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Productivity of Spring Chinook Salmon and Summer Steelhead in the John Day River Basin

Annual Technical Report

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Objectives

1. Estimate smolt-to-adult return (SAR) survival and out-migrant abundance for spring Chinook and summer steelhead.
2. Determine life history characteristics of summer steelhead.

Accomplishments and Findings

To estimate spring (stream-type) Chinook *Oncorhynchus tshawytscha* and summer steelhead *O. mykiss* smolt-to-adult return (SAR), we PIT tagged 4,056 juvenile spring Chinook and 4,052 juvenile steelhead during the spring of 2007. We estimate 40,615 (95% CL's 32,117–51,385) juvenile spring Chinook emigrated from the upper John Day subbasin past our seining area (river kilometers 274–296) between 15 February and 8 June 2007. We also estimate 26,489 (95% CL's 21,823 and 32,237) juvenile spring Chinook and 23,264 (95% CL's 18,450 and 29,507) juvenile steelhead migrated past our Mainstem rotary screw trap (RST) at river kilometer (rkm) 326 between 12 October 2006 and 22 June 2007. We estimate 7,524 (95% CL's 6,285 and 9,112) juvenile spring Chinook and 14,784 (95% CL's 11,947 and 18,004) steelhead migrated past our Middle Fork RST (rkm 24) between October 31, 2006 and June 14, 2007. For the 2005 brood year, we estimate 45 smolts/redd for spring Chinook throughout the John Day River basin, 118 smolts/redd for the Upper Mainstem, and 42 smolts/redd for the Middle Fork watersheds. Steelhead spring emigrant age structure differed among the three trap sites ($\chi^2 = 325.9$, df = 6, $P < 0.0001$). More age-1 (22.7%), fewer age-2 (63.7%) and more age-3 (13.7%) fish composed the summer steelhead sampled at the South Fork Trap than at the Mainstem and Middle Fork traps. The age structure of steelhead emigrants was 12.6% age-1, 77.9% age-2, 9.3% age-3, and 0.2% age-4 fish. Spring Chinook SAR for the 2002 brood year was 2.08% (84 returns of 4,036 PIT tagged smolts). Summer steelhead SAR for the 2005 migration year was 1.61% (79 returns of 4,913 PIT-tagged migrants).

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INTRODUCTION

The John Day River subbasin supports one of the last remaining intact wild populations of spring Chinook salmon and summer steelhead in the Columbia River Basin. These populations remain depressed relative to historic levels and limited information is available for steelhead life history. Numerous habitat protection and rehabilitation projects have been implemented in the basin to improve salmonid freshwater production and survival. However, these projects often lack effectiveness monitoring. 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 some of the data needs as index stocks. Our continued monitoring efforts to estimate salmonid smolt abundance, age structure, SAR, smolts/redd, freshwater habitat use, and distribution of critical life stages will allow managers to assess the long-term effectiveness of habitat projects and to differentiate freshwater and ocean survival.

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 NWPPC Fish and Wildlife Program, Independent Scientific Advisory Board (ISAB), Independent Scientific Review Panel (ISRP), NOAA National Marine Fisheries Service (NMFS), and the Oregon Plan for Salmon and Watersheds (OWEB). Each of these groups have 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 south and the Ochoco Mountains to the west.

Spring Chinook salmon primarily spawn in the upper Mainstem John Day River (hereafter called Mainstem) above the mouth of Indian Creek, in the Middle Fork John Day River (hereafter called Middle Fork) above Armstrong Creek, and the North Fork John Day River (hereafter called North Fork) 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. Spawning has also occurred in the South Fork John Day River (hereafter called South Fork), the North Fork tributaries Camas and Trail creeks, and the Mainstem tributary Deardorff Creek. Fall Chinook are thought to spawn in the Lower Mainstem downstream of Kimberly, OR (rkm 298) but primarily between Cottonwood Bridge (rkm 64) and Tumwater Falls (rkm 16).

Summer steelhead sampled during this study have a spawning and rearing distribution in the Mainstem, South Fork, Middle Fork, and North Fork channels and tributaries of the John Day River upstream of rkm 298 where the North Fork and Mainstem merge. Summer Steelhead also spawn and rear in the lower Mainstem tributaries downstream of rkm 298. When juvenile steelhead are referenced in this document, we acknowledge the presence of alternative life-history forms and that some juveniles of all sizes may be resident (redband trout) or anadromous (steelhead) life-history forms. These alternate life-history forms are typically morphologically indistinguishable when examined as immature parr. We therefore refer to all juvenile *O. mykiss* as steelhead. Maps of the distribution of both Chinook and steelhead in the John Day River basin can be viewed at: http://www.streamnet.org/online-data/map_catalog.html.

