FISH POPULATION MONITORING IN THE MIDDLE FORK JOHN DAY RIVER INTENSIVELY MONITORED WATERSHED

TECHNICAL REPORT

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Table of Contents

EXECUTIVE SUMMARY

Recovery efforts for federally threatened Mid-Columbia steelhead *Oncorhynchus mykiss* populations 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 (IMWs), including one in the Middle Fork John Day River (MFJDR), 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 *O. tschawytsha* population level monitoring within the MFJDR IMW. Here, we report on preliminary results of fish monitoring efforts funded through this IMW effort. Preliminary results of our fish monitoring show summer steelhead escapement has remained above recovery goals from 2009 to 2015 for the MFJDR IMW. Preliminary results for juvenile steelhead and Chinook monitoring show abundance at sampled sites varies seasonal and annually among sites and streams. Downstream detection rates of marked fish are variable for fish marked at each site and stream and are the product of detectability and survival rates of marked individuals. Final analysis of these data will incorporate survival models with the goal of separating true survival from capture probability and detectability of marked individuals. Factors limiting freshwater production in the Middle Fork John Day River Basin likely remain the same since this IMW began in 2008. High stream temperatures appear to limit the summer distribution of Chinook salmon parr and likely influence distribution and survival of rearing steelhead as well.

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*, herein referred to as steelhead, and spring Chinook salmon *O. tschawytsha*, herein referred to as Chinook in the Columbia River basin with no hatchery supplementation. However, summer steelhead 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 steelhead Major Population Group (MPG), 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 MPG 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 (MFJDR), 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 Mid-Columbia Steelhead Recovery Plan (Carmichael 2010). 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 steelhead and 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 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 per constructed redd (smolts/redd) or smolt to spawning adult (smolt/adult).

Project Objectives

1. Estimate spawner escapement of steelhead and Chinook to the MFJDR.
2. Estimate freshwater productivity (smolts/redd) of Chinook and (smolts/adult) of steelhead.
3. Estimate parr-to-smolt survival for steelhead and Chinook.

METHODS

Study Area

The MFJDR 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 MFJDR 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 our rotary screw trap near the town of Ritter, OR at river kilometer (RKM) 20 (Figure 3).

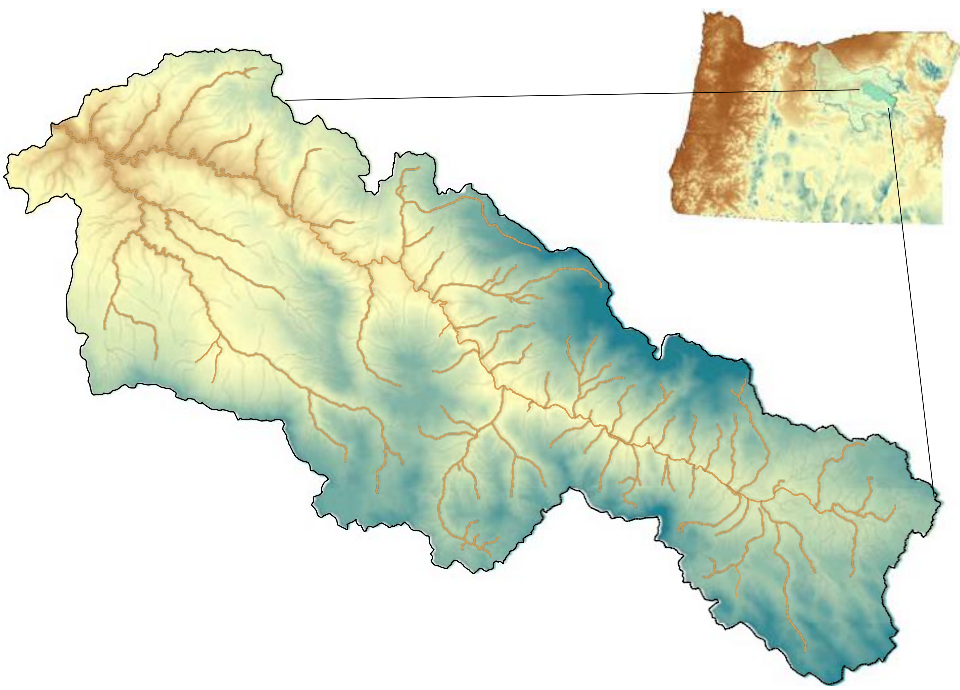

Figure 1. Map of the location of the MFJDR and its tributaries in relation to the John Day River sub-basin and the state of Oregon.

Passive In-stream PIT tag Antennae Arrays

An in-stream passive integrated transponder (PIT-tag) antenna array, installed in the MFJDR near the mouth of Mosquito Creek (RKM 68.5) hereafter referred to as the MF array, detects PIT tagged fish as they move over the instream antennae. This array consists of six antennae; four antennae that are 4.57 m in length and two that are 3.05 m in length. The antennae are oriented in two rows perpendicular to the stream channel to evaluate directional movement of detected fish (Figure 2). Each antenna is securely anchored to the streambed with nylon straps attached to duckbill anchors driven 50 to 80 centimeters into the stream substrate with a hydraulic post pounder. These antennae are operated by a Destron Fearing FishTracker Model 1001M Reader multilplexer which stores the date, time, antennae, and PIT tag code of each detection.

Additionally, two PIT-tag antenna arrays are operated in Bridge Creek, a tributary to the MFJDR, to evaluate fish movements into and out of Bates Pond (Figure 2). The upper array site, located just upstream of the inflow of Bates Pond, consists of two 30x80 cm antennae placed side by side across the stream channel and anchored to the stream bed. The lower array site, located downstream of the Bates Pond fish ladder and spillway, consists of one 30x80 cm antennae anchored to the streambed in the same manner as the mainstem array. Each antenna is powered by a Destron Fearing Model 2001F ISO portable transceiver system which stores the date, time, and PIT tag code of detections.

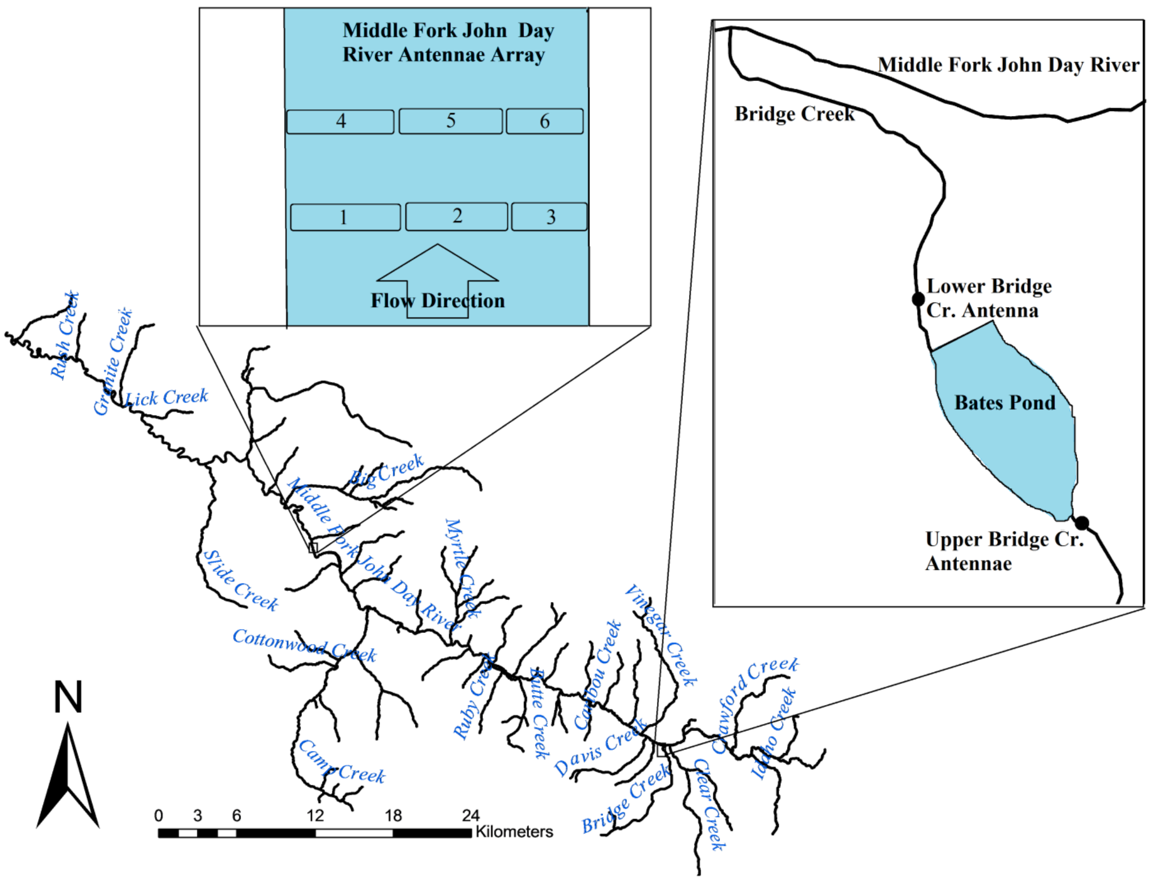

Figure 2. Map of the location of PIT-tag antenna arrays operated in the MFJDR IMW. The top left inset shows the configuration of the MF array, near Mosquito Creek with the numbered antenna sequence. The top right inset shows location of PIT tag arrays in Bridge Creek in reference to Bates Pond.

Adult Monitoring

Summer Steelhead Spawning Ground Surveys

Steelhead spawning surveys, based on standard Oregon Department of Fish and Wildlife (ODFW) methods (Susac and Jacobs 1999; Jacobs et al. 2000; Jacobs et al. 2001), were conducted during the spring (April to June) coinciding with 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 assigned to one of three different panels: 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 site selection is usually performed in a discrete random fashion, we were able to incorporate sites utilized by another steelhead monitoring project in the John Day River MPG 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 spawning habitat conditions. In 2013, we surveyed a total of 36 sites (18-Annual and 18 Two-2 sites) since nearly a third of sites in previous years occur in the mainstem MFJDR where conditions are generally only amenable for surveying once during the later portion of the spawning season.

We used a 1:100,000 Environmental Protection Agency (EPA) river reach file of summer steelhead distribution in the MFJDR population for site selection (Figure 3). 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 two km in length and encompassed the sample point derived from the GRTS 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 un-flagged redds.

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 MF IMW was estimated by:

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

where d_u is the total kilometers available to steelhead for spawning (452 km). Steelhead escapement (E_S) was then estimated by:

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

where C is an annual fish per redd determined from repeated spawning ground surveys upstream of the Deer Creek weir in the Grande Ronde River basin (Flesher et al. 2005). 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 2015).

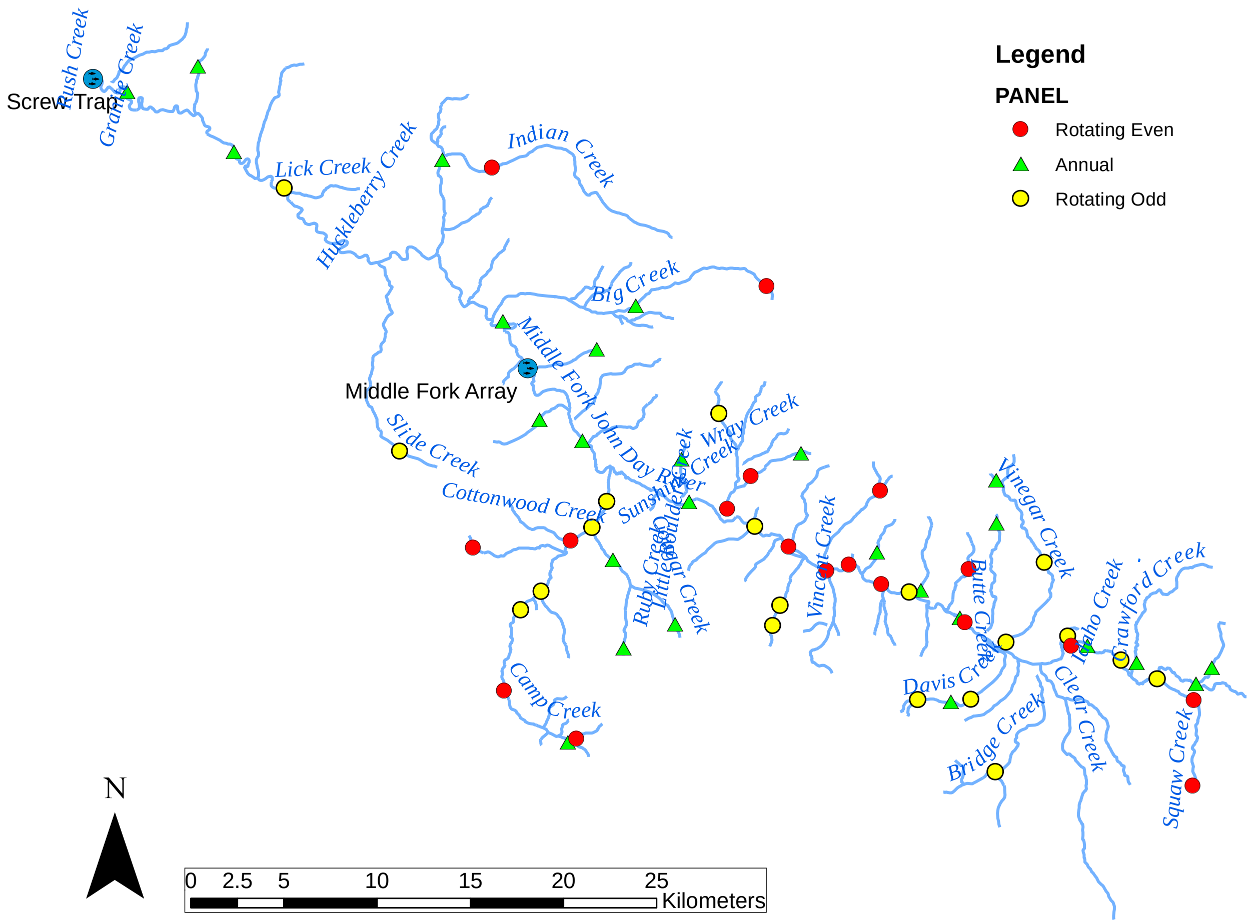

Figure 3. Map of summer steelhead spawning ground survey sites within the MFJDR IMW. The rotary screw trap (RST) near Ritter, and the Middle Fork PIT tag antennae array are shown for reference.

Spring Chinook Adult Monitoirng

Census surveys are conducted to monitor adult Chinook spawning escapement over the entire spawning habitat in the MFJDR 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, enumerated, and a waypoint is taken with a hand-held GPS to map redd locations. Carcasses are sampled for middle of the eye to the posterior scale (MEPS) length and fork length (FL), scanned for PIT tags, sexed, and if female, a determination of spawning success is defined. For further details on Chinook spawning methods and results, refer to Bare et al. 2014.

