Fish Population Monitoring in the Middle Fork John Day River Intensively Monitored Watershed

Annual Technical Report

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EXECUTIVE SUMMARY

Recovery efforts for federally threatened mid-Columbia steelhead *Oncorhynchus mykiss* populations and spring Chinook salmon *O. tschawytsha* rely on habitat restoration efforts as a major approach to recovery. However, most effectiveness monitoring efforts accompanying restoration actions are not adequate to determine if the actions have benefited the target populations. Therefore, a series of Intensively Monitored Watersheds, including one in the Middle Fork John Day River, have been developed to understand the interaction of fish and their habitat as well as the impact restoration actions have at watershed scales. We conducted summer steelhead and spring Chinook salmon monitoring within the Middle Fork John Day River Intensively Monitored Watershed. Here, we report on fish monitoring efforts funded through this IMW effort. Detailed information regarding spring Chinook salmon escapement and steelhead and Chinook smolt emigration from this watershed will be reported elsewhere. During steelhead spawning surveys, we observed 163 redds constructed at 20 of 30 survey reaches. Using these observations, we estimate a redd density of 2.7 redds/km or 1,156 redds in the Middle Fork Intensively Monitored Watershed constructed by an estimated 1,843 returning adult steelhead. Collectively, we also tagged 4,028 juvenile steelhead, Chinook, and Bull trout *Salvelinus confluentus* from July to October 2010. Abundance estimates for juveniles varied among survey sites and seasons.

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* and spring Chinook salmon *O. tschawytsha* 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 John Day River summer steelhead, as threatened under the Endangered Species Act (ESA). Both the 2000 and 2004 Biological Opinions that outline the recovery strategy for steelhead and salmon within the Columbia Basin rely on stream restoration as a major approach to recovery. However, past restoration efforts have rarely included effectiveness monitoring programs to determine if projects have provided a benefit to the target population (Roni et al. 2002; Roni et al. 2005), including restoration efforts within the John Day River basin intended to improve steelhead and other salmonid freshwater production and survival (James et al. 2007). As a result, watershed scale coordinated restoration efforts, with the associated effectiveness monitoring programs, have been initiated in the Pacific Northwest, including the Middle Fork John Day River, to evaluate population level responses to restoration actions. These programs are programmatically referred to as Intensively Monitored Watershed (IMW) studies (PNAMP 2005). The goal of the IMW is to improve our understanding of the relationships between fish and their habitat (PNAMP 2005).

Within the Middle Fork John Day River IMW (MFJDR_IMW), several habitat factors have been identified as limiting for the recovery of summer steelhead. Degraded floodplain and channel structure, altered sediment routing, altered hydrology, and water quality (temperature) are cited as limiting factors in the Draft Mid-Columbia Steelhead Recovery Plan (Carmichael 2008). Current and proposed restoration efforts for the MFJDR_IMW are anticipated to address these key limiting factors. In order to assess restoration effectiveness on focal fish species, monitoring and analyses must emphasize population level spatial scales. Fish population monitoring for the MFDJR_IMW includes evaluating summer steelhead and spring Chinook population productivity, survival, and abundance. While abundance is an important metric for population assessments, survival and production will be key indicators of population responses to planned restoration activities. Freshwater survival is assessed from the parr to smolt life stages (parr to smolt survival) and ocean or out-of-basin survival is estimated as a smolt to adult return ratio (SAR). Freshwater productivity is assessed as smolts produced for constructed redds (smolts/redd).

Project Objectives

1. Estimate spawner escapement of summer steelhead and spring Chinook to the MFJDR.
2. Estimate freshwater productivity (smolts/redd) of spring Chinook and summer steelhead.
3. Estimate parr-to-smolt survival for summer steelhead and spring Chinook.
4. Delineate seasonal parr rearing habitat.

METHODS

Study Area

The Middle Fork John Day River originates in the Blue Mountains of the Malheur National Forest, flows westerly for 120 km, and merges with the North Fork John Day River about 30 km above the town of Monument (Figure 1). The Middle Fork John Day is a fourth field watershed (USGS cataloging unit 17070203) that drains 2,090 km^2 with a perimeter of 250 km. Watershed elevations range from 700 m near the mouth to over 2,500 m in the headwater areas. The watershed receives approximately 40-60 cm of precipitation each year. The fish metrics reported here refer to the portion of this watershed upstream of the town of Ritter at river kilometer 20 (Figure 2).

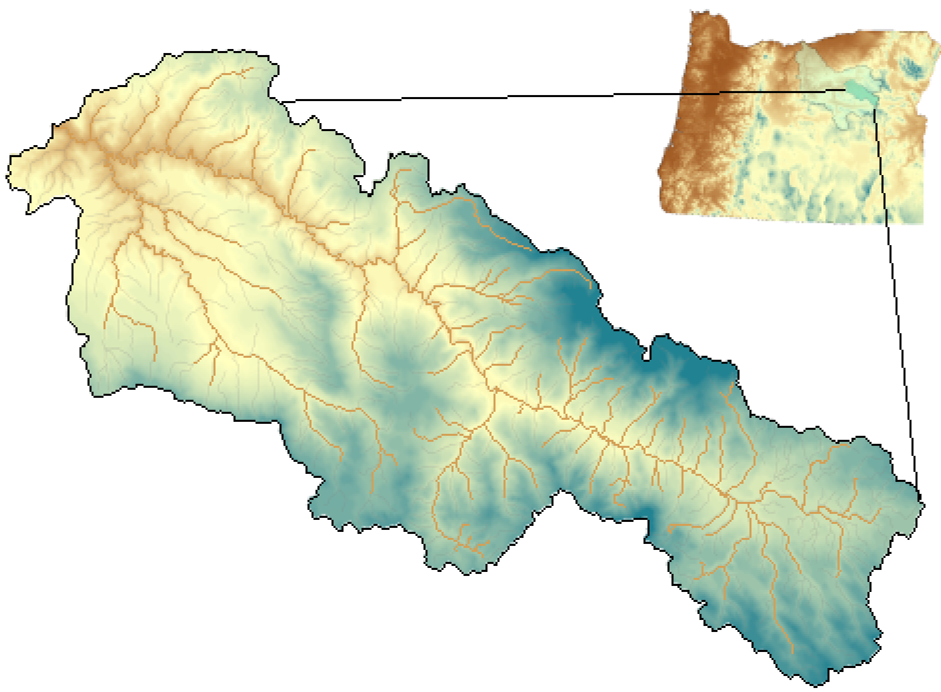

Figure 1. Map of the location of the Middle Fork John Day River and its tributaries in relation to the John Day River subbasin and the state of Oregon (Inset).

Steelhead Escapement Estimate

Steelhead redd surveys, based on standard ODFW methods (Susac and Jacobs 1999; Jacobs et al. 2000; Jacobs et al. 2001), were conducted during the spring (April to June) coinciding with steelhead spawn timing in the MFJDR. Survey sites were selected using a generalized random tessellation stratification (GRTS) design which randomly selects sites based on the spatial structure of the stream network of interest. Sites were then assigned to one of three different panels using the Environmental Monitoring and Assessment Protocol (EMAP): sites visited every year (Annual Sites), sites visited every other year beginning with year-1 (Two-1), or sites visited every other year beginning in year-2 (Two-2). Although assigning sites to a panel is usually performed in a random fashion, we were able to incorporate sites utilized by another steelhead monitoring project in the John Day River

Basin into our site selection to utilize their previously collected data and increase personnel and resource efficiencies. Thirty sites were selected to be surveyed each year and were equally distributed between Annual (n=15) and Two-year sites (n=15 for each panel). Additional sites were selected within each panel as replacement sites in the event that a site had to be removed due to access restrictions, unidentified in-stream barriers, or unsuitable haitat conditions.

We used a 1:100,000 EPA river reach file of summer steelhead distribution in the MFJDR subbasin for site selection (Figure 2). This spatial dataset is based on best professional knowledge provided by ODFW managers as well as other local agency biologists. The actual dataset utilized for site selection was modified to meet the objectives of this project. Specifically, stream segments downstream of a rotary screw trap (RST) operated by ODFW at river kilometer (Rkm) 24 (River mile 15) were excluded since this area was outside of the target IMW area.