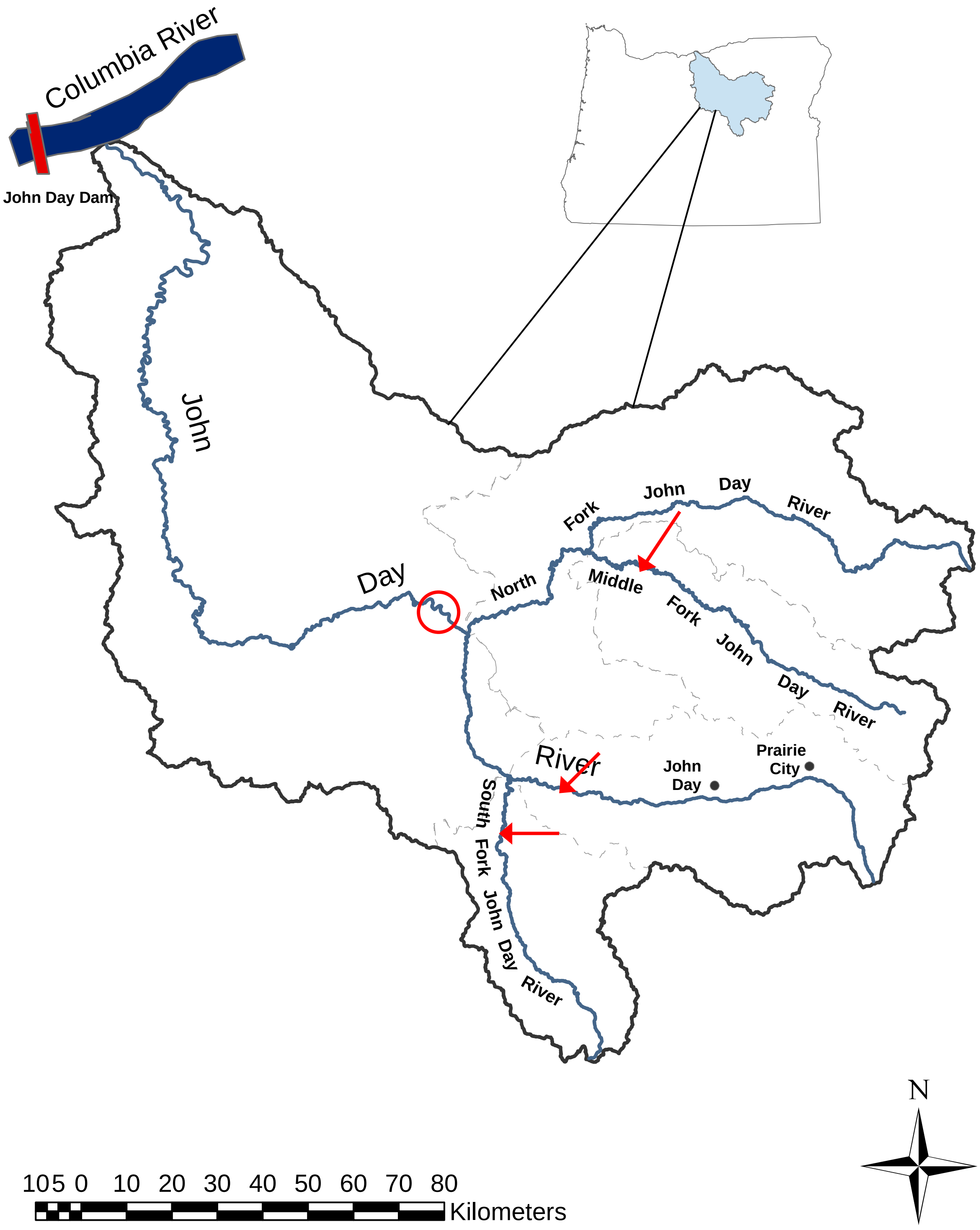

Figure 1. Map of John Day River basin. Arrows indicate approximate locations of rotary screw traps and the ellipse indicates our Mainstem seining reach.

METHODS

During 2007, juvenile spring Chinook and steelhead migrants were captured at three rotary screw trap (RST) sites and while seining in the Mainstem John Day River [river kilometers (rkm) 274–296] in order to estimate abundance, smolt-to-adult survival (SAR), and to study life history characteristics of summer steelhead in the John Day River subbasin.

Two RSTs were located in the Upper Mainstem fourth level HUC and are hereafter referred to as the Mainstem trap at rkm 352 and the South Fork trap located at rkm 10 of the South Fork John Day River. The Mainstem trap was relocated from its previous site at rkm 326 to the current site near the Flat Creek access road of the Phillip Schneider Wildlife Area upstream of the confluence with the South Fork John Day River. A third RST was located in the Middle Fork John Day River near Ritter at rkm 24 and is hereafter referred to as the Middle Fork trap. The Mainstem seining operation was located just downstream of the confluence of the Mainstem and North Fork (Figure 1).

The Mainstem trap, South Fork trap, and Mainstem seining operation are all located downstream of all known spring Chinook spawning habitat. Some summer rearing does occur in Bridge Creek (Ian Tattam, personal communication) and may occur in other tributaries downstream of our collection sites. The Middle Fork trap site is upstream of four fish bearing tributaries entering the Middle Fork including Six-mile Creek, Three-mile Creek, Long Creek, and Eight-mile Creek. 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 discharges, and during warm summer months after fish ceased migrating.

All RSTs were fished four days each week by lowering cones on Mondays and raising cones on Fridays. Traps were checked daily during these weekly fishing periods. We assumed that all fish captured were migrants. Non-target fish species were identified, enumerated, and returned to the stream. Captured juvenile spring Chinook and steelhead migrants were anesthetized with tricane methane sulfonate (MS-222), interrogated for passive integrated transponder tags (PIT tags) or pan jet paint marks, enumerated, weighed to the nearest 0.1 g, and measured (fork length, FL; mm). We followed PTAGIS marking procedures when handling, PIT tagging, and pan jet marking juvenile migrants (PTAGIS 1999, Keefe et al. 1998, Hart and Pitcher 1969).

