Chinook Salmon Productivity and Escapement Monitoring in the John Day River Basin

Annual Technical Report

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Objectives

1. Estimate number and distribution of Chinook salmon *Oncorhynchus tshawytscha* redds and spawners for the John Day River subbasin populations.

2. Estimate age composition and hatchery stray fraction of the John Day River subbasin spring Chinook salmon populations.

3. Estimate productivity metrics including smolts/redd for the John Day River spring Chinook populations.

Accomplishments and Findings

Spawning ground surveys for spring Chinook salmon *Oncorhynchus tshawytscha* were conducted in the John Day River basin from August to October, 2010. We observed 1,268 spring Chinook redds while surveying 278 km of Chinook spawning habitat (254.1 km were in the census areas and 23.9 km were random surveys). We estimated a total of 172 redds in the 14.5 km of census area where we were denied access (166 redds in the Mainstem John Day River and 6 redds in Clear Creek). We estimate that 1,440 spring Chinook redds were constructed in the John Day Basin at an overall density of 5.36 redds/km for the census area. We were able to determine the origin of 692 Chinook carcasses, 664 (96%) were of wild origin and 28 (4%) were of hatchery origin (Table 1). Redd numbers increased from 2009 both basin wide and across each subbasin with the exception of the Middle Fork. The 2010 redd estimate in the Mainstem (614) is the highest we have observed since implementing census surveys in 1998. Our spring Chinook escapement estimate for 2010 is 3,744 fish using a 2.6 fish/redd ratio observed at the Catherine Creek weir in the Grande Ronde River basin.

ACKNOWLEDGEMENTS

We would like to acknowledge the assistance and cooperation of private landowners throughout the John Day River basin who allowed us to survey on their property. Additionally, we would like to thank Jeff Neal for providing guidance and advice. We would also like to thank Wayne Wilson, Keith DeHart, Mikaela Alley, Chris Holsclaw, Ryan Carrasco, Rebecca Seyferth, Jenifer Deves, Chris James, and countless volunteers for helping conduct field surveys. This project was funded by the Oregon Watershed Enhancement Board, Contract Number 210-910.

INTRODUCTION

The John Day River subbasin supports one of the last remaining intact wild populations of spring Chinook salmon in the Columbia River Basin. These populations remain depressed relative to historic levels. Numerous habitat protection and rehabilitation projects have been implemented in the basin to improve salmonid freshwater production and survival. Often, these projects lack effectiveness monitoring (Bayley and Li 2008). While our monitoring efforts outlined here will not specifically measure the effectiveness of any individual project, they will provide much needed programmatic or watershed-scale (status and trend) information to help evaluate project-specific effectiveness monitoring efforts as well as meet the data needs as index stocks. Our continued monitoring efforts to estimate salmonid abundance, age structure, smolts/redd, freshwater habitat use, and distribution of critical life stages will allow managers to assess the long-term effectiveness of habitat projects.

Because Columbia Basin managers have identified the John Day subbasin spring Chinook population as an index population for assessing the effects of alternative future management actions on salmon stocks in the Columbia Basin (Schaller et al. 1999) we continue our ongoing studies. This project is high priority based on the level of emphasis by the Northwest Power Planning Council (NWPPC) Fish and Wildlife Program, Independent Scientific Advisory Board (ISAB), Independent Scientific Review Panel (ISRP), National Oceanic and Atmospheric Administration (NOAA), and the Oregon Watershed Enhancement Board (OWEB). Each of these groups has placed priority on monitoring and evaluation to provide the real-time data to guide restoration and adaptive management in the region.

STUDY AREA

The John Day River drains 20,300 km^2 of east central Oregon, the third largest drainage area in the state (Figure 1). From its source in the Strawberry Mountains at an elevation near 1,800 m, the John Day River flows 457 km, to an elevation near 90 m, to the Columbia River. It enters the Columbia River at river kilometer (rkm) 351. The basin is bounded by the Columbia River to the north, the Blue Mountains to the east, and the Ochoco Mountains to the west.

Spring Chinook salmon primarily spawn in the upper Mainstem John Day River (hereafter called Mainstem; Figure 2) above the mouth of Indian Creek, in the Middle Fork John Day River (hereafter called Middle Fork; Figure 3) above Armstrong Creek, and the North Fork John Day River (hereafter called North Fork; Figure 3) above the mouth of Camas Creek. Important spawning tributaries of the North Fork include Granite Creek and its tributaries (Clear Creek and Bull Run Creek; hereafter called Granite Creek System) and Desolation Creek (Figure 3). Spawning has also occurred in the South Fork John Day River (hereafter called South Fork; Figure 4), the North Fork tributaries, Camas and Trail creeks, and the Mainstem tributaries Deardorff Creek, Reynolds Creek and Bridge Creek. Fall Chinook are thought to spawn in the Lower Mainstem downstream of Kimberly, OR (rkm 298) but recent surveys have shown their distribution to be primarily between Cottonwood Bridge (rkm 64) and Tumwater Falls (rkm 16).

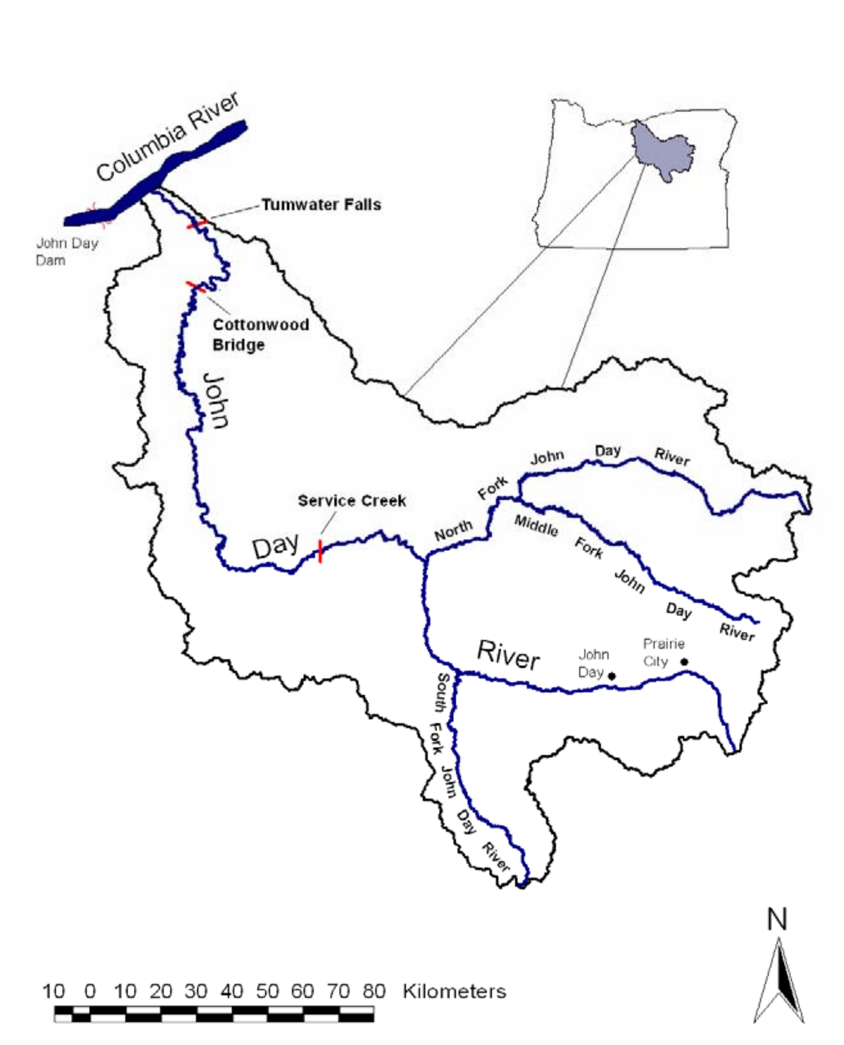

Figure 1. Map of John Day River basin.

METHODS

Sampling Design

Spring Chinook salmon spawning surveys were conducted during the months of August, September, and October to encompass the spatial and temporal distribution of Chinook spawning in the John Day River basin (Table 1). These surveys included historic index, census and random surveys. Census surveys were conducted in areas where redds have been previously documented, including index sections. Index sections were surveyed to provide relative abundance comparisons with historic redd count data collected since 1959. Collectively, these surveys provide an annual census of spawning spring Chinook salmon and their redds (Figures 2, 3, and 4). Random surveys were conducted outside of the known spawning area to account for range expansion. Random survey sections, approximately 2 km in length, were drawn from a non-random sampling universe. This sampling universe encompassed stream sections 20 km downstream from the downstream border of current survey sections or from the most downstream redd observed in each 4th level Hydrologic Unit Code (HUC; North Fork, Middle Fork, Upper Mainstem). A second sampling universe extended 4 km upstream from the border of our current census reaches or 4 km upstream from the most upstream redd observed since 1959. Survey sections were selected with a random number generator based on river kilometer. For every one site selected above the census section, two sites were selected below if stream length allows. If redds were observed in a random site, that survey section was added to the census survey the following year.

Index Surveys

Index surveys were scheduled to take place near the peak of spawning in each of the four primary spawning areas (Mainstem, Middle Fork, North Fork, and Granite Creek System). Pre-index surveys, were conducted one week prior to the index surveys. Post-index surveys, one week after the index surveys, were conducted in the Mainstem to account for temporal variation in spawning. Post-index surveys were not conducted in the Middle Fork, North Fork, and Granite Creek System because spawning was completed and few live fish were left at the time of the index survey. Post-index counts were not included in the overall index count. We surveyed a total of 78.3 km of spring Chinook spawning habitat within the historic index areas and were denied access to 6.3 km (Table 1; Figures 2 and 3).

Census Surveys

Census surveys were conducted the same day or within one day of the index in all four main spawning areas as well as in the South Fork and various tributaries of the North Fork to ensure that all spawning habitat was observed. If many live fish were observed during the initial surveys, we would return one week later to re-survey and make certain that all spawning was complete. Census surveys were conducted multiple times in the North Fork (between Trail Crossing and Trout Creek) due to early spawning activity. Pre-index, index and post-index counts were included in the census count, as well as redds observed at random sites. The census area includes 268.6 km of spring Chinook spawning habitat, 14.5 km of which we were denied access (Table 1; Figures 2, 3, and 4).

Random surveys

With the assistance of crews from Oregon State University we conducted random surveys on the Middle Fork, North Fork, South Fork, Reynolds Creek, Bridge Creek a tributary to the Lower Mainstem John Day River, and Bridge Creek a tributary to the Middle Fork. These surveys were conducted on the same day or within one day of the index surveys for their respective streams. Random surveys encompassed a total length of 23.9 km of stream habitat (Table 1; Figures 2 and 3).

Spring Chinook Spawning Surveys

Spawning surveys were conducted by walking in an upstream direction on the Mainstem, Middle Fork, South Fork, Trail Creek, and Clear Creek, and in a downstream direction on the North Fork, Camas Creek, Desolation Creek, Granite Creek, and Bull Run Creek. Where we were denied access to one side of the river on the Mainstem, we surveyed on the permissible side only. Survey sections ranged in length from 0.8 to 7.8 km depending on accessibility and difficulty. Typically, teams of two surveyors walked the stream for safety reasons and to ensure accuracy when distinguishing redds. In each section, surveyors recorded the number of new redds, number of live adult fish (on/near and off dig), and number of carcasses. On reaches surveyed more than once, the first team of surveyors marked redds with numbered colored flagging placed near each redd or group of redds. During subsequent surveys, surveyors re-identified flagged redds and recorded any new redds. During the last survey of each reach, surveyors marked redds with a GPS receiver. Flagging was removed during the final surveys.