Juvenile Monitoring

Closed Capture Sites

Granite Boulder Creek and Camp Creek were selected for juvenile steelhead parr to smolt survival monitoring because of the differences in temperature recorded during the summer rearing season. Camp Creek is generally warmer than Granite Boulder Creek during the summer months. Based on the current summer steelhead distribution and topographical features from 1:24,000 quad topographic maps, Camp Creek was divided into three reaches and Granite Boulder Creek was divided into two reaches. Although both steelhead and Chinook were targeted in this sampling, steelhead distribution was utilized for both species because steelhead distribution encompasses the entire suspected distribution of Chinook. Within each reach, three sites were selected for monitoring using a GIS layer developed by the Environmental Monitoring and Assessment Program (EMAP) for steelhead spawning surveys in the MFJDR IMW (see *Summer Steelhead Adult Escapement*). Specifically, the first EMAP 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 at a distance equal to 1/3 of the reach from the other sampling points within that reach this results 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, only four sites in Camp Creek and two sites in Granite Boulder Creek were sampled from 2012 to 2015 (Figure 4). 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. Block nets were deployed at the upstream and downstream extents of each sample section to eliminate fish movement during sampling. Sites were sampled using a backpack electrofisher (Smith-Root LR20B), once daily for three consecutive days. Block nets remained in place until sampling was completed on the third day at each site.

Once collected, fish were placed into an aerated 19 L bucket and transferred to in-stream live boxes where they were held until the entire site was sampled and tagging operations commenced. Captured juvenile Chinook, steelhead, and bull trout *Salvelinus confluentus* were anesthetized with tricane methane sulfonate (MS-222), interrogated for PIT-tags, PIT tagged if not previously tagged, weighed to the nearest 0.1 g, and measured for fork length (FL) to the nearest millimeter (mm). Scales were taken from a subsample of steelhead collected that were longer than 60 mm FL. Scales were collected from a key area located between the dorsal and anal fin and slightly above the lateral line. Scale samples were grouped into 10 mm FL bins with 15 fish sampled in each bin during both summer and fall sampling. Scales were also taken from all bull trout captured. All anesthetized fish were allowed to recover in an aerated 19 L bucket until they regained equilibrium (~5-10 minutes). Once recovered, fish were released in small batches throughout the site and allowed to distribute themselves 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 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 abundance (N). Model parameters 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 1). The most parsimonious model was selected based on the lowest Akaike Information Criteria corrected for small sample size (AICc) value. When AICc values of two or more potential models differed by less than two, the model with fewer parameters was selected as the most parsimonious model.

Table 1. Models fit to closed capture population estimate 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

Open Population Sites

We monitored parr survival of juvenile Chinook at ten sites in the MFJDR IMW consisting of eight sites in the mainstem MFJDR, one in Vinegar Creek, and one in Coyote Creek in 2013 (Figure 4). The eight sites in the MFJDR were distributed between treatment (n=4) and control (n=4) reaches as defined by the MFIMW Working Group (Curry et al. 2010 in draft). Tributary sites were selected at locations in streams with previous observations of juvenile Chinook (James et al. 2009, 2010). Sites were 20 times ACW in length with a maximum of 150 m for sites in the MFJDR and a minimum of 100 m for tributary sites.

Two methods of fish capture were employed during sampling at these sites depending on site specific characteristics. In the tributaries and the upper MFJDR, backpack electrofishing gear (Smith-Root LR20B) was used with two netters working in an upstream direction. Within the other seven MFJDR sites, fish were collected by snerding, where one to two snorkelers would move in an upstream direction to locate holding juvenile Chinook. Once fish were located, the snorkeler would direct deployment of a bag seine (7.6 m wide x1.22 m high seine net with a 1.22 m wide x 0.6 m deep bag) approximately 5 m downstream of the fish ensuring a proper seal of the lead line to the stream bed. After the net was deployed the snorkeler would position themselves upstream of the fish while being cautious not to spook them. Once in position, the snorkeler would herd the fish downstream into the seine. When the snorkeler reached the seine, the net was lifted and the fish were removed from the bag with a dip net. We sampled each of these sites four times from early July through early October from 2011 to 2015 with approximately three weeks between sampling intervals from early July late August, and one final sampling interval in early fall six weeks after the interval in late August. For simplification purposes, we will refer to these sampling periods as early summer (July 11–17), mid-summer (July 27–August 8), late summer (August 18–28), and fall (September 28–October 15). No block nets were deployed during or between sampling intervals.

All fish captured were processed as previously described (see *Closed Capture Sites*), however, scales were only taken from juvenile Chinook > 100 mm for age determination. All juvenile Chinook and steelhead captured which were < 60 mm FL were enumerated and released.

Encounter histories were developed for individual juvenile Chinook and steelhead captured at each site including detections and recaptures of marked indivduals at the MF Array, MF RST, and Columbia River. A multi-state mark recapture model which incorporated data from downstream PIT tag detections was used to estimate true survival rates for marked individuals. We tested covariates for temperature, brood year redds, and stream discharge to identify factors contributing to survival of juvenile salmonids.

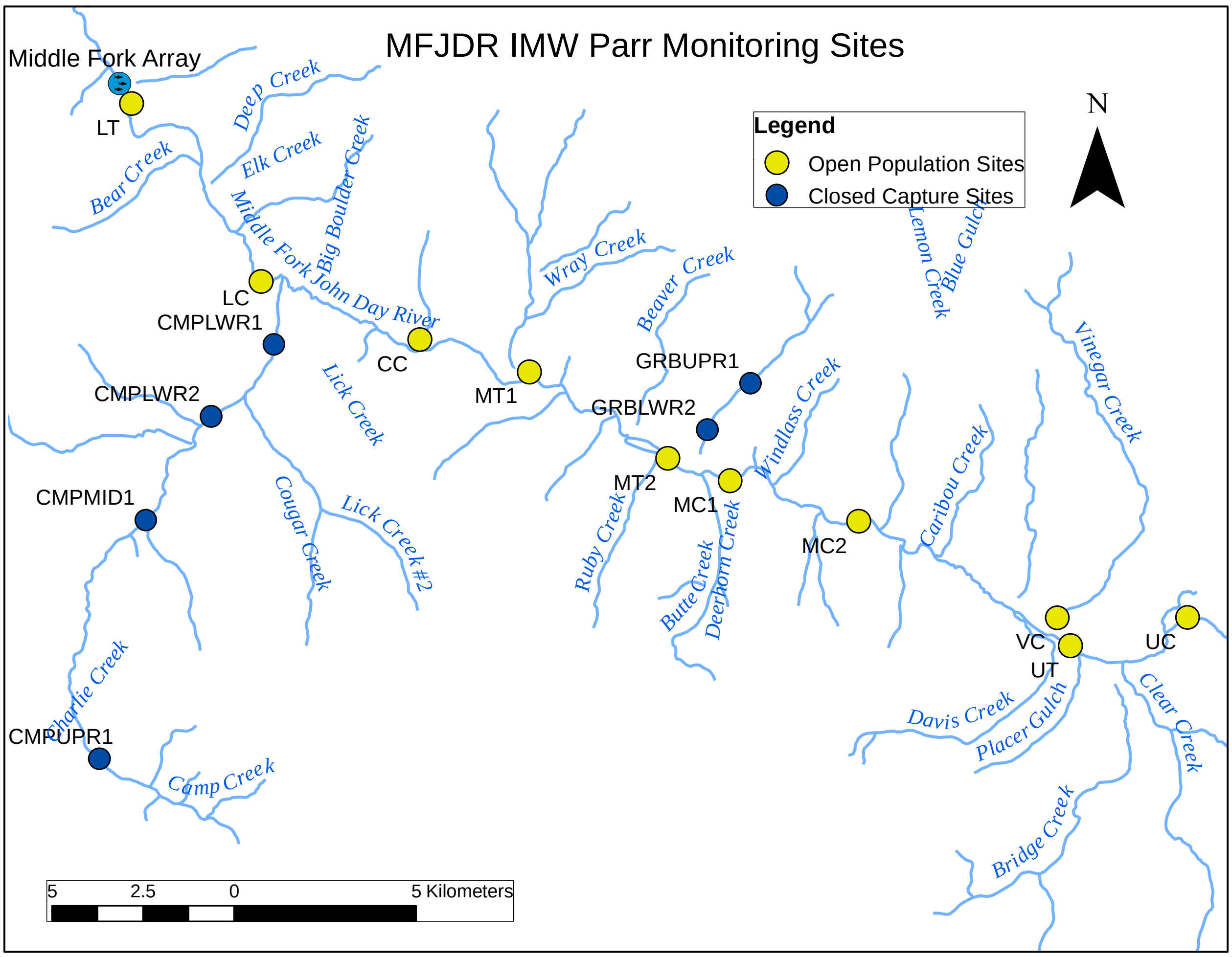

Figure 4. Map of the location of parr monitoring sites in the MFJDR IMW. Yellow dots represent open population sites: LT = Lower Treatment, LC = Lower Control, CC = Coyote Creek, MT1 = Mid Treatment-l, MT2 = Mid Treatment-2, MC1 = Mid Control-1, MC2 = Mid Control-2, VC = Vinegar Creek, UT = Upper Treatment, and UC = Upper Control. Blue dots represent closed capture sites in Camp Creek and Granite Boulder Creek.

Juvenile PIT Tag Detection Histories

We assessed PIT tag detection histories of all fish tagged as part of the MFJDR IMW project by querying tagging and interrogation files for observations of these fish. Fish tagged in the MFJDR IMW have the potential to be interrogated at remote instream PIT tag antennae arrays located in the MFJDR near Mosquito Creek, in the lower John Day River near McDonalds Ford, 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 MFJDR rotary screw trap (MF RST) near Ritter, OR. Detection histories were grouped by species (Chinook or steelhead), tag site (Camp Creek, Granite Boulder Creek, or the MFJDR), and by tag year across observation site and migration year (MY) where each MY begins on July 1 the previous year and ends on June 30th in order to align with in-stream tagging events and with migratory years that overlap from fall to spring.

Parr Rearing Distribution Surveys

Summer rearing distribution of juvenile Chinook within the MFJDR IMW was assessed by snorkeling the mainstem MFJDR and some tributaries. Sampling was done in a downstream direction in the mainstem MFJDR where stream flow and depth allowed the snorkeler to move unimpeded by the substrate. In shallow, low flows snorkelers moved in an upstream direction. During 2014 surveys, continuous reaches of stream were sampled by one snorkeler and a waypoint was marked by a shore based recorder at the start and end of each pool and/or run with a handheld Garmin etrex legend HCX GPS unit. All salmonid observations were recorded between waypoints. During 2015 distribution surveys waypoints were marked every 100 meters and observations of salmonids within each reach of stream were recorded in the same manner as 2014 surveys. Tributary streams were sampled the same way as the MFJDR but surveys ceased when no Chinook parr were observed in a continuous 300 meter reach of stream.

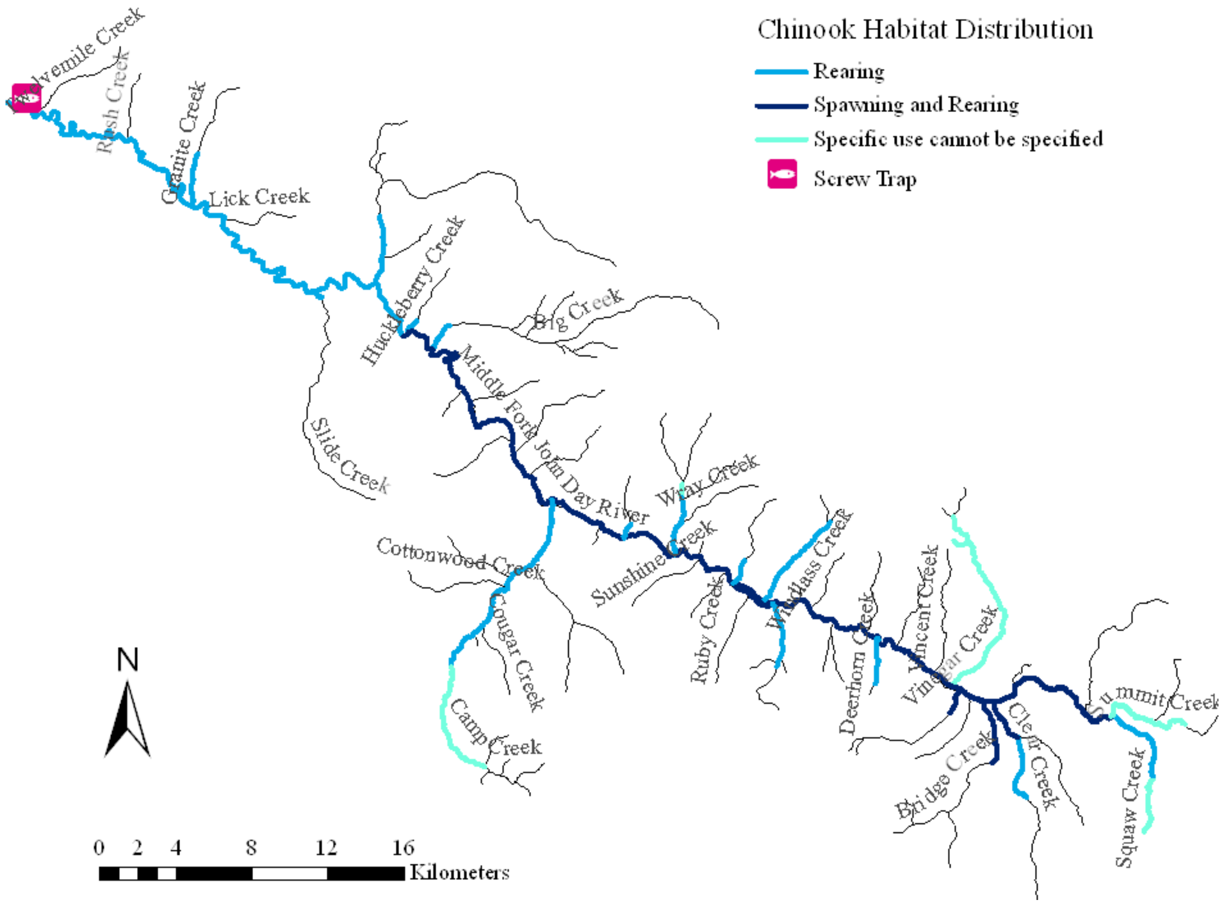

Figure 5. Chinook habitat distribution in the MFJDR IMW from Ritter upstream. The location of the rotary screw trap is shown for reference.