Juvenile spring Chinook and steelhead were captured by beach and boat seining in the Mainstem John Day River between rkm 274 and 296 from 15 February to 8 June 2007 to supplement trapping efforts when traps were not operational due to high water discharge. Eddies, riffles, and river margins were sampled with a seine constructed of 12.7 mm mesh netting that measured 30.5 m long by 2.4 m deep with a 1.2 x 1.2 m bag constructed of 9.5 mm mesh netting in the middle. Locations for sampling within our study reach varied on a daily basis depending on discharge and success during previous sampling days (see Appendix Table A-1 for a list of sample sites). Captured spring Chinook and steelhead emigrants were handled similar as at RST sites except all PIT-tagged emigrants were released at rkm 298, two kilometers upstream of our most upstream seining site. Recaptured smolts were released seven kilometers downstream of Spray, OR at rkm 267. Mean weekly catch-per-seine estimates were determined to assess smolt migration timing through the lower Mainstem during the months of February–June. All PIT-tag information was submitted to the PIT tag Information System (PTAGIS).

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). Fish were marked with either a pan jet paint mark below the surface of the fish's skin at the insertion of the anal fin (Hart and Pitcher 1969, Keefe et al, 1998) or by PIT tagging. Up to 20 fish of each species (spring Chinook and summer steelhead) were released daily upstream of the trap sites. These marked fish were released 4 km upstream of the Mainstem trap while recaptured and unmarked fish were released 550 m downstream. At the South Fork trap, marked fish were released 4.8 km upstream and all other fish were released 100 m downstream. At the Middle Fork trap, marked fish were released 2.5 km upstream and all others were released 100 m downstream. Trap efficiency intervals varied depending on the number of recaptured fish of each species (Keefe et al, 1998). Trap efficiency was estimated from the equation:

$$TE = R/M \quad (1)$$

where TE is the estimated trap efficiency, M is the number of marked fish released upstream and R is the number of marked fish recaptured. A stratified trap efficiency method, utilizing the Bailey estimator, was used to estimate migrant abundance (Steinhorst et al. 2004) for each species. A bootstrapping procedure was then used to estimate 95% confidence intervals for migrants during both the fall/winter and springtime periods. A similar mark-recapture and bootstrapping method was used to estimate capture efficiency for our seining efforts. Linear interpolation was used to estimate catch during time periods when traps or seines did not operate.

Additional life-history, parasite, and mark information was also collected from captured fish. Scale samples were taken from a subsample of steelhead migrants at all traps and from the seining operation during the spring. Scales were collected from the key scale area and annuli were counted to determine age at capture (Nicholas and Van Dyke, 1982). At each trapping site, scales were taken from the first 25 fish captured and PIT tagged fish in each of four FL intervals, 65–90 mm, 91–120 mm, 121–200 mm, and ≥ 201 mm during the fall/winter (October–January 31, South Fork Trap only) and spring (February 1–June). The age structure of all steelhead PIT tagged was estimated by assigning ages based the relationship between FL and age of fish in our aged subsample. The presence of trematode cysts (black spot disease; *Neascus sp.*) on captured smolts was noted. We identified fin clips on adult steelhead and spring Chinook captured to determine if they were of hatchery origin. Sex, MEPS length, FL, and scale samples were taken when steelhead carcasses were captured. Snouts of carcasses and captured steelhead with adipose and left ventral fin clips were collected for coded wire tag identification.

Mean, standard error, and range of fork length (L_F; mm), weight (W; g), and coefficient of condition (K) were reported for both fall/winter (12 October 2006 to 31 January 2007) and springtime (1 February to 22 June 2007) migrating juvenile spring Chinook and steelhead. Coefficient of condition was calculated as:

$$K = 100\ W/\ L_F^{\,b} \quad (2)$$

Where b = 3—the ratio of specific growth rates for length (L_F) and weight (W) (Saltzman 1977).

Travel times for fall/winter and spring-tagged emigrants to reach John Day and Bonneville Dams from the release sites were summarized for each tagging location. In addition, first and last detection dates and mean, standard error, and range of travel time to John Day Dam, Bonneville Dam, and the Columbia Estuary were estimated. Detection rates for each seasonal tag group were calculated by dividing the number of first time detections at dams by the number PIT tagged and released at collection sites. Detection rates represent a minimum survival rate because they are not adjusted to account for fish that pass undetected through the hydrosystem.

Smolt-to-adult return (SAR; marine survival) was estimated by the ratio of smolts PIT tagged in our trapping and seining efforts to the number of returning PIT-tagged adults detected at dams as they ascended the Columbia River using DART and PTAGIS databases (DART, PTAGIS). Spring Chinook adults typically return at three ages (ages 3–5) so return rate of any cohort requires three years of adult data detection. Summer steelhead typically spend 1–2 years in the ocean requiring two years of adult data detection for a single smolt cohort. We also estimated stray rates of adult spring Chinook and summer steelhead from PIT tag detections at Columbia River dams upstream of McNary Dam. Freshwater survival (smolt-per-redd estimates) for the 2005 brood year of spring Chinook was estimated using the number of smolts estimated to pass individual trap sites (Mainstem, Middle Fork) and the seining reach (representing the entire basin) during 2007 by the number of redds estimated during spawning ground surveys during 2005 (Schultz et al, 2006).