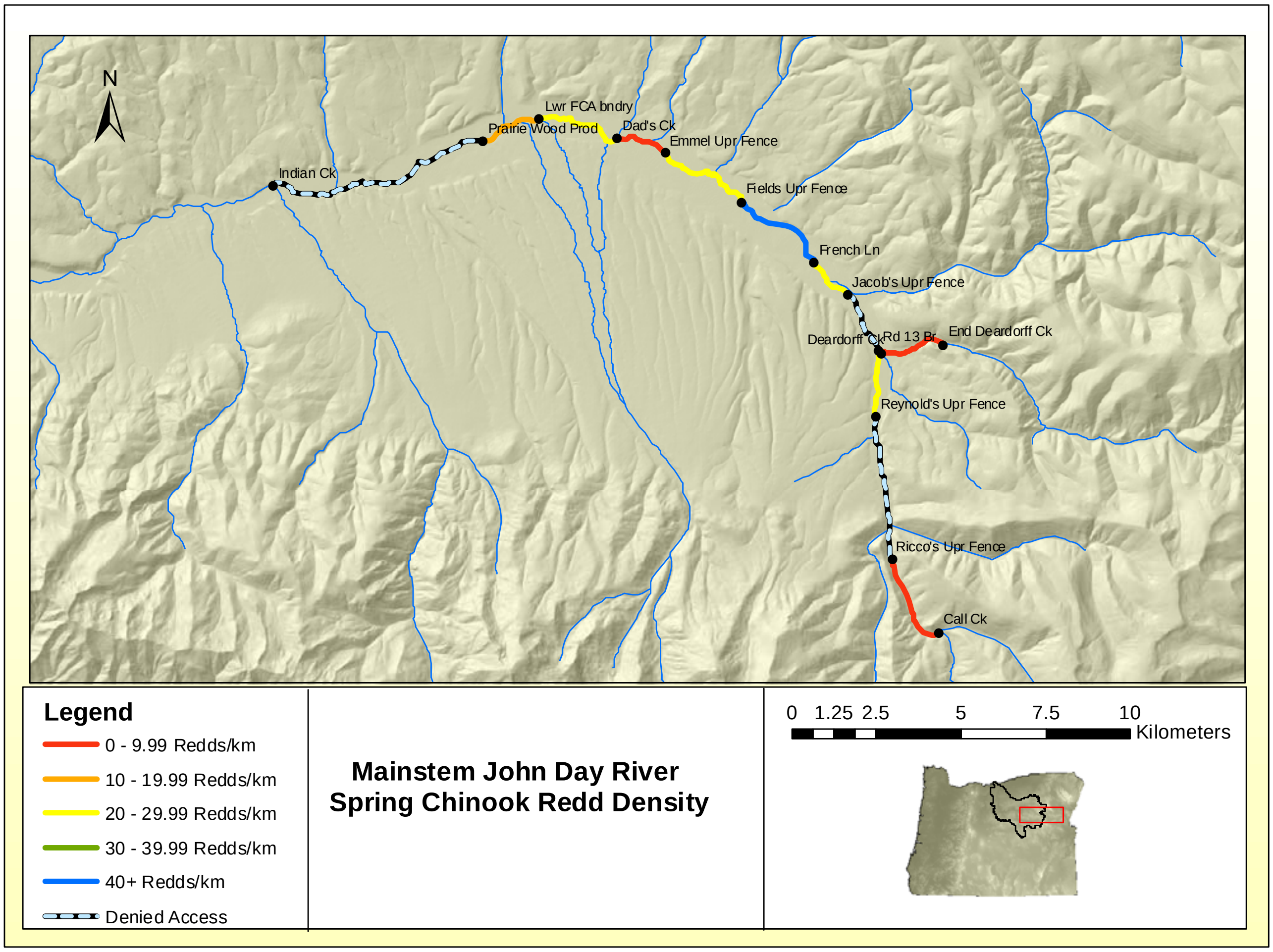

Figure 2. Map of the 2010 Mainstem spring Chinook spawning ground survey sections.

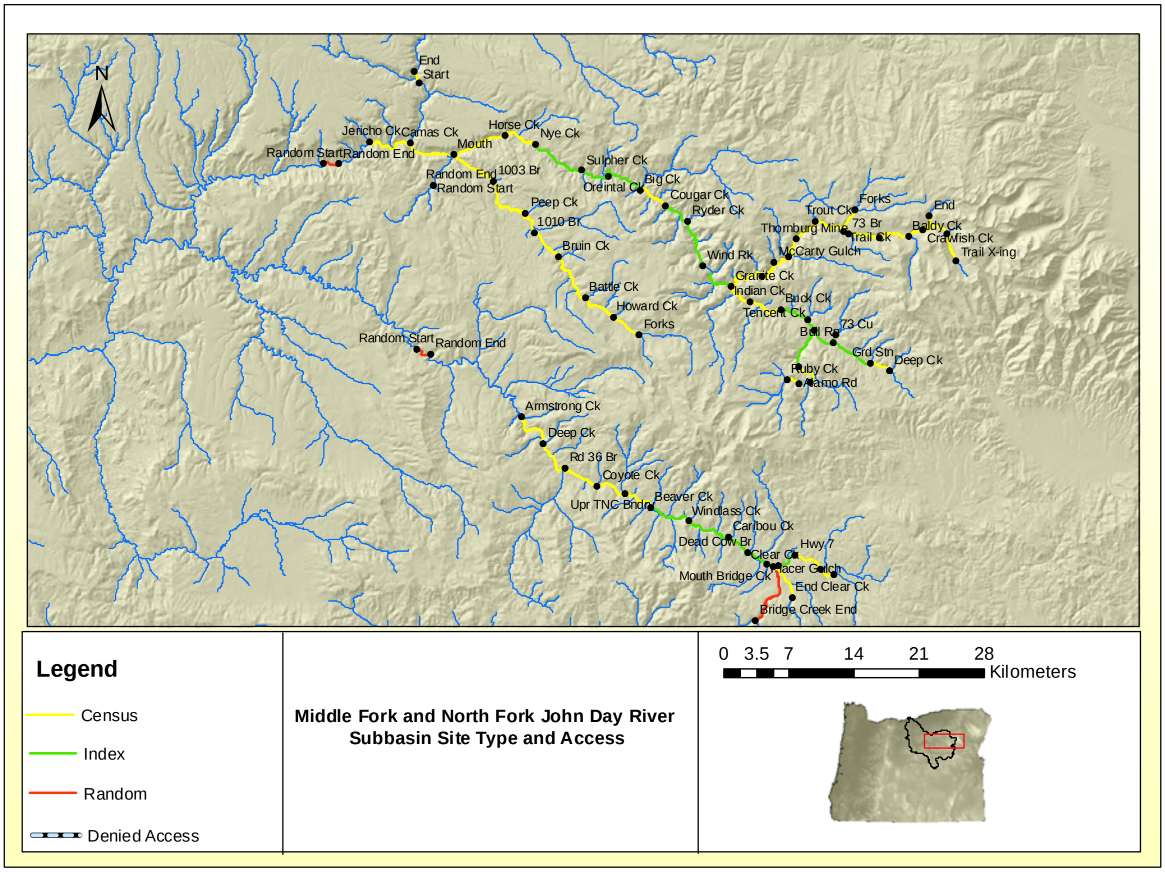

Figure 3. Map of the 2010 Middle Fork and North Fork spring Chinook spawning ground survey sections.

In each subbasin, every observed carcass was examined and sampled. Carcasses were measured for fork length (FL, mm) and medial eye to posterior scale length (MEPS, mm), and dissected to verify sex. Females were checked for egg retention, which was estimated to the nearest 25%. Trained surveyors recorded gill lesion presence or absence on fresh carcasses. In reaches with relatively high numbers of carcasses, a Passive Integrated Transponder (PIT) tag reader was used by surveyors to scan carcasses for the presence of PIT tags.

Kidney samples were collected from fresh spring Chinook carcasses in each of the main spawning areas to determine concentration and prevalence of *Renibacterium salmoninarum* (Rs) antigen, the causative agent of bacterial kidney disease (BKD), in the spawning population. Trained surveyors selected carcasses with intact organs and membranes, and non-glazed eyes, indicative of recent mortality. Plastic knives and spoons were used to scrape a 1–2 gram sample of kidney from each carcass. Samples were placed in sterile 1-ounce whirl-pack bags and stored in a cooler with ice until transported to a freezer. The enzyme-linked immunosorbent assay (ELISA) was used to obtain optical density (OD) values according to methodology adapted from Pascho and Mulcahy (1987). The Rs antigen level is an indication of bacterial infection load of *R. salmoninarum*. See Table (2) for a summary of the optical density value ranges and standard infection level categories used for BKD. An optical density (OD) equal to or greater than 1.000 is considered to be clinical BKD.

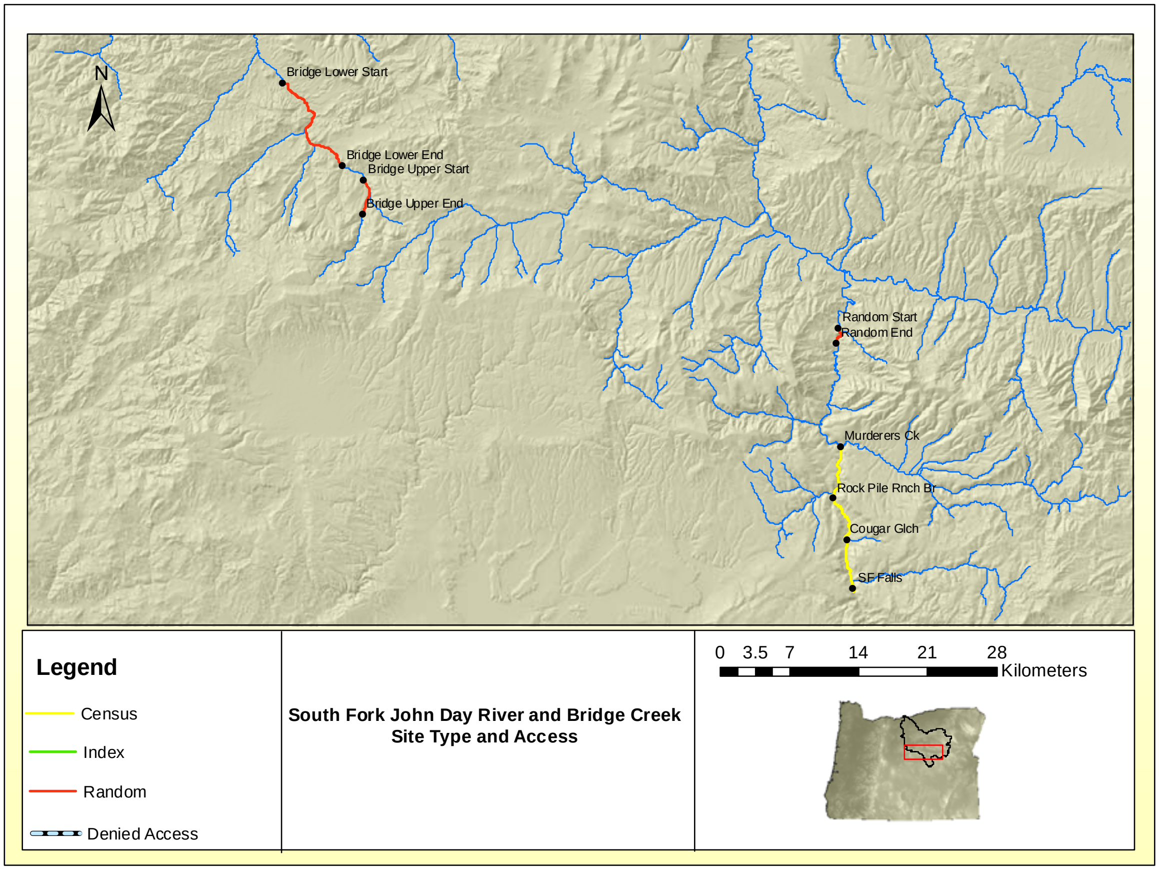

Figure 4. Map of the 2010 South Fork and Bridge Creek spring Chinook spawning ground survey sections.