Sites were surveyed on multiple occasions, to quantify the number of unique redds constructed at each site, at approximately two week intervals 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 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 (dd.dd – WGS84). During each visit, surveyors recorded the number of previously flagged redds and new unflagged redds.

Overall redd density (R_D) was estimated by:

$$R_D = \sum_{i=1}^{n} r_i/d_i \tag{1}$$

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 subbasin was estimated by:

$$R_T = R_D \cdot d_u \tag{2}$$

where d_u is the total kilometers available to steelhead for spawning (426 km). Steelhead escapement (E_S) was then estimated by:

$$E_S = C \cdot R_T \tag{3}$$

where C is an annual fish per redd constant (1.6 fish/redd for 2010) developed from repeat spawner surveys in the Grande Ronde River basin (Flesher et al. 2005; Lance Clarke, Jim Ruzycki, ODFW, unpublished data). 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 utilized to estimate 95% confidence intervals of the escapement estimate using R statistical software (R Development Core Team 2005).

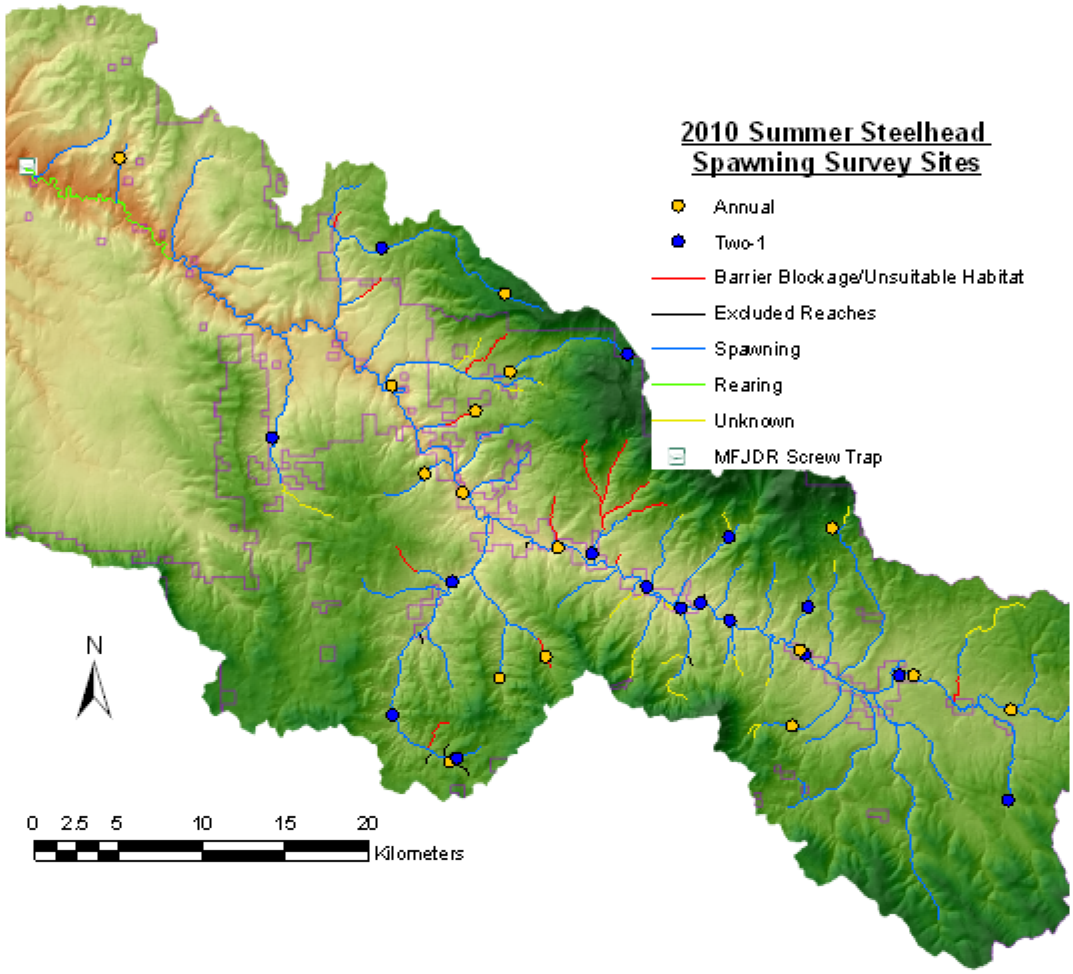

Figure 2. Map of summer steelhead distribution used for selecting steelhead spawning survey sites, with Annual and Two-1 sites sampled in 2010. The rotary screw trap (MFJDR Screw Trap) near Ritter, OR, is shown for reference.

Chinook Spawning Escapement

Census surveys are conducted to monitor adult Chinook spawning escapement over the entire spawning habitat in the Middle Fork sub-basin and are generally conducted during mid to late September. Surveys are conducted by walking upstream through identified sampling reaches and counting observed redds, live fish, and sampling carcasses. Observed redds are flagged, numbered, and a waypoint is taken with a hand-held GPS (Garmin) to map redd locations. Carcasses are sampled for length (MEPS and FL), assessed for gill lesions, sexed, and if female, a determination of spawning success is defined. For further details on Chinook spawning methods and results, refer to McCormick et al. (2010).

Parr Monitoring

Granite Boulder Creek and Camp Creek were selected for parr to smolt survival monitoring because of the differences in temperatures recorded during the summer rearing season. Camp Creek is generally warmer than Granite Boulder Creek during summer months. Each stream was divided into reaches based on the current summer steelhead distribution and topographical features from 1:24,000 quad topographic maps. Although both summer steelhead and spring Chinook were targeted in this sampling, summer steelhead distribution was utilized for both species because steelhead distribution encompasses the entire known distribution of spring Chinook. Within each reach, three sites were selected for monitoring (Figure 3). Sites were determined by utilizing the GIS layer developed by EMAP for steelhead spawning surveys in the MF_IMW (see Steelhead Escapement Estimate). Specifically, the first point encountered in each reach proceeding in an upstream direction was selected as a sampling site. Depending on whether that point was in the first third, middle third, or latter third of the reach, all other site locations in the reach were located a distance equal to 1/3 of the reach distance from the other sampling points within that reach, resulting in one sampling site occurring in each third of the reach. Coordinates were extracted for each site from ArcGIS to locate sites in the field. Because of logistical and time constraints not all sites were sampled during the current year and only sites labeled as 'Primary' were sampled during 2010. To reach our tagging goal for juvenile Chinook salmon (Table 1) we also sampled fish within the MFJDR between Camp Creek and Bridge Creek.

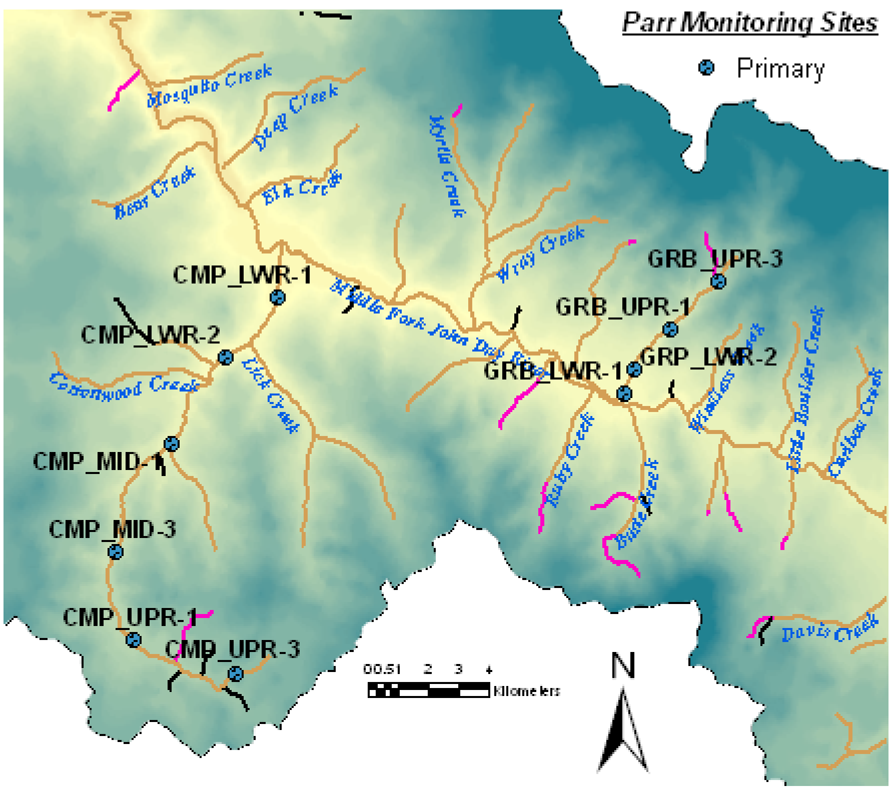

Figure 3. Parr Monitoring sites and associated site codes for Camp Creek and Granite Boulder Creek.