Bates Pond Juvenile Passage

Recently, Oregon Parks and Recreation Department acquired property on the lower section of Bridge Creek, a tributary to the MFJDR, to develop Bates State Park. Included in this acquisition was Bates Pond. Currently, there is concern of the ability for juvenile fish, especially Chinook, to navigate the fish ladder leading into Bates Pond and through Bates Pond itself, to locate potential rearing habitat upstream of this reservoir. To evaluate passage through the fish ladder and pond we collected juvenile Chinook and steelhead by electrofishing from the confluence of Bridge Creek with the MFJDR upstream to the Bates Pond spillway and from the mouth of Bridge Creek to Bates Pond upstream approximately 400 m. Fish were captured and processed using the previously described methods for electro-fishing, processing, and PIT tagging fish. However, no scales were collected from fish captured in Bridge Creek. Movement was assessed based on capture either upstream or downstream of Bates Pond and subsequent detections at passive in-stream PIT tag antenna arrays (Figure 2).

Summer Steelhead and Spring Chinook Smolt Abundance

Juvenile Chinook and steelhead migrants were captured using a 1.52 m RST operated on the MFJDR near Ritter, OR (Figure 3). Trap operation typically begins during early October and continues into June of the following year to encompass an entire MY. The trap was either removed or stopped during times of ice formation, high discharge, and during warm summer months after smolts cease migration.

The RST is typically fished four days/week by lowering cones on Monday and raising cones on Friday. The RST is checked daily during the weekly fishing period. We assumed that all fish captured were migrants. Non-target fish species were identified, enumerated, and returned to the stream. Captured juvenile Chinook and steelhead migrants were anesthetized with MS-222, interrogated for PIT tags or pan jet paint marks, enumerated, weighed to the nearest 0.1 g, and measured to the nearest mm FL. A sub-sample of fish were released above the trap to estimate migrant abundance using mark-recapture techniques. For further details of RST operation and methods see Bare et al. 2015.

RESULTS

Adult Monitoring

Summer Steelhead Spawning Ground Surveys

Spawning ground surveys in the Middle Fork IMW showed some variation in annual spawn timing but typically spawning began in early April and continued through May in the MFJDR IMW (Figure 6). During 2015 spawning ground surveys, eighteen redds were observed prior to April first.

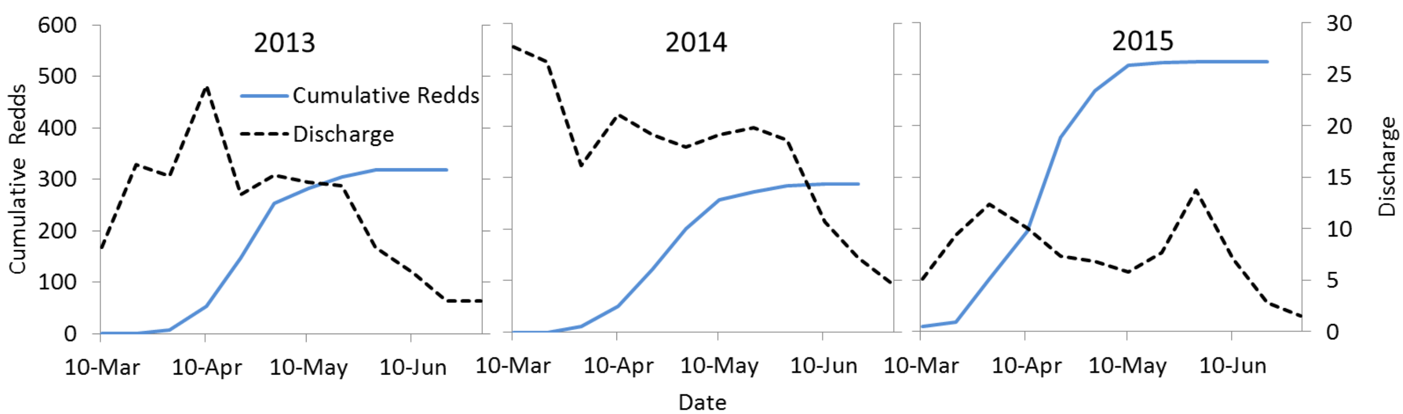

Figure 6. Discharge and cumulative adult steelhead redds observed March through June during steelhead spawning ground surveys 2013 to 2015 at all spawning ground survey sites throughout the MFJDR IMW. Discharge was recorded at the USGS gauging station located near Ritter on the MFJDR and is shown in cubic meters per second.

Observed redd densities varied by site, with the highest densities in 2013 at site 301 in Davis Creek (Figure 7), in 2014 we observed the highest densities at site 207 in Beaver Creek (Figure 8), and in 2015 the highest redd densities were observed at site 130 in Lick Creek (Figure 9). Sites where no redds were observed typically occurred upstream of suspected fish passage barriers or in sections of streams with high gradient and a low percentage of available spawning habitat for anadromous fish.

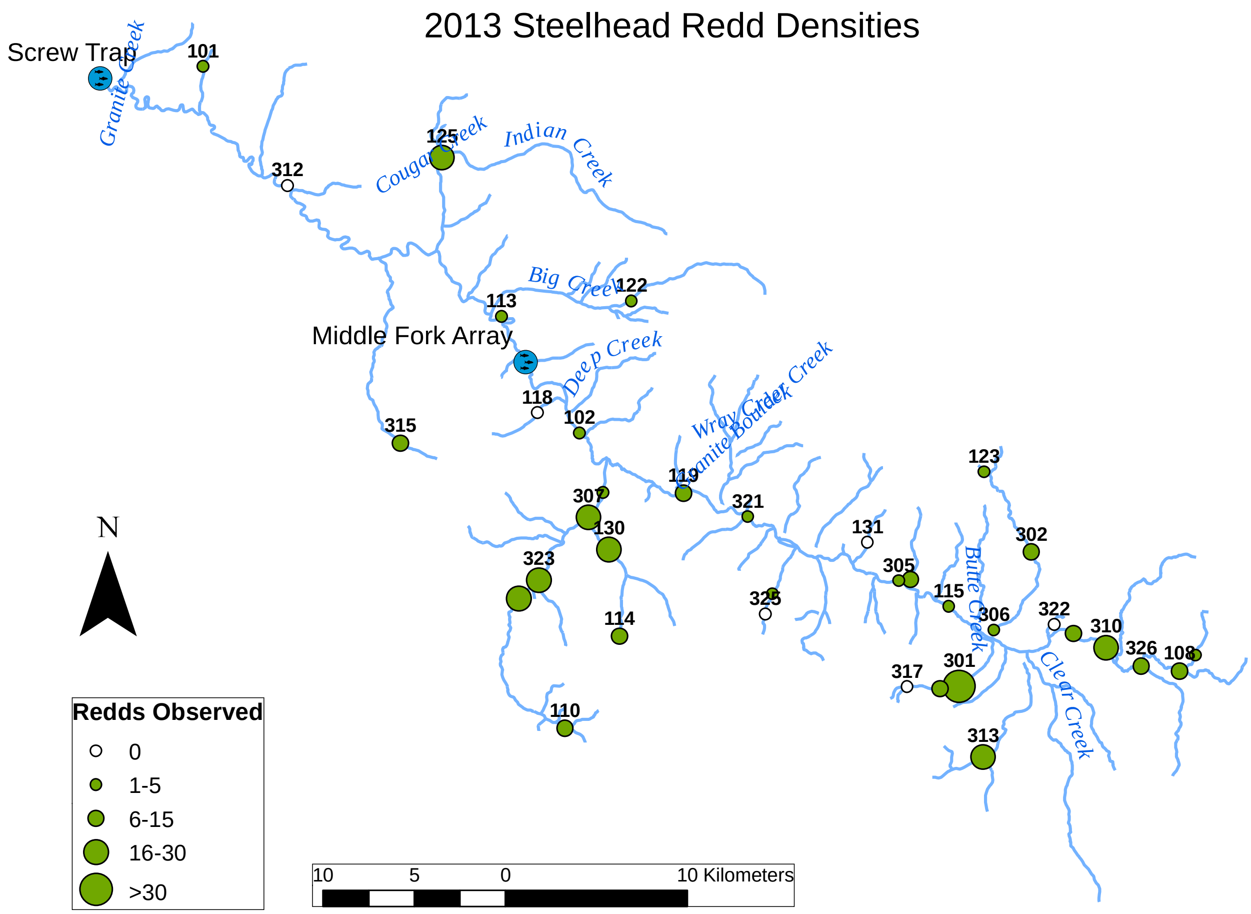

Figure 7. Adult steelhead redd counts at sites surveyed throughout the MFJDR IMW in 2013. All sites were approximately two km long. Site numbers are shown for reference.

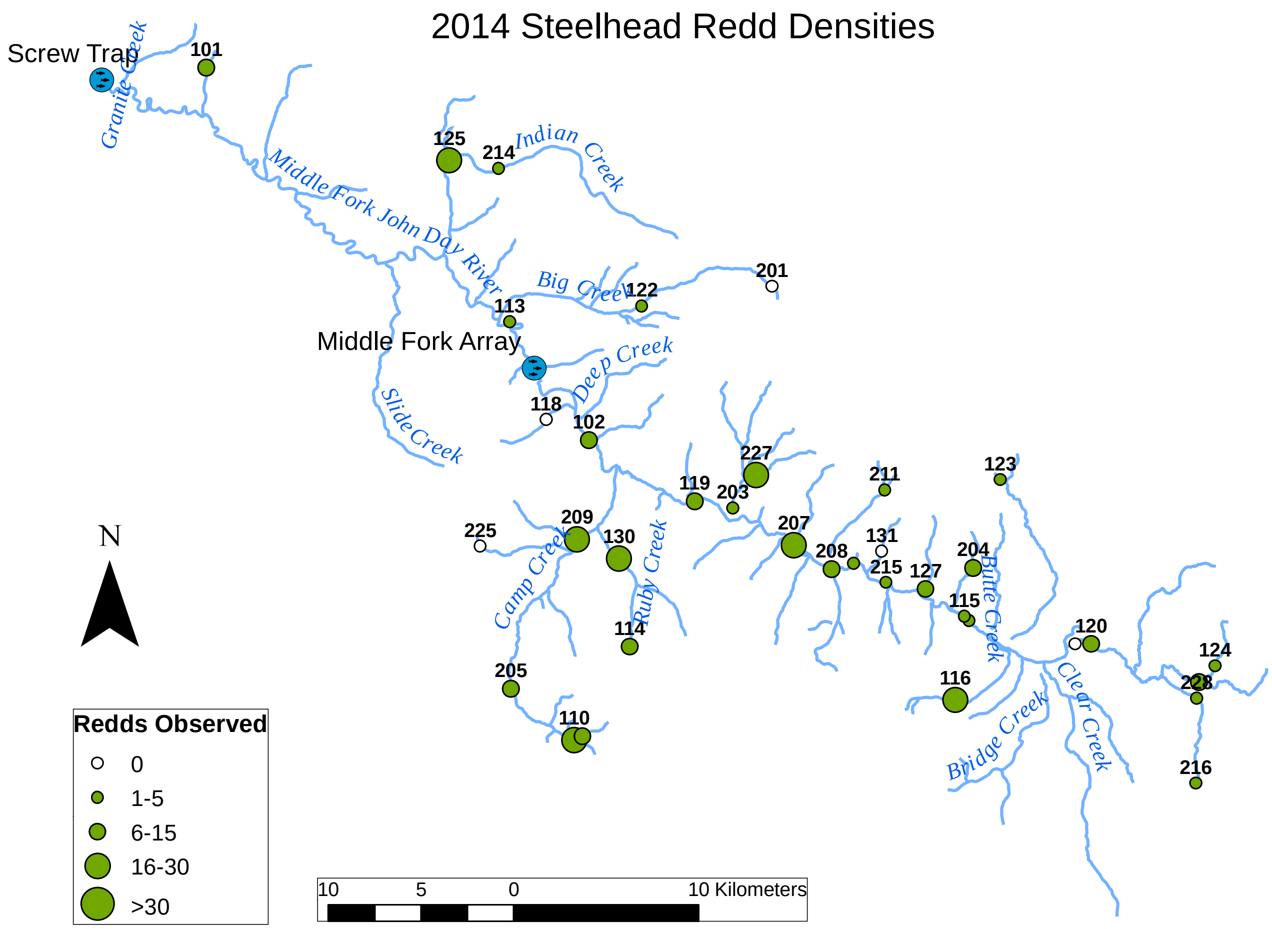

Figure 8. Adult steelhead redd counts at sites surveyed throughout the MFJDR IMW in 2014. All sites were approximately two km long. Site numbers are shown for reference.

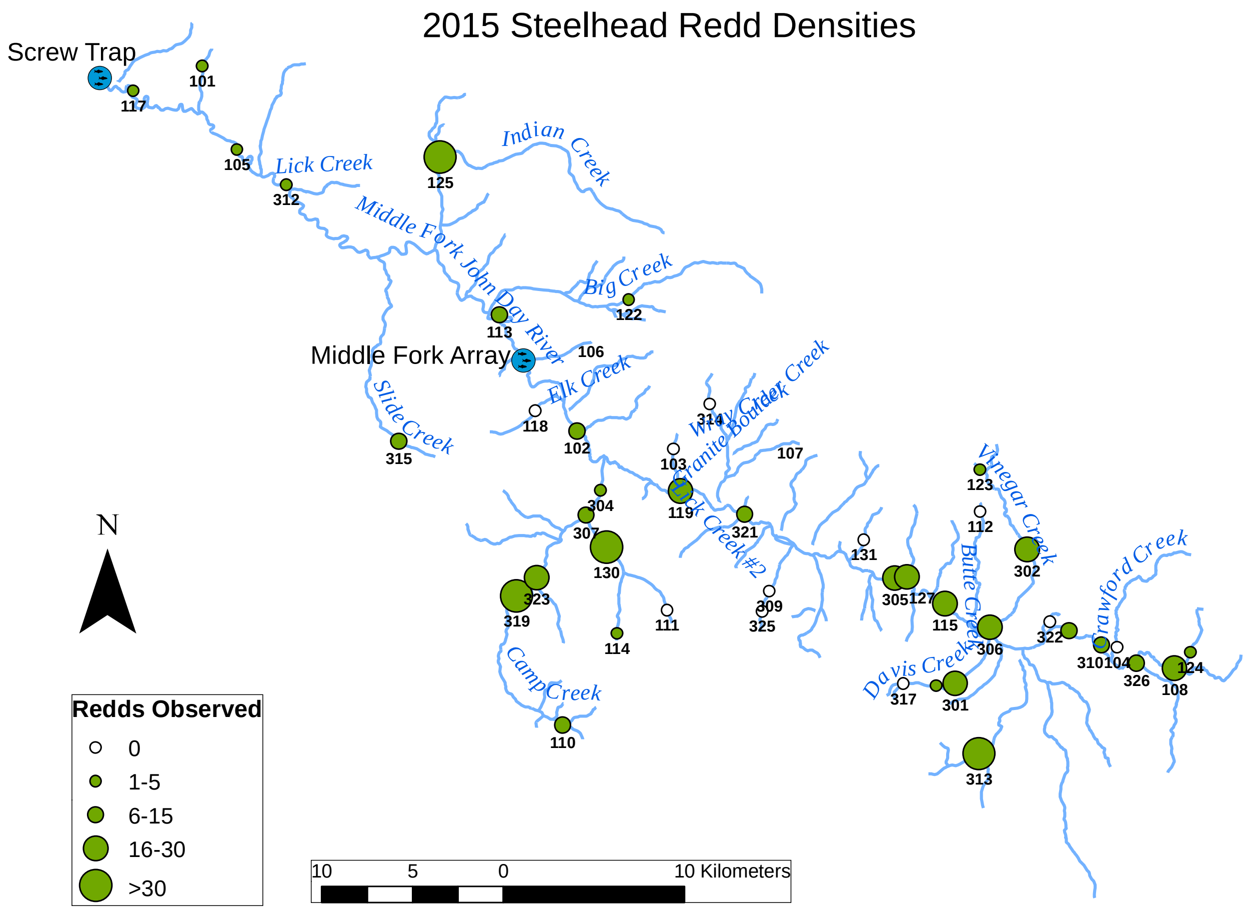

Figure 9. Adult steelhead redd counts at sites surveyed throughout the MFJDR IMW in 2015. All sites were approximately two km long. Site numbers are shown for reference.