Table 1. Survey type, access, and reach length (km) for spawning survey reaches in the John Day Basin 2010.

		Survey Type		
Stream Name	**Access Granted**	**Census**	**Index**	**Random**
Bridge Creek (LMJD)	Y	--	--	16.7
Mainstem John Day River	**N**	**7.0**	**6.3**	--
Mainstem John Day River	Y	7.6	11.4	--
Deardorff Creek	Y	2.0	--	--
Reynolds Creek	Y	--	--	10.0
Middle Fork John Day River	Y	27.7	19.8	2.0
Clear Creek (MFJD)	Y	4.1	--	--
Bridge Creek (MFJD)	Y	--	--	7.8
Camas Creek	Y	0.8	--	--
Bull Run Creek	Y	2.3	4.9	--
Clear Creek (GCS)	**N**	**1.2**		--
Clear Creek (GCS)	Y	4.3	4.7	--
Granite Creek	Y	7.5	9.0	--
Desolation Creek	Y	34.0	--	--
Crawfish Creek	Y	2.0	--	--
Meadowbrook Creek	Y	--	--	0.1
Trail Creek	Y	3.0	--	--
North Fork John Day River	Y	63.2	28.5	2.0
South Fork John Day River	Y	17.3	--	2.0
Total		**184.1**	**84.5**	**23.9**

Table 2. Summary of ELISA optical density value ranges, designated Rs antigen category, and significance of result with respect to adult Chinook salmon.

Optical density value (OD_{405}) range	**Rs antigen category**	**Significance to adult Chinook**
≤ 0.100	Negative or Very Low	Infection not detected by ELISA.
0.100–0.299	Low Positive	Low level of Rs antigen detected, not a factor in death, did not have BKD.
0.300–0.699	Moderate Positive	Moderate level of Rs antigen detected, beginning of significant infection with Rs in this range, signs of disease absent, rarely factor in death.
0.700–0.999	High Positive	Infection with Rs at high level, gross signs rare, could be factor in death.
≥ 1.000	Clinical[a]	Grossly infected with Rs, signs of disease usually, death probable, fish had BKD.

Surveyors collected scale samples from wild and hatchery carcasses with a MEPS length of ≤ 550 mm (likely age-3 adults) and ≥ 650 mm (likely ≥ age-5 adults). Carcasses from 551 to 649 mm were assumed to be 4-year old fish, based on the size-at-age distribution of carcasses examined during previous years. Scales were mounted on gummed cards, impressions were made in acetate, viewed using a microfiche reader, and annuli were counted by two different readers to determine age. We examined age structure for spawning populations separately for the Mainstem, Middle Fork, North Fork, GCS, and Desolation Creek.

Carcasses of hatchery fish were identified by an adipose fin clip and subsequently had their snout removed to detect the presence of a coded wire tag (CWT). Snouts were bagged with a numbered identification card and frozen. Later in the laboratory, snouts were halved and scanned for a CWT using a v-box tag detector. Any CWTs found were cleaned and examined for a tag code using a microscope. Tag codes were entered into the CWT database for Oregon Department of Fish and Wildlife (ODFW) and hatchery of origin was queried using the Pacific State Marine Fisheries Commission (PSMFC) database. Tails were removed from all carcasses to prevent resampling. Carcasses were then returned near their original position in the stream.

In September 2007, a PIT tag detection array became operational at McDonald's Ford at river km 32 in the John Day River. In 2010, for the third year, we were able to monitor in and out of basin PIT tagged spring Chinook use in the John Day River with data provided from the McDonald's Ford PIT tag array (DART 2007).

Redd and Escapement Estimates

All spring Chinook redds in the basin were visually counted with the exception of areas in the Mainstem and Clear Creek (GCS) where landowners denied access. A Geographic Information System (GIS) incorporating a 1:100,000 digital stream network was used to estimate stream reach and total reach lengths. Previous to 2009, redd density estimates in sampled reaches were expanded to areas where surveyors were denied access. After reviewing historic data, it became apparent that spawning habitat in areas where we were denied access were not representative of the entire spawning reach—primarily in the section from Indian Creek to Prairie Wood Products on the Mainstem. Issak and Thurow (2006) suggested that Chinook redds were not found in a random fashion, but were clustered, and redd distribution was influenced by habitat and run size.

In order to estimate the number of redds constructed in the Mainstem and account for this non-random distribution we used a spatially stratified reach rank approach. Using the 1:100,000 digital stream network layer, we divided the Mainstem into 65, 500m sections. We then used redd GPS locations from 2002–2010 to determine the number of redds in each 500m section for each year, with the 2002 spawning year providing the only complete dataset. Each section was then ranked based on the number of redds observed within individual years. From 2003 to 2010 we appended the rank from the 2002 rank order to the current year data set and each subsequent reach rank was ordered one rank higher. We then used liner regression of section rank versus $\log_e$ (redds [n]) to fit a model to predict redds in sections where we were denied access. In certain individual years, the GPS data did not account for all redds observed in the areas we surveyed. When this was the case, we used the proportion of redds observed to redds georeferenced in order to estimate the total number of redds based on the regression model. Because we were denied access to a relatively short stream reach in Clear Creek, we expanded our redd density estimate from the Clear Creek census count to the reach where we were denied access. A lack of weir counts in the basin prevents basin-specific fish/redd estimates. We therefore estimated spawner escapement by multiplying the number of redds by 2.6, the fish/redd estimate from above the Catherine Creek weir in the Grande Ronde Basin during 2010 (ODFW unpublished data).

Smolt Capture and Tagging

In the fall of 2009 and spring of 2010, juvenile spring Chinook and summer steelhead *O. mykiss* migrants were captured at three rotary screw trap (RST) sites and while seining in the Mainstem John Day River (river kilometers 274–296) to estimate smolt abundance and freshwater productivity (smolts/redd). The Mainstem seining operation was located just downstream of the confluence of the Mainstem and North Fork. The RSTs and Mainstem seining operation are all located downstream of all known spring Chinook spawning habitat. All RSTs are equipped with live boxes, which safely hold juvenile fish for 24–72 h time intervals. At the Mainstem and South Fork trap sites we fished a 1.52 or 2.44 m diameter RST, depending on water conditions, to optimize trap efficiency. A 1.52 m RST was fished at the Middle Fork (rkm 24) trap site. Traps were either removed or stopped during times of ice-up, high discharge, and during warm summer months after fish ceased migrating. Trapping efficiency was estimated separately for each fish species at each RST site by releasing previously marked fish upstream of the trap and then counting the number of marked fish recaptured (Thedinga et al. 1994). A complete description of smolt collection methods is described by Wilson et al. (2008). In order to estimate smolt abundance and freshwater productivity for the entire John Day Basin we used data from the seining reach only. We used a combination of data collected from each of the RSTs and seining data to estimate freshwater productivity for the Mainstem, Middle Fork, and North Fork subbasins.

RESULTS

We observed 1,268 spring Chinook redds while surveying 268.2 km of Chinook spawning habitat within the John Day River basin in 2010 (252.1 km were in the census areas and 16.1 km were random surveys). In the 14.5 km of census area where we were denied access we estimated a total of 172 redds (166 redds in the Mainstem John Day River and 6 redds in Clear Creek). This results in an estimated 1,440 spring Chinook redds in the John Day Basin in 2010 at an overall density of 5.36 redds/km for the census area (Table 3). Of the 1,440 estimated redds in the John Day basin, 734 were included in the historic index count at a density of 8.68 redds/km. Sixteen redds were observed in random reaches outside of both the historic census area in 2010; 11 in Bridge Creek (LMJD), four in Reynolds Creek and one in Meadowbrook Creek. The Mainstem subbasin accounted for 43% of the total redds observed in 2010 while 27% were observed in the North Fork, 14% in the Middle Fork, 11% in GCS, 5% in Desolation Creek, and <1% in the South Fork (Table 3). The Mainstem had the highest density of redds with 18.2 redds/km followed by, GCS with 4.75 redds/km, the North Fork with 3.96 redds/km, the Middle Fork with 3.81 redds/km, Desolation Creek with 2.05 redds/km, and the South Fork with 0.11 redds/km (Figure 6, 7, and 8). We found a statistically significant relationship between reach rank and $\log_e$ (redds [n]) using the methods described above for estimating redds in reaches where we were denied access ($r^2 = 0.913$, p-value <0.001, n = 39; Figure 5).

Table 3. Total number of index and census redds and carcasses observed during spring Chinook salmon spawning surveys in the John Day River basin, 2010.

		Carcasses (n)		
Stream Name	**Redds (n)**	**Hatchery**	**Unknown**	**Wild**
Bridge Creek (LMJD)	11	0	0	2
Mainstem John Day River	600	5	7	133
Deardorff Creek	9	0	0	0
Reynolds Creek	4	0	0	0
Middle Fork John Day River	183	6	1	203
Clear Creek (MFJD)	14	0	0	0
Bridge Creek (MFJD)	0	0	0	2
Camas Creek	0	0	0	0
Bull Run Creek	18	0	0	16
Clear Creek	50	1	3	78
Granite Creek	93	0	2	76
Desolation Creek	70	4	0	22
Crawfish Creek	3	0	0	0
Meadowbrook Creek	1	0	0	0
Trail Creek	4	0	0	2
North Fork John Day River	378	12	10	129
South Fork John Day River	2	0	0	0
Total	**1440**	**28**	**23**	**663**

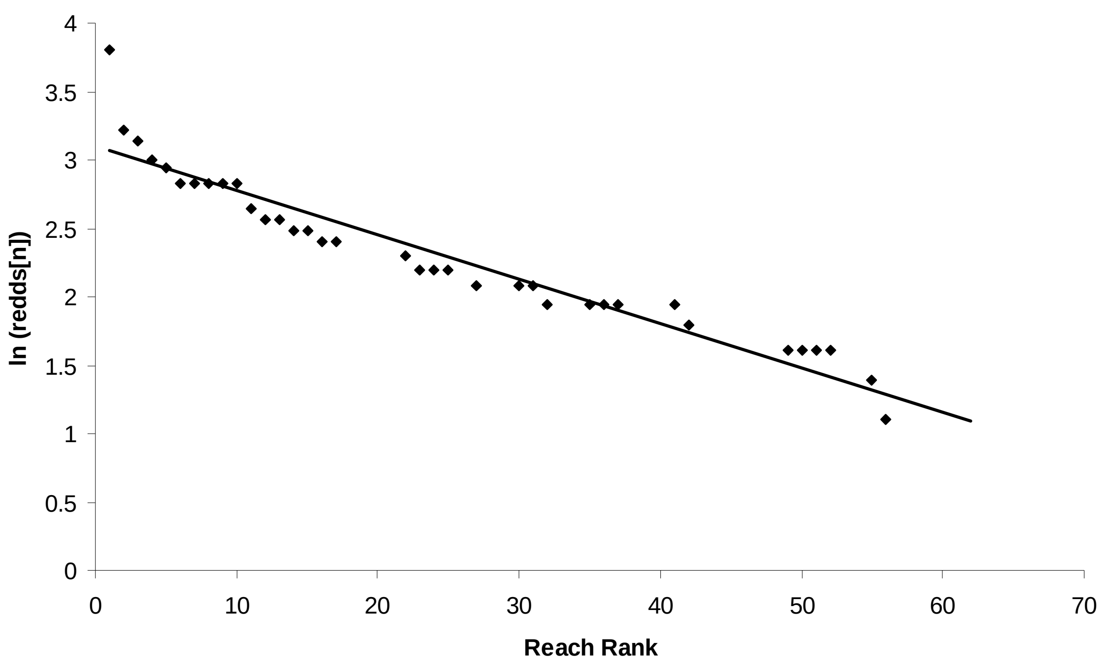

Figure 5. Linear regression of reach rank versus $\log_e$ redds (n) for the spring Chinook survey reaches of the Mainstem John Day River.