Table 1. PIT-tagging goals by stream and species for 2010.

Stream	Chinook	Steelhead	Total Tags
Camp Creek	100	600	700
Granite Boulder Cr.	200	600	800
Middle Fork JDR	1,500		1,500
Total Tags	*1,800*	*1,200*	*3,000*

Site lengths were 20 times the average active channel width (ACW) measured at five locations near the site point. The site point was considered the mid-point of the sampling section, however in some instances the section was moved upstream or downstream to avoid constraints from secondary channels or tributaries where necessary. Block nets were employed at the upstream and downstream extents of each sample section to eliminate fish movement during sampling. Sites were sampled once a day for three consecutive days. Block nets remained in place until sampling was completed on the third day at each site. Fish collection at all sites in Camp Creek and Granite Boulder Creek were conducted using a backpack electorshocker (Smith-Root LR20B). Within the Middle Fork John Day River, fish were collected by snerding, where a snorkeler would enter at the head of a pool and attempt to herd fish downstream into a 12’ wide by 4’ high seine with a 2’x2’ bag anchored at the pool tailout.

Once collected, fish were placed into an aerated 5gal. bucket and transferred to instream live boxes where they were held until the entire site was sampled and tagging operations commenced. Captured juvenile spring Chinook, steelhead, and Bull trout *Salvelinus confluentus* were anesthetized with tricane methane sulfonate (MS-222), interrogated for passive integrated transponder tags (PIT tags), weighed to the nearest 0.1 g, and fork length (FL) measured to the nearest millimeter (mm). Scales were taken from a subsample of steelhead collected that were larger than 60 mm. Subsamples were grouped into 10 mm bins and 15 samples were collected in each bin during summer sampling and 15 samples collected during fall sampling. All bull trout were sampled for scales. All anesthetized fish were allowed to recover in an aerated bucket until they regained equilibrium (~5-10 min). Once recovered, fish were released in small groups throughout the site and allowed to distribute themselves naturally within the sampling reach.

Encounter histories were developed for each tagged steelhead to estimate population abundance. A closed capture model (Otis et al. 1978) was used to analyze the encounter histories by site in Program MARK (White and Burnham 1999). This analysis utilizes a log maximum likelihood probability to estimate both capture (p) and recapture (c) probabilities as well as population abundances (N). Model variables for capture and recapture estimates can vary temporally, or can be constant, either together or separately. For each site, three potential models were fit to the data (Table 2). The most parsimonious model was selected based on the lowest Akaike Information Criteria (AICc) value. When AICc values of two or more potential models differed by less than two, the model with fewer parameters was selected.

PIT-Tag Detection Histories

We assessed PIT-tag detection histories of all fish tagged as part of the MF IMW project by querying tagging and interrogation files for observation of these fish. Fish tagged in the MF IMW have the potential to be interrogated at remote instream antenna arrays located in the Middle Fork John Day River near Mosquito Creek, in the John Day River near McDonalds Ford, and at John Day Dam, Bonneville Dam and the Columbia River estuary. Other observations are also possible during collection events within streams where surveys are being conducted as well as at the MF RST near Ritter, OR. Detection histories were grouped by species (spring Chinook or summer steelhead), tag site (Camp Creek, Granite Boulder Creek, or the MFJDR), and by tag year. Subsequent interrogations were grouped by observation site and year of observation where observation year began on 1-July and ended on 30-June the following year to incorporate in-stream tagging events and align with migratory years that overlap from fall to spring. Operation of the instream antenna array in the MFJDR also allows us to interrogate returning adult fish that may cross our antenna to spawn upstream. This information allows us to assess the origin of these fish as they migrate past our array by querying tag files within PTAGIS (PTAGIS).

Table 2. Models fit to encounter history data, description of the models, and the number of parameters in the associated model. All models also parameterized population abundance, which is not included in this table.

Model	Model Description	# of Parameters
p(.),c(.)	Capture and recapture are constant but not equal	2
p(.)=c(.)	Capture and recapture are constant and equal	1
p(t)=c(t)	Capture and recapture vary temporally but equal during individual sampling events	3

Smolt Abundance

Juvenile spring Chinook and steelhead migrants were captured using a 1.52 m rotary screw trap (RST) operated on the Middle Fork John Day River near Ritter (see Figure 2). Trap operation typically begins during early October and continues into June of the following year to encompass a migration year. The trap was either removed or stopped during times of ice formation, high discharge, and during warm summer months after fish ceased migrating.

The RST is typically fished four days/week by lowering cones on Mondays and raising cones on Fridays and is checked daily during these weekly fishing periods. We assumed that all fish captured were migrants. Non-target fish species were identified, enumerated, and returned to the stream. Captured juvenile spring Chinook and steelhead migrants were anesthetized with tricane methane sulfonate (MS-222), interrogated for passive integrated transponder tags (PIT tags) or pan jet paint marks, enumerated, weighed to the nearest 0.1 g, and measured (fork length, FL; mm). A subsample of fish was released above the trap to estimate migrant abundance using mark-recapture techniques. Further details of our RST operation are available in Wilson et al. (2010).

Summer Rearing Distribution

Summer rearing distribution of juvenile Chinook salmon within the MFJDR_IMW was assessed by snorkeling or electro-fishing pools in tributaries of the Middle Fork John Day River. Sampling proceeded upstream from the tributary mouth noting the presence or absence of juvenile Chinook, steelhead, or Bull trout based on reported juvenile Chinook data (Figure 4). Locations of all pools sampled were recorded with a handheld GPS along with focal fish presence/absence. Within tributary streams, we sampled every fifth pool beginning at the first pool upstream of the tributary confluence. In the event that no juvenile Chinook were observed in a sampled pool, we proceeded to sample every pool encountered, until a juvenile Chinook was encountered at which point we returned to sampling every fifth pool. If no juvenile Chinook were encountered after sampling five consecutive pools, sampling ceased in that tributary.

