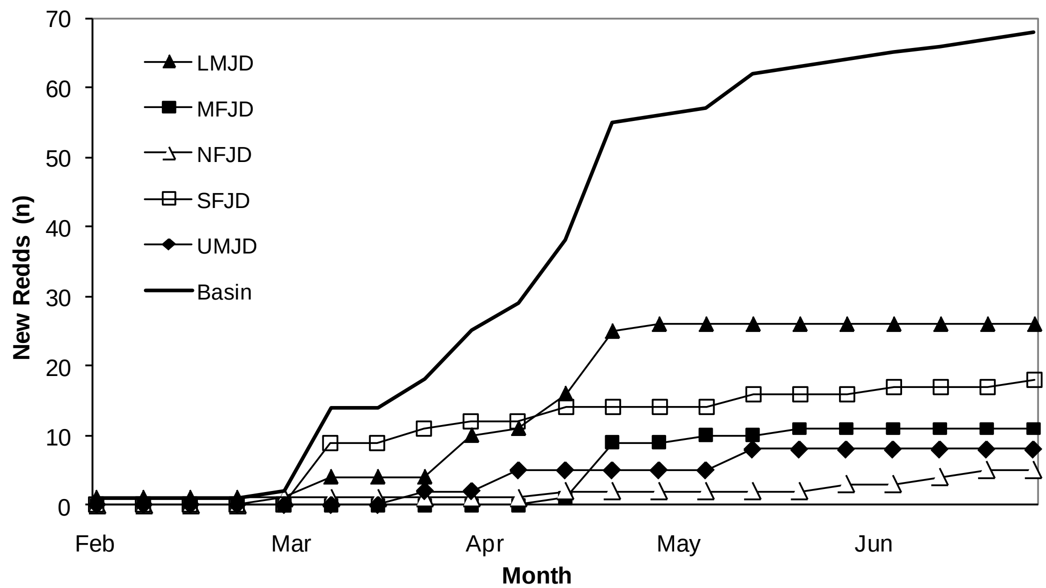

Figure 10. Cumulative number of new steelhead redds observed weekly during EMAP spawning surveys in 2011. LMJD: Lower Mainstem subbasin; UMJD: Upper Mainstem subbasin; NFJD: North Fork subbasin; MFJD: Middle Fork subbasin; SFJD: South Fork subbasin (includes redds observed during SF subsample surveys).

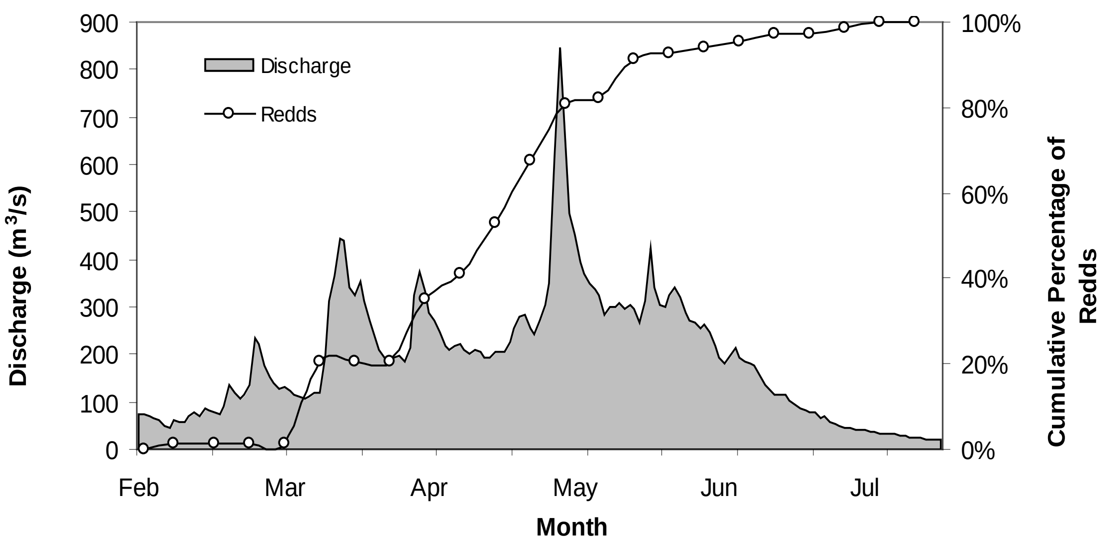

Figure 11. Mean daily discharge (m^3/s) in the John Day River at Service Creek (rkm 252) from 21 February to 26 July 2011 and cumulative percentage of new redds observed during EMAP and South Fork subsample surveys.

JUVENILE SALMONID ABUNDANCE AND DENSITY ESTIMATES

We captured a total of 4,020 juvenile *O. mykiss*, 317 juvenile spring Chinook salmon *O. tshawytscha*, 243 brook trout *Salvelinus fontinalis*, 21 westslope cutthroat trout *O. clarkii lewisi*, and nine bull trout *S. confluentus* while surveying 6.12 km of the John Day River basin during the summer of 2011 (Table 14). Of the 6.12 km sampled 1.92 km were sampled in the LMJDR, 1.08 km in the MFJDR, 2.28 km in the NFJDR, 0.24 km in the SFJDR, and 0.6 km in the UMJDR subbasins.

Abundance estimates were calculated for 32 of the 37 sites where juvenile *O. mykiss* were present (Table 15). An insufficient number of recaptures occurred at five sites (Site IDs: CBW05583-032138, OJD03458-000025, CBW05583-032138, OJD03458-000025, and OJD032458-000005) where *O. mykiss* were present, resulting in inestimable abundance parameters. Abundance estimates were calculated for juvenile spring Chinook salmon at four of the six sites where fish were present (Table 16). An insufficient number of fish were recaptured at the Middle Fork John Day River (site ID: OJD03458-000534) and Camas Creek (site ID: OJD03458-000004) sites to estimate abundances. Abundance estimates were calculated for brook trout at the two sites within the NFJDR subbasin where they were present (Table 17). Abundance estimates for westslope cutthroat trout were calculated at one of the three sites within the UMJDR subbasin where fish were present (Table 18). An insufficient number of fish were recaptured at two sites: Vance Creek (site ID: OJD03458-000015) and Rail Creek (site ID: OJD03458-000013). No abundance estimates were calculated for bull trout because zero fish were recaptured at the two sites where they were present.

Overall, *O. mykiss* were the most frequently observed salmonid in all subbasins, occurring at 37 of the 40 sites sampled (Figure 12). The highest density of *O. mykiss* occurred in the SFJDR subbasin with 1.7 fish/m (CI=1.5-2.1; Figure 14) followed by the NFJDR subbasin (1.6 fish/m, CI=1.5-1.7; Figure 15), the LMJDR subbasin (1.2 fish/m, CI=1.0-1.5; Figure 16), the MFJDR subbasin (0.6 fish/m, CI=0.5-0.7; Figure 17), and the lowest in the UMJDR subbasin (0.4 fish/m, CI=0.4-0.5; Figure 18). Juvenile spring Chinook salmon were the second most frequently observed salmonid occurring at six of 40 sites sampled, however, they were only present at sites in the MFJDR and NFJDR subbasins, with densities of 0.4 fish/m (CI=0.2-1.0; Figure 19) and 0.4 fish/m (CI=0.3-0.7; Figure 20), respectively. Brook trout were observed in the NFJDR subbasin with a density of 0.12 fish/m (CI=0.11-0.14; Figure 21). However, their occurrence was isolated to two sites within the Trout Creek Hydrologic Unit HUC5 within the NFJDR subbasin. Densities at these two sites within the HUC5 were 1.2 fish/m (CI=1.0-1.4). Westslope cutthroat trout observations were isolated to the UMJDR subbasin with an estimated density of 0.07 fish/meter (CI=0.05-0.16; Figure 22). Bull trout were the least frequently observed salmonid with one individual sampled in Vinegar Creek (site ID: OJD03458-000536) of the MFJDR subbasin and seven individuals in Rail Creek (site ID: OJD03458-000013) of the UMJDR subbasin.

In the LMJDR subbasin, four incidental species were observed; dace *Rhinichthys spp.*, suckers *Catastomus spp.*, mottled sculpin *Cottus bairdii* and redside shiner *Richardsonius balteatus*. In the MFJDR subbasin, six incidental species were captured: including dace spp., sucker spp., mottled sculpin, redside shiner, northern pikeminnow *Ptychocheilus oregonensis* and lamprey *Lampetra spp.*. In the NFJDR subbasin, seven incidental species were observed including all six species observed in the MFJDR subbasin, as well as smallmouth bass *Micropterus dolomieu*. Mottled sculpin were the only incidental species observed in the UMJDR subbasin. No incidental fish were observed in the SFJDR subbasin.

Table 14. Summary of captured (New) and recaptured (RE) salmonid species sampled between June and September 2011 in the John Day River basin, Oregon. New and recaptured juvenile *O. mykiss* (RbT), spring Chinook salmon (ChS), brook trout (BrT), bull trout (BuT), and westslope cutthroat trout (WcT) are separated by subbasin: Lower Mainstem John Day River (LMJDR), Middle Fork John Day River (MFJDR), North Fork John Day River (NFJDR), South Fork John Day River (SFJDR) and the Upper Mainstem John Day River (UMJDR) subbasins.

	RbT		ChS		BrT		BuT		WcT	
Subbasin	New	RE	New	RE	New	RE	New	RE	New	RE
LMJDR	783	75	0	0	0	0	0	0	0	0
MFJDR	342	43	68	4	0	0	1	0	0	0
NFJDR	2346	385	249	17	243	53	0	0	0	0
SFJDR	274	45	0	0	0	0	0	0	0	0
UMJDR	275	76	0	0	0	0	8	0	21	3

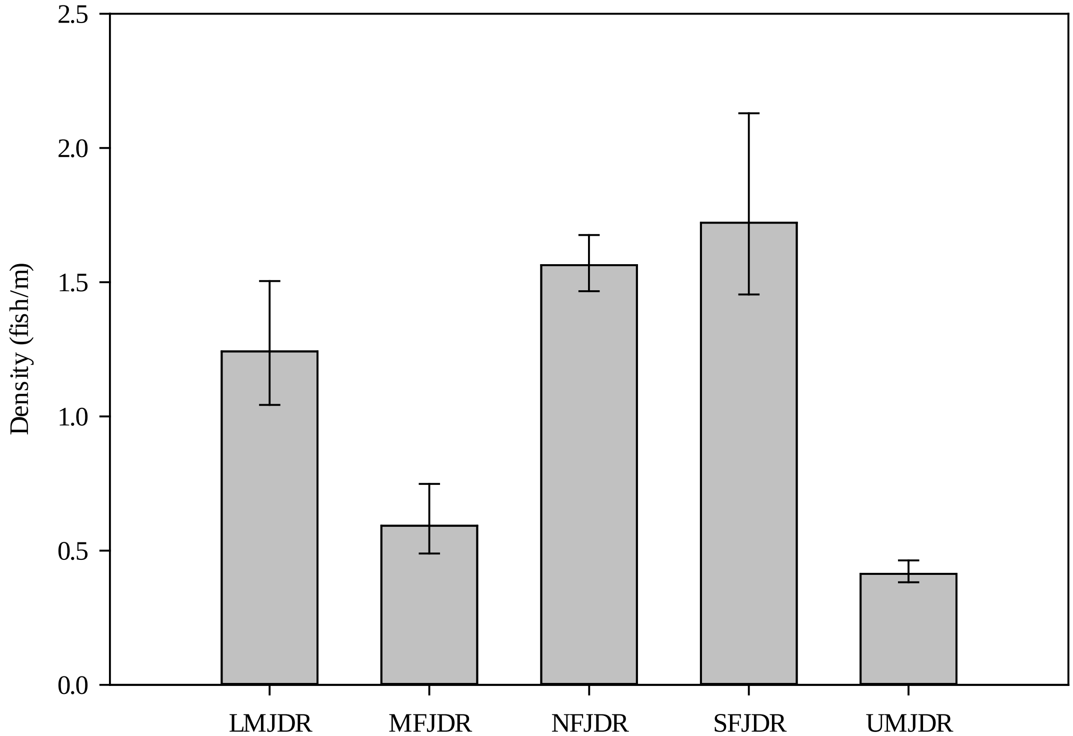

Figure 12. Mean juvenile *O. mykiss* densities (# of fish/m) in the Lower Mainstem John Day River (LMJDR), Middle Fork John Day River (MFJDR), North Fork John Day River (NFJDR), South Fork John Day River (SFJDR) and Upper Mainstem John Day River (UMJDR) subbasins for the sampling period of June – September 2011. Error bars represent 95% confidence intervals.