Table 2. Adult steelhead spawning ground survey results for redds observed and adult escapement estimates by year. Redd densities are multiplied by the fish per redd constant from the Deer Creek weir each year and expanded to the entire MFJDR IMW.

Year	Sites Surveyed	Redds Observed	Redd Density	Fish/Redd	Escapement	Lower 95% CI	Upper 95% CI
2008	29	23	0.398	4.07	811	0	1668
2009	29	75	1.295	3.81	2229	1392	3065
2010	30	164	2.715	1.6	2100	1194	3011
2011	31	115	1.861	4.75	4094	2298	5889
2012	36	194	2.691	3.09	3883	2676	5088
2013	36	319	4.455	1.91	3828	2781	4875
2014	36	290	4.022	2.67	4859	3690	6029
2015	45	524	5.829	1.37	3616	2488	4743

Adult steelhead escapement estimates for the eight years of monitoring in the MFJDR IMW show the highest escapement estimate occurred in 2014 when 290 redds were observed for an estimated 4,859 adult steelhead. More redds were observed in 2015 than any other year surveyed. We estimated lower adult escapement in 2015 than 2014 despite a higher redd count due to a greater number of sites surveyed in 2015 (N=43) and a lower fish per redd estimate at the Deer Creek Weir (Table 2). Adult steelhead escapement in the South Fork John Day River was highest in 2012 over this same time period (Figure 10).

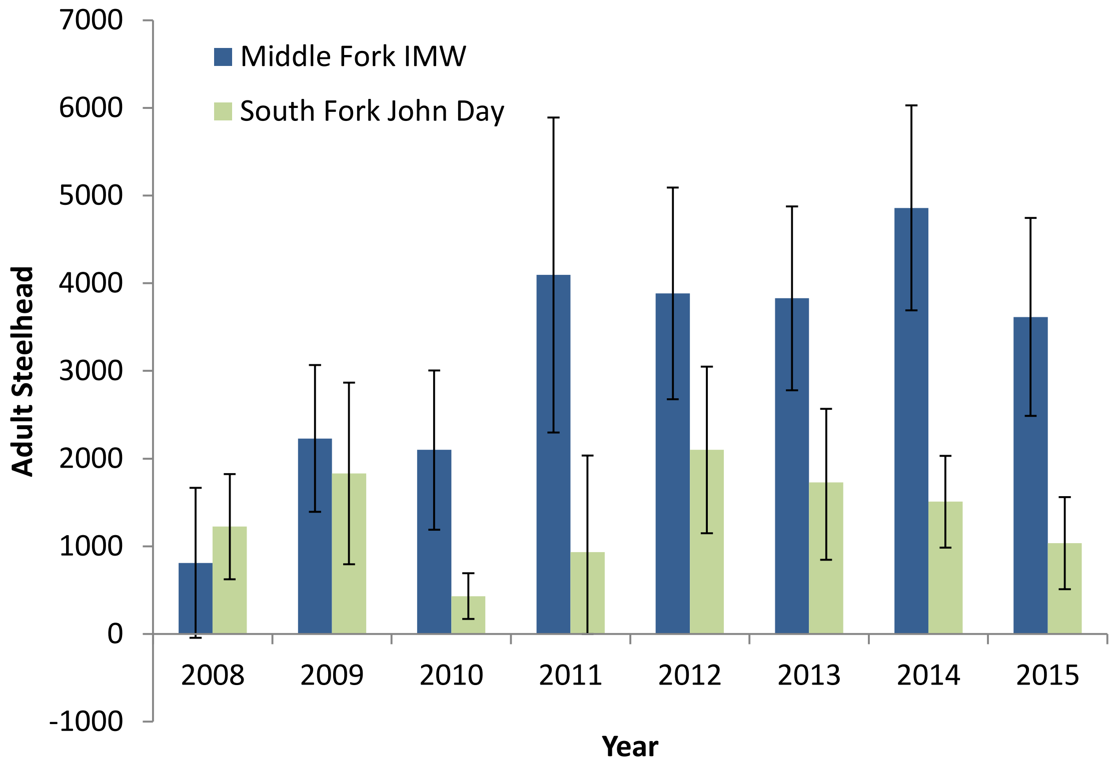

Figure 10. Adult steelhead escapement by year for the MFJDR IMW and South Fork John Day River Basin. Error bars represent 95% confidence intervals.

Table 3. Count and origin of adult steelhead observed on spawning ground surveys from 2008 to 2015 within the MFJDR IMW.

	Live Steelhead Observed				Steelhead Carcasses		
Year	Total Observed	Hatchery	Unknown	Wild	Hatchery	Wild	Total Dead
2008	23	0	9	14	0	0	0
2009	48	0	23	25	0	1	1
2010	61	1	17	43	0	0	0
2011	82	2	27	53	0	0	0
2012	108	0	20	88	1	7	9
2013	95	1	15	79	0	4	4
2014	159	1	33	125	0	5	5
2015	105	0	17	88	0	11	11

During all spawning ground surveys from 2008- 2015 only six of the 550 adult steelhead that we observed, and were able to confirm origin, were hatchery fish (Table 3).

Table 4. Adult steelhead detected at the MF array by detection year. Life stage at tagging shows number of detected adults tagged during each life stage. Adult steelhead detected upstream of the John Day River confluence in the Columbia Basin are also noted.

Year Detected	Total Detections	Life Stage at Tagging			Detected at McNary Dam	Detected at Ice Harbor	Ocean Residency			Repeat spawners
		parr	smolt	adult			1 salt	2 salt	Unknown	
2013	15	2	9	4	9	0	3	6	6	2
2014	24	5	13	6	20	6	15	0	9	0
2015	54	18	24	12	39	5	17	14	23	1

No hatchery steelhead were detected at the MF array from 2013 to 2015. The majority of adult steelhead detected at the MF array had also been detected at McNary dam (73%) and 11 of the 93 adults (12%) were detected at least as far up the Columbia River as Ice Harbor Dam (Table 4). Three of the ninety three adult steelhead detected at the MF Array from 2013 to 2015 were repeat spawners (Table 4).

Spring Chinook Adult Monitoring

Adult spring Chinook holding in the MFJDR during the summers of 2013 and 2014 experienced relatively high mortality rates. During the first week of July in 2013 we recovered 82 carcasses and estimate 144 adult Chinook died during a rapid increase in stream temperature which occurred during unseasonably low water (Bare et al 2014). Using PIT tag recoveries from adult fish detected at the MF array we estimated that this represented 31% of the entire run of adult spring Chinook to the MFJDR in 2013 (Bare et al 2013). During late June 2015, a similar mortality event occurred in the MFJDR, we observed 74 carcasses and estimate that 98 adult died the first two weeks of July 2015 in the MFJDR. Additional pre spawn mortalities where observed throughout the summer of 2015 prior to spawning ground surveys.

Chinook redd counts for the MFJDR IMW 2013 to 2015 have ranged from a low of 113 in 2013 to a high of 518 in 2014 since the MFJDR IMW started in 2008 (Figure 11). Chinook redd counts in the North Fork John Day River Basin (NFJDRB) show a similar trend to Middle Fork Basin counts from 2000 to 2015 (Figure 11). Preliminary results show redd counts were lower in the NFJDRB for the first time from 2000 to 2015 in 2015 (Figure 11). Despite a noticeable level of adult mortality throughout the summer of 2015, our preliminary Middle Fork Basin redd count for 2015 of 442 redds is over the 15 year average of 305 redds in the Middle Fork Basin (Christopher Bare personal communication) (Bare 2016 in draft).

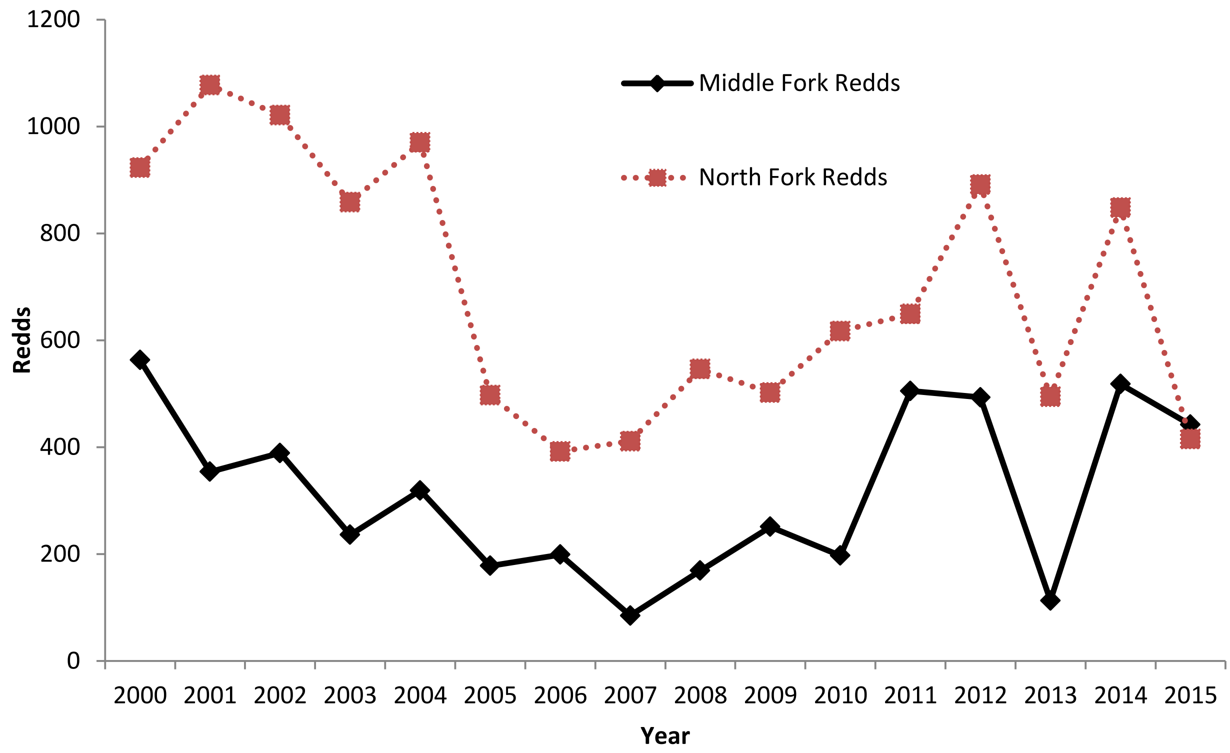

Figure 11. Adult Chinook redd counts in the Middle and North Fork John Day River Basins from 2000 through 2015.

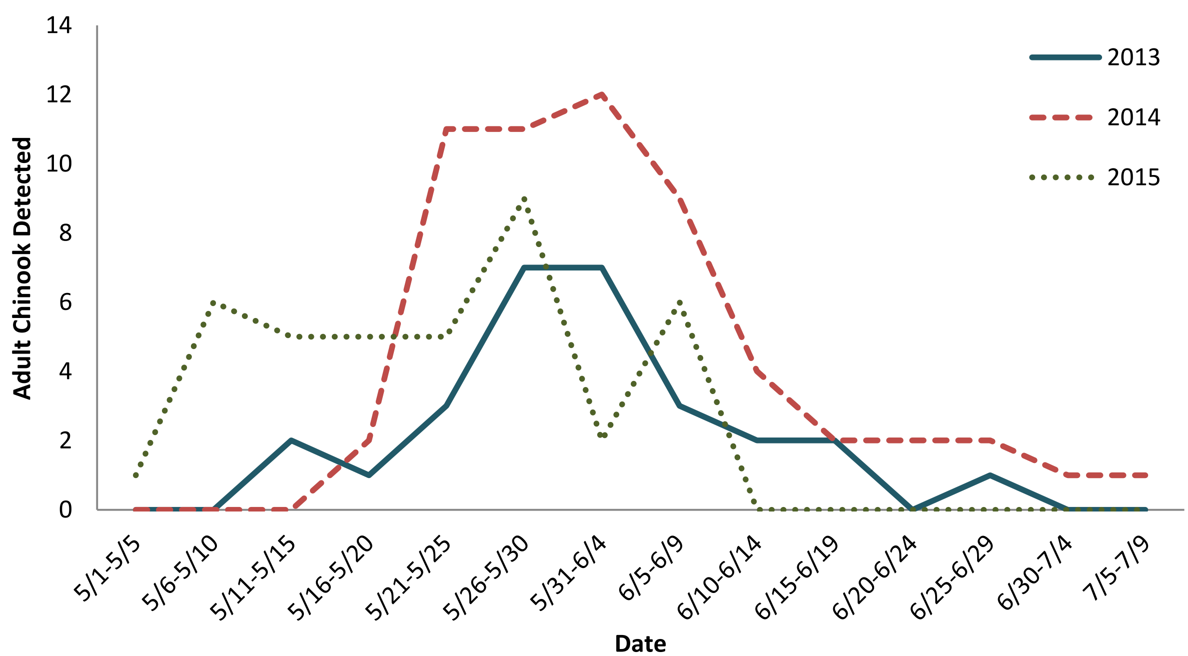

Figure 12. Frequency of PIT tagged adult Chinook detections at the MF array by date and year.

Table 5. Detections of PIT tagged adult spring Chinook at the MF array for years 2013 to 2015.