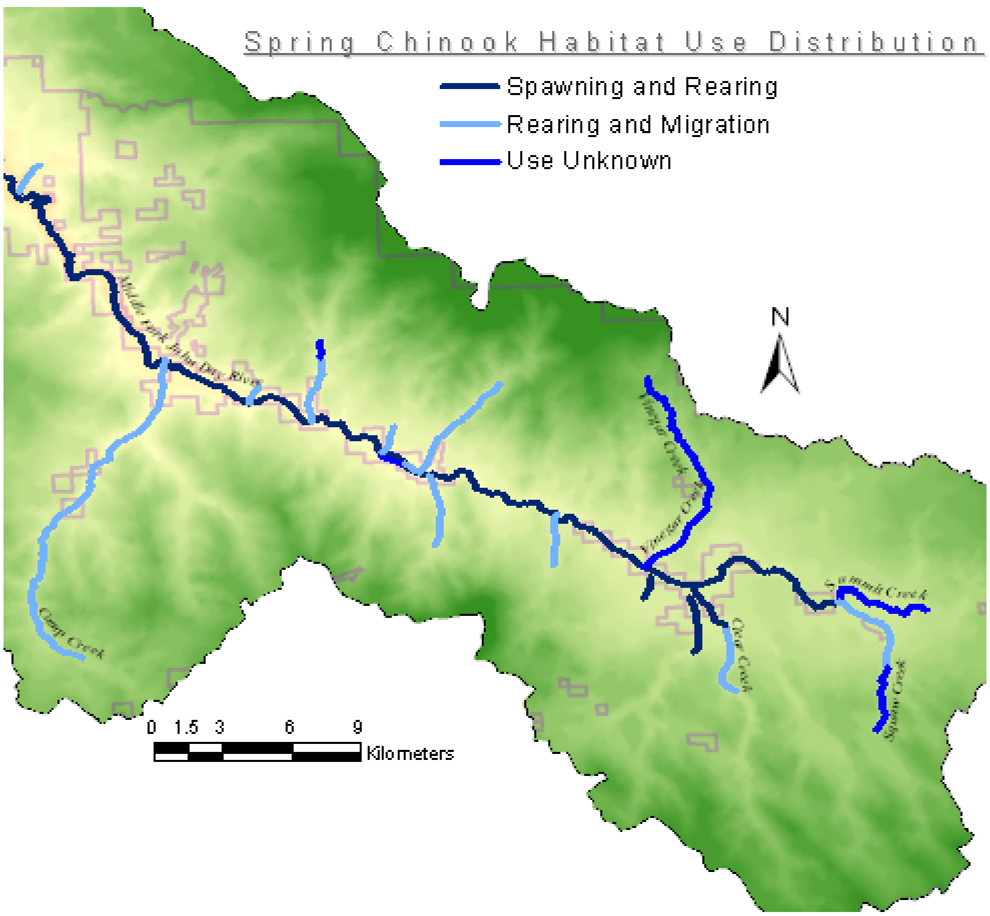

Figure 4. Spring Chinook habitat use distribution in the Middle Fork John Day River Intensively Monitored Watershed upstream and including Big Creek.

RESULTS

Summer Steelhead Escapement

We surveyed 30 sites for spawning adult summer steelhead in the Middle Fork John Day River from 30 March to 16 June 2010 (Table 4). We observed 163 total redds at 20 of the 30 sites surveyed (77%). Corresponding redd densities at all sites ranged from zero to

15.5 redds per kilometer (Table 3; Figure 5) and averaged 2.7 redds/km (Table 5). Given this redd density, we estimate that 1,156 redds were constructed in the MFJDR_IMW by 1,843 returning adults (Table 5).

Table 3. Total redds, redd density and number of wild, hatchery, and unknown origin steelhead observed at spawning ground survey sites in the MFJDR_IMW during 2009.

Stream	Site ID	Total Redds	Redd Density (redds/km)	Wild Steelhead	Hatchery Steelhead	Unknown Origin Steelhead
Rush Creek	101	1	0.50	0	0	0
Mosquito Cr.	106	0	0.00	0	0	0
Summit Creek	108	4	1.90	1	0	0
Indian Creek	109	0	0.00	0	0	0
Camp Creek	110	19	9.50	15	0	3
Lick Creek	111	0	0.00	0	0	0
W.F. Lick Cr.	114	5	2.50	0	0	0
MFJDR	115	0	0.00	0	0	0
Davis Creek	116	11	5.50	1	0	1
Bear Creek	118	0	0.00	0	0	0
MFJDR	119	0	0.00	0	0	0
MFJDR	120	5	2.38	0	0	0
Big Creek	122	4	2.00	4	0	1
Vinegar Creek	123	3	1.50	1	0	1
Big Creek	201	0	0.00	0	0	0
Big Boulder Cr.	203	9	4.50	3	0	1
Caribou Creek	204	4	2.00	0	0	0
Camp Creek	205	9	4.50	2	0	4
Beaver Creek	207	28	14.74	6	0	0
Butte Creek	208	31	15.50	2	0	2
Camp Creek	209	9	4.50	3	0	1
Granite Boulder Cr.	211	4	2.00	2	0	0
Indian Creek	214	1	0.56	0	0	3
MFJDR	215	0	0.00	0	0	0
Squaw Creek	216	2	0.95	0	0	0
Camp Creek	217	4	2.00	2	0	0
MFJDR	220	0	0.00	0	0	0
Slide Creek	221	9	3.91	1	1	2
MFJDR	223	0	0.00	0	0	0
MFJDR	224	1	0.43	0	0	0

Initiation of redd construction started in early April 2010 with spawning activity peaking during May (Figure 6). Few redds were observed after a large flow event of approximately 2,500 cfs in early June (Figure 6), which may have obscured further observation of newly constructed redds.

Chinook Spawning Escapement

We observed 183 redds and sampled 210 carcasses during census surveys for Spring Chinook salmon (see McCormick et al. 2011 for full results).

Parr Monitoring

We collected and tagged a combined 4,028 juvenile steelhead, juvenile Chinook salmon, and Bull trout during July and October 2010 (Table 6). Nearly half (1,116) of the juvenile steelhead tagged were captured and tagged during the fall in Camp Creek (Table 6). This disproportionate sampling appears to be partially the result of a very strong year class of age-0 steelhead present in Camp Creek during October (Figure 7).

Table 4. Stream name, site identification number, site coordinates (DD.DD, WGS-84), panel type, reach length, and survey dates for steelhead spawning ground surveys conducted during 2008 in the Middle Fork John Day River IMW.

Stream	Site ID	Start Coordinates (DD)		End Coordinates (DD)		Panel Type	Distance (km)	Survey Dates				
		Latitude	Longitude	Latitude	Longitude			1	2	3	4	5
Bear Creek	118	44.72279	-118.83202	44.71159	-118.85023	Annual	2.0	3/31	4/14	4/29	5/12	5/25
Beaver Creek	207	44.65306	-118.67645	44.66683	-118.66424	Two1	1.9	4/7	4/15	4/29	5/12	5/27
Big Boulder Cr.	203	44.66615	-118.71613	44.68254	-118.71193	Two1	2.0	4/7	4/29	5/13		
Big Creek	122	44.76916	-118.78721	44.77627	-118.76908	Annual	2.0	4/14	4/28	5/12	6/16	
Big Creek	201	44.78802	-118.70816	44.77908	-118.68759	Two1	2.0	6/11				
Butte Creek	208	44.64112	-118.65109	44.62368	-118.64658	Two1	2.0	4/8	4/19	5/6	5/27	
Camp Creek	110	44.56925	-118.84995	44.56060	-118.82869	Annual	2.0	4/20	5/3	5/17	6/3	
Camp Creek	205	44.59856	-118.87045	44.58186	-118.86809	Two1	2.0	4/20	5/3	5/17	5/28	
Camp Creek	209	44.66412	-118.80971	44.65306	-118.82754	Two1	2.0	4/6	4/27	5/14	6/1	
Camp Creek	217	44.56060	-118.82517	44.56911	-118.80526	Two1	2.0	4/20	5/3	5/17	6/3	
Caribou Creek	204	44.62572	-118.56631	44.64011	-118.55493	Two1	2.0	4/8	4/19	5/4	5/19	
Davis Creek	116	44.57668	-118.55641	44.57740	-118.58000	Annual	2.0	4/22	5/7	5/27		
Granite Boulder Cr.	211	44.66702	-118.63133	44.67901	-118.61363	Two1	2.0	4/23	5/7	6/1		
Indian Creek	109	44.82456	-118.80019	44.81340	-118.77983	Annual	2.1	6/7				
Indian Creek	214	44.94419	-118.89086	44.83923	-118.87231	Two1	1.8	4/27				
Lick Creek	111	44.62634	-118.76067	44.61007	-118.75147	Annual	2.0	4/22	5/4			
MFJDR	115	44.62157	-118.57913	44.61668	-118.56166	Annual	1.9	6/14				
MFJDR	119	44.67462	-118.74974	44.67266	-118.72723	Annual	2.0	6/15				
MFJDR	120	44.60390	-118.48398	44.59869	-118.46475	Annual	2.1	5/21	6/14			
MFJDR	215	44.63388	-118.61449	44.62976	-118.59653	Two1	1.6	6/15				
MFJDR	220	44.61668	-118.56166	44.60772	-118.54739	Two1	2.0	6/14				
MFJDR	223	44.64181	-118.63792	44.63532	-118.62119	Two1	2.0	6/15				
MFJDR	224	44.59397	-118.50098	44.60390	-118.48398	Two1	2.3	5/21	6/14			
Mosquito Cr.	106	44.74345	-118.82775	44.75012	-118.80361	Annual	2.1	4/2	4/28			
Rush Creek	101	44.87314	-119.07295	44.89066	-119.07083	Annual	2.0	3/30	4/12	5/5		
Slide Creek	221	44.74243	-118.95623	44.72481	-118.95845	Two1	2.3	4/1	4/13	4/26	5/10	5/24
Squaw Creek	216	44.54792	-118.40604	44.53022	-118.40996	Two1	2.1	4/30	5/21	6/10		
Summit Creek	108	44.58652	-118.41705	44.58047	-118.39681	Annual	2.1	5/19	6/10			
Vinegar Creek	123	44.67240	-118.52240	44.68412	-118.53688	Annual	2.0	5/26	6/16			
W.F. Lick Cr.	114	44.62350	-118.78779	44.60543	-118.78974	Annual	2.0	4/22	5/4	5/18	6/3	