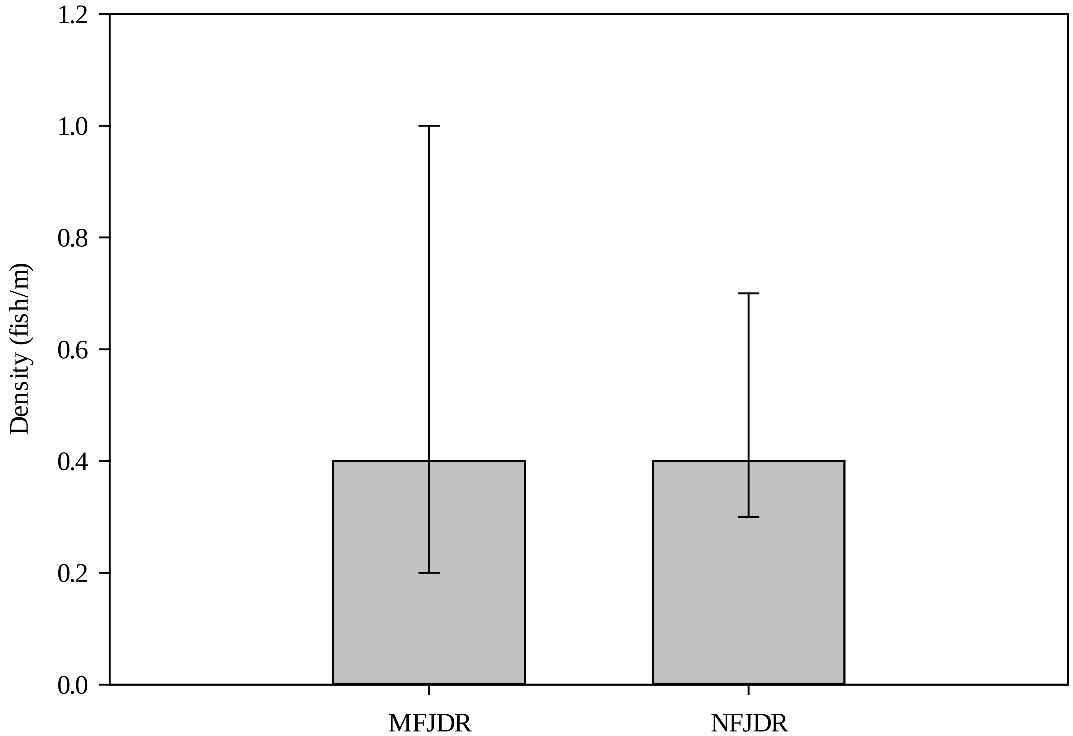

Figure 13. Mean juvenile spring Chinook salmon densities (# of fish/m) in the Middle Fork John Day River (MFJDR) and North Fork John Day River (NFJDR) subbasins for the sampling period of June – September 2011. Error bars represent 95% confidence intervals.

Table 15. Abundance estimates for juvenile *O. mykiss* in the John Day River basin for the summer sampling period of June – September 2011.

				95% Confidence Intervals	
SiteID	**Stream**	**Subbasin**	**Abundance**	**Lower**	**Upper**
CBW05583-022570	Rowe Creek	LMJDR	301	213	471
CBW05583-401098	Rock Creek	LMJDR	44	39	60
OJD03458-000009	Rock Creek	LMJDR	1311	522	3680
OJD03458-000011	Service Creek	LMJDR	228	178	318
OJD03458-000029	Fort Creek	LMJDR	19	16	35
OJD03458-000082	Thirtymile Creek	LMJDR	229	128	500
OJD03458-000514	Big Pine Hollow	LMJDR	899	577	1504
OJD03458-000539	Rock Creek	LMJDR	32	27	51
CBW05583-518642	Deadwood Creek	MFJDR	55	36	138
OJD03458-000017	West Fork Lick Creek	MFJDR	47	37	79
OJD03458-000147	Middle Fork John Day River	MFJDR	142	98	245
OJD03458-000505	Camp Creek	MFJDR	138	95	237
OJD03458-000534	Middle Fork John Day River	MFJDR	64	48	110
OJD03458-000536	Vinegar Creek	MFJDR	157	113	249
CBW05583-013642	Little Wall Creek	NFJDR	103	87	137
CBW05583-021738	Unnamed trib to Trout Creek	NFJDR	25	20	50
CBW05583-241210	Hidaway Creek	NFJDR	297	277	328
OJD03458-000004	Camas Creek	NFJDR	453	300	748
OJD03458-000007	Gilmore Creek	NFJDR	56	51	70
OJD03458-000016	Clear Creek	NFJDR	190	118	361
OJD03458-000019	Tribble Creek	NFJDR	62	55	81
OJD03458-000085	Wall Creek	NFJDR	761	663	896
OJD03458-000132	Wilson Creek	NFJDR	958	681	1417
OJD03458-000490	Granite Creek	NFJDR	892	569	1496
OJD03458-000496	Beaver Creek	NFJDR	32	28	46
OJD03458-000520	Pine Creek	NFJDR	162	119	251
OJD03458-000529	Trout Creek	NFJDR	112	81	185
OJD03458-000535	Battle Creek	NFJDR	61	42	118
OJD03458-000553	Potamus Creek	NFJDR	422	371	498
OJD03458-000097	North Fork Wind Creek	SFJDR	345	293	426
OJD03458-000532	South Fork Deer Creek	SFJDR	58	35	149
OJD03458-000116	Cummings Creek	UMJDR	245	227	276

Table 16. Abundance estimates for juvenile spring Chinook salmon in the John Day River basin for the summer sampling period of June – September 2011.

				95% Confidence Intervals	
SiteID	**Stream**	**Subbasin**	**Abundance**	**Lower**	**Upper**
OJD03458-000147	Middle Fork John Day River	MFJDR	212	99	580
OJD03458-000536	Vinegar Creek	MFJDR	29	20	74
OJD03458-000016	Clear Creek	NFJDR	203	127	387
OJD03458-000490	Granite Creek	NFJDR	601	392	999

Table 17. Abundance estimates for brook trout in the John Day River basin for the summer sampling period of June – September 2011.

				95% Confidence Intervals	
SiteID	**Stream**	**Subbasin**	**Abundance**	**Lower**	**Upper**
CBW05583-021738	Unnamed Trib to Trout Creek	NFJDR	272	239	327
OJD03458-000529	Trout Creek	NFJDR	7	7	11

Table 18. Abundance estimates for westslope cutthroat trout in the John Day River basin for the summer sampling period of June – September 2011.

				95% Confidence Intervals	
SiteID	**Stream**	**Subbasin**	**Abundance**	**Lower**	**Upper**
OJD03458-000081	John Day River	UMJDR	24	18	51

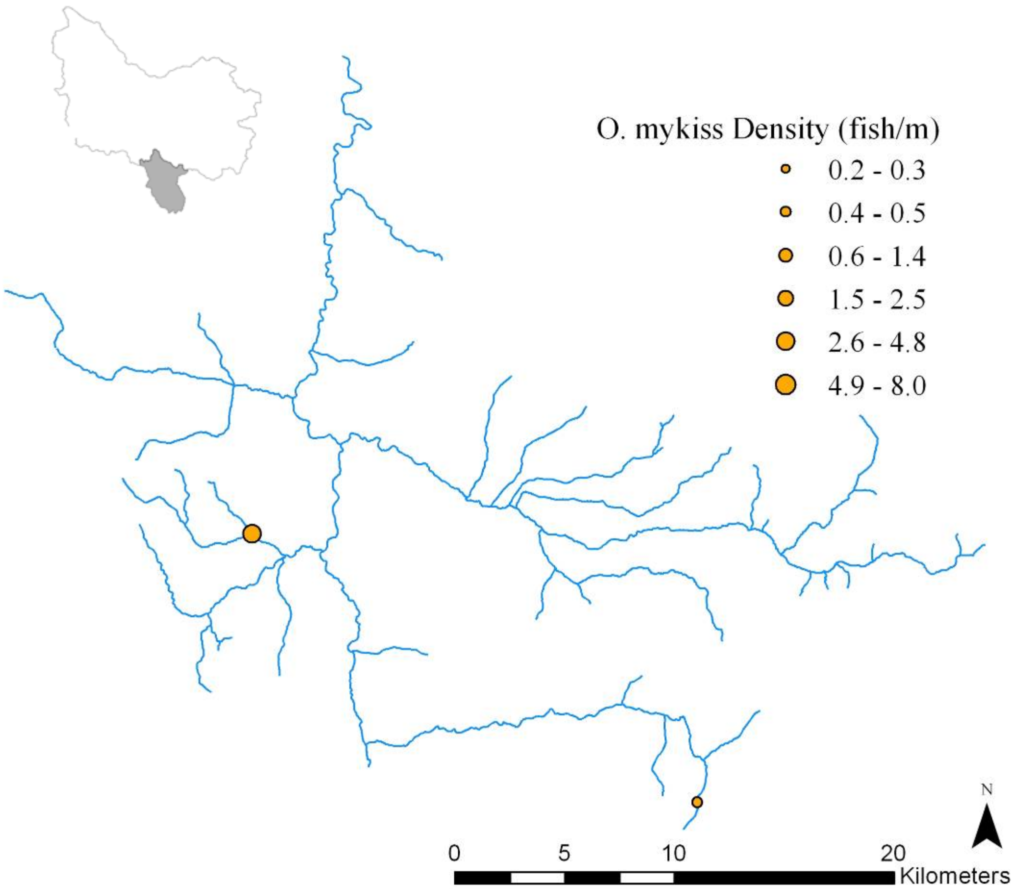

Figure 14. Juvenile *O. mykiss* densities (# of fish/m) within the South Fork John Day River subbasin during the sampling period of June – September 2011.