Year	Adults Detected	Mean Detection Date	Life stage at tagging			Hatchery Fish
			parr	smolt	adult	
2013	27	1-Jun	7	11	9	0
2014	58	3-Jun	33	8	17	1
2015	39	22-May	14	18	7	0

Adult Chinook arrival dates at the MF array were relatively consistent in 2013 and 2014. The mean detection date in 2015 was about 10 days earlier than the previous two years (Table 5) but the mode of detections at the array for this three year period occurred during the same ten day period from May 20-May 30 (Figure 12). Only one hatchery origin spring Chinook has been detected at the MF array from 2013 to 2015. This hatchery fish was released as a smolt in Catherine Creek Acclimation Pond located in the Grande Ronde River Basin.

Juvenile Monitoring

Closed Capture Sites

Steelhead parr were captured and marked at all six closed capture sites in the summer and fall each year from 2013 to 2015. Chinook parr were only captured consistently at the lower three sites in Camp Creek. Chinook parr were occasionally captured at the lowest Granite Boulder Site.

Table 6. Abundance estimates for steelhead parr at closed capture sites in Camp Creek and Granite Boulder Creek during summer and fall sampling 2013 to 2015. LCI, UCI are lower and upper 95% confidence intervals respectively.

Site	2013						2014						2015					
	Summer	LCI	UCI	**Fall**	LCI	UCI	**Summer**	LCI	UCI	**Fall**	LCI	UCI	**Summer**	LCI	UCI	**Fall**	LCI	UCI
CMPLWR-1	**600**	529	697	**288**	266	321	**215**	177	304	**320**	295	367	**365**	275	515	**393**	358	442
CMPLWR-2	**453**	359	599	**520**	460	604	**165**	137	237	**310**	279	368	**145**	112	246	**426**	344	553
CMPMID-1	**461**	386	571	**238**	224	269	**196**	168	244	**412**	380	467	**294**	205	459	**318**	274	383
CMPUPR-1	**133**	115	166	**114**	107	130	**68**	61	96	**82**	79	94	**312**	218	489	**146**	139	166
GRBLWR-2	**158**	129	210	**149**	132	191	**96**	84	133	**196**	169	241	**128**	84	233	**341**	289	421
GRBUPR-1	**69**	53	107	**82**	70	123	**98**	66	178	**64**	60	79	**86**	53	173	**157**	125	217

Steelhead parr abundance estimates at closed capture sites in Camp Creek showed greater temporal variation from 2013 to 2014 than steelhead parr abundance at Granite Boulder Creek sites. Granite Boulder Creek abundance estimates remain relatively stable over this three year period with a near significant increase for the fall of 2015 when both sites are grouped. The greatest increase in abundance from summer to fall 2015 occurred at GRBLWR2 where a significant increase was observed over this period (Table 6). Steelhead parr abundance within Camp Creek sites showed a significant increase between summer and fall estimates in 2014 and abundance has remained stable through the fall sampling in 2015 when all sites are grouped (Figure 13). When individual sites are compared within Camp Creek CMPLWR1, and CMPLWR2 show the most annual variation in abundance from 2013 to 2015 (Table 6).

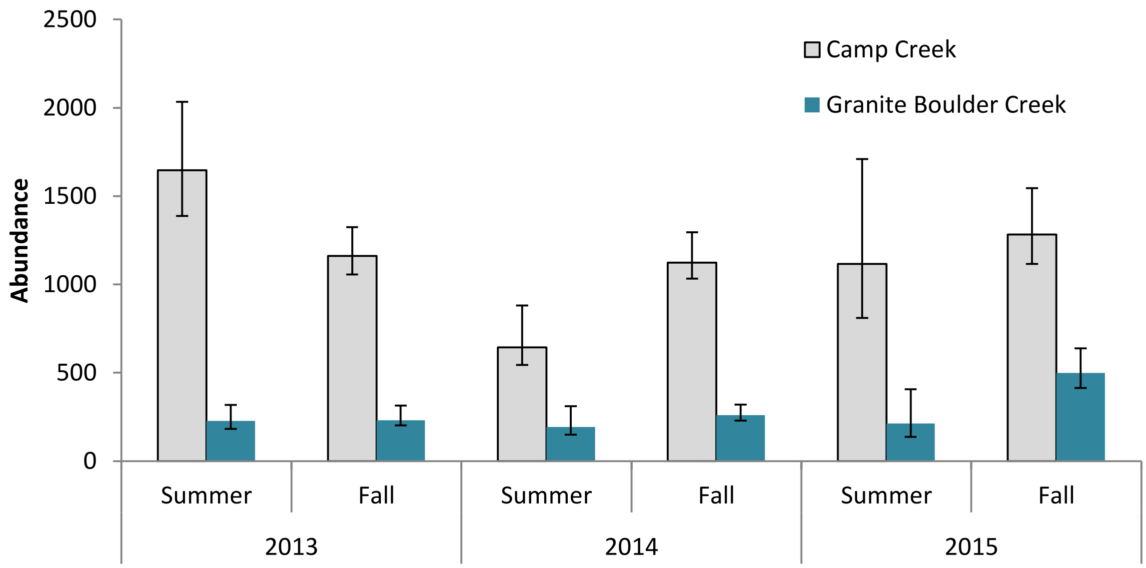

Figure 13. Combined steelhead parr abundance of closed capture sites in Camp Creek and Granite Boulder Creek years 2013 to 2015. Error bars represent 95% confidence intervals.

Table 7. Abundance estimates and best fit models for Chinook parr at closed capture sties 2013 to 2015. Lower and upper 95% confidence intervals are shown as LCI and UCI respectively. Captures are also noted as C= number captured for all three passes or NC if no Chinook were captured during any of the three passes.

Year	Site	Summer				Fall			
		Model	Abundance	LCI	UCI	Model	Abundance	LCI	UCI
2013	CMPLWR1	p.,c.	60	57	75	p.=c.	35	33	43
	CMPLWR2	-	C=10	-	-	p.=c.	42	34	67
	CMPMID1	-	C=1	-	-	-	C=2	-	-
2014	CMPLWR1	-	NC	-	-	-	C=11	-	-
	CMPLWR2	-	NC	-	-	-	NC	-	-
	CMPMID1	-	NC	-	-	-	NC	-	-
2015	CMPLWR1	p.=c.	997	608	1735	p.,c.	105	98	125
	CMPLWR2	p.=c.	205	102	499	p.=c.	235	182	327
	CMPMID1	-	C= 9	-	-	p.,c.	C=4[a]	4	4

a – only four chinook parr were captured at CMPMID1 during fall 2015 sampling and all were recaptured on subsequent passes.

Chinook parr abundance estimates are available for sampling occasions at closed capture sites when marked and recaptured individuals were sufficient to produce them. Only 11 Chinook were captured in 2013 at all closed capture sites and all at CMPLWR1 (Table 7). Chinook are only occasionally observed at sites sampled in Granite Boulder Creek, no Chinook abundance estimates are available for either of the Granite Boulder sites.

Table 8. Steelhead marked with PIT tags at Camp Creek sites and subsequent in-stream recaptures from 2013 to 2015.

Mark Year	Mark Season	Number Marked	In-Stream Recpatures					
			2013		2014		2015	
			Summer	Fall	Summer	Fall	Summer	Fall
2010	Summer	597						
	Fall	1114	1					
2011	Summer	385	1	2				
	Fall	668	8	8	2	1		1
2012	Summer	678	60	39	1	2		
	Fall	1160	75	46	8	5		
2013	Summer	705		139	20	21	1	
	Fall	591			18	16	1	1
2014	Summer	401				135	9	10
	Fall	750					24	29
2015	Summer	335						81
	Fall	659						

Table 9. Steelhead marked with PIT tags at Granite Boulder Creek sites and subsequent in-stream recaptures from 2013 to 2015.

Mark Year	Mark Season	Number Marked	In-Stream Recaptures					
			2013		2014		2015	
			Summer	Fall	Summer	Fall	Summer	Fall
2008	Summer	331						
	Fall	129						
2009	Summer	181						
	Fall	178	1	1	1			
2010	Summer	121						
	Fall	67						
2011	Summer	83						
	Fall	96						
2012	Summer	145	2					
	Fall	123	7	2	4			1
2013	Summer	124		16	1	1		1
	Fall	164			9	6		
2014	Summer	105				21	1	
	Fall	159					4	3
2015	Summer	64						12
	Fall	258						

In-stream recapture rates of marked fish from previous sampling events were highest during fall sampling for fish marked during the previous sampling interval (Table 8 and 9). In-stream recapture rates for Camp Creek steelhead were nearly double those for Granite Boulder Creek steelhead marked from 2012 to 2015 sampling (Tables 10 and 11).

Table 10. Steelhead parr marked in Camp Creek and recaptured at the MF RST. Table includes the number of individuals tagged each year in Camp Creek and the year they were recaptured at the RST.

Year Marked	Number Marked	Recaptures 2009	2010	2011	2012	2013	2014	2015
2008	1055	2	6	1	0	0	0	0
2009	961		2	2	0	0	0	0
2010	1711			5	15	2	0	0
2011	1053				3	9	0	0
2012	1838					5	6	0
2013	1296						3	3
2014	1151							12
2015	994							

Table 11. Steelhead parr marked in Granite Boulder Creek and recaptured at the MF RST. Table includes the number of individuals tagged each year in Granite Boulder Creek and the year they were recaptured at the RST.

Year Marked	Marked	Recaptures 2009	2010	2011	2012	2013	2014	2015
2008	460	1	0	0	0	0	0	0
2009	359		0	0	0	0	0	0
2010	188			0	0	0	0	0
2011	179				0	0	0	0
2012	268					1	0	0
2013	288						1	2
2014	264							1
2015	322							

Table 12. Detections of steelhead parr PIT tagged in Camp Creek at the MF array during 2010-2015 migration years.

Year Marked	Number Marked	Detections 2010	2011	2012	2013	2014	2015
2008	1055	25	5	1	3	0	0
2009	961	105	25	6	12	0	0
2010	1711		124	79	0	2	6
2011	1053			46	30	2	2
2012	1838				106	49	11
2013	1296					47	29
2014	1151						121
2015	994						

Table 13. Detections of steelhead parr PIT tagged in Granite Boulder Creek at the MF array during 2010-2015 migration years.

Year Marked	Marked	Detections 2010	2011	2012	2013	2014	2015
2008	460	0	2	0	0	0	1
2009	359	17	2	3	0	3	1
2010	188		1	2	0	0	0
2011	179			4	0	0	0
2012	268				0	2	0
2013	288					2	6
2014	264						7
2015	322						

Less than 1% of steelhead marked at closed capture sites were recaptured at the MF RST from 2008 to 2009 but the majority of RST recaps are Camp Creek origin fish (Tables 10 and 11). Detections of steelhead parr marked at closed captures sites at the MF Array are highest for fish marked in 2009 in both streams. When individual migration years (MY) are compared, the highest detection rates occur during MY 2015 for steelhead marked in both streams. Detection rates during the 2015 migration year were 14% and 5% for Camp and Granite Boulder Creek respectively (Tables 12, and 13). No Granite Boulder Creek origin steelhead were detected during MY 2013 at the MF array.

Table 14. Downstream detections of steelhead PIT tagged at Camp Creek closed capture sites throughout the Columbia River migration corridor.

Year Marked	Number Marked	Detections						
		2009	2010	2011	2012	2013	2014	2015
2008	1055	39	20	5	1	0	0	0
2009	961		15	42	5	0	0	0
2010	1711			56	56	8	3	0
2011	1053				27	20	2	1
2012	1838					16	17	5
2013	1296						8	4
2014	1151							13
2015	994							

Table 15. Downstream detections of steelhead PIT tagged at Granite Boulder Creek closed capture sites throughout the Columbia River migration corridor.

Year Marked	Number Marked	Detections						
		2009	2010	2011	2012	2013	2014	2015
2008	460	4	10	5	0	1	0	0
2009	359		3	6	2	0	0	0
2010	188			3	3	0	0	0
2011	179				5	1	0	0
2012	268					0	0	0
2013	288						0	1
2014	264							6
2015	322							

Downstream detection rates through the Columbia River of steelhead marked in Camp Creek are nearly double those for steelhead marked at Granite Boulder Creek sites (Table 14 and 15). None of the steelhead marked in Granite Boulder Creek in 2012 were detected throughout the Columbia River migration corridor (Table 15). Detection rates throughout the Columbia River migration corridor for fish marked in 2013 are less than 1% for both streams for MY 2014 and 2015 (Tables 14 and 15). Detection rates of PIT tagged steelhead smolts throughout the Columbia River migration corridor are as high as 7% for steelhead marked in Camp Creek and as high as 4% for steelhead marked in Granite Boulder Creek (Tables 14 and 15).

Open Population Sites

Chinook

The number of Chinook parr PIT-tagged at each sampling interval varied annually and seasonally at each open population site. If no Chinook were captured or observed at sites during the initial sampling run in early summer, sampling continued at those sites to document any immigration that might occur throughout the summer and early fall.

Table 16. Number of Chinook parr PIT-tagged and recaptured at each sampling occasion at open population sites in each stream during summer and fall of 2013. Sampling occasion one was completed in early summer, occasion two in mid-summer, occasion 3 in late summer, and occasion 4 was completed in early fall.

Marking Occasion	MFJDR				Coyote Creek				Vinegar Creek			
	New Marks	Recaptures			New Marks	Recaptures			New Marks	Recaptures		
		2	3	4		2	3	4		2	3	4
1	391	73	38	24	0	0	0	0	23	0	2	0
2	427		115	46	0		0	0	27		8	2
3	265			45	0			0	47			10
4	234				0				33			

Table 17. Number of Chinook parr PIT-tagged and recaptured at each sampling occasion at open population sites in each stream during summer and fall of 2014. Sampling occasion one was completed in early summer, occasion two in mid-summer, occasion 3 in late summer, and occasion 4 was completed in early fall.

Marking Occasion	MFJDR				Coyote Creek				Vinegar Creek			
	New Marks	Recaptures			New Marks	Recaptures			New Marks	Recaptures		
		2	3	4		2	3	4		2	3	4
1	319	7	21	9	0	0	0	0	7	1	1	0
2	105		12	6	0		0	0	8		0	1
3	53			8	0			0	6			0
4	122				0				9			

Table 18. Number of Chinook parr PIT-tagged and recaptured at each sampling occasion at open population sites in each stream during summer and fall of 2015. Sampling occasion one was completed in early summer, occasion two in mid-summer, occasion 3 in late summer, and occasion 4 was completed in early fall.

Marking Occasion	MFJDR				Coyote Creek				Vinegar Creek			
	New Marks	Recaptures			New Marks	Recaptures			New Marks	Recaptures		
		2	3	4		2	3	4		2	3	4
1	422	47	29	12	13	3	4	2	24	1	3	5
2	190		30	14	8		2	2	15		1	2
3	121			44	7			2	13			4
4	151				3				38			

Chinook parr were absent in the Coyote Creek site in 2013 and 2014 but were present at the Vinegar Creek site during all four sampling intervals each year it was sampled (Tables 16 to 18). A greater number of Chinook parr were marked during the first sampling occasion than any of the last three at sites located in the MFJDR with the exception of mid-summer sampling in 2013. This increase in unmarked fish captured in the MFJDR was likely due to fish salvage operations near the Mid Treatment 2 site (Figure 4) that occurred between the first and second sampling intervals in July 2013. At the Vinegar Creek site, more Chinook parr were marked in mid and late summer than during the initial sampling run. There have been no adult Chinook documented spawning within or upstream of the Vinegar or Coyote Creek sites that we sampled therefore we assume all individuals captured at both of these sites are immigrants from downstream locations.