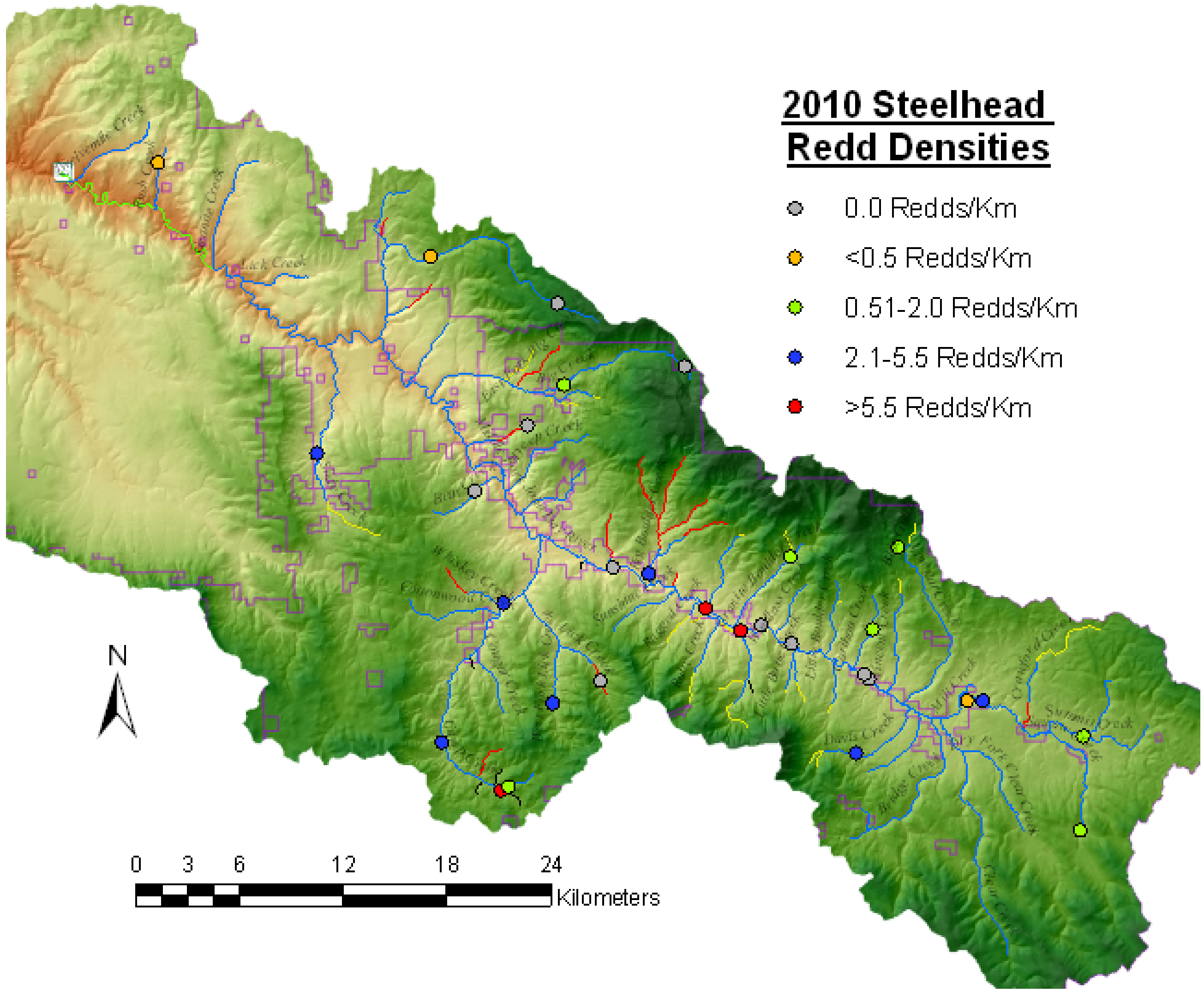

Figure 5. Redd densities at steelhead spawning sites surveyed during 2010 in the Middle Fork John Day River IMW.

Table 5. Distance surveyed, number of redds observed, estimated redd density, total estimated redds, and spawner escapement (95%CLs), from 2008-2010 summer steelhead spawning surveys in the MFJDR_IMW.

Year	Kilometers Surveyed	Unique Redds	Redd/Km	Total Redds	Escapement	95% LCI	95% UCI
2008	57.5	24	0.41	192	769	-135	1,675
2009	57.9	76	1.30	556	2,114	1,326	2,901
2010	60.3	163	2.7	1,141	1,820	1,041	2,598

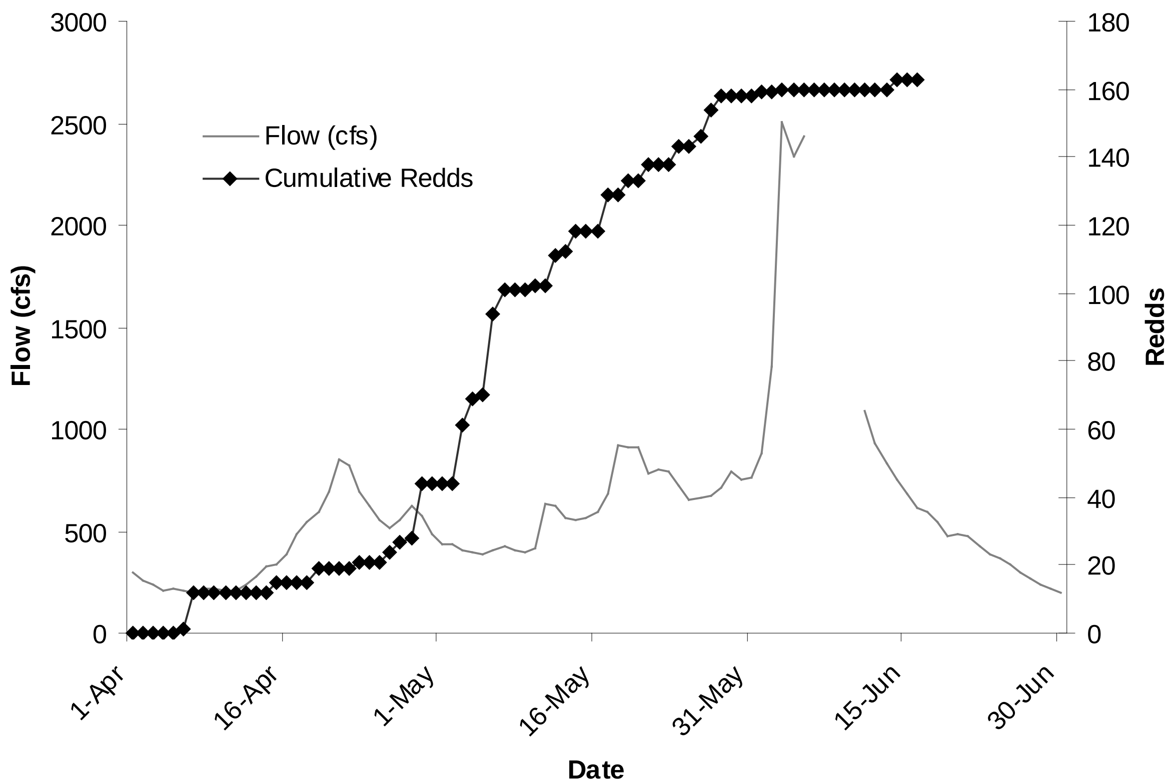

Figure 6. Cumulative redd construction in the Middle Fork John Day River IMW and mean daily discharge measured at the USGS gauging station near Ritter, OR from 1-April-2010 to 30-June-2010.