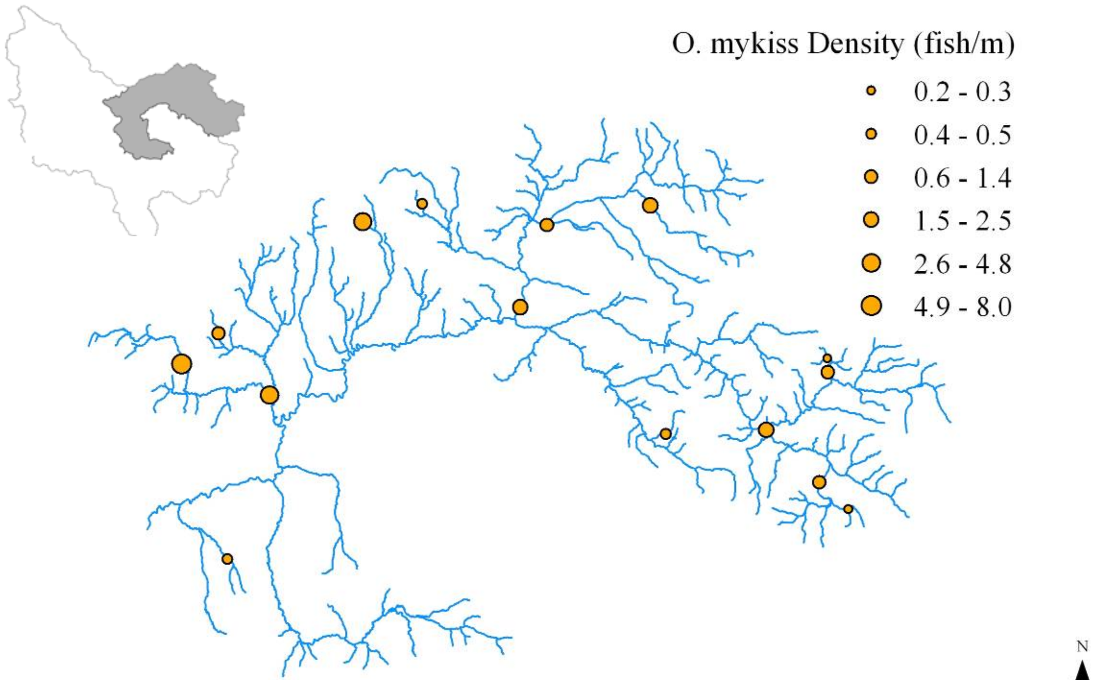

Figure 15. Juvenile *O. mykiss* densities (# of fish/m) within the North Fork John Day River subbasin during the sampling period of June – September 2011.

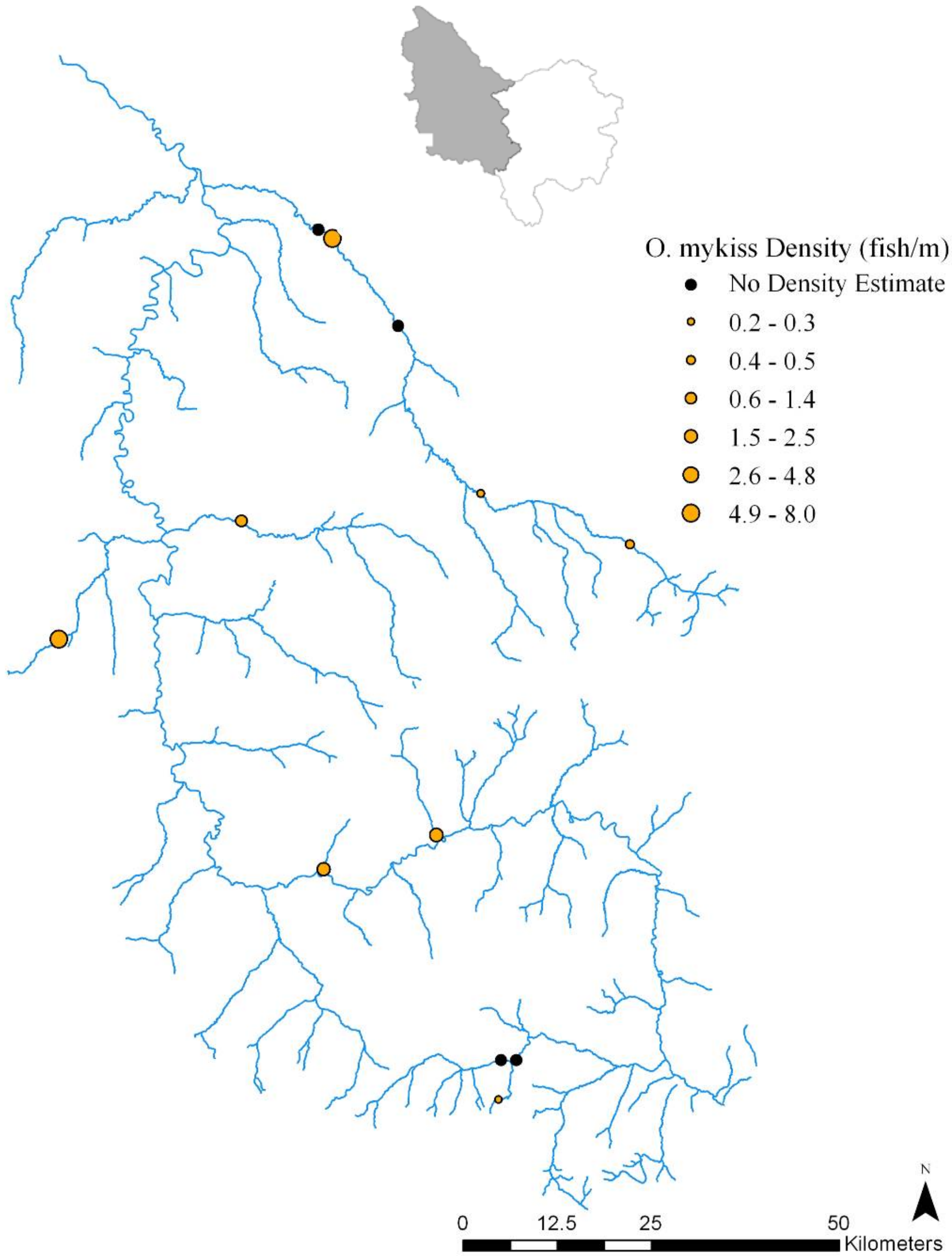

Figure 16. Juvenile *O. mykiss* densities (# of fish/m) within the Lower Mainstem John Day River subbasin during the sampling period of June – September 2011.

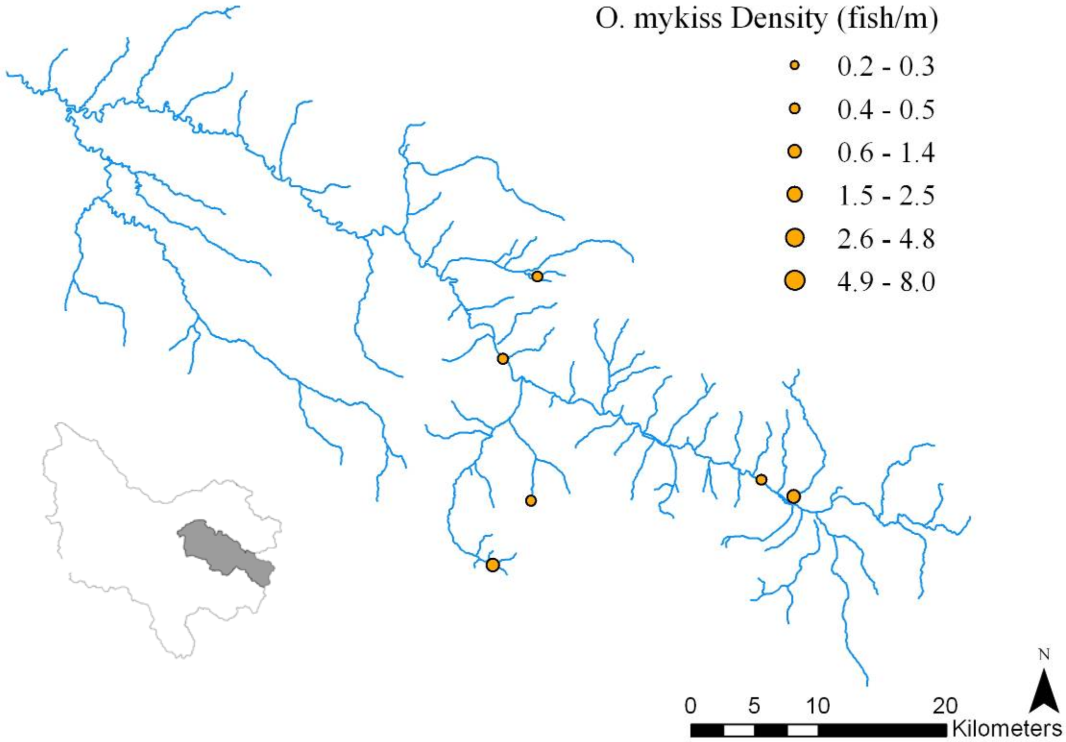

Figure 17. Juvenile *O. mykiss* densities (# of fish/m) within the Middle Fork John Day River subbasin during the sampling period of June – September 2011.

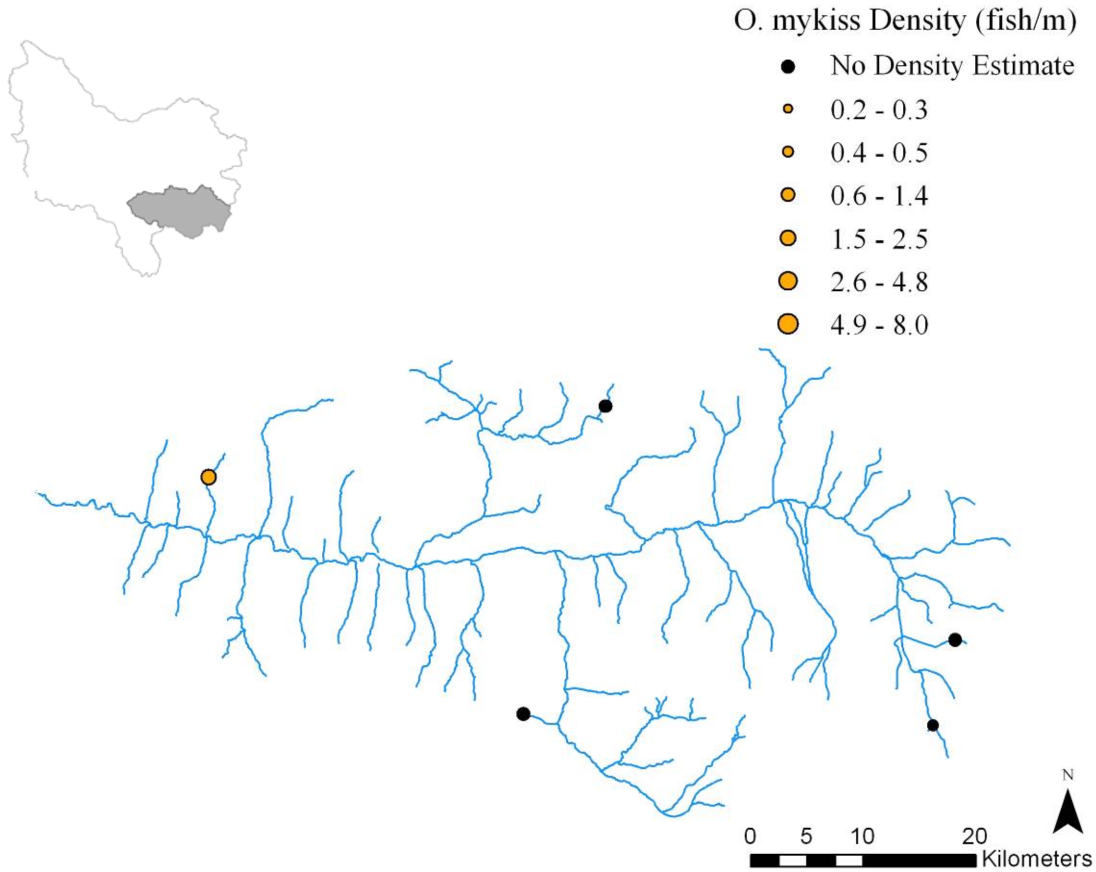

Figure 18. Juvenile *O. mykiss* densities (# of fish/m) within the Upper Mainstem John Day River subbasin during the sampling period of June – September 2011.