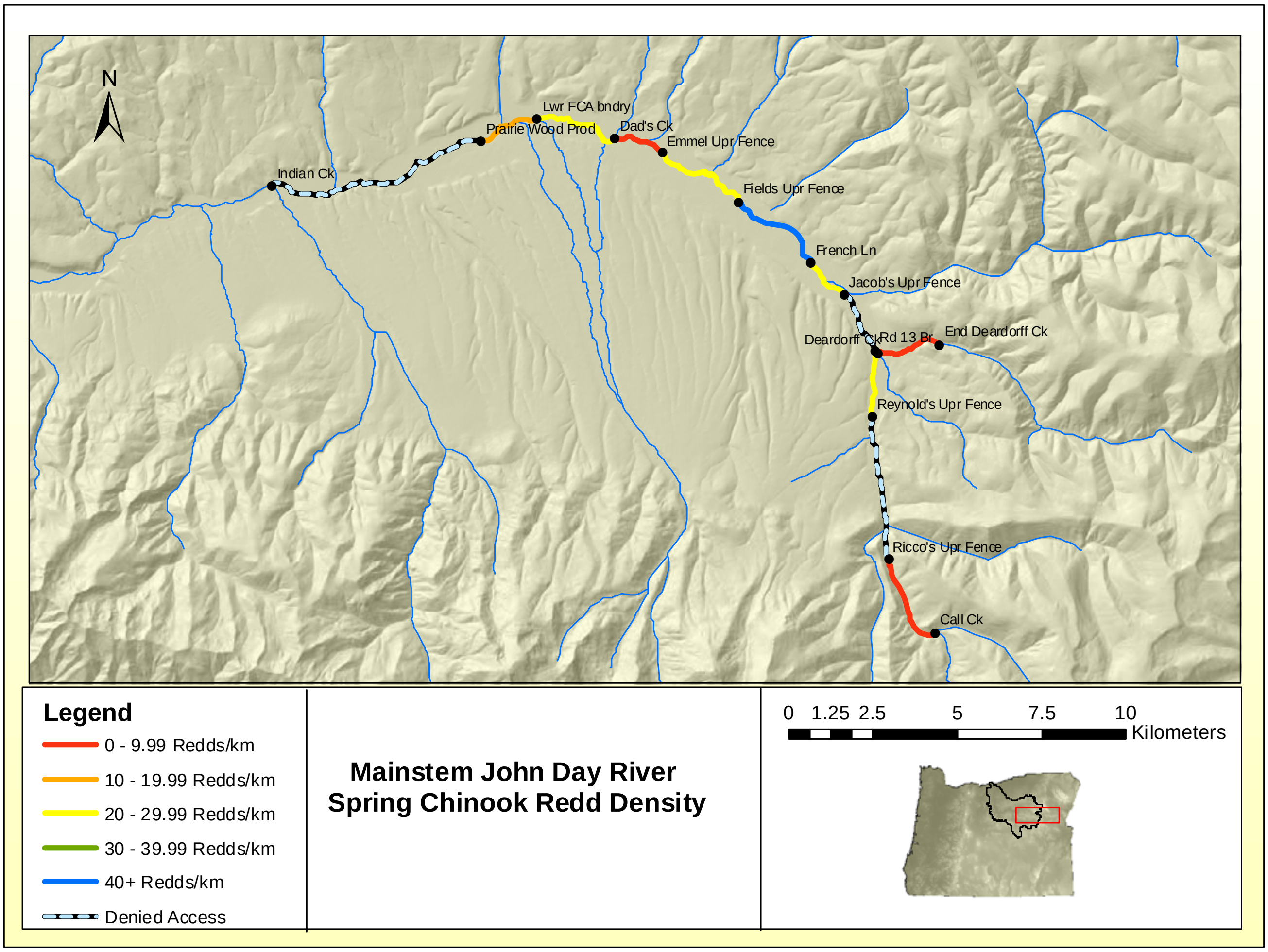

Figure 6. Map of sample reaches and density of redds observed in the Upper Mainstem John Day River subbasin during spring Chinook spawning surveys conducted in September 2010.

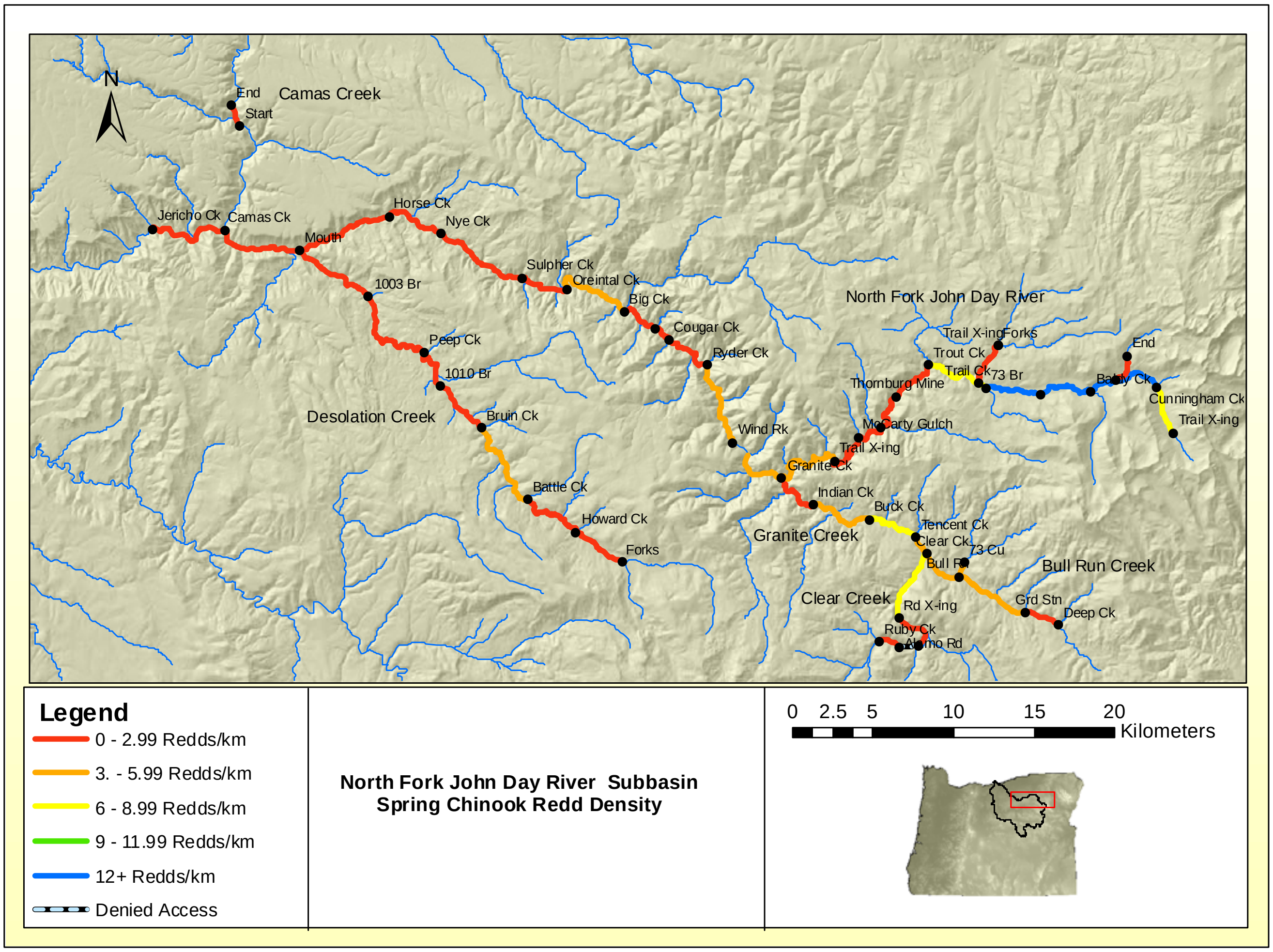

Figure 7. Map of sample reaches and density of redds observed in the North Fork John Day River subbasin during spring Chinook spawning surveys conducted in August and September 2010.