Table 19. Chinook parr pit tagged at open population sites in the MFJDR from 2011 to 2015.

Site	Year				
	2011	2012	2013	2014	2015
Lower Treatment	70	195	4	0	2
Lower Control	143	165	25	5	2
Mid Treatment 1	296	518	187	61	29
Mid Treatment 2	277	587	390	284	254
Mid Control 1	734	616	7	63	4
Mid Control 2	442	556	424	145	343
Upper Treatment	228	227	101	44	149
Upper Control	74	367	152	36	49

Not all open population sites in the MFJDR contained Chinook parr during each occasion or year (Table 19). At the Lower Treatment site, Chinook parr were not present during any of the four sampling occasions during 2014. Only six Chinook parr were captured and PIT tagged at this site from 2013 to 2015 combined. Of those six fish, five were captured in the final sampling occasion in the fall. An additional preliminary sampling occasion at this site was completed June 2015 and 60 Chinook parr were captured and marked with colored elastomere but none were recaptured within the site during subsequent sampling intervals. During the summers of 2011 and 2012, Mid Control 1 had the highest captures of any of the open population sites (Table 19). After completion of phase I and II on the Oxbow Conservation Area in 2012 relatively few Chinook parr have been captured and PIT tagged within the Mid-Control 1 site (Table 20).

High capture rates of un-marked individuals at these sites throughout the summer and fall indicate Chinook parr are immigrating into these sites throughout the period that we sample (Tables 16-18). It is also likely there is substantial emigration from these sites at the same time. Selecting a survival model that can incorporate downstream detections of PIT tagged individuals as they out-migrate as smolts will be important to reduce bias of emigration on apparent survival estimates due to movement out of the stream reaches we sampled.

Table 20. Downstream detection of Chinook smolts marked as parr at open population sites throughout the MFJDR IMW and PIT tag detections at the MF array and throughout the Columbia Basin. Columbia Basin detections include John Day Dam, The Dalles Dam, Bonneville Dam, and detections or recaptures in the Columbia River Estuary.

Tag Site	Marking Year	Number Marked	Migration Year							
			Middle Fork Array				Columbia Basin			
			2012	2013	2014	2015	2012	2013	2014	2015
Coyote Creek	2011	83	0				1			
	2012	6		0				0		
	2013	0			0				0	
	2014	0				0				0
MFJDR	2011	3407	157				465			
	2012	3209		100				107		
	2013	1293			50				33	
	2014	601				30				9
Vinegar Creek	2011	35	0				0			
	2012	392		7				16		
	2013	90			1				1	
	2014	30				2				0

Downstream detection rates of PIT tagged smolts vary annually with the highest detection rate of 13.6% occurring during the 2012 migration year throughout the Columbia River migration corridor (Table 20, Figure 14). Detection rates are relatively stable for Chinook marked in the MFJDR during the 2012 to 2015 migration years at the MF array and range from 3 to 5% over the four years. Detection rates are more variable for Chinook marked in Vinegar Creek where they range from 0% to 7% over the same period (Table 20).

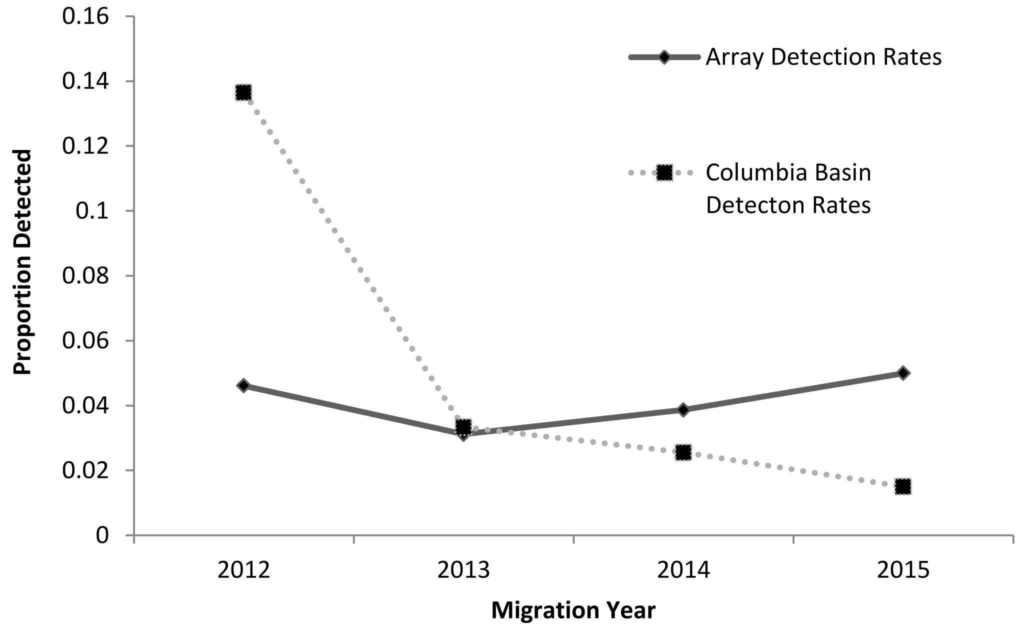

Figure 14. Downstream detection rates of Chinook smolts marked as parr in the MFJDR from 2011 to 2014. MF array detections are shown as array detection rates for each migration year. Columbia Basin detections include John Day Dam, the Dalles Dam, Bonneville Dam, and detections or recaptures in the Columbia River Estuary.

Steelhead

Steelhead parr were captured at every open population site with the exception of the lower treatment site in 2013 and 2014. Only four steelhead parr were marked at this site in 2015; all during the final early fall sampling interval (Table 21). Backpack electrofishing techniques were more effective at capturing juvenile steelhead than snorkel herding, which was used at most main-stem MFJDR open population sites.

Table 21. Steelhead parr PIT tagged at MFJDR IMW open population sites from 2011 to 2015.

Site	Year and Number Marked				
	2011	2012	2013	2014	2015
Lower Treatment	1	15	0	0	4
Lower Control	21	64	23	65	9
Mid Treatment 1	2	16	24	7	40
Mid Treatment 2	10	88	29	24	24
Mid Control 1	29	48	3	32	2
Mid Control 2	44	215	75	26	123
Upper Treatment	34	94	56	12	53
Upper Control	90	203	133	89	57

Table 22. In-stream recaptures for steelhead parr 2013 to 2015 and number marked in each stream at open population sites. Sampling occasion one was completed in early summer, occasion two in mid-summer, occasion three in late summer, and occasion four was completed in early fall.

Mark Site	Mark Interval	2013				2014				2015			
		Number Marked	Recaptures / Interval			Number Marked	Recaptures / Interval			Number Marked	Recaptures / Interval		
			2	3	4		2	3	4		2	3	4
Middle Fork John Day River	1	86	19	10	10	67	9	13	5	74	11	2	12
	2	84		16	14	41		14	2	60		11	10
	3	79			13	58			5	42			6
	4	111				71				167			
Coyote Creek	1	34	11	12	9	30	13	7	7	13	2	7	3
	2	12		7	3	11		4	3	24		11	4
	3	17			3	9			4	10			1
	4	15				10				3			
Vinegar Creek	1	66	9	8	9	47	7	8	11	40	8	4	8
	2	54		15	11	32		2	3	23		7	12
	3	68			20	33			11	19			7
	4	103				72				103			

Table 23. Steelhead parr PIT tagged at open population sites and in-stream recaptures during subsequent years.

Tag Site	Year Marked	Number Marked	Year Recaptured			
			2012	2013	2014	2015
Coyote Creek	2011	52	0	1	0	0
	2012	55		3	1	0
	2013	74			4	0
	2014	55				2
	2015	48				
MFJDR	2011	348	3	0	0	0
	2012	742		12	0	0
	2013	342			8	0
	2014	228				0
	2015	338				
Vinegar Creek	2011	330	15	0	0	0
	2012	212		14	0	0
	2013	192			5	1
	2014	173				5
	2015	228				

Recapture rates of steelhead in subsequent years after tagging range from 0% to 6% with the highest rates in Vinegar Creek and Coyote Creek in 2013 (Table 22). In-stream recapture rates of steelhead parr during the same marking year are highest in Coyote Creek between initial marking and the next sampling interval (Table 23). Average recapture rates during the first recapture run after marking for steelhead from 2013 to 2015 are 34% for Coyote Creek, 24% for Vinegar Creek, and 18% for the MFJDR.

Table 24. Downstream detection of steelhead smolts marked as parr at open population sites throughout the MFJDR IMW and PIT tag detections at the MF array and throughout the Columbia Basin. Columbia Basin detections include John Day Dam, the Dalles Dam, Bonneville Dam, and detections or recaptures in the Columbia River Estuary.

Tag Site	Marking Year	Number Marked	Migration Year							
			Middle Fork Array				Columbia Basin			
			2012	2013	2014	2015	2012	2013	2014	2015
Coyote Creek	2011	52	0	1	0	0	1	0	0	0
	2012	55		1	0	0		1	1	0
	2013	74			1	1			0	1
	2014	55				2				1
Middle Fork John Day	2011	348	16	1	2	2	18	2	2	0
	2012	742		21	5	3		25	4	1
	2013	342			13	4			6	0
	2014	228				16				6
Vinegar Creek	2011	330	5	7	1	0	5	4	2	0
	2012	212		1	2	0		1	2	0
	2013	192			4	4			0	1
	2014	173				5				2

Among streams that we sampled using open population mark recapture techniques, downstream detections of marked steelhead smolts are highest for fish marked as parr in the MFJDR. Sixteen of the 228 steelhead parr (7%) marked in the MFJDR in 2014 were detected at the MF array during the 2015 migration year (Table 24). Detection rates of steelhead parr marked at open population sites in Vinegar Creek and Coyote Creek are < 4% from 2013 to 2015 (Table 24). Detection rates have increased at the MF array in 2014 and 2015, but have declined in the Columbia River migration corridor when compared to 2012 and 2013 rates (Table 24).

Parr Distribution Surveys

Parr distribution surveys were done in the summers of 2014 and 2015 and were conducted starting near the assumed downstream limit of Chinook parr distribution in the MFJDR near the MF array. Approximately 20 river kilometers (rkm) were snorkeled in 2014, only the lower 13 rkm were snorkeled in 2015 due to time constraints. During snorkel surveys in 2014, 10 Chinook parr and 125 steelhead parr were observed in the MFJDR downstream of Camp Creek (Figure 15 and 16). Twelve Chinook parr and 189 steelhead parr were observed downstream of Camp Creeek during 2015 surveys in the MFJDR (Figure 17 and 18). During 2014 surveys, Chinook parr observations increased in the snorkeled section between Balance Creek and Big Boulder Creek yet this trend was not observed during 2015 snorkel surveys (Figures 15 and 17). During 2014 surveys, Chinook parr observations were more common from the Mid-Treatment 2 (MT2) parr monitoring site (Figure 4) on the Oxbow Conservation Area upstream to Middle Fork Campground located on USFS land (Figure 19). We observed a total of 1,606 Chinook parr from MT2 to Middle Fork Campground during 2014 snorkel surveys.

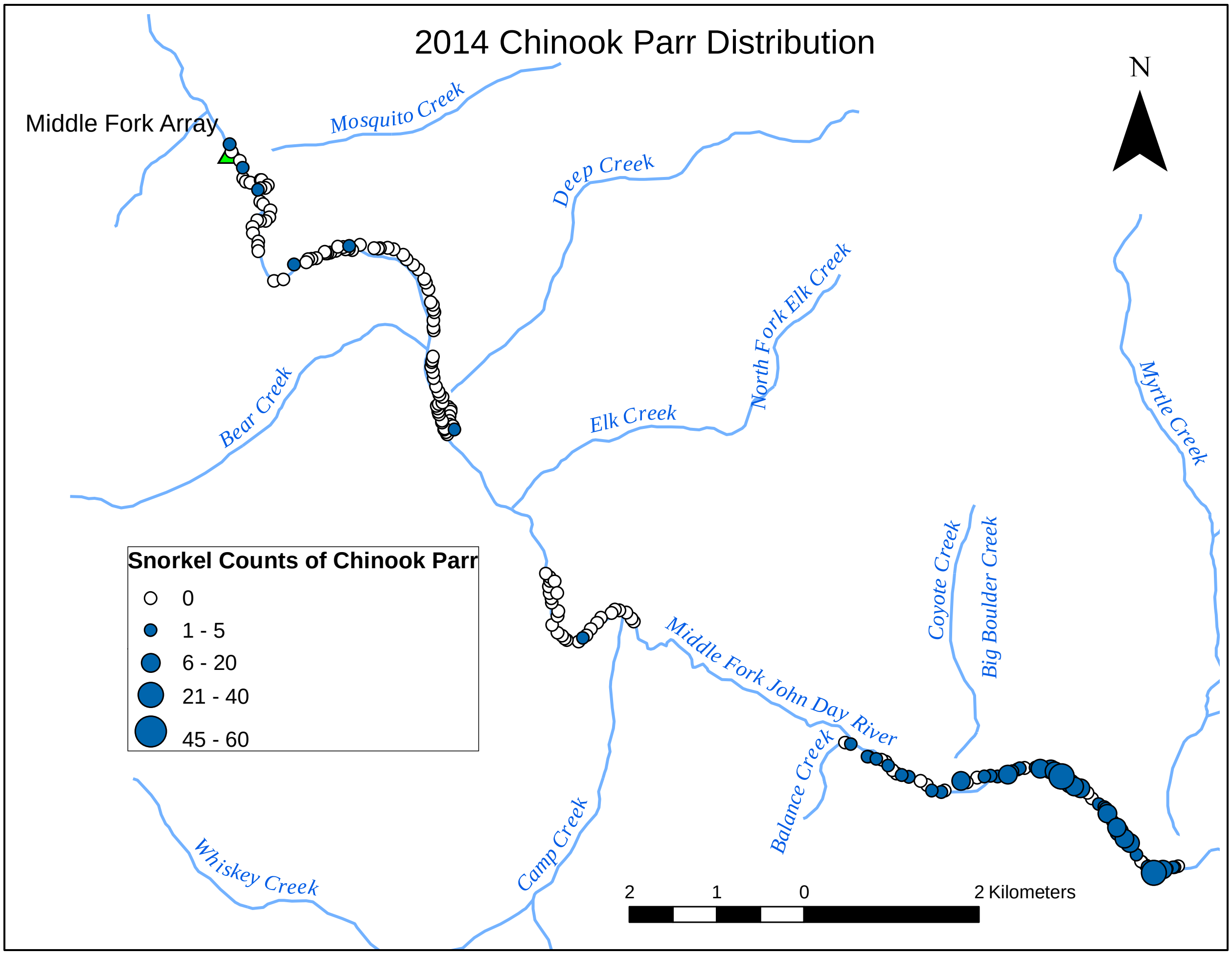

Figure 15. Chinook parr observations during snorkel surveys from the MF array upstream to Big Boulder Creek during August 2014.