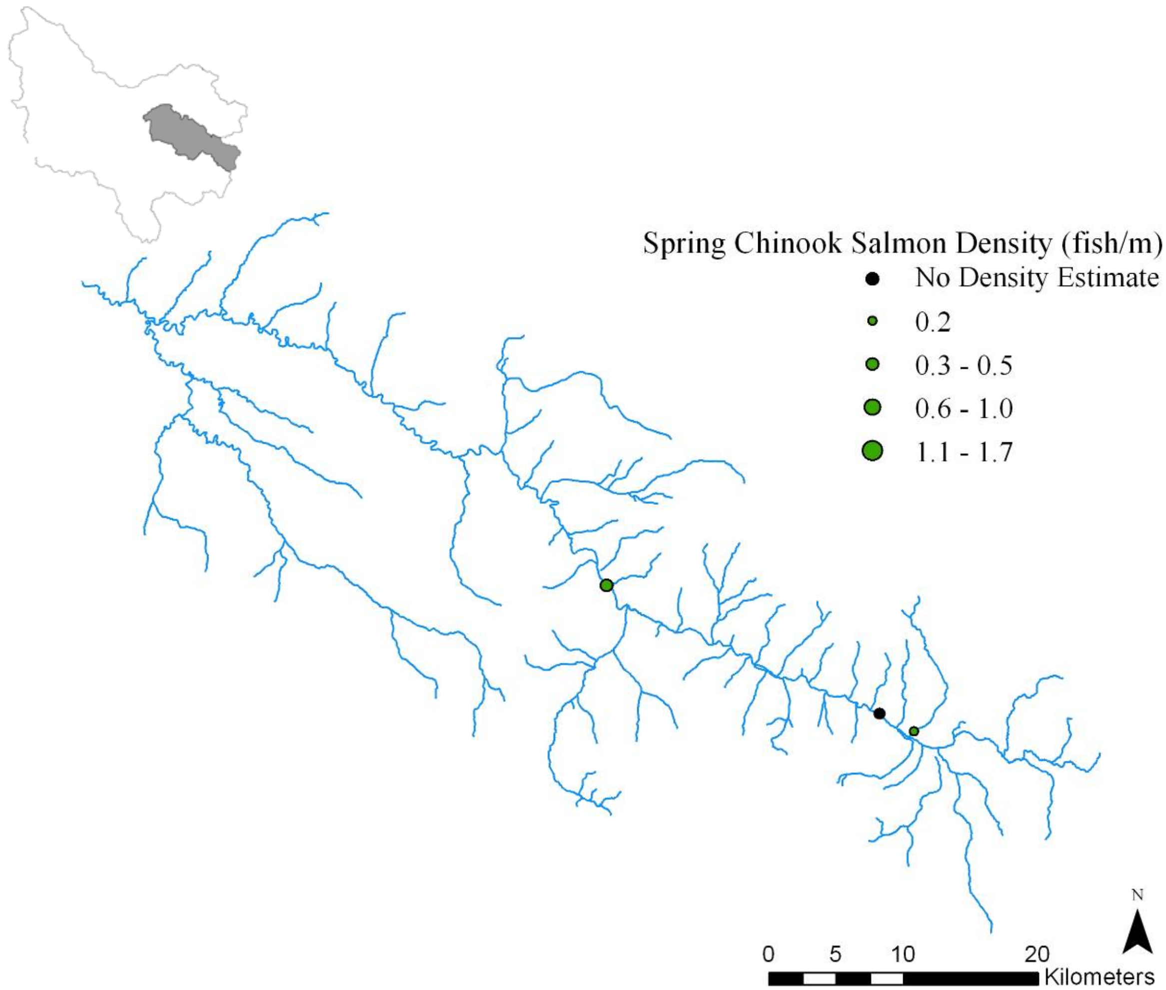

Figure 19. Juvenile spring Chinook salmon density (# of fish/m) within the Middle Fork John Day River subbasin during the sampling period of June – September 2011.

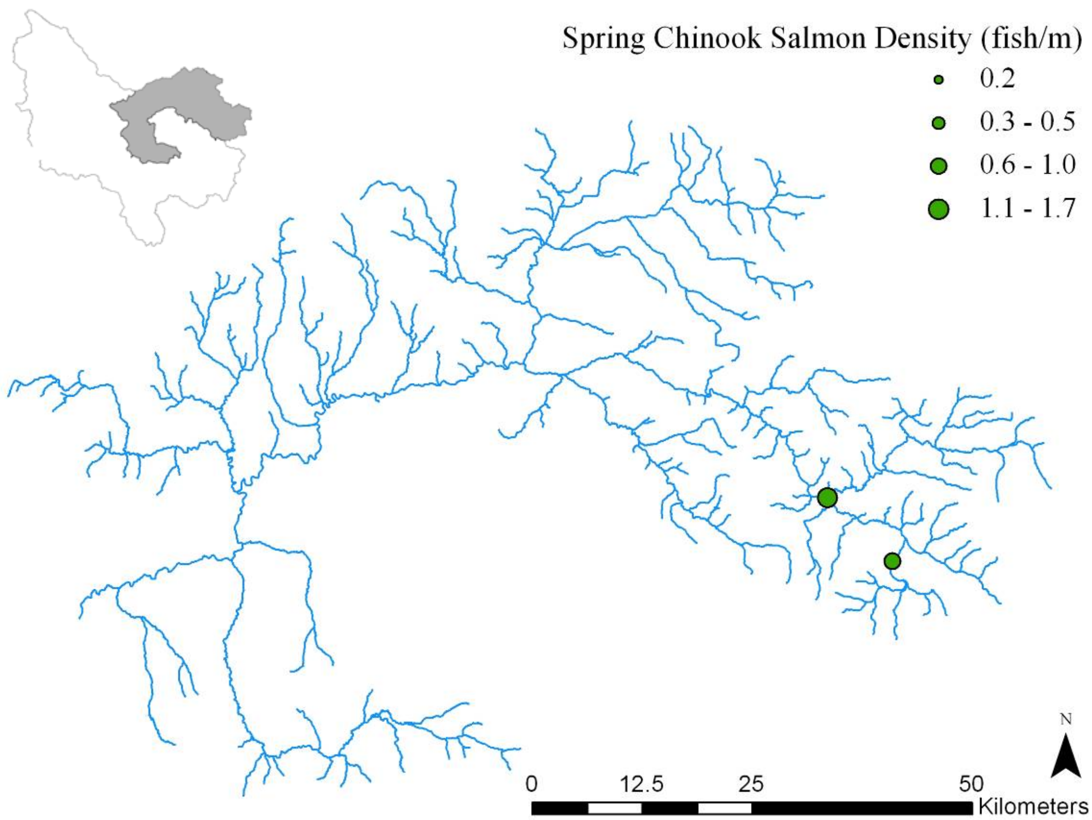

Figure 20. Juvenile spring Chinook salmon density (# of fish/m) within the North Fork John Day River subbasin during the sampling period of June – September 2011.

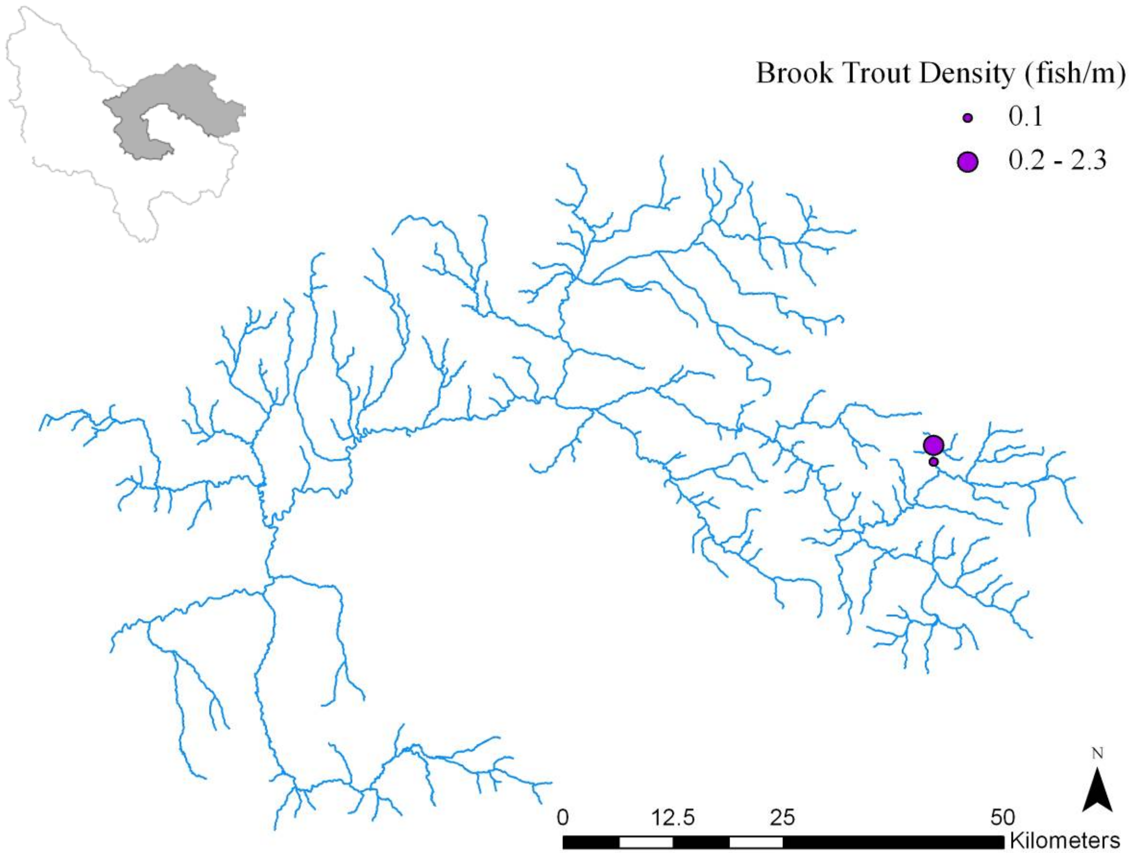

Figure 21. Brook trout density (# of fish/m) within the North Fork John Day River subbasin during the sampling period of June – September 2011.

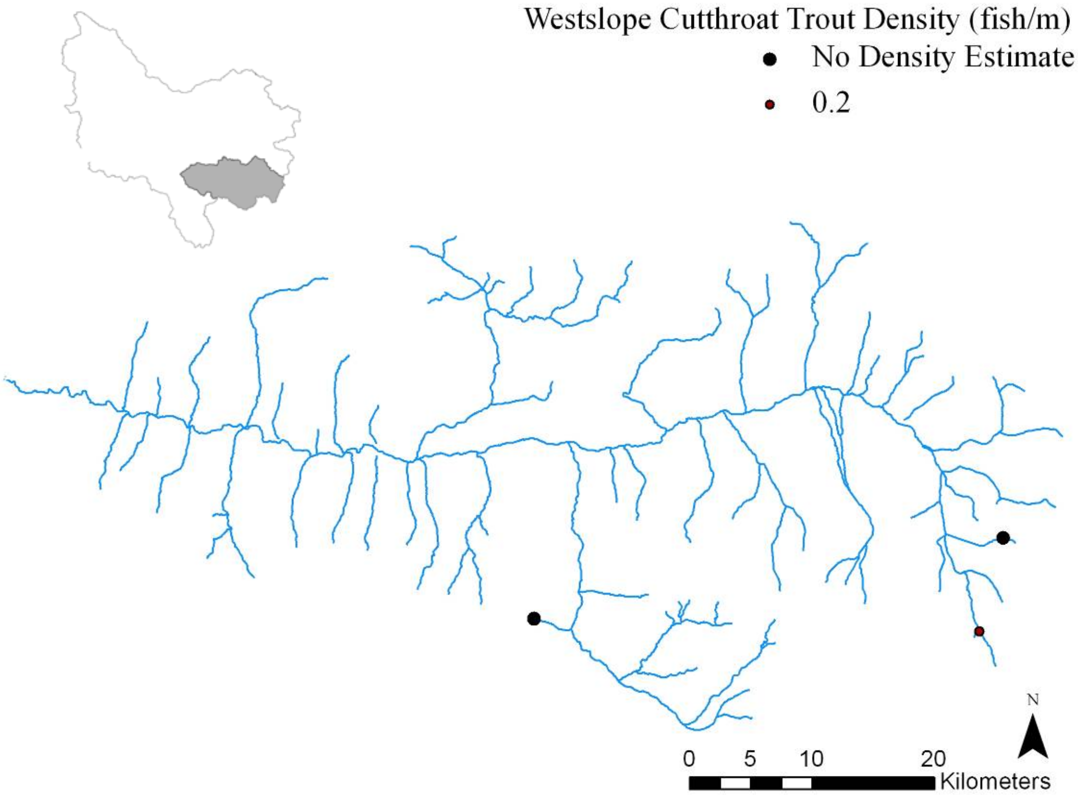

Figure 22. Westslope cutthroat trout density (# of fish/m) within the Upper Mainstem John Day River subbasin during the sampling period of June – September 2011.