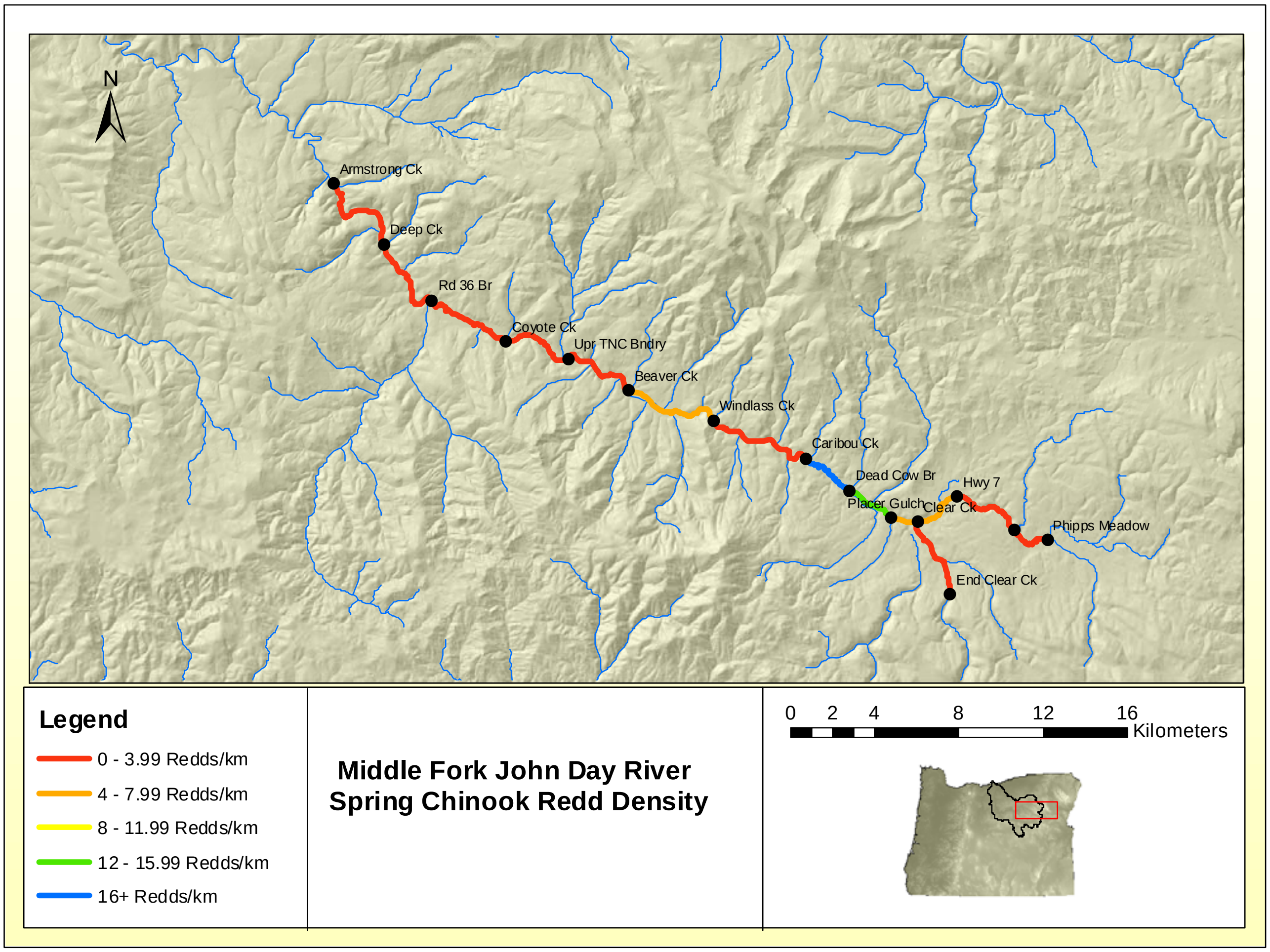

Figure 8. Map of sample reaches and density of redds observed in the Middle Fork John Day River subbasin during spring Chinook spawning surveys conducted in September 2010.

Using a 2.6 fish per redd ratio observed above the weir on Catherine Creek in the Grande Ronde River basin, we estimate an escapement of 3,744 spring Chinook spawners in the John Day basin during 2010. We estimate that 1,560 fish spawned in the Mainstem, 983 in the North Fork, 476 in the Middle Fork, 242 in Granite Creek, 182 in Desolation Creek, 130 in Clear Creek (GCS), 47 in Bull Run Creek, 36 in Clear Creek (MFJD), 29 in Bridge Creek (LMJD), 23 in Deardorff Creek (UMJD), 10 in Reynolds Creek, 10 in Trail Creek (NFJD), 8 in Crawfish Creek (NFJD), 5 in the South Fork John Day River, and 3 in Meadowbrook Creek (NFJD) (Figure 9; Table 4).

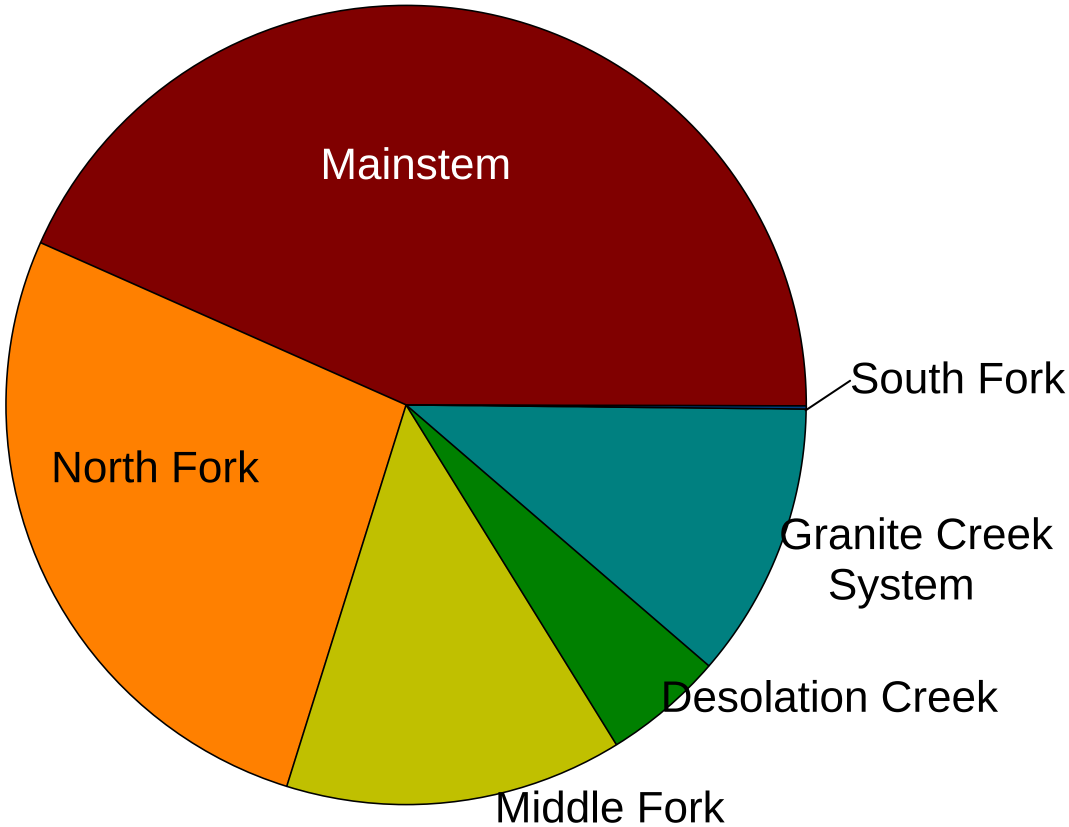

Figure 9. Spawner escapement estimate by subbasin in the John Day River basin 2010.

Table 4. Distance surveyed, number of unique redds observed, redd density, fish per redd estimate, and spring Chinook spawner escapement for the John Day River basin from 1998 to 2010.

Year	Distance (km)	Redds	Redds/km	Fish/Redd	Escapement
1998	175.4	430	2.5	2.97	1,277
1999	176.2	478	2.7	1.21	579
2000	236.1	1,869	7.9	1.69	3,163
2001	243.2	1,863	7.7	4.20	7,822
2002	255.9	1,959	7.7	2.90	5,676
2003	243.0	1,354	5.6	2.94	3,980
2004	260.0	1,531	5.9	2.27	3,469
2005	267.5	878	3.3	2.14	1,878
2006	264.6	909	3.4	2.42	2,197
2007	267.5	746	2.8	2.96	2,212
2008	264.6	963	3.6	2.15	2,072
2009	265.9	1,221	4.6	3.24	3,958
2010	268.2	1,440	5.4	2.60	3,744

During 2010 we sampled 715 carcasses representing 19% of the estimated spring Chinook spawner escapement (Table 3). We sampled approximately 42% of the estimated carcasses in the Granite Creek system, 41% in the Middle Fork, 15% in the North Fork, 14% in Desolation Creek, 9% in the Mainstem. We were able to determine origin of 692 carcasses, 28 (4 %) of which lacked an adipose fin. Only two of the 25 snouts that we collected from known hatchery fish contained coded wire tags. Both fish were age 4 that originated and were realeased at Rapid River Hatchery. One carcass was recovered in the North Fork and the other in Desolation Creek. Both fish were aged correctly by the scale readers. Hatchery carcasses were observed in every subbasin with the exception of the South Fork.

We determined the sex of 644 carcasses, 330 (51%) were female and 314 (49%) were male. We estimated the age of 587 carcasses, 198 from scale pattern analysis and 389 were within the 550–650 MEPS length range which we assumed to be age-4 fish. Twenty eight fish were age 3 (5%), 524 (89%) were age 4, and 35 (6%) were age 5 (Figure 10; Table 5). There were no age-2 precocious Chinook carcasses recovered in 2010. All age-3 Chinook carcasses recovered were males with the greatest proportion coming from the Mainstem (Tables 5 and 6). Of the 35 age-5 carcasses recovered, 14 (40%) were in the Middle Fork and 13 (37%) were in the North Fork (Table 6).

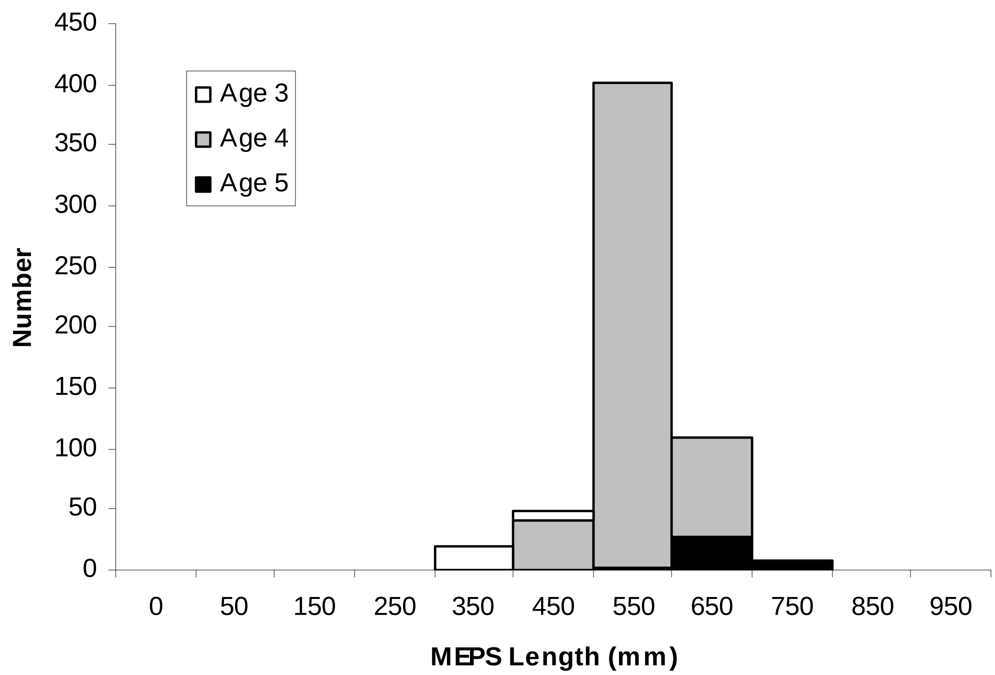

Figure 10. Length frequency and age distributions for aged spring Chinook salmon carcasses recovered during 2010 (n= 587).

Table 5. Age, mean MEPS length (mm), standard error, sample size (n), Range (mm), and % of total Chinook aged from 2010 basin wide carcasses recovered.

	Male					Female				
Age	Length (mm)	SE	n	Range (mm)	%	Length (mm)	SE	n	Range (mm)	%
3	430	11.6	28	350–645	5			0		0
4	602	3.3	237	465–775	40	610.6	2.3	287	490–715	49
5	701.7	8.0	24	595–780	4	717.4	10.3	11	670–770	2

Table 6. Sex, age composition (%), and sample size (n) of aged Chinook carcasses by subbasin 2010.

		Male			Female		
	n	3	4	5	3	4	5
Mainstem	119	7.6	38.7	2.5	0	48.7	2.5
Middle Fork	168	6.5	36.9	7.1	0	48.2	1.2
North Fork	127	0.8	37.0	6.3	0	52.0	3.9
Desolation Creek	24	4.2	37.5	0.0	0	58.3	0.0
Granite Creek System	149	4.0	49.0	0.7	0	45.6	0.7
Basin Total	587	4.7	40.4	4.1	0	48.9	2.4

We determined the presence or absence of gill lesions in 583 carcasses, 13 (2%) of which were positive for the presence of gill lesions. Seven fish in Granite Creek were positive for gill lesions, three were positive in the Middle Fork, and one was positive in each the Mainstem, North Fork, and Desolation Creek. All fish with gill lesions were of wild origin. All eight females that tested positive for gill lesions had 0% egg retention. The proportion of carcasses with gill lesions in Granite Creek was significantly greater when compared to the rest of the John Day basin ($z = 1.986$; $P = 0.047$).