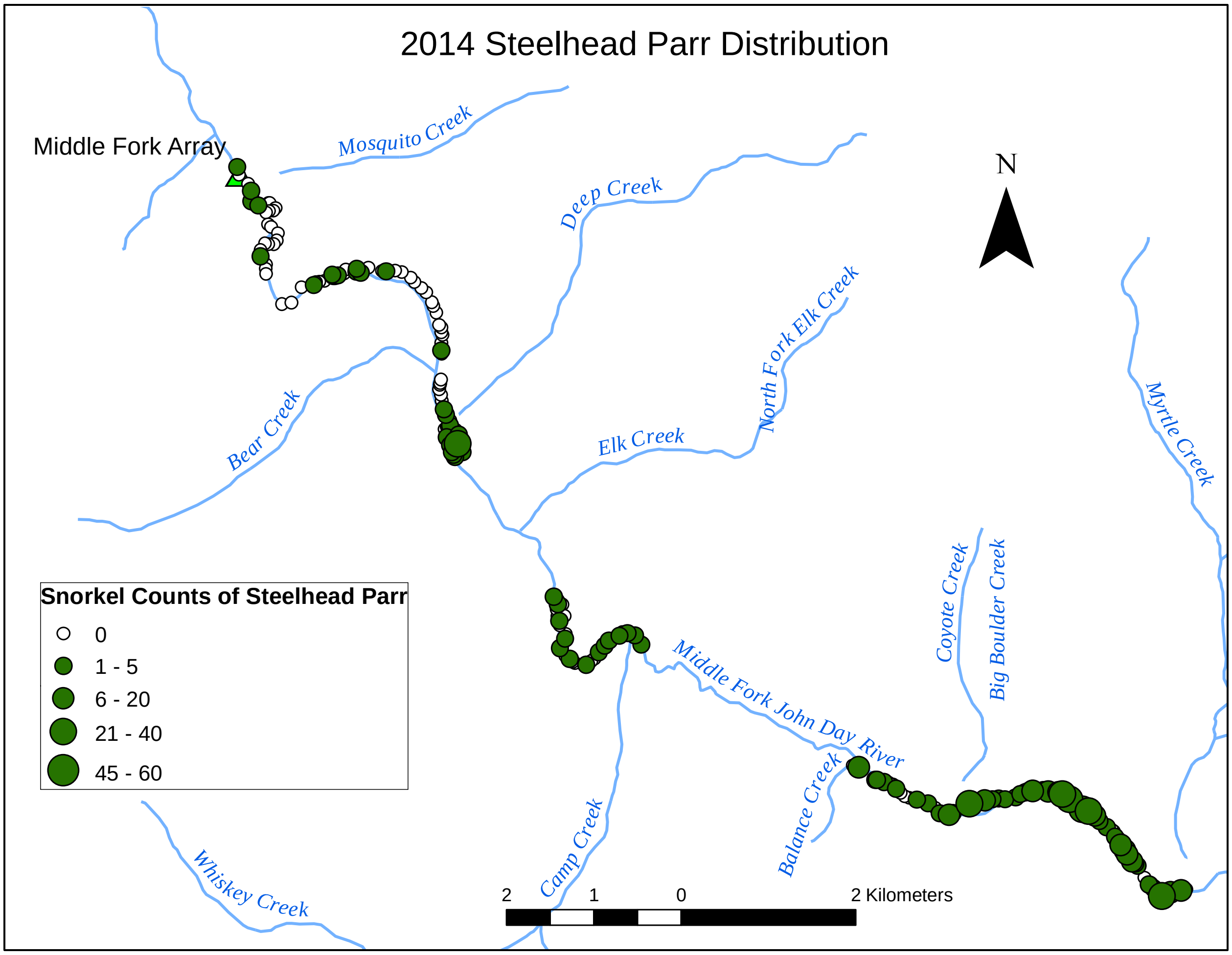

Figure 16. Steelhead parr observations during snorkel surveys from the MF array upstream to Big Boulder Creek during August 2014.

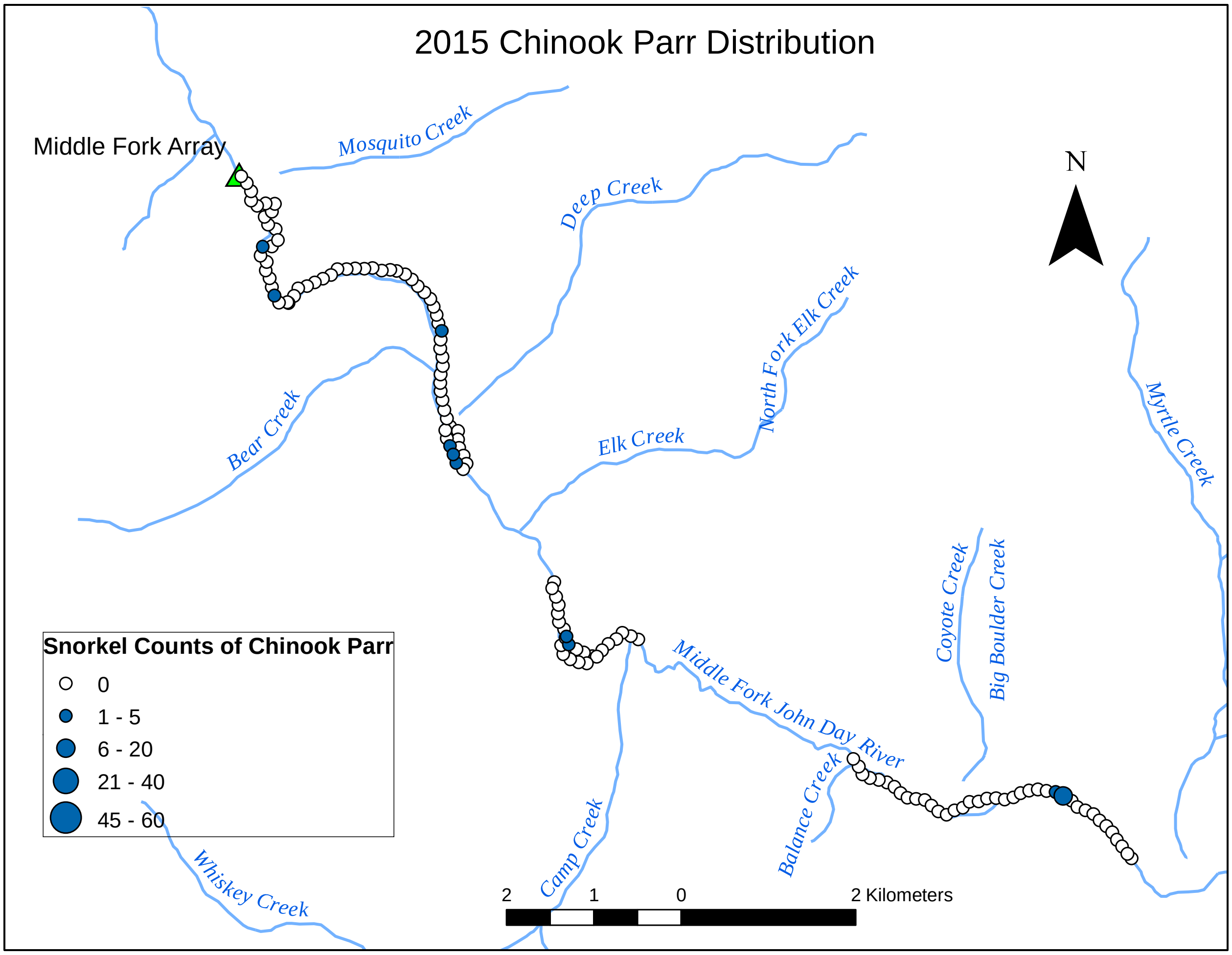

Figure 17. Chinook parr observations during snorkel surveys from the MF array upstream to Big Boulder Creek during August 2015.

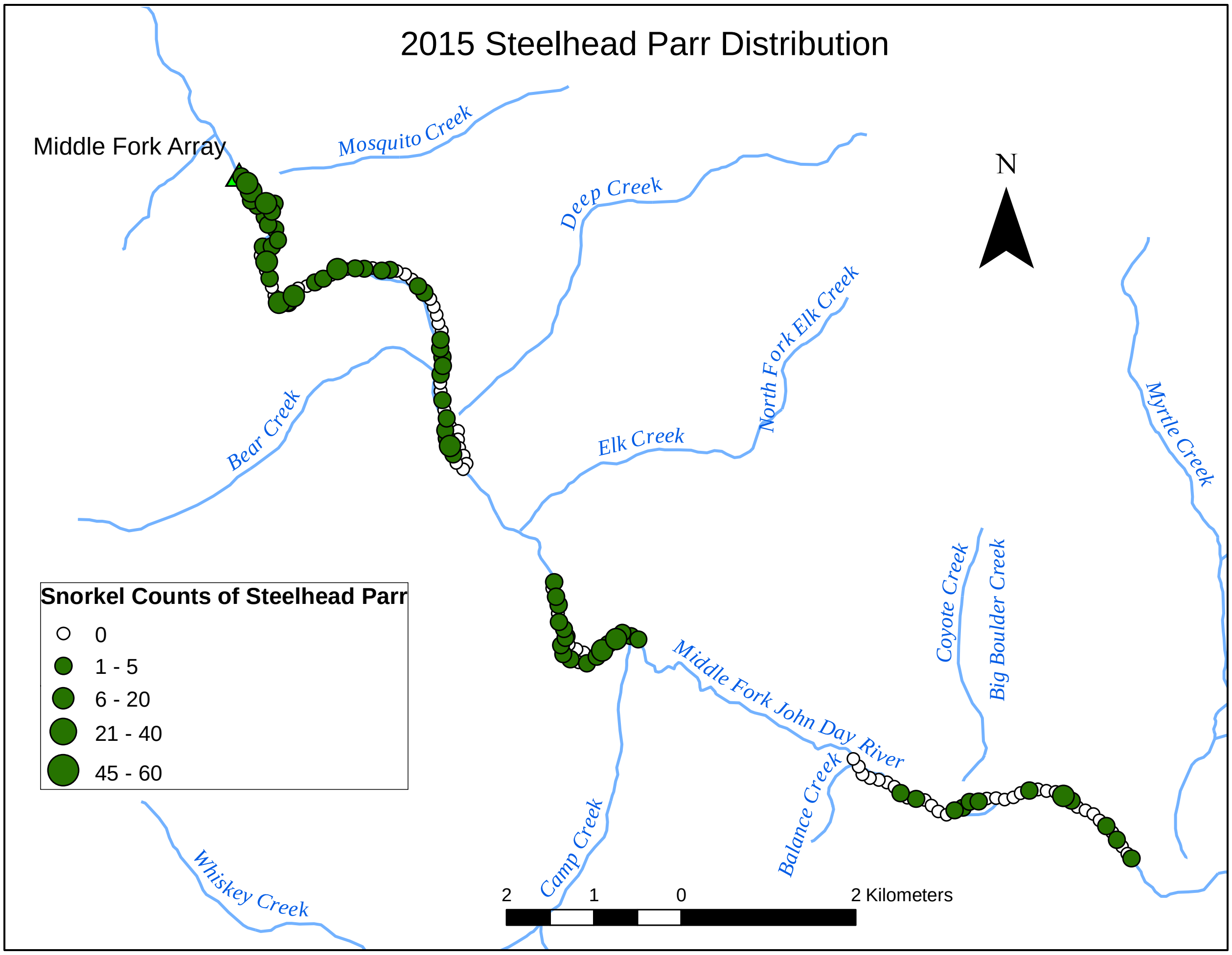

Figure 18. Steelhead parr observations during snorkel surveys from the MF array upstream to Big Boulder Creek during August 2015.

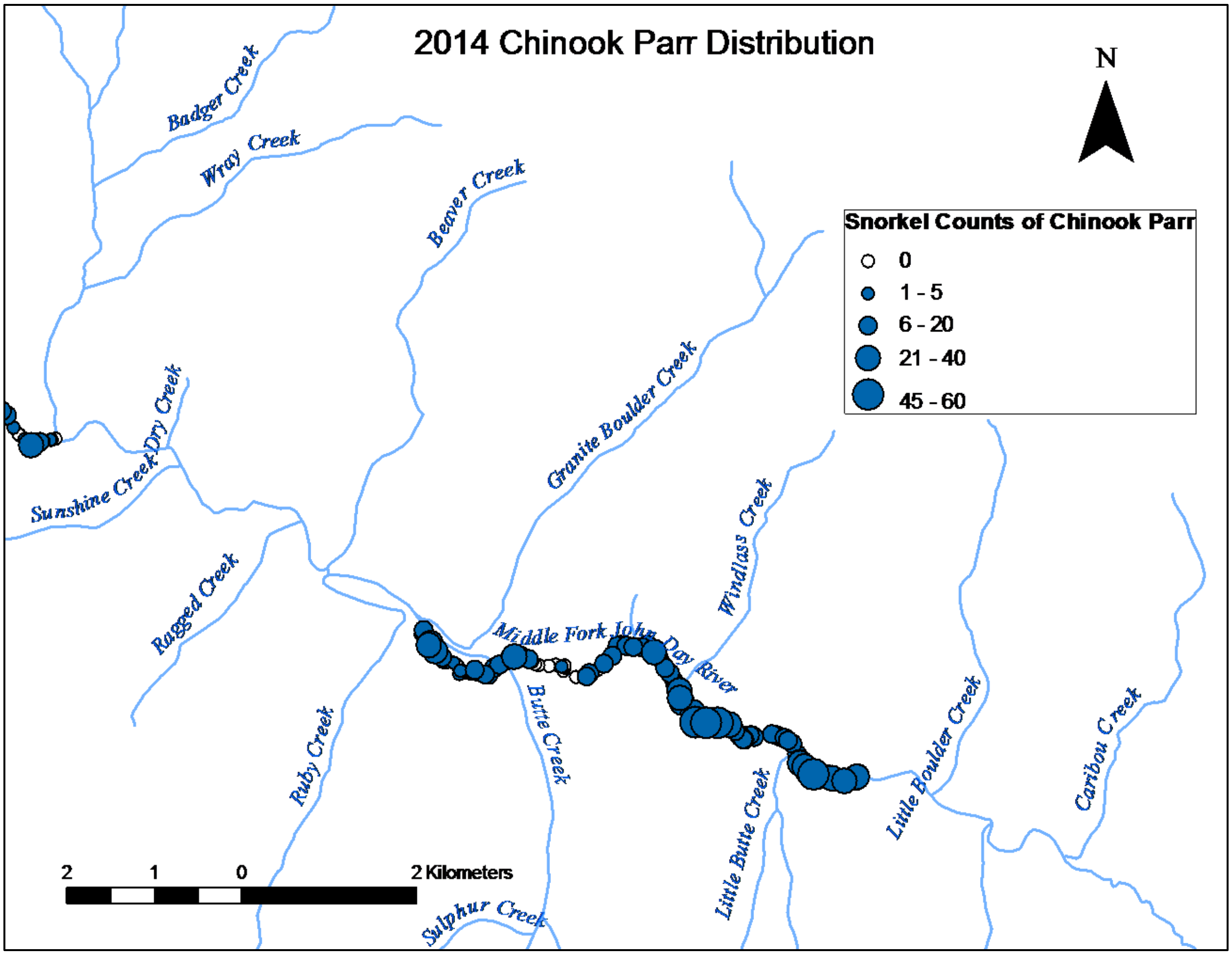

Figure 19. Chinook parr observations during snorkel surveys from the Mid-Treatment 2 parr monitoring site upstream to Middle Fork Campground in the MFJDR during August 2014.