RESULTS

Juvenile Spring Chinook Smolt Capture and Tagging

We PIT tagged 4,056 juvenile spring Chinook at our three trap sites and in the Mainstem seining operation during the spring migration from 1 February to 22 June 2007 (Table 1). Peak movements were recorded during the month of April at all three trap sites and a second peak was recorded during June at the Mainstem trap (Figure 2). Mean FL at capture for spring migrants from all trapping sites was 105.2 mm (Table 2). Mass varied from 12.3 to 18.4 g and their coefficient of condition was typically greater than 1.2 (Table 2). Of the 4,070 juvenile spring Chinook examined for *Neascus sp.* infestation, 70 (1.7%) showed visible signs of black spot. Based on adult spring Chinook redd counts from spawning ground surveys and juvenile abundance estimates from our seining operation we estimate freshwater production as 45 smolts/redd for the 2005 brood year (Table 3).

At our Mainstem RST, we captured 2,126 and PIT tagged 1,447 juvenile spring Chinook during the spring migration (Tables 1). Trapping efficiency (TE) was 9.9%. We estimate 26,489 juveniles migrated past this site during our trapping period (Table 4). Mean FL during the fall migration was 99.9 mm (Table 2). Mean FL during the spring migration was 97.6 mm (Table 2). Of 1,458 juvenile spring Chinook examined for *Neascus sp.* infestation, 15 (1.0%) showed visible signs of black spot. Based on adult spring Chinook upper Mainstem redd counts and abundance estimates from our Mainstem trap we estimated freshwater survival to be 118 smolts/redd for the 2005 brood year (Table 4).

At our South Fork trap we captured 247 juvenile spring Chinook between 12 October, 2006 and 15 June 2007. We estimate 414 juveniles migrated past this site (Table 3). Only 149 spring Chinook were PIT tagged for the spring tag group (Table 1). Mean FL of spring migrants was 107.3 mm.

At our Middle Fork trap we captured 947 and PIT tagged 927 juvenile spring Chinook during the spring migration from 13 February to 14 June 2007 (Table 1). Trapping efficiency was 18.8% during the spring (Table 1). We estimate 7,524 juvenile spring Chinook migrated past the Middle Fork trap site during our trapping period (Table 1). Mean FL was 102.4 mm (range 65–150 mm) during the spring. Of 927 juvenile spring Chinook examined for *Neascus sp.* infestation, 22 (2.4%) showed visible signs of black spot. Based on Middle Fork adult spring Chinook redd counts and abundance estimates from our Middle Fork trap, we estimated freshwater survival in the Middle Fork to be 42 smolts/redd for the 2005 brood year (Table 5).

We PIT tagged 1,533 of the 1,650 juvenile spring Chinook captured in 330 seine hauls in the Mainstem John Day River from 15 February to 8 June 2007 (Table 1). Sixty-four juveniles were recaptured indicating a capture efficiency of 4%. We estimated that 40,615 juveniles migrated past the seining area during our seining period (Table 4). Mean FL was 114.2 mm (Table 2). Of 1,458 smolts examined for *Neascus sp*. infestation in our Mainstem seining operation, 32 (1.0%) showed visible signs of black spots.

Table 1. Season, collection period, number captured (n), number PIT tagged, percent capture efficiency, and abundance estimates (± 95% confidence limits) for juvenile spring Chinook migrants captured at three rotary screw trap sites and while seining in the John Day River (rkm 274–296) from 12 October 2006 to 22 June 2007.

Trap Location	Season	Collection Period	n	PIT tagged	Capture Efficiency	Abundance	95% CI
South	Fall/winter	10/12/06–1/31/07	83		52.5		
Fork	Spring	2/1/07–6/15/07	164	149	62.9		
	Total		**247**			**414**	**361–479**
Mainstem	Fall/winter	10/12/06–1/31/07	199		0.7		
	Spring	2/1/07–6/22/07	2,126	1,447	9.9		
	Total		**2,325**			**26,489**	**21,823–32,237**
Middle	Fall	10/31/06–11/21/06	19		0.3		
Fork	Spring	2/13/07–6/14/07	1,328	927	18.8		
	Total		**1,347**			**7,524**	**6,285– 9,112**
Mainstem Seining	Spring	2/15/07–6/8/07	**1,650**	1,533	4.0	**40,615**	**32,117–51,385**

Table 2. Number (N), mean, and range of fork length (mm), mass (g), and coefficient of condition for spring Chinook migrants captured in four rotary screw traps and while seining on the Mainstem John Day River during two periods (Fall/Winter, 12 October 2006 to 31 January 2007; Spring, 1 February to 22 June 2007).