Of the 297 female carcasses for which we estimated egg retention, 269 (91%) were completely spawned, 5 (2 %) were incompletely spawned and 23 (8 %) were pre-spawn mortalities at the time of the spawning ground surveys. Twenty-four of the 28 (86%) fish that were incompletely spawned or pre-spawn mortalities were in the upper portion of the North Fork subbasin.

A total of 157 kidney samples were collected from spring Chinook salmon carcasses and analyzed for the Rs antigen using the ELISA method. One of the 157 samples (0.6%) had a clinical ELISA OD value above 1.0 (1.224 OD units) indicating the presence of BKD. The infected fish was sampled on the Mainstem and was a female fish of wild origin with no gill lesions and 0% egg retention. All other samples had negative or low positive OD values of ≤0.279 (Appendix C).

A total of 546 carcasses were scanned for PIT tags during the spawning ground surveys and twelve tags were recovered. All twelve PIT tags were from native carcasses. One carcass was female, one was from unknown origin, and ten were male. Three of the 12 PIT tagged fish recovered during spawning surveys had been detected at the McDonald Ford array in the spring of 2010. The one PIT tagged fish found in the Middle Fork subbasin was not detected at the Middle Fork array. Of the 12 PIT tags recovered during spawning surveys, 7 were recovered in the Mainstem, three in the North Fork, one in the Middle Fork, and one in Granite Creek.

We estimate that freshwater spring Chinook productivity for the entire John Day Basin was 226 smolts per redd (199–259, 95% CI) for the 2008 brood year (Table 7). Further, we estimate that freshwater productivity in the Mainstem was 223 smolts per redd (193–260, 95% CI), and 211 smolts per redd (198–227, 95% CI) in the Middle Fork for the 2008 brood year. Smolt production for the entire subbasin shows a strong density-dependent relationship to redd number since estimates began in 1978 (Figure 11).

Table 7. Smolt/redd ratios based on recent and historic estimates of smolt abundance and census redd counts for spring Chinook salmon for the entire John Day River basin. Historic estimates from the 1978-1982 brood years are from Lindsay et al. (1986).

Brood Year	Number of redds[a]	Smolt migration Year	Smolt abundance	95% CI	Smolts/redd	95% CI
1978	611	1980	169,000	80,000–257,000	277	131–421
1979	641	1981	83,000	52,000–113,000	129	81–176
1980	306	1982	94,000	1,000–211,000	307	3–690
1981	401	1983	64,000	40,000–89,000	160	100–222
1982	498	1984	78,000	64,000–93,000	157	129–187
1999	478	2001	92,922	79,258–111,228	194	166–233
2000	1,869	2002	103,097	90,280–119,774	55	48–64
2001	1,863	2003	83,394	76,739–91,734	45	41–49
2002	1,959	2004	91,372	76,507–113,027	47	39–58
2003	1,354	2005	130,144	97,133–168,409	96	72–124
2004	1,531	2006	101,262	59,688–179,494	66	39–117
2005	878	2007	40,615	32,117–51,385	46	37–59
2006	909	2008	70,319	60,597–83,201	77	67–92
2007	746	2009	129,565	89,301–190,356	174	120–255
2008	963	2010	217,259	191,865–249,448	226	199–259

[a] includes all redds counted from spawning surveys in the John Day Basin for individual brood years.

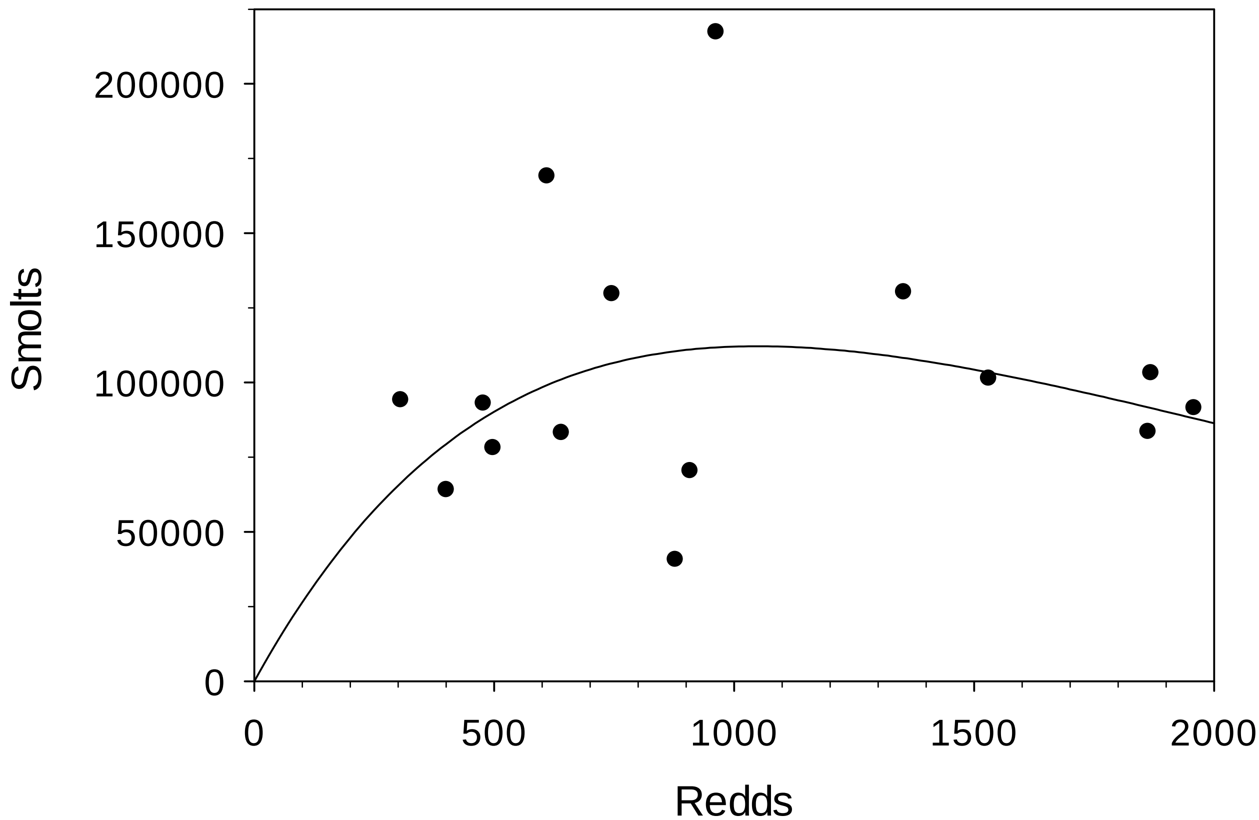

Figure 11. Smolt production as a function of redd counts by brood year of John Day River basin spring Chinook salmon since 1978. A Ricker (solid line) stock recruitment curve is also fit to the data.

DISCUSSION

We estimate that 1,440 spring Chinook redds were constructed in the John Day River Basin in 2010, which resulted in an estimated escapement of 3,744 spawners. This is an increase of 219 redds from 2009, but is within the range observed since 1998. We counted 734 redds during index surveys in 2010, an increase of 26 redds from 2009. Index counts continued to represent a majority of redds observed in the basin at 51%, but was well below the mean of 68% since 1998, continuing a downward trend in index representation (Ruzycki et al. 2008). Again in 2010, the upper North Fork accounted for a large proportion of redds outside of the index area.

The 2010 redd estimate in the Mainstem (613) is the highest we have recorded since implementing census surveys in 1998. Many habitat improvement projects have been completed in the upper Mainstem subbasin in recent years, which has increased fish passage upwards of 100 miles, therefore increasing juvenile rearing habitat (Jeff Neal, ODFW District Fish Biologist, personal communication). In addition, two redds were observed in the South Fork in 2010. This is the second documented observation of spring Chinook redds in the subbasin since 1998, the other being 3 redds in 2000.

Sixteen redds were observed in random reaches outside of both the historic census area in 2010; 11 in Bridge Creek (LMJD), 4 in Reynolds Creek, and 1 in Meadowbrook Creek. This is the first year that spring Chinook redds were observed and documented in these tributaries and these reaches will be added to the 2011 census area.

Currently, a limited ceremonial tribal fishery is the only within-basin fishery for spring Chinook. John Day basin Umatilla tribal members harvested 13 adult spring Chinook from Granite Creek system in 2010 (Jeff Neal, ODFW District Fish Biologist, personal communication). Insufficient numbers of spring Chinook have returned to the John Day River basin to meet the management goal of an average annual escapement of 5,950 adults for natural production (Columbia-Blue Mountain Resource Conservation and Development Area 2005). A three year average annual escapement to the mouth of the John Day River of 7,000 spring Chinook is the goal to implement a limited sport fishery on the Mainstem that was discontinued in 1976 (ODFW et al. 1990). The mean spawner escapement estimate since 1998 is 3,232 adults, with the highest three year average of 5,826 from 2001 to 2003. It is possible in years where we have sub-optimal holding and drought conditions that we have relatively high adult pre-spawn mortality, a variable that is difficult to quantify on the basin-wide scale (Ruzycki et al. 2008). Given the recent smolt abundance estimates and smolt-per-redd estimates, it appears that adult abundance has a relatively small effect on smolt production at the escapement levels we have observed since 1998 (Table 7). Managers may need to consider this apparent density dependence when setting escapement goals for a fishery. During recent years, however, where we have observed above average flows and cooler water temperatures, available rearing habitat may be greatly increased and as a result, smolt-per-redd ratios and smolt production may exceed historic levels.

Scheuerell (2005) suggests that juvenile growth rates may have some affect on age at maturity, where larger juveniles are more likely to mature at a younger age than slower growing individuals. Again in 2010, the North Fork had the lowest proportion of natural origin jacks (age 3) of each of the sub basins and the highest proportion of age 5 spawners. This suggests that the North Fork is a less productive system that could result in slow growth rates delaying age at maturity. In contrast, the Mainstem has had the highest proportion of age 3 fish in 2010 and the second to lowest proportion of age 5 spawners. This trend, observed since 2008, suggests that the Mainstem is becoming a more productive system where fish are growing faster compared to the North Fork.

For eight consecutive years, carcasses in the GCS showed a significantly higher incidence of gill lesions than the remainder of the John Day River basin. Gill lesions were not present in any of the pre-spawn mortality fish sampled. This supports the theory that, given optimal holding conditions, gill lesions may not be a significant source of adult mortality in the John Day Basin. However, we did not account for mortalities that may have occurred during July and early August because carcasses would have been decomposed or scavenged by the time of spawning ground surveys in late August and September. In the future, when summer water temperatures reach near lethal levels, it should be beneficial to conduct pre-spawn mortality surveys on Granite Creek to assess the effects of water temperature and gill lesions on adult survival.