AGE STRUCTURE AND CONDITION OF JUVENILE *O. MYKISS*

We differentiated between age-O and age-1+ *O. mykiss* by assessing length frequency histograms for each subbasin (Appendix Figures B1-B5). We defined age-0 *O. mykiss* in the LMJDR and MFJDR subbasins as fish ≤80 mm, ≤60mm in the NFJDR, and ≤70mm in the SFJDR and UMJDR subbasins. In lower Rock Creek (Site IDs: OJD03458-000006 and OJD03458-000557) no juvenile *O. mykiss* were captured that were >85 mm FL and only five *O. mykiss* were 81-85 mm FL. Additionally, in Rock Creek (Site ID: OJD03458-000009) all juvenile *O. mykiss* were ≤80 mm FL except one which was 203 mm at time of capture. In the UMJDR subbasin, nearly all *O. mykiss* included in the length frequency histogram were captured in Cummings Creek (Site ID: OJD03458-000116) since very few *O. mykiss* were captured at other sites within the subbasin.

Summer condition factors of *O. mykiss* ≥100 mm FL differed significantly among subbasins (ANOVA, $p < 0.001$; Figure 23). Moreover, all subbasins were significantly different ($p < 0.05$) except for the SFJDR compared to the LMJDR and MFJDR subbasins ($p > 0.05$).

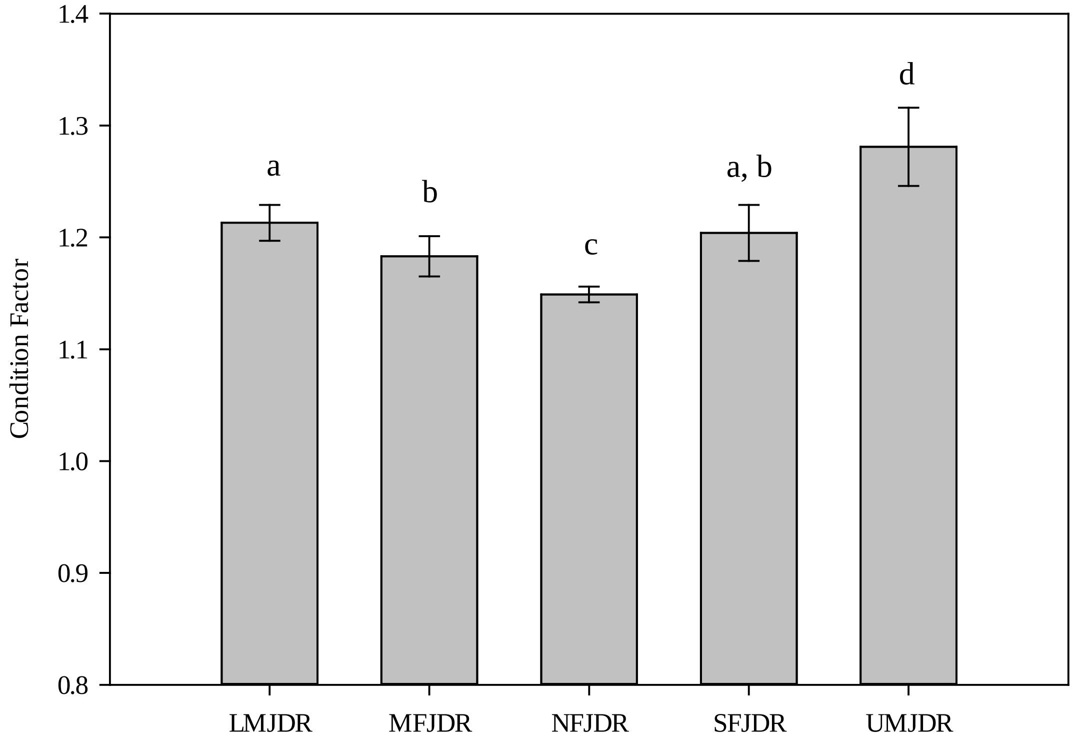

Figure 23. Subbasin level comparison of condition factor for juvenile *O. mykiss* sampled in the in the Lower Mainstem John Day River (LMJDR), Middle Fork John River (MFJDR), North John Day River (NFJDR), South Fork John Day River (SFJDR) and Upper Mainstem John Day River (UMJDR) subbasins for the summer of 2011. Error bars represent 95% confidence intervals. Letters not shared among subbasins indicate significant differences.

DISCUSSION

ADULT STEELHEAD ESCAPEMENT

Our 2011 redd density estimate for the John Day River basin was a third of that observed in 2010. The intensity of stream discharge may have a direct negative effect on probability of detecting redds. Comparing the eight years of spawning ground survey data in the John Day River basin with corresponding stream flow data reveals a point at which discharge may preclude redd detection (Appendix Figure A1). Approximately 95% of the 607 steelhead redds detected since 2004 have been observed when the John Day River is flowing less than 250 m^3/s at the Service Creek gauging station. Daily flows from 1 March to 14 June of 2011 averaged 250 m^3/s, the highest recorded during EMAP monitoring (Appendix Figure A2).

Above average discharge impaired Index survey efforts as well. The 2011 Index density estimate was 1.24 redds/km, half of the average density seen over the past ten years (mean = 2.4, SE = 0.43) (Appendix Figure A3). Difficult stream access due to snow and limited visibility in turbid water likely contributed to Index surveys producing the lowest redd count recorded since 1979 (ODFW unpublished data). A significant correlation between EMAP and Index redd densities remains, however ($R = 0.92$, p-value < 0.01) (Appendix Figure A4).

Through the eight years of EMAP monitoring, a negative relationship is beginning to appear between discharge and redd density (Appendix Figure A5). Fewer new redds were observed after the flooding in May that caused most sites to run high with turbid water. The protracted runoff extended our survey period beyond the spawning season and surveys were delayed until flows subsided, possibly after redds became obscured by shifting bedload, sediment, or periphyton growth, making them more difficult to detect. However, the annual fish per redd constant, developed at the Deer Creek weir in the Grande Ronde River basin, was the highest we have used to estimate escapement. The large estimate likely resulted from survey conditions in Deer Creek being similar to those in the John Day River basin and reducing redd detections. The 2007 spawning year, for example, produced the lowest fish per redd constant as well as the lowest daily average discharge in the John Day River since 2004. A statistically significant correlation between springtime discharge in the John Day River basin and fish per redd estimates at the Deer Creek weir lends credibility to the use of the fish per redd constant as a suitable expansion factor and suggests that Deer Creek survey conditions are similar to conditions in the John Day River basin (Appendix Figure A6).

John Day Basin redd counts, when corrected with the Deer Creek fish per redd estimate, are significantly correlated with Columbia River dam counts (Appendix Figure A7). The estimated steelhead spawner escapement in 2011 of 11,334 spawners is the highest return since commencing the EMAP monitoring project in 2004. The 120,529 non adipose-clipped “A-run” steelhead passing over Bonneville Dam from 1 July 2010 to 31 October 2010 was the second-highest count since 2004 (Kathryn Kostow, ODFW Clackamas, personal communication). Conversely, there appears to be no relationship between uncorrected redd density and Columbia River dam counts (Appendix Figure A8). This emphasizes the necessity of a weir where a fish per redd estimate can be generated to correct for variable survey conditions.

As in previous years, spawning activity was not observed at a large proportion of survey sites in 2011 (55%). In the past seven years, greater than 50% of sites surveyed in any given year have been void of any observable spawning activity (Wiley et al. 2004, Wiley et al. 2005, James et al. 2006; James et al. 2007; McCormick et al. 2008; McCormick et al. 2009; McCormick et al. 2010,). Despite a high escapement estimate, we observed spawning at only seven of the 17 sites that we survey annually, a percentage of sites without redds that is within the range observed since 2004. This suggests that with increased escapement levels, steelhead spawning range is not increasing. While the steelhead spawning distribution in the John Day River basin likely varies from year to year, the fact that over half the sites surveyed in any given year, including annual and four year sites, are not being utilized for steelhead spawning suggests that we do not fully understand current steelhead spawning habitat in the basin.

Since 2004, we have provided John Day River MPG escapement estimates with coefficients of variation (CV) ranging from 16% to 34% with a mean of 26.7%. The National Oceanic and Atmospheric Administration (NOAA) Fisheries Service suggests that we should strive for a CV of 15% when describing adult spawner populations that are listed under the ESA (Crawford and Rumsey 2009). We have annually sampled approximately 2% of the available habitat in the John Day River MPG and approximately 9% of the available habitat in the South Fork population. Even with increased sampling intensity, CVs for South Fork population escapement estimates ranged from 25% to 60% with a mean of 34.3%. Similar results have been observed in the Middle Fork John Day population from 2008-2011, where approximately 15% of the available habitat has been surveyed with a mean CV of 29% and a range of 18 to 51% (C. James, unpublished data). These CVs suggest an inherent level of variance in steelhead spawning activity, perhaps due to the patchy distribution of redds. Patchiness of spawning suggests some level of stratification may be useful for reducing variance. We are using the CHaMP protocol (Beechie classification of source, transport, and depositional stream types) to stratify 2012 spawning survey samples and will discuss in the 2012 annual report if this approach will increase our precision. If it is successful, we can post-stratify our previous year's samples and possibly attain greater precision for those estimates. Increased sampling intensity may not significantly reduce variance but it would allow us to evaluate additional spawning habitat while conducting spawning surveys, thus further refining the sampling universe. Detection of short term changes in steelhead escapement remains difficult given the apparent natural variability in redd density. This may affect our evaluation of restoration efforts and management decisions in the short term (Maxell 1999), but the strength of our data grows as we continue through time and develop strong temporal trends.

Inter-observer variation in redd identification can be another source of variation in redd-count based escapement estimation. For example, Dunham et al. (2001) and Muhlfeld et al. (2006) suggest that observer variability creates error when estimating bull trout escapement with redd counts, especially when inexperienced observers conduct surveys. We currently supply annual training for redd identification to survey crews and rely heavily on experienced crew members for survey teams. Additionally, during 2012 we will conduct repeat surveys wherein multiple observers survey the same stream section in a single day to quantify inter-observer variability in redd identification. Even with experienced surveyors, distinguishing between true redds (steelhead-created structures which conceal all or part of the eggs of one female steelhead) and incomplete redds or "test digs" can be difficult. Holecek and Walters (2007) found that a large number of test digs were misidentified as redds while conducting spawning surveys of an adfluvial rainbow trout population in Idaho. The sampling artifact of redd misidentification is corrected by our annual fish per redd value because they are developed using the same redd identification protocol. The fish per redd values simply relate what we identify as redds to the actual fish escapement at a weir on our reference stream. Using this fish per redd value obviates the need to determine whether a steelhead-created structure is actually a redd, provided that observers are consistent in identifying steelhead-created structures.