Table 6. PIT-tagging results for parr to smolt monitoring of juvenile steelhead, Chinook, and Bull trout in the MFJDR_IMW during Summer (June-July) and Fall (October) of 2010. No sampling was conducted in the MFJDR during the Fall period.

	Summer				Fall			
	Steelhead	**Chinook**	**Bull Trout**	**Total**	**Steelhead**	**Chinook**	**Bull Trout**	**Total**
Camp Cr.								
CMP_LWR-1	234	49		283	214	113		327
CMP_LWR-2	127	15		142	231	57		288
CMP_MID-1	99			99	283	13		296
CMP_MID-3	49			49	137			137
CMP_UPR-1	48			48	179			179
CMP_UPR-3	44			44	72			72
Total	**601**	**64**		**665**	**1,116**	**183**		**1,299**
Granite Boulder Cr.								
GRB_LWR-2	74	1	1	76	45	1		46
GRB_UPR-1	22		3	25	35			35
GRB_UPR-3	25		9	34	32		6	38
Total	**121**	**1**	**13**	**135**	**112**	**1**	**6**	**119**
MFJDR	*139*	*1,671*		*1,810*				
TOTAL	**861**	**1,736**	**13**	**2,610**	**1,228**	**184**	**6**	**1,418**

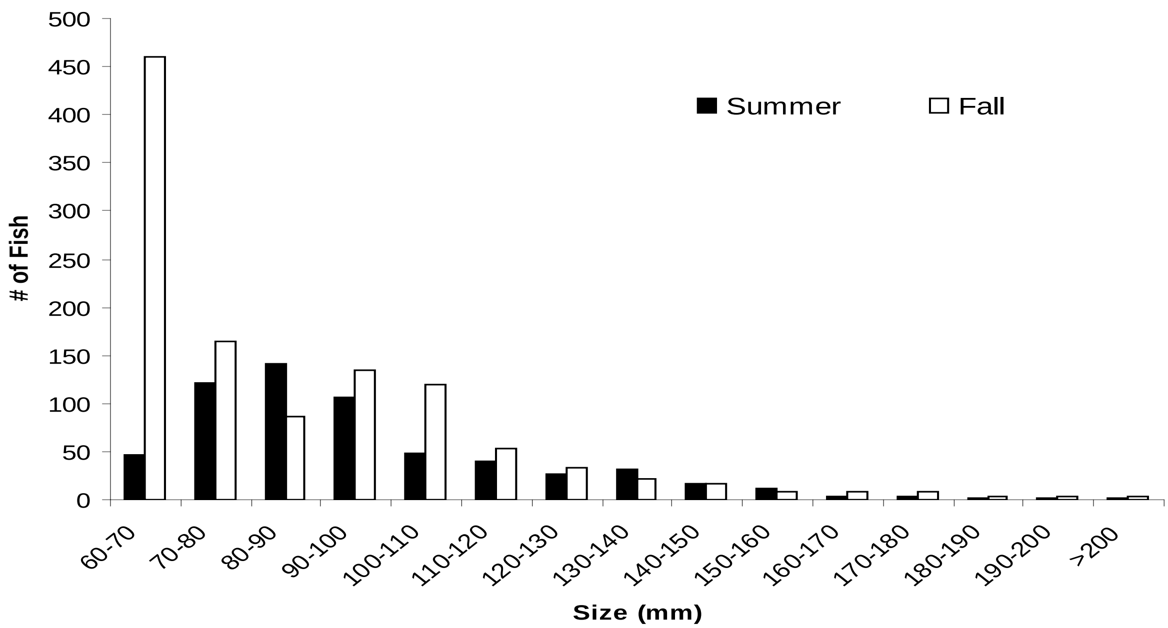

Figure 7. Number of juvenile steelhead by 10mm length increments collected in Camp Creek during Summer (June-July) and Fall (October-November) 2010.

Population modeling for abundance estimates of juvenile steelhead yielded varying results among both streams and sites (Figure 9). Although we tagged a greater number of fish in Camp Creek in the Fall compared to Summer, we did not observe a statistically larger population estimate for most sites (Figure 9). Granite Boulder Creek abundance estimates were similar during fall and summer except in GRBLWR-2 (Figure 8).

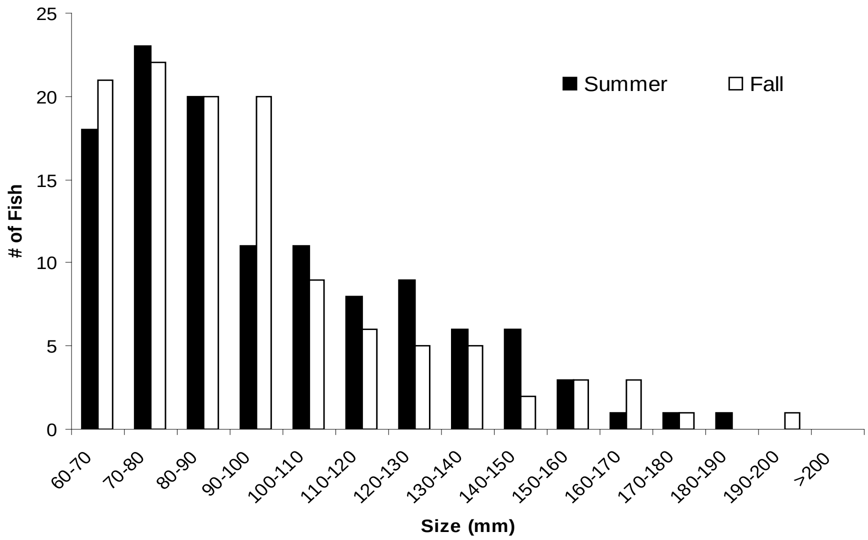

Figure 8. Number of juvenile steelhead by 10mm length increments collected in Granite Boulder Creek during sampling in Summer (June-July) and Fall (October) 2010.

A total of 1,920 juvenile Chinook were collected and tagged in MFJDR_IMW during July and October, 2009 (Table 6). The majority of these individuals were sampled from the MFJDR itself between Camp Creek and Bridge Creek (Table 6). The sampling that occurred in the MFJDR was not conducted as a mark-recapture event, therefore no abundance estimates are available.

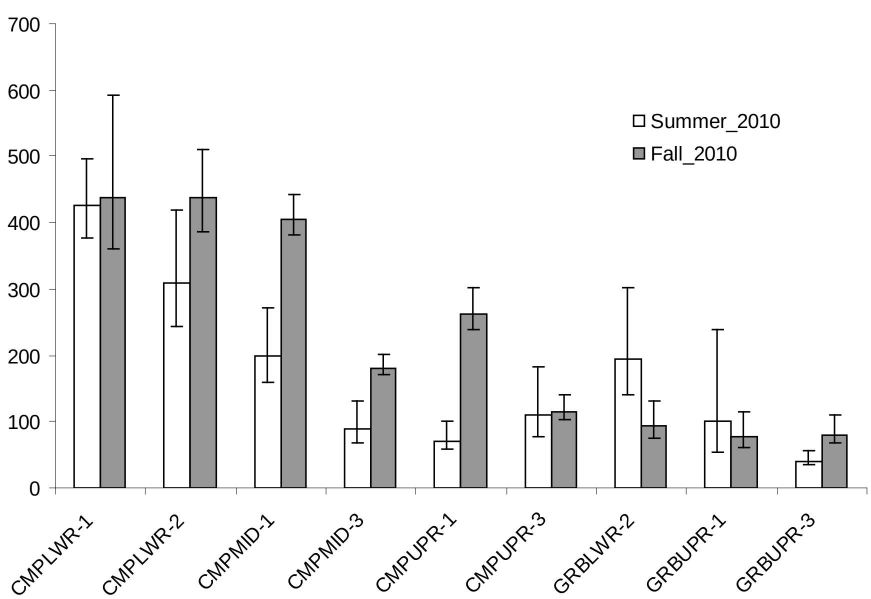

Figure 9. Abundance estimates (± 95% CI) for juvenile steelhead in Camp Creek (CMP prefix) and Granite Boulder Creek (GRB prefix) for Summer (June-July) and Fall (October-November) sampling during 2010. See Figure 3 for site location.