The proportion of hatchery carcasses observed in 2010 (4%) was within the range reported since 1998, which has ranged from a low of <1% in 1998 to a high of 5% in 2007. We did not recover CWTs from any carcass this year that originated at the Lookingglass Hatchery, which has produced several strays during previous years (Schultz et al. 2007, Wilson et al. 2007, Schultz et al. 2006, McCormick et al. 2009). Both recovered CWTs were from the Rapid River Hatchery in Idaho. Of the 28 carcasses of hatchery origin that were recovered, 16 (57%) were in the North Fork subbasin. Through genetic analysis on carcasses recovered from 2004 to 2006, Narum et al. (2008) found similar results indicating that the North Fork subbasin had a higher rate of out-of-basin strays, both marked (hatchery origin) and unmarked (wild origin), than the Mainstem or Middle Fork. Narum et al. (2008) also suggested that wild strays may be more prevalent than hatchery strays in the John Day River basin.

Smolt-per-redd ratios indicate that juvenile rearing areas are fully seeded at recent escapement levels and rearing habitat is limiting freshwater production (Table 7, Figure 11). This relationship illustrates the need for further restoration efforts targeting rearing habitat and that adult escapement estimates may not be a suitable metric to assess the effectiveness of individual restoration projects on a short term scale (Lawson 1993). This also shows the importance of considering the entire life history when developing recovery plans. In the Middle Fork alone, there exist multiple tributaries that contain upstream migration barriers blocking access to juvenile Chinook rearing and adult Chinook spawning habitat (James et al. 2009). Removing barriers and allowing juvenile and adult Chinook access to additional spawning and rearing habitat is a valuable tool to increase smolt production through freshwater habitat restoration (Sharma and Hilborn 2001).

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APPENDIX

Appendix Table A-1. Spring Chinook census redd counts in the John Day Basin, 1998-2010. Includes redds estimated where we were denied access.

					North Fork Subbasin				
					Granite Creek System				
Year	Mainstem	South Fork	Middle Fork	North Fork	Granite Creek	Clear Creek	Bull Run Creek	Desolation Creek	Basin Total
1998	135	-	88	127	61	18	1	-	430
1999	62	-	132	162	92	22	8	-	478
2000	380	3	563	612	198	96	12	5	1869
2001	432	0	354	803	126	80	45	23	1863
2002	549	0	389	707	163	64	31	56	1959
2003	260	0	236	668	118	32	1	39	1354
2004	242	0	319	806	72	38	8	46	1531
2005	203	0	178	420	43	15	4	15	878
2006	318	0	199	262	55	28	14	33	909
2007	250	0	85	358	19	9	2	23	746
2008	248	0	169	432	57	16	10	31	963
2009	468	0	251	360	47	53	4	38	1221
2010	624	2	197	386	93	50	18	70	1440

Appendix Table A-2. Stream length (km) for spring Chinook salmon spawning surveys (census) in the John Day River basin, 1998–2010. Includes stream lengths in areas where we were denied access.

				North Fork Subbasin					
					Granite Creek System				
Year	Mainstem	South Fork	Middle Fork	North Fork	Granite Creek	Clear Creek	Bull Run Creek	Desolation Creek	Basin Total
1998	22.4	-	51.5	72.5	16.5	7.6	4.9	-	175.4
1999	22.4	-	51.5	72.5	16.5	7.6	5.7	-	176.2
2000	32.2	17.3	51.5	83.9	16.5	7.6	5.7	21.4	236.1
2001	32.2	17.3	51.5	83.9	16.5	7.6	5.7	28.5	243.2
2002	32.2	17.3	51.5	86.9	16.5	10.3	7.2	34.0	255.9
2003	32.2	0.2	51.5	86.9	16.5	10.3	7.2	38.2	243.0
2004	34.3	17.3	51.5	88.3	16.5	10.3	7.2	34.6	260.0
2005	34.3	17.3	51.5	92.2	16.5	10.3	7.2	38.2	267.5
2006	34.3	17.3	51.5	92.2	16.5	10.3	7.2	35.3	264.6
2007	34.3	17.3	51.5	92.2	16.5	10.3	7.2	38.2	267.5
2008	34.3	17.3	51.5	92.2	16.5	10.3	7.2	35.3	264.6
2009	34.3	17.3	51.5	94.8	16.5	10.2	7.2	34.0	265.9
2010	34.3	17.3	51.5	97.5	16.5	10.2	7.2	34.0	268.6

Appendix Table A-3. Density (redds/km) of spring Chinook salmon redds encountered during census surveys in the John Day River basin, 1998–2009. Includes density estimates for areas where we were denied access.

				North Fork Subbasin					
					Granite Creek System				
Year	Mainstem	South Fork	Middle Fork	North Fork	Granite Creek	Clear Creek	Bull Run Creek	Desolation Creek	Basin Total
1998	6.0	-	1.7	1.8	3.7	2.4	0.2	-	2.5
1999	2.8	-	2.6	2.2	5.6	2.9	1.4	-	2.7
2000	11.8	0.2	10.9	7.3	12.0	12.6	2.1	0.2	7.9
2001	13.4	0.0	6.9	9.6	7.6	10.5	7.9	0.8	7.7
2002	17.0	0.0	7.6	8.1	9.9	6.2	4.3	1.6	7.7
2003	8.1	0.0	4.6	7.7	7.2	3.1	0.1	1.0	5.6
2004	7.1	0.0	6.2	9.1	4.4	3.7	1.1	1.3	5.9
2005	5.9	0.0	3.5	4.6	2.6	1.5	0.6	0.4	3.3
2006	9.3	0.0	3.9	2.8	3.3	2.7	1.9	0.9	3.4
2007	7.3	0.0	1.7	3.9	1.2	0.9	0.3	0.6	2.8
2008	7.2	0.0	3.3	4.7	3.5	1.6	1.4	0.9	3.6
2009	13.6	0.0	4.9	3.8	2.8	5.2	0.6	1.1	4.6
2010	18.2	0.1	3.8	4.0	5.6	4.9	2.5	2.1	5.4

Appendix Table A-4. Spring Chinook redd counts from index surveys in the John Day River basin, 1959–2009. Includes estimated redd counts in areas where we were denied access

Year	Granite Creek System	Mainstem	Middle Fork	North Fork	Total
1959	40	1	0		41
1960	94	3	29		126
1961	34	12	8		54
1962	398	110	23		531
1963	256	11	7		274
1964	383	13	36	78	510
1965	204	58	37	65	364
1966	454	140	129	437	1160
1967	266	78	14	55	413
1968	509	8	4	80	601
1969	296	121	87	452	956
1970	309	108	76	286	779
1971	260	91	41	200	592
1972	458	51	51	178	738
1973	324	116	43	350	833
1974	191	33	81	130	435
1975	229	92	89	211	621
1976	162	60	66	111	399
1977	207	63	58	261	589
1978	165	58	107	108	438
1979	130	68	118	200	516
1980	78	16	58	78	230
1981	110	51	26	138	325
1982	122	49	62	107	340
1983	46	133	51	76	306
1984	48	73	67	63	251
1985	132	116	40	110	398
1986	163	159	76	257	655
1987	147	247	340	375	1109
1988	116	82	241	245	684
1989	149	165	113	196	623
1990	78	124	47	257	506
1991	55	61	35	115	266
1992	138	142	108	339	727
1993	268	135	155	379	937
1994	96	169	93	201	559
1995	23	29	15	27	94
1996	128	227	136	291	782
1997	102	125	163	197	587
1998	58	108	79	109	354
1999	87	58	105	120	370
2000	241	337	356	477	1411
2001	222	383	199	607	1411
2002	198	480	309	513	1500
2003	81	241	184	483	989
2004	81	172	176	602	1031
2005	41	156	114	271	582
2006	63	222	153	160	598
2007	21	175	73	196	465
2008	63	207	113	174	557
2009	76	325	179	128	708
2010	117	388	150	79	734

Appendix Table A-5. Index redd density (redds/km) in the John Day River basin 1998–2008. Includes estimated redd densities in areas where we were denied access.

Year	Granite Creek System	Mainstem	Middle Fork	North Fork	Total
1998	3.1	6.1	8.2	3.8	4.2
1999	4.7	3.3	4.0	4.2	4.4
2000	13.0	19.0	5.3	16.7	16.7
2001	11.9	21.6	18.0	21.3	16.7
2002	10.6	27.1	10.1	18.0	17.7
2003	4.4	13.6	15.6	16.9	11.7
2004	4.4	9.7	9.3	21.1	12.2
2005	2.2	8.8	8.9	9.5	6.9
2006	3.4	12.5	5.8	5.6	7.1
2007	1.1	9.9	7.7	6.9	5.5
2008	3.4	11.7	3.7	6.1	6.6
2009	4.1	18.4	5.7	4.5	8.4
2010	6.3	21.9	7.6	2.8	8.7

Appendix Table B-1. Spring Chinook spawning survey section locations and coordinates (DD.DD, NAD 27 conus datum).

System	Description	Latitude	Longitude
Camas Creek	START	45.06838904	-118.98221263
Camas Creek	END	45.07972531	-118.98768760
Crawfish Creek	END	44.92876707	-118.28941321
Crawfish Creek	MOUTH CRAWFISH CK	44.91494891	-118.29828462
Desolation Creek	1003 BR	44.97179917	-118.88286285
Desolation Creek	1010 BR	44.92123190	-118.82925890
Desolation Creek	BATTLE CK	44.85676392	-118.76126859
Desolation Creek	BRUIN CK	44.89697426	-118.79616681
Desolation Creek	FORKS	44.82040104	-118.68940970
Desolation Creek	HOWARD CK	44.83801486	-118.72402302
Desolation Creek	PEEP CK	44.94012178	-118.83968214
Desolation Creek	45 RD	44.80965234	-118.68332905
Granite Creek	ALAMO RD	44.76960059	-118.47329331
Granite Creek	GRD STN	44.78718222	-118.37420396
Granite Creek	BUCK CK	44.84137349	-118.49458208
Granite Creek	BULL RN	44.80796414	-118.42515369
Granite Creek	CLEAR CK	44.82148365	-118.45027819
Granite Creek	DEEP CK	44.77991654	-118.34862599
Granite Creek	INDIAN CK	44.85040348	-118.53732434
Granite Creek	73 CU	44.81614103	-118.42054901
Granite Creek	RD X-ING	44.78559553	-118.47267623
Granite Creek	RUBY CK	44.77295042	-118.48848090
Granite Creek	SMITH LWR BNDRY	44.76996965	-118.45790338
Granite Creek	TENCENT CK	44.83107070	-118.45803321
Mainstem	CALL CK	44.32011911	-118.55734100
Mainstem	END	44.29668012	-118.95367761
Mainstem	START	44.31166001	-118.95189537
Mainstem	DAD'S CK	44.45350612	-118.67248161
Mainstem	DEARDORFF CK	44.39478694	-118.57650991
Mainstem	EMMEL UPR FENCE	44.44953661	-118.65513752
Mainstem	END DEARDORFF CK	44.39672492	-118.55334467
Mainstem	FIELDS UPR FENCE	44.43589632	-118.62702110
Mainstem	FRENCH LN	44.41933678	-118.60050897
Mainstem	INDIAN CK	44.44276647	-118.80030404
Mainstem	JACOB'S UPR FENCE	44.41051416	-118.58824868
Mainstem	LWR FCA BNDRY	44.45927773	-118.70108334
Mainstem	END	44.41945983	-118.89704503
Mainstem	START	44.41763685	-118.92008504
Mainstem	PRAIRIE WOOD PROD	44.45355968	-118.72218051
Mainstem	RD 13 BR	44.39564047	-118.57728624
Mainstem	RICCO'S UPR FENCE	44.34001196	-118.57401235
Mainstem	REYNOLD'S UPR FENCE	44.37787972	-118.57910637
Middle Fork	WINDLASS CK	44.63896226	-118.62734221
Middle Fork	ARMSTRONG CK	44.74324814	-118.85135938
Middle Fork	BEAVER CK	44.65241815	-118.67797712
Middle Fork	CARIBOU CK	44.62201263	-118.57308942

Appendix Table B-1 Coninued.