A CV of 15% may be an unrealistic expectation of precision for adult spawner escapement estimates in watersheds as large and variable as the John Day. Our method of estimation requires no in-stream infrastructure. There are no significant weirs on the John Day River to capture and handle adults at the population scale. There is a weir on Bridge Creek operated as part of the Bridge Creek IMW, however, this stream is not ideal for consistent weir operation during the seasonal flows experienced when steelhead are migrating upstream. The John Day River has no hatchery operation nor supplementation and is managed as a natural origin system so significant weirs have never been installed nor considered. We are exploring the use of capture/recapture techniques for estimating adult escapement using Passive Integrated Transponder (PIT) tags and in-stream antenna arrays. Boughton (2010) demonstrated that detection of returning PIT tagged adults can provide escapement estimates with an approximate CV of 10% if > 200 PIT tagged adults per population can be detected on their return migration. Since 2004, we have observed mean returns of 165 PIT tagged adults at Bonneville Dam from a mean annual tagging effort of 3,708 juvenile steelhead. However, fewer of these adults are detected in either the Mainstem John Day River, or individual subbasins. If proposed improvements to the PIT tag detection array at rkm 32 of the John Day River (M. Nesbit, NOAA Fisheries, personal communication) result in > 90% detection efficiency of returning adult steelhead; PIT tag capture/recapture will become a feasible method for estimating escapement of John Day origin wild adults into the John Day River MPG given our current level of tagging effort. With an approximate doubling of the number of juvenile steelhead tagged in combination with placing PIT tag detection sites in the Upper Mainstem and North Fork of the John Day River, we could provide estimates of John Day origin wild adults escaping to four of the five populations (South Fork, Upper Mainstem, Middle Fork and North Fork).

Lower Mainstem tributaries have accounted for the majority of redds constructed in any given year, suggesting that the Lower Mainstem habitat is an important component of adult steelhead spawning within the John Day Basin. With the exception of 2005, when water limited adult steelhead access to smaller tributaries, the Lower Mainstem tributaries have accounted for 52% of redd observations in the basin since 2004. There is potential for smolt production in the Lower Mainstem habitat as well. Unfortunately, we are currently unable to monitor Lower Mainstem smolt production.

In 2011 we estimated hatchery composition of adult steelhead at 4.2%, the lowest proportion since we began using the EMAP sampling design. Similarly, fewer than average hatchery strays were observed in other ongoing monitoring projects in the basin in 2011 (Appendix Table A1). Visual observations during spawning surveys potentially underestimate the hatchery fish component because of a bias towards detecting an adipose fin rather than determining its absence (Susac 2005). Furthermore, not all hatchery fish released in the Columbia River basin have adipose fin clips. In 2011, the Lower Mainstem had the majority of total fish and hatchery fish observations, a trend that has been apparent since 2004. Using our current protocol, it is possible that we overestimate basinwide hatchery proportion because the Lower Mainstem fish are apparently easier to observe on the spawning grounds and a higher relative proportion are of hatchery origin.

JUVENILE *O. MYKISS* MONITORING

Although juvenile *O. mykiss* were the most abundant salmonid found during 2011 fish surveys, they were absent at several sites in the Upper Mainstem John Day River subbasin; Rail Creek (Site ID: OJD03458-000013), Vance Creek (Site ID: OJD03458-000015), and the upper John Day River (Site ID: OJD03458-000081). These three sites were dominated by westslope cutthroat trout and bull trout. These species typically prefer cooler water than *O. mykiss* (Rodtka and Volpe 2007, Selong et al. 2001, Bear et al. 2007). Therefore these sites may be temperature limited in that they have insufficient degree days for *O. mykiss*. We will be able to elucidate this relationship with future years of temperature and habitat monitoring.

Native fish were predominant at a majority of our sampling sites. Juvenile spring Chinook salmon were the second most abundant salmonid, but only observed during sampling at six (15%) sites and generally at sites with larger bankfull widths (Middle Fork John Day River, Granite, and Clear creeks). Westslope cutthroat trout were only captured in the Upper Mainstem John Day River subbasin. Bull trout were captured infrequently in both the Middle Fork and Upper Mainstem John Day River subbasins. Non-native Brook trout were observed at two sites in the Trout Creek HUC5 drainage in the North Fork John Day River subbasin. Moreover, in the unnamed tributary to Trout Creek (Site ID: CBW05583-021738) brook trout abundance was much greater than *O. mykiss*, suggesting that brook trout may be out competing *O. mykiss* in this system.

Condition factor of *O. mykiss* did vary significantly between subbasins. However, this could be an artifact of the relatively low number of *O. mykiss* ≥100 mm FL sampled in both the LMJDR and UMJDR subbasins. This may especially be true for the lower 80 km of Rock Creek in the LMJDR, which was almost void of age-1+ fish at the 4 sites sampled in that section of stream. Site CBW05583-401098, located in the headwaters of Rock Creek, was the only site in Rock Creek where age-1+ *O. mykiss* were commonly captured. Relative lack of age-1 *O. mykiss* in the lower section of Rock Creek raises concerns about the fate of abundant young-of-year brood classes; possibly a result of high mortality or significant emigration at age-1. It is unlikely that fish from the lower section are migrating to the upper section (i.e., Site ID: CBW05583-401098) due to the high number of juvenile fish barriers (Banks, S., personal observation). Passive Integrated Transponder (PIT) tagging fish in Rock Creek could test these theories. Additionally, PIT tagging *O. mykiss* in Rock Creek could elucidate life history patterns of *O. mykiss* from the lower river. Currently, *O. mykiss* parr are tagged in the MFJDR subbasin, Bridge Creek in the LMJDR, and Murderers Creek in the SFJDR. Rotary Screw Traps (RSTs) capture and tag emigrating summer steelhead smolts. RST sites are in UMJDR at rkm 352, SFJDR at rkm 10, MFJDR at rkm 24, and the NFJDR at rkm 97.

Thus, life history patterns from *O. mykiss* in the LMJDR population tributaries are relatively unknown, and could perhaps differ from higher elevation populations within the John Day River MPG. PIT tagging may help elucidate the condition of *O. mykiss* and separate anomalous sites within each subbasin. Furthermore, scale sampling at annual sites will help better define age structure of *O. mykiss* throughout the basin.

Future years of CHaMP habitat and fish surveys will allow for a more comprehensive evaluation to be made regarding the status and trend in salmonid distribution and abundance over a variety of habitat and biological conditions throughout the basin. Future analysis of CHaMP habitat data will also allow for a quantitative assessment to be made regarding factors that could be influencing salmonid distribution and abundance.

CONCLUSIONS

ADULT STEELHEAD ESCAPEMENT

Sustained periods of high flow and a large peak discharge impaired redd visibility and possibly obscured redds before they could be observed. The difficult survey conditions experienced this year illustrate how susceptible redd counts and redd density estimates are to inter- and intra-annual variation. Correlative evidence supports our use of the Deer Creek weir as a surrogate for John Day River basin streams with a known population of adult steelhead and provides a suitable expansion factor. However, the estimate is based on a single site located in a separate drainage basin, therefore, a John Day River basin fish/redd constant generated from sites within the basin would be more appropriate, if it is possible to overcome monetary and logistical constraints.

To further improve our ability to estimate steelhead escapement in the John Day River basin, we need to refine the current distribution of steelhead spawning habitat by eliminating reaches with a zero probability of adult steelhead use (e.g., sites that are not accessible, consistently lack adequate discharge for utilization by adult steelhead, or do not have spawning gravel). Such refinements will allow us to focus limited staff and resources on sites which have a non-zero probability of adult steelhead use. We currently provide escapement estimates with 95% confidence intervals approximately 50% of the point estimate. Given similar precision even with increased sampling intensity within the South Fork subsample, increasing the sample size for the rest of the basin may not be sufficient to reduce sample variance. Refining the current steelhead sampling universe will reduce the number of sample reaches with zero redd counts and thus, reduce the variance of our escapement estimates. Alternatively, mark-resight approaches to estimating population size may be a feasible option if sufficient marked adults (with PIT tags or external tags) are available.

Finally, 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, including the relative productivity of tributaries with hatchery fish compared to tributaries where they are still absent. The use of genetic analysis to understand the influence of hatchery stocks and wild strays on John Day River wild summer steelhead stock genetics is one approach worth considering.

JUVENILE *O. MYKISS* MONITORING

Initiation of the CHaMP protocol in the John Day River basin in 2011, and continuation of the project in future years coupled with previous habitat and juvenile monitoring will provide much needed information for determining the status and trends in juvenile salmonid abundance and distribution and their habitat. We have completed one year of baseline data collection on juvenile salmonids and habitat conditions. This will give a better understanding of the distribution and abundance of native and non-native salmonids and condition of habitat in the basin. Furthermore, we recommend PIT tagging fish at annual sites and in the LMJDR subbasin for a better understanding of life history patterns throughout the basin.