		Fork Length (mm)			Mass (g)			Coefficient of condition		
Location	Period	N	Mean	Range	N	Mean	Range	N	Mean	Range
South Fork Trap	Fall/Winter	61	109.5	84–130	60	16.4	7.3–27.7	60	1.21	1.04–1.5
Mainstem Trap	Fall/Winter	142	99.9	80–126	120	12.5	5.7–25.7	120	1.21	0.81–1.6
Middle Fork Trap	Fall/Winter	10	96.1	90–105	0			0		
All sites	Fall/Winter	213	102.5	80–130	180	13.8	5.7–27.7	180	1.21	0.81–1.6
South Fork Trap	Spring	154	107.3	71–133	145	16.4	5.0–30.7	145	1.22	0.89–1.8
Mainstem Trap	Spring	1,569	97.6	61–136	1,388	12.3	3.3–30.3	1,388	1.29	0.65–2.6
Middle Fork Trap	Spring	947	102.4	64–147	922	13.1	3.5–34.8	922	1.19	0.79–1.9
Mainstem Seining	Spring	1,599	114.2	90–157	1,293	18.4	7.1–49.1	1,293	1.20	0.80–1.8
All sites	Spring	4,269	105.2	61–157	3,748	14.7	3.3–49.1	3,748	1.23	0.65–2.6

Table 3. 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	1,417	2005	130,144	97,133–168,409	92	69–119
2004	1,656	2006	101,262	59,688–179,494	61	36–108
2005	902	2007	40,615	32,117–51,385	45	36–57

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

Table 4. Mainstem John Day River smolt/redd ratios based on estimates of smolt abundance and census redd counts for spring Chinook salmon, 2002–2004 brood years.

Brood year	Number of redds	Migration year	Trapping period	Smolt abundance	95% CI	Smolt/redd	95% CI
2002	549	2004	10/23/03–6/24/04	23,589	18,310–30,833	43	33–56
2003	323	2005	10/4/04–7/6/05	32,601	29,651–36,264	101	92–112
2004	368	2006	2/10/06–6/26/06	58,490	22,089–90,428	159	60–246
2005	227	2007		26,903[a]	22,184–32,716[a]	118	98–144

[a] Mainstem trap was moved upstream of the confluence with the South Fork. Estimated abundance from Mainstem and South Fork traps were summed.

Table 5. Middle Fork John Day River smolt/redd ratios based on estimates of smolt abundance and census redd counts for spring Chinook salmon, 2002-2004 brood years.

Brood year	Number of redds	Migration year	Trapping period	Smolt abundance	95% CI	Smolt/redd	95% CI
2002	389	2004	10/29/03–6/23/04	9,744	7,918–12,257	25	20–32
2003	236	2005	10/6/04–6/17/05	20,193	17,699–22,983	86	75–97
2004	319	2006	3/6/06–6/22/06	20,720	14,401–30,870	65	45–97
2005	178	2007		7,524	6,285–9,112	42	35–51

Table 6. North Fork John Day River smolt/redd ratios based on estimates of smolt abundance and census redd counts for spring Chinook salmon, 2002-2004 brood years.

Brood year	Number of redds	Migration year	Trapping period	Smolt abundance	95% CI	Smolt/redd	95% CI
2002	1,021	2004		58,039	50,279–69,937	57	49–68
2003	858	2005		77,350	49,783–109,162	90	58–127
2004	969	2006	2/6/06–6/15/06	52,640	26,320–101,614	54	27–105
2005	497	2007		6,188	3,648–9,557	13	7–19

[a] Estimated by subtracting Mainstem Trap and Middle Fork Trap estimates from the Mainstem seining estimate.

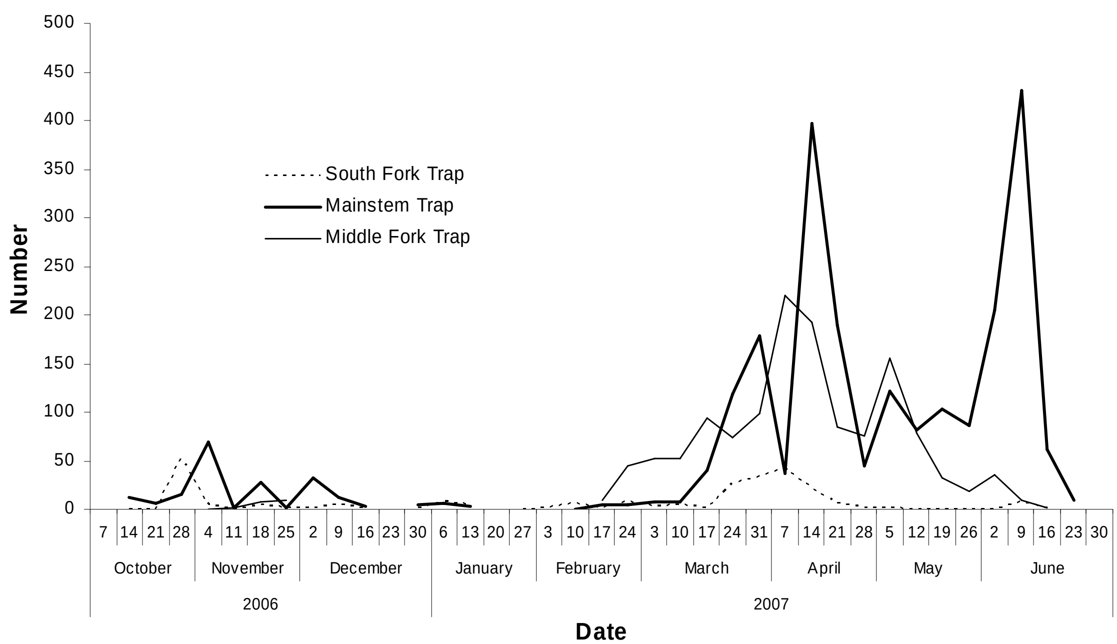

Figure 2. Weekly number of juvenile spring Chinook captured at four rotary screw traps operated in the John Day River basin during autumn 2006 and spring 2007.