Bates Pond Juvenile Passage

Table 25. Detections of PIT tagged juvenile steelhead at in-stream PIT tag antennae in Bridge Creek (MFJDR Basin). Tag sites are Bridge Creek downstream of Bates Pond (LBC), Bridge Creek upstream of Bates Pond (UBC), and fish marked outside of Bridge Creek (OBC).

Tag Site	Tag Year	# Tagged	Lower Antennae						Upper Antennae					
			2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015
LBC	2010	256	13	4	1	0	0	0	0	0	0	1	0	0
	2011	45	-	0	0	0	0	0	-	0	0	0	0	0
	2012	52	-	-	8	0	0	0	-	-	2	0	0	0
	2013	44	-	-	-	15	1	0	-	-	-	1	1	0
	2014	39	-	-	-	-	8	3	-	-	-	-	0	1
	2015	14	-	-	-	-	-	7						1
UBC	2010	85	0	0	0	0	0	0	89	21	7	1	0	0
	2011	30	-	2	5	1	0	0	-	1	9	0	0	0
	2012	94	-	-	7	3	1	0	-	-	44	12	0	0
	2013	56	-	-	-	7	1	0	-	-	-	24	3	0
	2014	51	-	-	-	-	1	2	-	-	-	-	15	6
	2015	43	-	-	-	-	-	1	-	-	-	-	-	0
OBC	2010	2089	0	0	0	0	0	0	0	0	0	0	0	0
	2011	1995	-	2	5	1	0	0	-	0	6	1	0	0
	2012	3120	-	-	7	3	2	0	-	-	2	0	1	0
	2013	1509	-	-	-	7	0	0	-	-	-	1	0	0
	2014	774	-	-	-	-	2	0	-	-	-	-	0	4
	2015	2035	-	-	-	-	-	0	-	-	-	-	-	0

Table 26. Detections of PIT tagged juvenile Chinook at in-stream PIT tag antennae in Bridge Creek (MFJDR Basin). Tag sites are Bridge Creek downstream of Bates Pond (LBC), Bridge Creek upstream of Bates Pond (UBC), and fish marked outside of Bridge Creek (OBC).

Tag Site	Tag Year	# Tagged	Lower Antennae						Upper Antennae					
			2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015
LBC	2010	50	6	2	0	0	0	0	0	0	0	0	0	0
	2011	3	-	3	0	0	0	0	-	0	0	0	0	0
	2012	35	-	-	6	0	0	0	-	-	2	0	0	0
	2013	11	-	-	-	3	0	0	-	-	-	1	0	0
	2014	5	-	-	-	-	2	0	-	-	-	-	0	0
	2015	34	-	-	-	-	-	10	-	-	-	-	-	1
UBC	2010	3	0	1	0	0	0	0	2	0	0	0	0	0
	2011	0	-	0	0	0	0	0	-	0	0	0	0	0
	2012	1	-	-	0	0	0	0	-	-	0	0	0	0
	2013	1	-	-	-	0	0	0	-	-	-	0	0	0
	2014	0	-	-	-	-	0	0	-	-	-	-	0	0
	2015	5	-	-	-	-	-	0	-	-	-	-	-	0
OBC	2010	1920	0	0	0	0	0	0	0	0	0	0	0	0
	2011	3651	-	1	1	0	0	0	-	3	0	0	0	0
	2012	4623	-	-	8	1	0	0	-	-	0	0	0	0
	2013	2200	-	-	-	10	0	0	-	-	-	0	0	0
	2014	504	-	-	-	-	2	1	-	-	-	-	0	2
	2015	1422	-	-	-	-	-	0	-	-	-	-	-	0

Detections of PIT tagged fish at the Bridge Creek antennae sites show juvenile steelhead and Chinook marked downstream of Bates Pond are able to ascend the fish ladder and move through Bates Pond to access upper Bridge Creek. (Tables 25, and 26). Juvenile steelhead and Chinook marked outside of Bridge Creek have also been detected at the upper and lower antennae sites. Preliminary results show we have detected 9 juvenile Chinook and 22 steelhead that were marked downstream of Bates Pond at the upper antennae. Detections of fish marked outside of Bridge Creek at both antennae sites show some juvenile salmonids moving from their tag site in another stream into Bridge Creek during fresh water residency.

Summer Steelhead and Spring Chinook Smolt Abundance

Chinook smolt abundance at the MF RST declined from 2013 to 2015 from a high of 49,141 total migrants in MY 2013 to a low of 6,307 total migrants for MY 2015 (Figure 20). Chinook smolt abundance at the Mainstem John Day River RST also declined during this same time period from 146,628 total migrants in MY 2013 to 92,097 total migrants in MY 2015 (Keith Dehart preliminary data 2015).

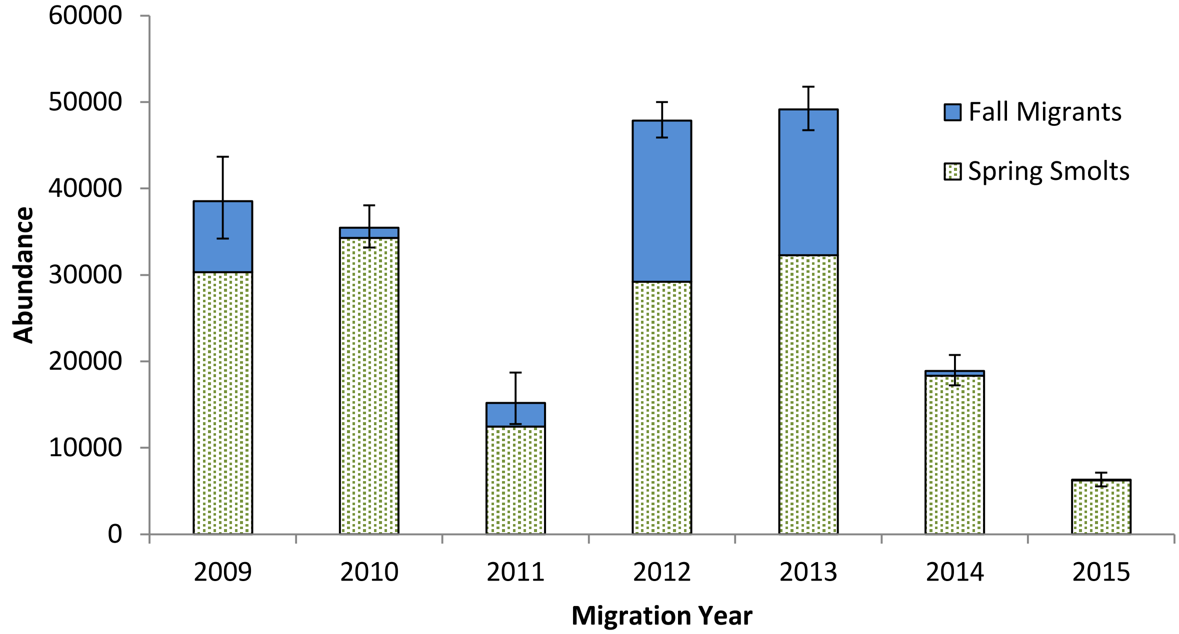

Figure 20. Chinook smolt abundance estimates at the MF RST for migration years 2009 to 2015. Fall migrant abundance estimates are for migrants passing the trap prior to February 1 each MY. Error bars are upper and lower 95% confidence intervals for total migrant abundance estimates.

Steelhead smolt estimates at the MF RST declined from 2013 to 2015 from 35,252 to 19,873 respectively (Figure 21). Steelhead smolt abundance showed a significant decrease from 2013-2014 at the MF RST. The RST operated in the South Fork John Day River has shown an increasing trend in steelhead smolt abundance from 2012 to 2015 with a significant increase in smolt abundance from 2013 to 2015 (Figure 21).

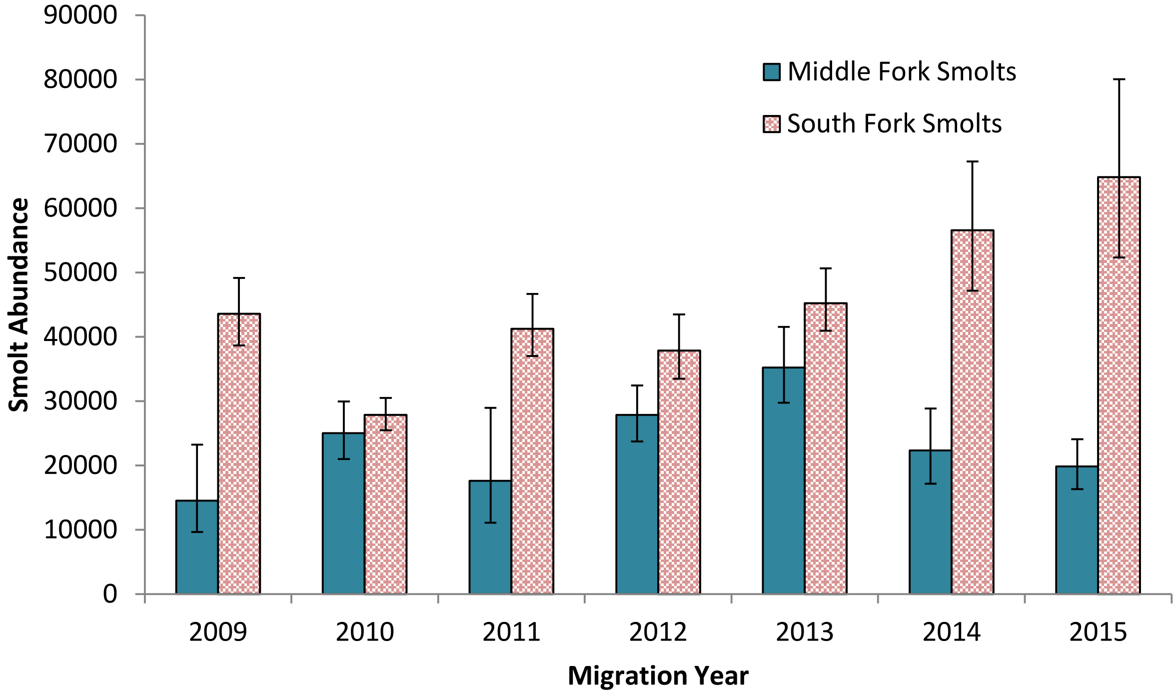

Figure 21. Steelhead smolt abundance estimates at MF RST and South Fork John Day River RST for 2009-2015 migration years. Error bars are upper and lower 95% confidence intervals.

DISCUSSION

Adult steelhead escapement for the MFJDR IMW remained above recovery goals (Carmichael 2010) for the MFJDR basin from 2009 to 2015. High adult abundance is driven by both freshwater and ocean productivity and is not reliable for determining restoration success. The trend in South Fork John Day River adult steelhead escapement shows a more consistent downward trend over the same period (Figure 10). Observations of hatchery origin adult steelhead have composed less than 1% of the total live steelhead with visually confirmed origin (Table 4). This suggests that hatchery strays make up a very small proportion of the spawning adult steelhead population within the MFJDR IMW.

Preliminary results from 2013 to 2015 monitoring in the MFJDR IMW show temperature is still likely limiting freshwater productivity of this watershed. The MFJDR experienced high pre-spawn adult Chinook salmon mortality in 2013 and 2015. Both events occurred in early summer and were synonymous with higher than average temperatures and lower than average stream flows. Future restoration aimed at protecting adult salmon from high water temperatures should create deep pool type habitat that is associated with cool water refugia (Torgerson et al 1999). Creating deep pool habitat in areas that expose adults to high water temperatures may be detrimental to survival of adult Chinook during periods of extreme heat. We were able to document adult salmon mortality during both high temperature events but juvenile salmonid mortality is more difficult to detect via visual shoreline surveys. Survival estimates from PIT tagged juvenile fish will help quantify mortality from harsh conditions fish experience between mark and recapture events but may be confounded by fish movement. Incorporating downstream detections into a multi-state survival model will be important to reduce bias from emigration from sample sites during summer monitoring at open population sites.

Monitoring at closed captures sites shows less temporal variability in steelhead abundance at Granite Boulder Creek sites than Camp Creek sites. Temperature data collected from Camp Creek and Granite Boulder Creek show Camp Creek is more susceptible to environmental extremes such as heat, and drought due to lower watershed elevation and riparian management practices. Despite warmer summer temperatures, downstream PIT tag detections of marked steelhead suggest Camp Creek produces smolts at a higher rate than Granite Boulder Creek which is cooler and experiences higher summer flows.

Detection histories of PIT tagged fish at both Bridge Creek antennae sites show there is movement of juvenile steelhead and Chinook between streams in the Middle Fork Basin during freshwater rearing. Understanding these movement patterns and knowing what habitat types are used throughout the year and at different stages of a juvenile fish's development may help managers prioritize habitat needs. Future research should place a greater priority on in-stream PIT tag antennae to help document movement patterns of marked fish.

Chinook parr distribution during the summer seems limited to reaches of the MFJDR upstream of Camp Creek and tributary streams where summer flows are sufficient for parr to gain access. Steelhead parr distribution during mid-summer is also limited by high temperature in the mainstem MFJDR but to a lesser extent than Chinook during mid-summer.

Chinook and steelhead smolt abundance estimates have trended downward in the MFJDR since MY 2013. This trend is likely the result of on-going drought from 2013 to 2015 however the declining trend in steelhead smolt abundance was not observed in the South Fork John Day Basin which experienced a similar climactic trend over the same time period.

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