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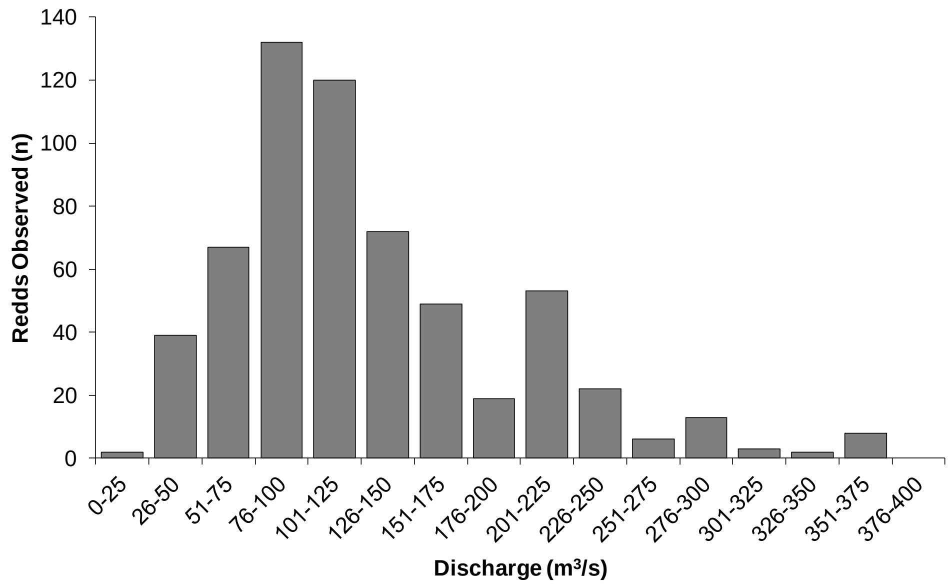
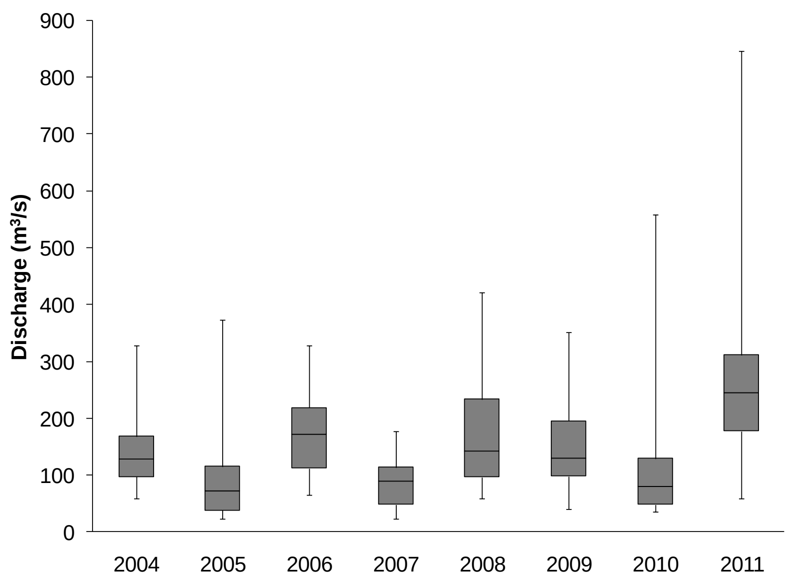
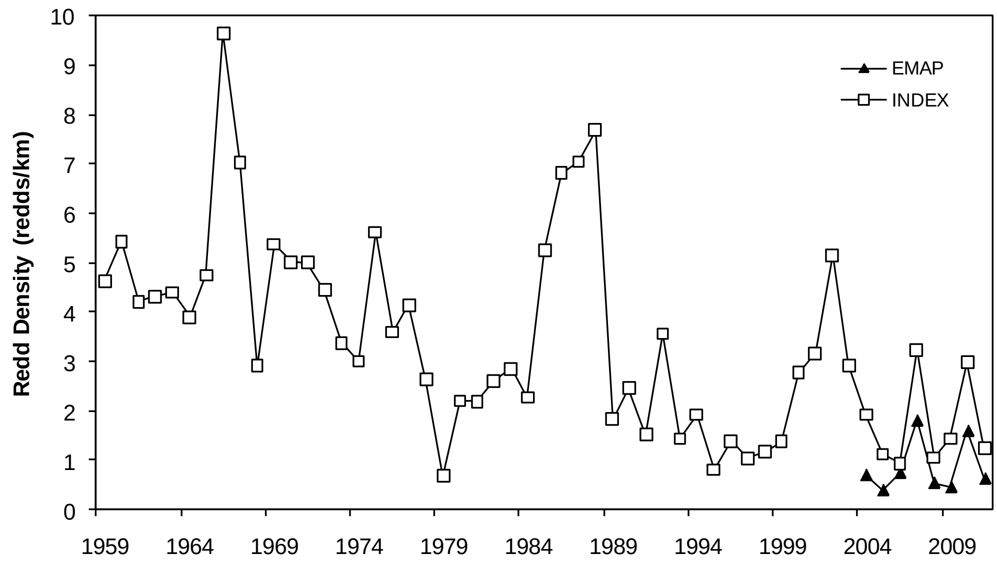
APPENDIX A



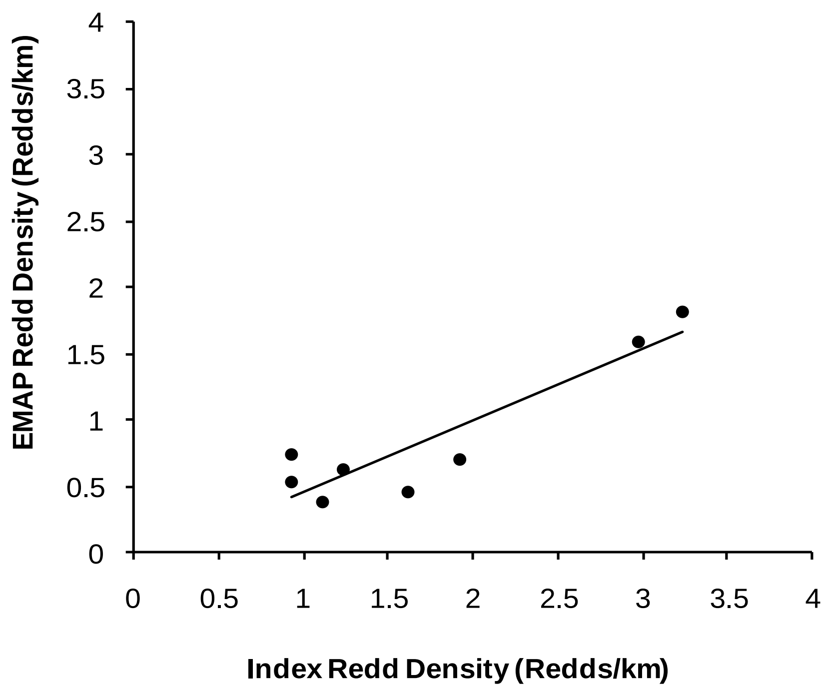
Appendix Figure A1. Number of redds observed during spawning surveys conducted in the John Day River basin from 2004 to 2011 versus mean daily discharge in the John Day River at Service Creek (rkm 252).



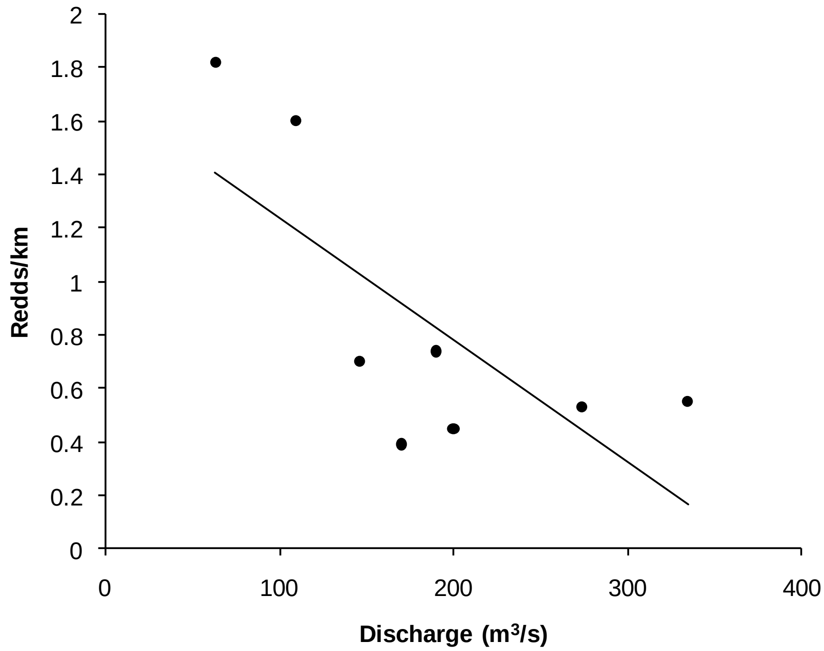
Appendix Figure A2. Mean daily discharge in the John Day River at Service Creek (rkm 252) from 1 March to 14 June for 2004 to 2011. Boxes include the median and are bound by lower and upper quartiles, whiskers represent minimum and maximum discharges.



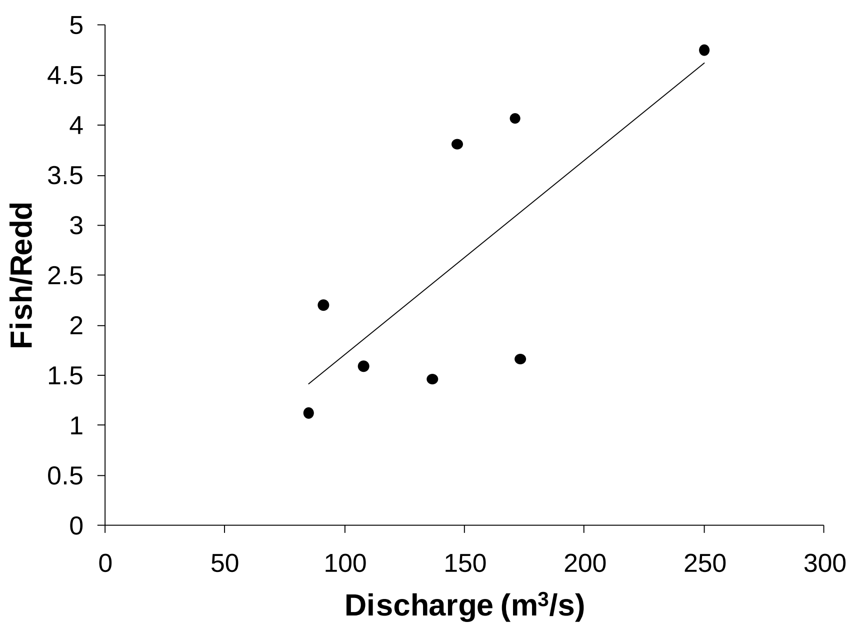
Appendix Figure A3. Redd density (redds/km) observed at EMAP and Index survey sites sampled by ODFW personnel in the John Day River basin from 1959 to 2011.



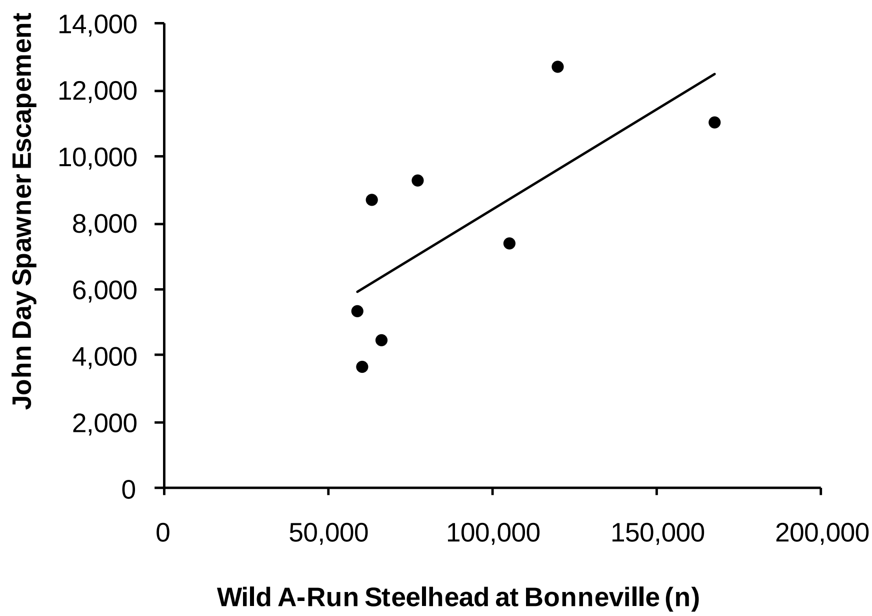
Appendix Figure A4. Relationship between Index redd density and EMAP redd density from 2004 to 2011 (R = 0.92, p-value < 0.01).



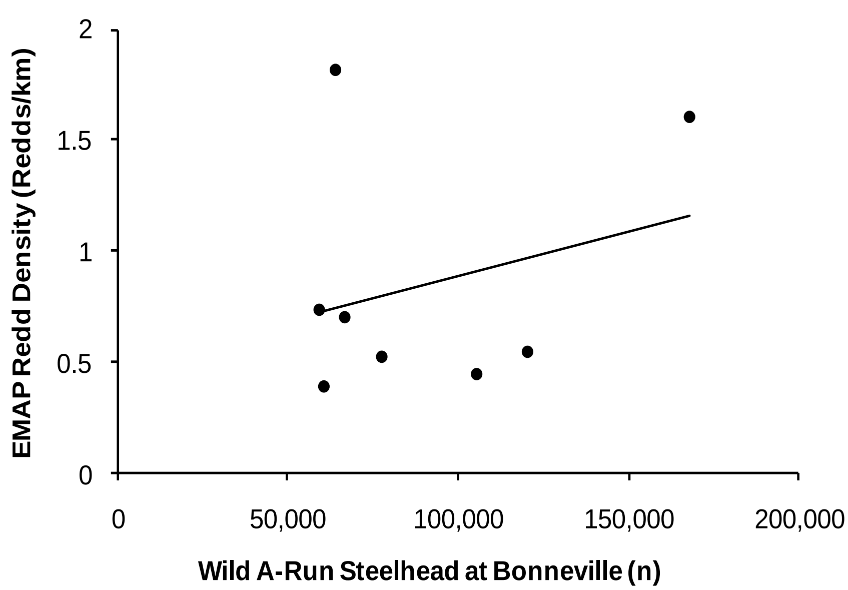
Appendix Figure A5. Relationship between mean discharge (m^3/s) during May in the John Day River at Service Creek (rkm 252) and redd density estimated from spawning surveys conducted from 2004 through 2011(r^2 = 0.53, p-value = 0.04).