Middle Fork	COYOTE CK	44.67452534	-118.75024027
Middle Fork	DEAD COW BR	44.60764412	-118.54734910
Middle Fork	DEEP CK	44.71684883	-118.82196941
Middle Fork	END CLEAR CK	44.56246574	-118.48890703
Middle Fork	HWY 7	44.60395893	-118.48325042
Middle Fork	RANDOM END	44.76452024	-118.87448832
Middle Fork	RANDOM START	44.77414920	-118.88813758
Middle Fork	RANDOM END	44.79057656	-118.90750791
Middle Fork	RANDOM START	44.79780427	-118.92128918
Middle Fork	CLEAR CK	44.59374382	-118.50683458
Middle Fork	PHIPPS MEADOW	44.58450001	-118.42998611
Middle Fork	PLACER GULCH	44.59563780	-118.52258661
Middle Fork	RD 36 BR	44.69258800	-118.79407352
Middle Fork	UPR TNC BNDRY	44.66646630	-118.71350256
North Fork	BALDY CK	44.90961978	-118.31780582
North Fork	BIG CK	44.96019476	-118.68288447
North Fork	CAMAS CK	45.01021067	-118.99595032
North Fork	COUGAR CK	44.94410846	-118.64759373
North Fork	TRAIL X-ING	44.87456013	-118.52073672
North Fork	CUNNINGHAM CK	44.91076483	-118.26667705
North Fork	GLADE CK	44.89914961	-118.60699648
North Fork	GRANITE CK	44.86561152	-118.56229939
North Fork	HORSE CK	45.01638184	-118.86541408
North Fork	JERICHO CK	45.01185712	-119.05162593
North Fork	MCCARTY GULCH	44.88727782	-118.50110865
North Fork	MOUTH	44.99792137	-118.93582726
North Fork	NF RANDOM END	44.96965944	-119.27594293
North Fork	NF RANDOM START	44.98133535	-119.27086928
North Fork	NYE CK	45.00629112	-118.82465716
North Fork	OREINTAL CK	44.97379147	-118.72678276
North Fork	73 BR	44.91288856	-118.40022792
North Fork	RYDER CK	44.92956268	-118.61847416
North Fork	SILVER CK	44.87863080	-118.58830593
North Fork	SULPHER CK	44.98044192	-118.76178693
North Fork	THORNBURG MINE	44.90943136	-118.47127184
North Fork	TRAIL CK	44.91554135	-118.40631033
North Fork	TROUT CK	44.92665776	-118.44459719
North Fork	WIND RK	44.88594711	-118.59987974
North Fork	WINOM CK	44.97606196	-118.67137620
North Fork	TRAIL X-ING	44.88506089	-118.25485605
South Fork	COUGAR GLCH	44.22957879	-119.53378511
South Fork	SF FALLS	44.18510450	-119.52482125
South Fork	MURDERERS CK	44.31455478	-119.53957382
South Fork	ROCK PILE RNCH BR	44.26765233	-119.55075720
Trail Creek	TRAIL CK END	44.93673717	-118.38974610
Trail Creek	FORKS	44.93675343	-118.38974325

Appendix Table C-1. Kidney sample analysis results, egg retention estimates, and gill lesion presence of kidney sampled of adult Spring Chinook in the John Day basin 2010.

Stream Name	% Egg Retention	Gill Lesion	Kidney Sample #	ELISA OD Value
Bull Run Creek-Granite Creek		N	401	0.098
Bull Run Creek-Granite Creek		N	405	0.136
Bull Run Creek-Granite Creek		N	407	0.091
Bull Run Creek-Granite Creek		N	411	0.119
Bull Run Creek-Granite Creek		N	413	0.114
Clear Creek - Granite Creek Tributary		N	314	0.106
Clear Creek - Granite Creek Tributary		N	404	0.114
Clear Creek - Granite Creek Tributary		N	408	0.089
Clear Creek - Granite Creek Tributary	0	N	417	0.097
Clear Creek - Granite Creek Tributary	0	N	418	0.102
Clear Creek - Granite Creek Tributary	0	N	422	0.104
Clear Creek - Granite Creek Tributary	0	N	423	0.126
Clear Creek - Granite Creek Tributary	0	N	424	0.083
Desolation Creek	0	Y	300	0.086
Desolation Creek	0	N	301	0.092
Desolation Creek		N	309	0.129
Desolation Creek	0	N	311	0.114
Desolation Creek	0	N	312	0.078
Desolation Creek		N	319	0.098
Granite Creek		N	316	0.179
Granite Creek		N	400	0.073
Granite Creek	0	N	406	0.084
Granite Creek		N	409	0.148
Granite Creek		N	410	0.104
Granite Creek	0	N	412	0.099
Granite Creek	0	N	414	0.300
Granite Creek	0	N	415	0.102
Granite Creek	0	N	416	0.085
Granite Creek		N	420	0.112
Granite Creek		N	425	0.085
Mainstem John Day River		N	1	1.224
Mainstem John Day River		N	2	0.071
Mainstem John Day River		N	3	0.086
Mainstem John Day River		N	4	0.074
Mainstem John Day River		N	5	0.104
Mainstem John Day River		N	6	0.077
Mainstem John Day River		N	7	0.075
Mainstem John Day River		N	8	0.069
Mainstem John Day River	0	N	9	0.112
Mainstem John Day River		N	10	0.096
Mainstem John Day River		N	11	0.090
Mainstem John Day River		N	12	0.117
Mainstem John Day River	0	N	13	0.113
Mainstem John Day River	0	N	14	0.114
Mainstem John Day River		N	15	0.110
Mainstem John Day River		N	16	0.081

Appendix Table C-1 Continued

Stream Name	% Egg Retention	Gill Lesion	Kidney Sample #	ELISA OD Value
Mainstem John Day River		Y	17	0.177
Mainstem John Day River	0	N	18	0.084
Mainstem John Day River			21	0.097
Mainstem John Day River	0	N	22	0.128
Mainstem John Day River		N	23	0.087
Mainstem John Day River	0	N	24	0.166
Mainstem John Day River	0	N	25	0.110
Mainstem John Day River		N	26	0.106
Mainstem John Day River		N	27	0.114
Mainstem John Day River	0	N	28	0.094
Mainstem John Day River	0	N	30	0.105
Mainstem John Day River		N	31	0.096
Mainstem John Day River		N	32	0.081
Mainstem John Day River	0	N	33	0.107
Mainstem John Day River	0	N	34	0.115
Mainstem John Day River	0	N	35	0.087
Mainstem John Day River		N	36	0.077
Mainstem John Day River		N	37	0.109
Mainstem John Day River		N	38	0.111
Mainstem John Day River	0	N	39	0.089
Mainstem John Day River	0	N	40	0.099
Mainstem John Day River		N	402	0.110
Mainstem John Day River		N	403	0.075
Mainstem John Day River	0	N	419	0.128
Middle Fork John Day River	0	N	19	0.241
Middle Fork John Day River		N	20	0.209
Middle Fork John Day River		N	100	0.271
Middle Fork John Day River		Y	101	0.276
Middle Fork John Day River	0	N	102	0.344
Middle Fork John Day River	0	N	103	0.153
Middle Fork John Day River		N	104	0.367
Middle Fork John Day River		N	105	0.181
Middle Fork John Day River	0	N	106	0.110
Middle Fork John Day River		N	107	0.244
Middle Fork John Day River		N	108	0.229
Middle Fork John Day River		N	109	0.062
Middle Fork John Day River		N	110	0.181
Middle Fork John Day River		N	111	0.172
Middle Fork John Day River		N	112	0.180
Middle Fork John Day River		N	113	0.282
Middle Fork John Day River		N	114	0.213
Middle Fork John Day River		N	116	0.287
Middle Fork John Day River		N	117	0.132
Middle Fork John Day River		N	118	0.294
Middle Fork John Day River		N	119	0.209
Middle Fork John Day River	0	N	120	0.139
Middle Fork John Day River	0	N	121	0.117

Appendix Table C-1 Continued

Stream Name	% Egg Retention	Gill Lesion	Kidney Sample #	ELISA OD Value
Middle Fork John Day River	0	N	122	0.436
Middle Fork John Day River		N	123	0.247
Middle Fork John Day River			124	0.265
Middle Fork John Day River	0	N	125	0.218
Middle Fork John Day River		N	126	0.289
Middle Fork John Day River		N	127	0.198
Middle Fork John Day River		N	128	0.130
Middle Fork John Day River	0	N	129	0.161
Middle Fork John Day River	0	N	130	0.131
Middle Fork John Day River		N	131	0.166
Middle Fork John Day River		N	132	0.068
Middle Fork John Day River	0	N	133	0.146
Middle Fork John Day River	0	N	134	0.206
Middle Fork John Day River			135	0.300
Middle Fork John Day River		N	136	0.290
Middle Fork John Day River	0	N	137	0.134
Middle Fork John Day River	0	N	138	0.210
Middle Fork John Day River	0	Y	139	0.253
Middle Fork John Day River		N	140	0.240
North Fork John Day River		N	205	0.108
North Fork John Day River		N	206	0.102
North Fork John Day River	0	N	213	0.148
North Fork John Day River	0	N	214	0.137
North Fork John Day River		N	216	0.254
North Fork John Day River		N	223	0.099
North Fork John Day River	0	N	224	0.092
North Fork John Day River	0	N	225	0.108
North Fork John Day River	100	N	226	0.086
North Fork John Day River		N	227	0.103
North Fork John Day River	100	N	229	0.088
North Fork John Day River	0	N	233	0.087
North Fork John Day River	0	N	234	0.152
North Fork John Day River		N	235	0.088
North Fork John Day River		N	236	0.081
North Fork John Day River	0	N	238	0.129
North Fork John Day River	0	N	240	0.112
North Fork John Day River	100	N	241	0.150
North Fork John Day River		N	242	0.138
North Fork John Day River	0	N	244	0.465
North Fork John Day River		N	245	0.161
North Fork John Day River		N	246	0.118
North Fork John Day River	0	N	247	0.166
North Fork John Day River	0	N	248	0.096
North Fork John Day River	0	N	249	0.099
North Fork John Day River		N	250	0.082
North Fork John Day River	100	N	251	0.081
North Fork John Day River		N	252	0.094
North Fork John Day River		N	253	0.111

Appendix Table C-1 Continued

Stream Name	% Egg Retention	Gill Lesion	Kidney Sample #	ELISA OD Value
North Fork John Day River	25	N	254	0.117
North Fork John Day River	50	N	255	0.085
North Fork John Day River	0	N	256	0.109
North Fork John Day River		N	257	0.082
North Fork John Day River		N	258	0.124
North Fork John Day River		N	259	0.118
North Fork John Day River	100	N	260	0.087
North Fork John Day River	100	N	261	0.084
North Fork John Day River	0	N	262	0.107
North Fork John Day River	50	N	263	0.072
North Fork John Day River	100	N	264	0.069
North Fork John Day River	0	N	265	0.073
North Fork John Day River	100	N	266	0.092
North Fork John Day River	100	N	267	0.092
North Fork John Day River		N	268	0.089
North Fork John Day River		N	269	0.089