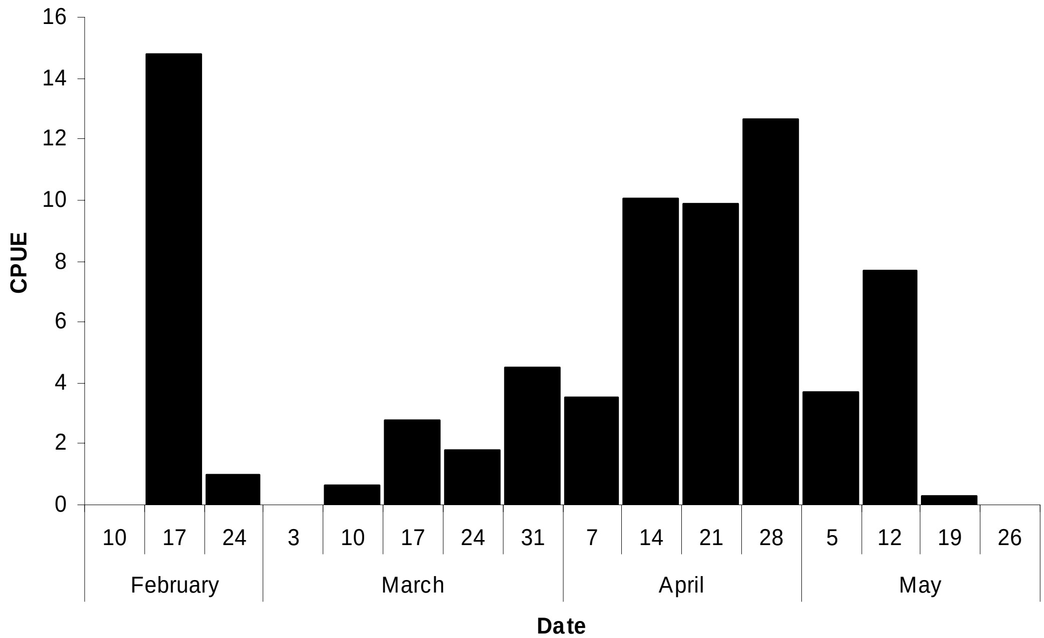

Figure 3. Weekly catch per unit effort (CPUE, number/seine haul) of spring Chinook salmon smolts captured while seining the John Day River between river kilometers 274 and 296 from 15 February to 8 June 2007.

Juvenile Steelhead Smolt Capture and Tagging

Of the 4,257 juvenile steelhead PIT tagged during the 2007 migration, 205 were tagged during the fall and winter (fall/winter tag group) at the South Fork trap site and 4,052 were tagged during the spring (spring tag group) at our three RSTs and while seining in the Mainstem between Kimberly and Spray (Table 7). Migration timing peaked during the month of May at all three trapping sites (Figure 4). Mean FL of migrants captured during the spring period was 172.3 mm (Table 8). Age structure of steelhead varied among trap sites. There were more age-1, fewer age-2 and more age-3 fish observed at the South Fork trap than at the other sites (χ^2 = 325.9, df = 6, P < 0.0001; Table 9). Age structure of all 4,562 steelhead migrants was dominated by age-2 fish (Table 9). Of 4,257 juvenile steelhead examined for *Neascus sp.* infestation, 11 (0.3%) showed visible signs of black spot.

At our Mainstem trap, we captured 1,721 and PIT tagged 1,307 juvenile steelhead during the spring period and trapping efficiency was 6.9% (Table 7). Juvenile steelhead migration peaked during the first week of May (Figure 4). We estimate 23,264 (95% CL's; 18,450 and 29,507) juvenile steelhead migrated past the Mainstem trap site during our spring trapping period. Mean FL of spring migrants was 179.1 mm (± 0.6 SE, range 74–284 mm). The age structure of steelhead migrants captured during the spring was dominated by age-2 fish (Table 9). Of 1,721 juvenile steelhead examined for *Neascus sp.* infestation at the Mainstem trap, five (0.3%) showed visible signs of black spot.

At our South Fork trap, we captured 2,010 and PIT tagged 1,644 juvenile steelhead during the 2007 migration from 12 October 2007 to 15 June 2007 (Table 7). Of those PIT tagged, 205 were tagged for the fall/winter tag group and 1,439 were tagged for the spring tag group. Trapping efficiency varied seasonally from 37.7% during the fall/winter, and 19.1% during the spring (Table 7). Juvenile steelhead migration peaked during the first and last weeks of May (Figure 4). We estimated that 10,598 (95% CL's; 9,276 and 12,311) juveniles migrated past the trap site during our trapping period. Mean FL of fall/winter migrants was slightly smaller than spring migrants (Table 8). The age structure of fall and spring migrants differed significantly with more age-2 and fewer age-1 and age-3 emigrants in the fall than in the spring ($\chi^2 = 209.8$, df = 1, $P < 0.0001$; Table 9). The age structure of steelhead migrants during the spring was dominated by age-2 fish (Table 9). Of 4,257 juvenile steelhead examined for *Neascus sp.* infestation at the South Fork trap, 3 (0.07%) showed visible signs of black spot.