Table 7. Parsimonious model selection results and associated parameter estimates of encounter histories for juvenile steelhead tagged in Camp Creek during Summer and Fall of 2010 [p = probability of capture, c = probability of recapture, N = abundance estimate, (.) = constant parameter, (t) = parameter varies temporally].

	Summer					Fall				
Site	**Model**	**Parameter**	**Estimate**	**LCI**	**UCI**	**Model**	**Parameter**	**Estimate**	**LCI**	**UCI**
LWR-1	N,p(.)=c(.)	N	425.9	375.9	497.4	N,p(.),c(.)	N	437.3	359.7	592.5
		p	0.269	0.227	0.316		p	0.291	0.199	0.405
							c	0.148	0.114	0.190
LWR-2	N,p(.)=c(.)	N	309.5	243.0	419.4	N,p(.)=c(.)	N	438.2	387.2	510.8
		p	0.183	0.133	0.247		p	0.268	0.226	0.315
MID-1	N,p(.)=c(.)	N	200.3	159.7	271.5	N,p(t)=c(t)	N	406.3	381.1	442.4
		p	0.221	0.160	0.297		p_1	0.482	0.422	0.543
							p_2	0.401	0.346	0.458
							p_3	0.327	0.278	0.381
MID-3	N,p(.)=c(.)	N	89.0	69.5	131.6	N,p(.),c(.)	N	179.7	170.6	201.3
		p	0.258	0.171	0.370		p	0.552	0.454	0.646
							c	0.413	0.353	0.476
UPR-1	N,p(.)=c(.)	N	71.0	58.0	100.8	N,p(t)=c(t)	N	263.4	237.8	302.8
		p	0.310	0.214	0.426		p_1	0.285	0.225	0.353
							p_2	0.410	0.335	0.489
							p_3	0.345	0.278	0.420
UPR-3	N,p(.)=c(.)	N	110.3	78.0	182.8	N,p(t)=c(t)	N	115.3	102.4	140.4
		p	0.190	0.113	0.303		p_1	0.503	0.384	0.621
							p_2	0.225	0.152	0.320
							p_3	0.399	0.296	0.512

Table 8. Parsimonious model selection results and associated parameter estimates of encounter histories for juvenile steelhead tagged in Granite Boulder Creek during Summer and Fall of 2010 [p = probability of capture, c = probability of recapture, N = abundance estimate, (.) = constant parameter, (t) = parameter varies temporally].

	Summer					Fall				
Site	**Model**	**Parameter**	**Estimate**	**LCI**	**UCI**	**Model**	**Parameter**	**Estimate**	**LCI**	**UCI**
LWR-2	N,p(.)=c(.)	N	194.8	139.9	301.7	N,p(.)=c(.)	N	92.7	75.0	130.0
		p	0.166	0.105	0.252		p	0.284	0.198	0.388
UPR-1	N,p(.)=c(.)	N	99.7	54.1	239.3	N,p(.)=c(.)	N	78.4	62.0	115.3
		p	0.120	0.048	0.272		p	0.276	0.184	0.392
UPR-3	N,p(.),c(.)	N	39.0	35.7	57.0	N,p(t)=c(t)	N	80.1	66.9	109.5
		p	0.514	0.302	0.721		p_1	0.399	0.265	0.551
		c	0.122	0.056	0.247		p_2	0.374	0.247	0.523
							p_3	0.187	0.108	0.304

We captured and tagged a total of 19 Bull trout in Granite Boulder Creek during sampling events in 2010 (Table 9). Lengths of captured Bull trout ranged from 85 to 158 mm (Table 9).

Table 9. Bull trout PIT-tag codes, tag date, fork length (mm), and mass (g) captured and tagged in Granite Boulder Creek during 2010.

PITCode	TagDate	Fork Length (mm)	Weight (g)
3D9.1C2D45F0D1	19-Jul-10	116	14.9
3D9.1C2D45F6BD	19-Jul-10	102	10.0
3D9.1C2D460003	19-Jul-10	112	13.7
3D9.1C2D4624F5	21-Jul-10	109	12.5
3D9.1C2D463367	20-Jul-10	129	22.3
3D9.1C2D463424	21-Jul-10	114	12.5
3D9.1C2D577245	13-Jul-10	134	21.6
3D9.1C2D57DC7A	12-Jul-10	95	7.5
3D9.1C2D58036C	19-Jul-10	85	5.8
3D9.1C2D58662C	12-Jul-10	133	
3D9.1C2D58BF24	12-Jul-10	98	9.4
3D9.1C2D60C070	20-Jul-10	110	19.3
3D9.1C2D60C64D	21-Jul-10	158	40.2
3D9.1C2D637352	05-Oct-10	97	8.3
3D9.1C2D698B70	06-Oct-10	104	10.4
3D9.1C2D698D18	06-Oct-10	114	14.1
3D9.1C2D699028	06-Oct-10	129	19.2
3D9.1C2D699B87	06-Oct-10	94	
3D9.1C2D699E16	07-Oct-10	97	

PIT-Tag Detection History

A relatively small percentage (9-28%) of fish PIT-tagged in the Middle Fork John Day River IMW are ever re-observed during subsequent capture or interrogation events (Tables10-15). The fewest capture events occur at the MFJDR RST near Ritter, OR with a total of 109 captures (<2%) of all fish tagged as part of the IMW project.

Table 10. Total Detections of juvenile steelhead PIT-tagged in Camp Creek and subsequently detected at various interrogation/capture sites in the Middle Fork John Day River and smolt migration corridor. Numbers in parentheses represent the number of total fish detected at each site that were never observed again.

Tag Year	# Unique Tags	# Recaptured in Stream		# Detected @ MFJDR array		# Detected @ RST		# Detected outside MFJDR	
		2009	2010	2009	2010	2009	2010	2009	2010
2008	1055	56 (52)	4 (4)	40 (31)	31 (23)	2 (1)	5 (5)	35	19
2009	962	n/a	75 (70)	0	102 (94)	n/a	2 (1)	n/a	15

Table 11. Detections of juvenile steelhead PIT-tagged in Granite Boulder Creek and subsequently detected at various interrogation/capture sites in the Middle Fork John Day River and smolt migration corridor. Numbers in parentheses represent the number of total fish detected at each site that were never observed again.

Tag Year	# Unique Tags	# Detected in Stream		# Detected @ MFJDR array		# Detected @ RST		# Detected outside MFJDR	
		2009	2010	2009	2010	2009	2010	2009	2010
2008	461	56 (49)	17 (17)	3 (3)	14 (11)	1 (0)	0	4	10
2009	359	n/a	33 (33)	0	14 (12)	n/a	0	n/a	3

Table 12. Detections of juvenile steelhead PIT-tagged in the Middle Fork John Day River and subsequently detected at various interrogation/capture sites in the Middle Fork John Day River and smolt migration corridor. Numbers in parentheses represent the number of total fish detected at each site that were never observed again.

Tag Year	# Unique Tags	# Detected @ MFJDR array		# Detected @ RST		# Detected outside MFJDR	
		2009	2010	2009	2010	2009	2010
2008	34	0	0	0	0	3	0
2009	111	0	12 (7)	n/a	3 (1)	n/a	12

Table 13. Detections of juvenile Chinook PIT-tagged in Camp Creek and subsequently detected at various interrogation/capture sites in the Middle Fork John Day River and smolt migration corridor. Numbers in parentheses represent the number of total fish detected at each site that were never observed again.

Tag Year	# Unique Tags	# Detected @ MFJDR array		# Detected @ RST		# Detected outside MFJDR	
		2009	2010	2009	2010	2009	2010
2008	42	0	0	0	0	6	0
2009	292	0	71 (57)	n/a	6 (5)	n/a	20

Table 14. Detections of juvenile Chinook PIT-tagged in Granite Boulder Creek and subsequently detected at various interrogation/capture sites in the Middle Fork John Day River and smolt migration corridor. Numbers in parentheses represent the number of total fish detected at each site that were never observed again.