Appendix Figure A6. Relationship between mean daily discharge in the John Day River at Service Creek (rkm 252) from 1 March to 14 June and fish per redd estimates from the Deer Creek weir for 2004 through 2011 (R = 0.75, p-value = 0.03).



Appendix Figure A7. Relationship between wild A-run steelhead counts at Bonneville Dam and EMAP steelhead spawner escapement estimate from 2004 to 2011 ($r^2 = 0.55$, p-value = 0.03).

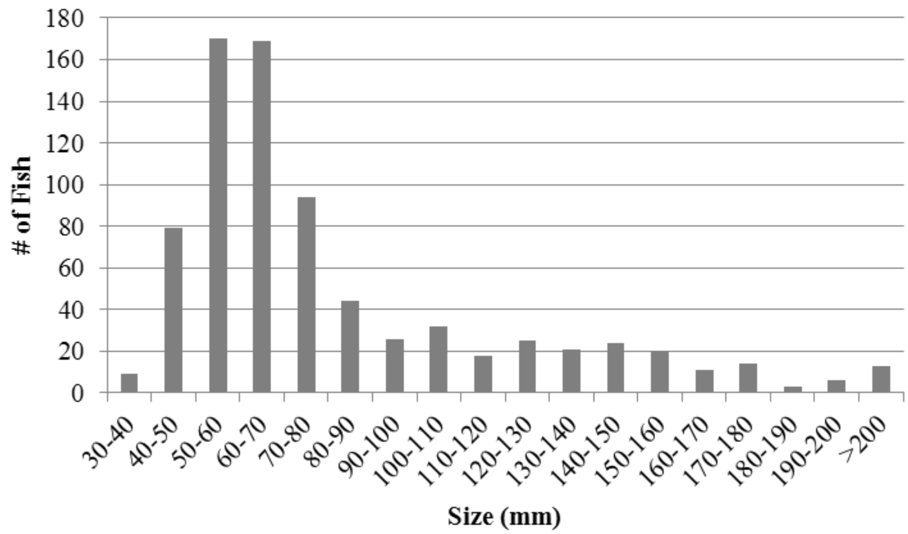


Appendix Figure A8. Relationship between wild A-run steelhead counts at Bonneville Dam and EMAP redd density estimates from 2004 to 2011 ($r^2 = 0.08$, p-value = 0.49).

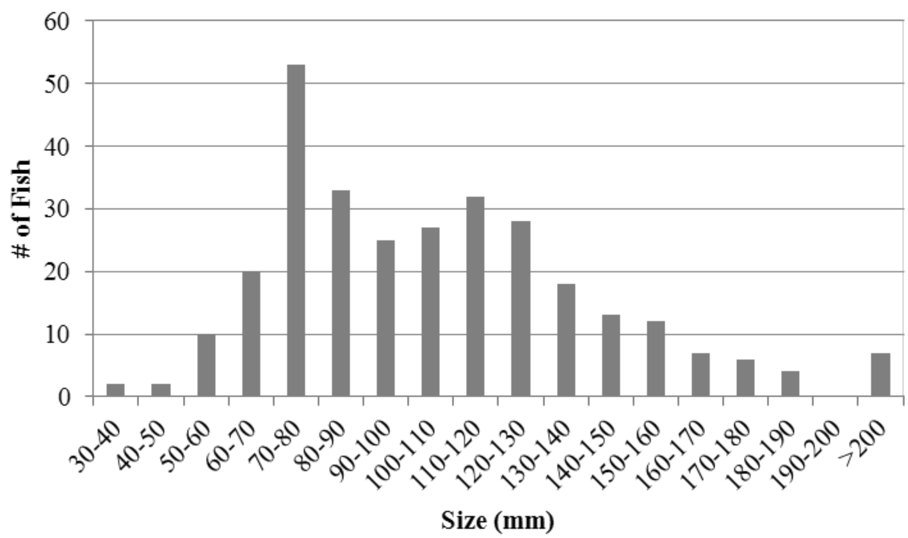
Appendix Table A1. Recovery year, number of wild steelhead, number of hatchery steelhead, and percent hatchery steelhead observed during Index steelhead spawning surveys in the John Day River basin (Jeff Neal, unpublished data), seining in the Mainstem John Day River between Kimberly (rkm 298) and Spray (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 and Keith DeHart, unpublished data).

	ODFW Index			**ODFW Juvenile Monitoring Project**		
Year	**Wild (n)**	**Hatchery (n)**	**% Hatchery**	**Wild (n)**	**Hatchery (n)**	**% Hatchery**
2000	--	--	--	11	1	8.3
2001	--	--	--	8	2	20.0
2002	173	16	8.5	20	13	39.4
2003	27	2	6.9	11	2	15.4
2004	12	1	7.7	16	6	27.3
2005	15	1	6.3	8	4	33.3
2006	22	4	15.4	10	5	33.3
2007	41	2	4.7	10	0	0.0
2008	28	2	6.7	19	1	5.0
2009	55	0	0.0	24	5	17.2
2010	57	5	8.1	24	1	4.0
2011	19	1	5.0	15	0	0
TOTAL	**449**	**34**	**7.0**	**176**	**40**	**18.5**

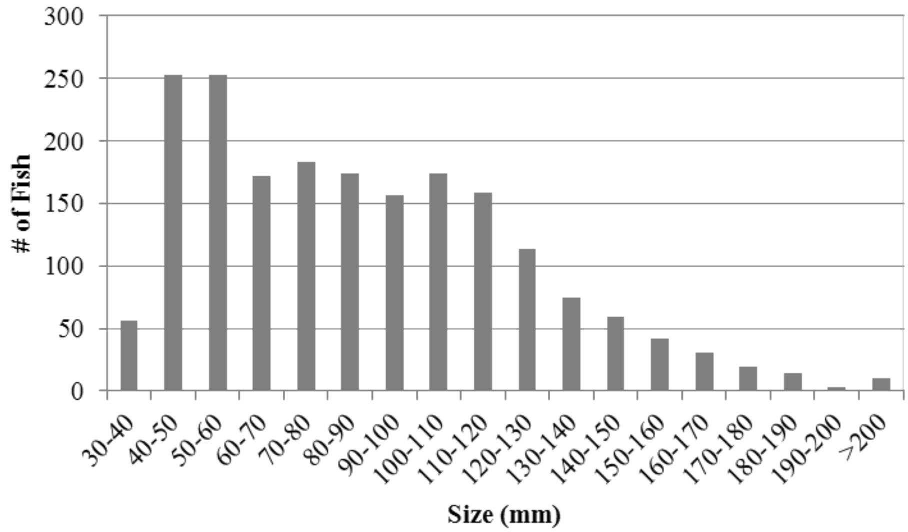
APPENDIX B



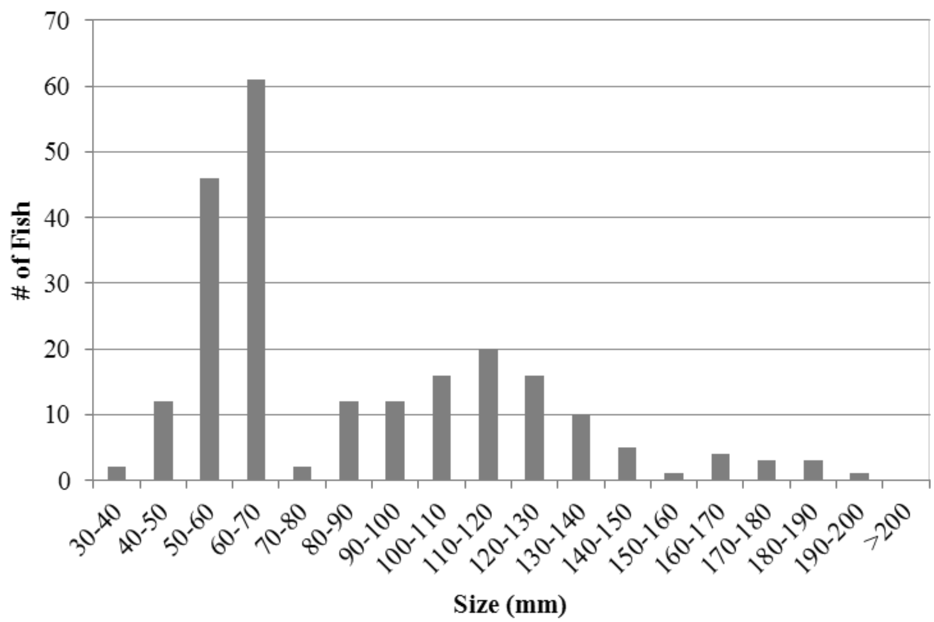
Appendix Figure B1. Length frequency histogram of juvenile *O. mykiss* sampled from the Lower Mainstem John Day River subbasin from June - September 2011.



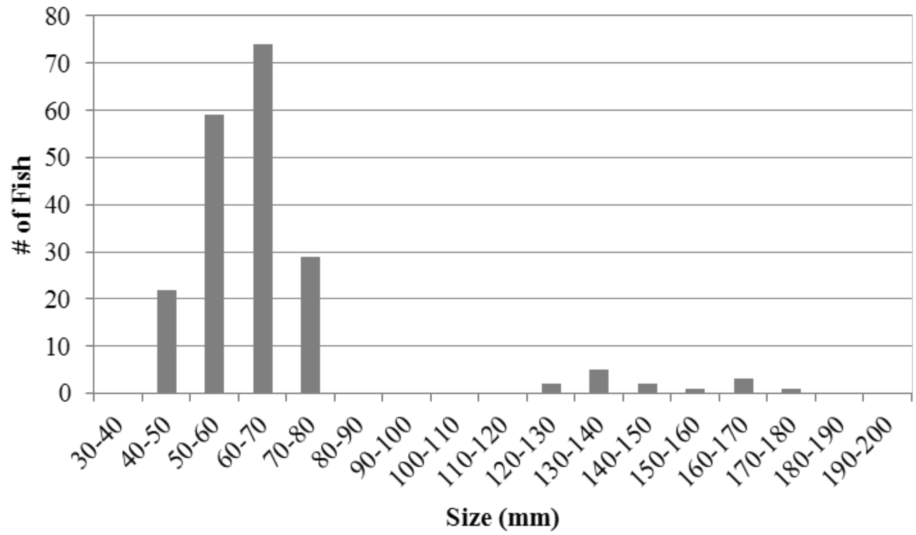
Appendix Figure B2. Length frequency of juvenile *O. mykiss* sampled from the Middle Fork John Day River subbasin from June - September 2011.



Appendix Figure B3. Length frequency of juvenile *O. mykiss* sampled from the North Fork John Day River subbasin from June - September 2011.



Appendix Figure B4. Length frequency of juvenile *O. mykiss* sampled from the South Fork John Day River subbasin from June through September 2011.



Appendix Figure B5. Length frequency of juvenile *O. mykiss* sampled from the Upper Mainstem John Day River subbasin from June - September 2011.