At our Middle Fork trap we captured 1,308 and PIT tagged 1,269 juvenile steelhead from 14 February to 14 June 2007. Trapping efficiency for steelhead during the spring was 8.8% (Table 7). Juvenile steelhead migration peaked during the first week of May (Figure 8). We estimated that 14,784 (95% CL's; 11,947 and 18,004) juvenile steelhead migrated past the Middle Fork trap site during our spring trapping period. Mean FL of spring migrants was 170.2 mm (Table 8). The age structure of steelhead migrants was dominated by age-2 fish (Table 9). Of 1,309 juvenile steelhead examined for *Neascus sp.* infestation at the Middle Fork trap, three (0.2%) showed visible signs of black spot.

We captured 41 and PIT tagged 37 juvenile steelhead while seining in the Mainstem John Day River. We were unable to estimate an abundance for steelhead through this reach due to low recapture rates. Mean FL was 162.5 mm (Table 8). The age structure of these steelhead emigrants was again dominated by age-2 fish (Table 10). None of the 41 emigrants examined for *Neascus sp.* infestation showed visible signs of black spot.

Table 7. Season, collection period, number captured (n), percent capture efficiency, and abundance estimates (95% confidence limits) for juvenile steelhead migrants captured at four rotary screw trap sites and while seining in the John Day River (rkm (274–296) from 12 October 2006 to 22 June 2007.

Trap Location	Season	Collection Period	n	PIT tagged	Capture Efficiency	Abundance	95% CI
South	Fall/winter	10/12/06–1/31/07	252	205	37.7		
Fork	Spring	2/1/07–6/15/07	1,758	1,439	19.1		
	Total		**2,010**	**1,644**		**10,598**	**9,276–12,311**
Mainstem	Fall/winter	10/12/06–1/31/07	10				
	Spring	2/1/07–6/22/07	1,711	1,307	6.9		
	Total		**1,721**			**23,264**	**18,450–29,507**
Middle	Fall/winter	10/31/06–11/21/06	1				
Fork	Spring	2/13/07–6/14/07	1,308	1,269	8.8		
	Total		**1,309**			**14,784**	**11,947–18,004**
Mainstem							
Seining	Spring	2/15/07–6/8/07	41	37			

Table 8. Number (N), mean, standard error (SE), and range of fork length (mm), mass (g), and coefficient of condition for steelhead migrants captured in four rotary screw traps and while seining on the Mainstem John Day River during two periods (Fall/Winter, 12 October 2006 to 31 January 2007; Spring, 1 February to 22 June 2007).

		Fork Length (mm)			Weight (g)			Coefficient of condition		
Location	Period	N	Mean	Range	N	Mean	Range	N	Mean	Range
South Fork Trap	Fall/Winter	205	160.3	72–227	200	48.8	4.8–126.1	200	1.06	0.79–1.3
Mainstem Trap	Fall/Winter	8	111.4	79–146	8	18.8	5.2–39.1	8	1.13	1.03–1.3
Middle Fork Trap	Fall/Winter	1	67							
All sites	Fall/Winter	214	158	67–227	208	47.6	4.8–126.1	208	1.06	0.78–1.3
South Fork Trap	Spring	1,581	168.0	70–260	1,494	54.2	4.1–180.7	1,494	1.07	0.56–1.8
Mainstem Trap	Spring	1,436	179.1	74–284	1,306	64.2	5.6–216.0	1,305	1.07	0.49–2.3
Middle Fork Trap	Spring	1,294	170.2	61–258	1,227	53.5	2.9–194.4	1,227	1.04	0.57–1.9
Mainstem Seining	Spring	37	162.5	89–208	36	51.8	8.8–99.0	36	1.11	0.97–1.4
All sites	Spring	4,348	172.3	61–284	4,063	57.2	2.9–216.4	4,062	1.06	0.49–2.3

Table 9. Number captured and measured for fork length (n) and estimated percent age structure of juvenile steelhead captured at three rotary screw trap sites and while seining in the John Day River during two periods (Fall/Winter, 12 October 2006 to 31 January 2007; Spring, 1 February to 22 June 2007).

			Brood Year (age)			
Trap Site	Season	n	2006 (age 1)	2005 (age 2)	2004 (age 3)	2003 (age 4)
South Fork	Fall/Winter	205	5.4	90.0	4.2	0.5
South Fork	Spring	1,581	22.7	63.7	13.7	0
Mainstem	Spring	1,444	8.3	86.0	5.7	0
Middle Fork	Spring	1,295	5.6	84.6	9.1	0.6
Mainstem Seine	Spring	37	33.1	66.9	0	0
All Sites		4,562	12.6	77.9	9.3	0.2