Tag Year	# Unique Tags	# Detected @ MFJDR array		# Detected @ RST		# Detected outside MFJDR	
		2009	2010	2009	2010	2009	2010
2008	94	0	0	7 (6)	0	12	0
2009	254	0	44 (29)	n/a	8 (6)	n/a	20

Table 15. Detections of juvenile Chinook PIT-tagged in the Middle Fork John Day River and subsequently detected at various interrogation/capture sites in the Middle Fork John Day River and smolt migration corridor. Numbers in parentheses represent the number of total fish detected at each site that were never observed again.

Tag Year	# Unique Tags	# Detected @ MFJDR array		# Detected @ RST		# Detected outside MFJDR	
		2009	2010	2009	2010	2009	2010
2008	950	0	0	39 (36)	0	115	0
2009	1285	0	234 (159)	n/a	36 (25)	n/a	97

Thirty returning adults tagged in the Middle Fork John Day River subbasin, both steelhead and Chinook, were detected at our instream PIT-tag antenna array during 2010 (Table 16). Of the 23 adult Chinook detected, one was age-3, 21 were age-4, and one age-5. Of the 7 adult steelhead detected four were 1-ocean fish and three were a 2-ocean fish.

Table 16. Middle Fork John Day River tagged fish detected as adults at the MFJDR in-stream PIT-tag antenna array during 2010.

Species	Juvenile MY	Ocean Residence	# Detected
Chinook	2007	3 yr	1
	2008	2 yr	21
	2009	1 yr	1
	2010	Precocious	0
Steelhead	2006	2 yr	3
	2007	1 yr	4

A total of eight adult steelhead and nine adult Chinook, which were PIT-tagged outside the MFJDR subbasin, were detected at the MF array during 2010 (Table 17).

Smolt Abundance

The smolt abundance estimate in the Middle Fork John Day River for spring Chinook salmon was 35,712 and for summer steelhead was 25,032 during the 2009-2010 migration year (Table 18).

Chinook Summer Rearing Distribution

We sampled 424 pools in the MFJDR_IMW to assess summer rearing distribution of juvenile Chinook salmon. The observed summer distribution of juvenile Chinook salmon during 2010 (Figure 10) was quite similar in comparison to that observed during 2008 and 2010 in streams sampled all years (James et al 2009, 2010). Additional sampling in Lick Creek identified juvenile Chinook rearing approximately 3.5 km above what was observed during 2009 (Figure 11). Additionally, distributions in Big and Davis Creek extended beyond the previously identified habitat (Figure 10). However, in the majority of tributaries, distribution appears truncated from suspected rearing habitat (Figure 10).

Table 17. Adult PIT-tag detections of tagged fish from outside the Middle Fork John Day River sub-basin detected at the MFJDR in-stream PIT-tag antenna array during 2010.

Species	Detection Date	Tag Site	Tagging Organization	Life Stage at Tagging
Steelhead	27-Mar-10	JDAR1	NMFS	Adult
Steelhead	01-May-10	JDAR1	NMFS	Adult
Steelhead	01-Apr-10	JDAR1	NMFS	Adult
Steelhead	01-May-10	BONAFF	CRITFC	Adult
Steelhead	24-Mar-10	BONAFF	CRITFC	Adult
Steelhead	04-Mar-10	BONAFF	CRITFC	Adult
Steelhead	11-Apr-10	BONAFF	CRITFC	Adult
Steelhead	22-Mar-10	PRDLD1	WDFW	Adult
Chinook	25-May-10	RAPH	FPC	Juvenile
Chinook	09-Jun-10	LGRRBR	NMFS	Juvenile
Chinook	07-Jun-10	JDAR1	ODFW	Juvenile
Chinook	31-May-10	JDAR1	ODFW	Juvenile
Chinook	19-Jun-10	RAPH	FPC	Juvenile
Chinook	14-Jun-10	JDAR1	ODFW	Juvenile
Chinook	09-Jun-10	BONAFF	CRITFC	Adult
Chinook	21-Jun-10	BONAFF	CRITFC	Adult
Chinook	23-Jun-10	BONAFF	UIDAHO	Adult

Table 18. Smolt abundance estimates for spring Chinook and summer Steelhead from the MF RST.

Species	**Trapping Period**	**Captured**	**Tagged**	**Abundance**	**95% CI**
Chinook	10/7/09 – 6/25/10	5,207	895	35,712	33,413-64,407
Steelhead	10/7/09 – 6/25/10	1,423	1,102	25,032	21,016–29,982

DISCUSSION

Summer steelhead redd counts and redd estimates were the highest since the IMW began in 2008. However, adult escapement estimates were lower than reported in 2009 due to a lower fish per redd expansion estimate. Additionally, none of the differences in adult escapement estimates for 2008-2010 were statistically significant. Large variability in redd counts from site to site contributes greatly to the substantial variance in our escapement estimates and the lack of significant change in escapement. Given that the 95% CIs range approximately 40% of the estimate in any give year, even with a two fold increase in escapement we are not likely to detect a statistically significant difference in adult steelhead escapement. This variance associated with steelhead redd counts is not true for Chinook counts where we conduct a census survey that has no sample variance.

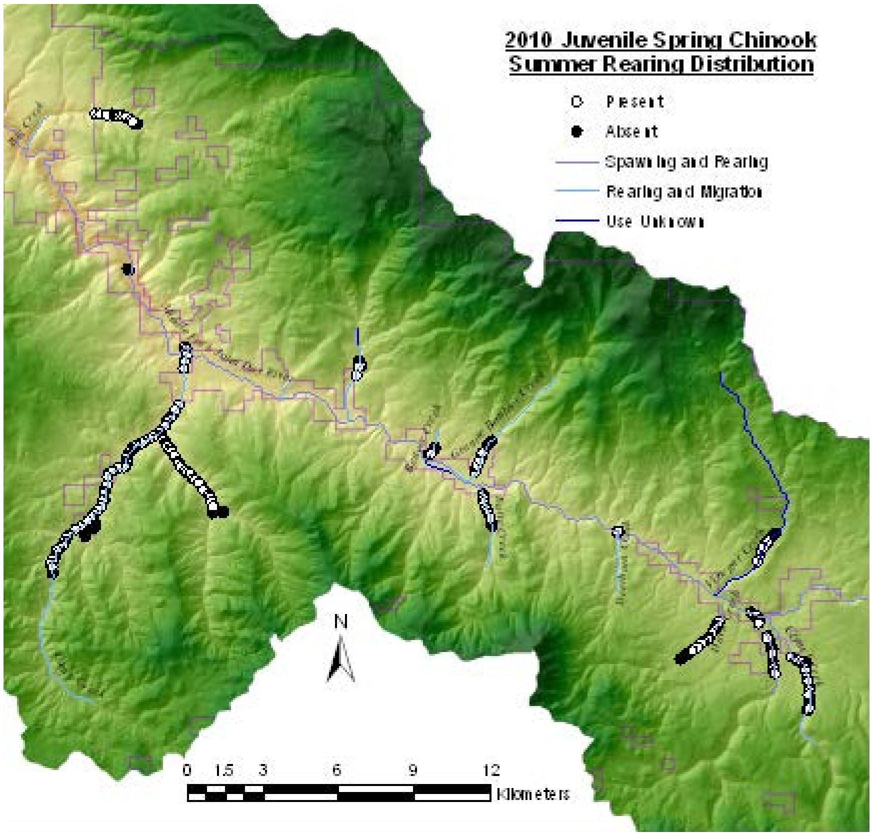

Figure 10. Presence (open circles) and absence (closed circles) of juvenile Chinook salmon in pools sampled within the MFJDR_IMW during 2010.

Downstream detections of PIT-tagged fish vary by interrogation site, with the lowest detection occurring at the RST; less than 2% of all fish tagged are observed at the rotary screw trap. Estimated trap efficiencies for juvenile Chinook, based on fish tagged in the MFIMW detected downstream of the RST and those that were detected at the trap, suggest that approximately 10% of fish migrating past the Middle Fork RST are captured as opposed to the traditional estimate of 21-28% reported by Wilson et al. (2010). Since survival to smolt stage is an important metric in evaluating population response to restoration activity, its imperative that accurate measurements of smolt production are conducted and greater efficiencies for trapping are assessed. We will continue to analyze our efficiency estimates to better represent the abundance of smolts emigrating from the IMW.

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