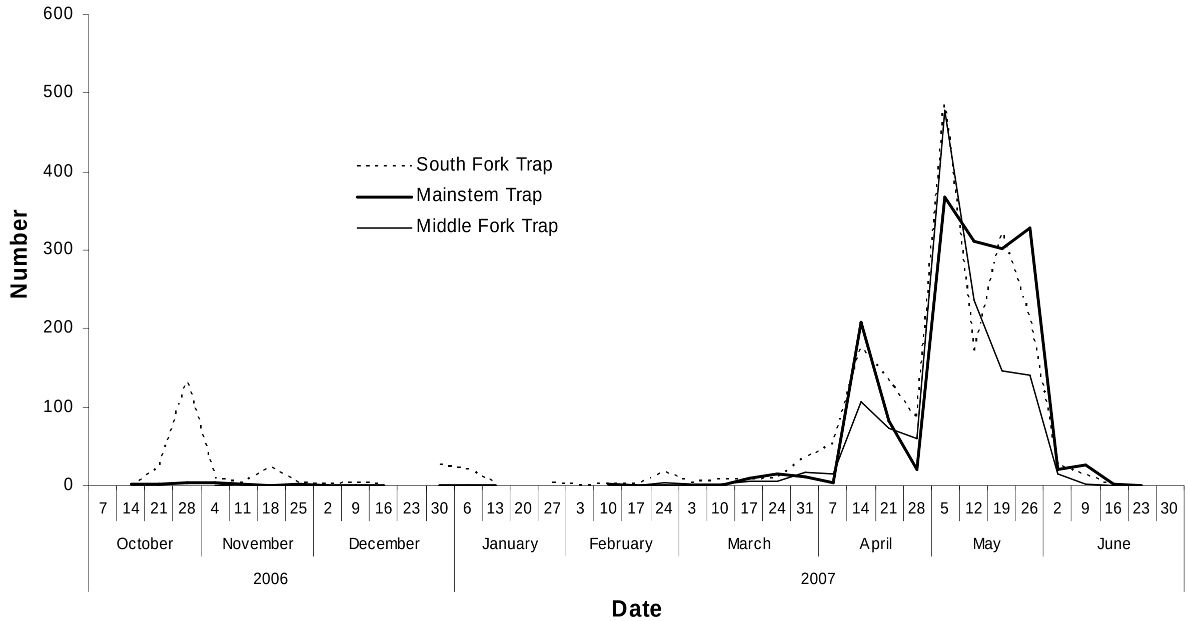

Figure 4. Weekly number of summer steelhead captured at four rotary screw traps operated on the John Day River basin during autumn 2006 and spring 2007.

Incidental Catch and Observations

We captured 14 incidental species of fish in our seining and trapping efforts during the 2007 migration (Table 10). Twelve adult summer steelhead were captured during our trapping and seining efforts. Of these, two (17%) were of hatchery origin (adipose fin clips). A coded wire tag was found in the hatchery steelhead captured at the Mainstem Trap. It was from the 2003 brood of Wallowa stock released into the Wallowa River (coded wire tag code 093914). We captured one bull trout (136 mm FL) in the Middle Fork Trap on May 21 and one during our seining operation (280 mm FL) on March 30. Two adult pacific lampreys were captured alive at our Middle Fork trap on June 1 and two were also captured at our South Fork Trap on 15 and 17 May. Juvenile pacific lamprey of three morphological types were captured at all three rotary screw trap sites (Table 10). The brown with no eyes morph comprised the majority of juvenile pacific lamprey observed. We captured 3,428 juvenile pacific lamprey at all three rotary screw trap sites with the majority at the Middle Fork trap (Table 10).

PIT-tag Detections of Juveniles at FCRPS Facilities

Of 4,056 juvenile spring Chinook migrants captured, PIT tagged, and released at our trapping and seining sites between 1 February and 22 June 2007 (spring tag group), 34.7% (1,407) were detected at John Day Dam, 9.2% were detected at Bonneville Dam, and 1.5% were detected in the Columbia estuary. Detections at John Day Dam occurred between 11 April and 27 June 2007 and 50% of these were recorded by 6 May (Table 11). Mean travel time from all release sites to John Day Dam was 25 days (Table 11). Detections at Bonneville Dam occurred

Table 10. Number of each fish species captured incidentally at the South Fork (SF) Mainstem (MS), and Middle Fork (MF) trap sites, and in the Mainstem seining operation (rkms 274-296, 15 February to 8 June 2007).

	Number captured			
Species	SF	MS	MF	Seining
Hatchery adult Summer Steelhead (*Oncorhynchus mykiss*)	1	1		
Wild adult Summer Steelhead (*O. mykiss*)	2		2	6
Spring Chinook fry (*O. tshawytscha*)		29	57	
Summer Steelhead fry (*O. mykiss*)	102	32	5	
Mountain Whitefish (*Prosopium williamsoni*)	3	1	1	2
Brown Bullhead (*Ameiurus nebulosus*)		3		15
Bull Trout (*Salvelinus confluentus*)			1	1
Chiselmouth (*Acrocheilus alutaceus*)	183	785	255	10
Bluegill (*Lepomis macrochirus*)		9		
Common Carp (*Cyprinus carpio*)				10
Dace (*Rhinichthys sp.)*	3,234	1,065	1,588	
Northern Pike Minnow (*Ptychocheilus oregonensis*)	741	319	367	59
Sucker Sp. (*Catostomus macrocheilus or C. columbianus*)	1,501	1,807		105
Smallmouth Bass (*Micropterus dolomieui*)		34	62	30
Red Side Shiner (*Richardsonius balteatus*)	1,901	1,570	1,525	
Sculpin sp. (*Cottus sp.*)	68	29	1	
West Slope Cutthroat (*O. clarki lewisi*)		1		
Adult Pacific Lamprey (*Lampetra tridentata*)	2		2	
Juvenile Pacific Lamprey (*L. tridentata*)				
Silver with visible eyes	27	9	1,856	
Brown with visible eyes		2	12	
Brown without visible eyes	44	211	1,267	
Total Juvenile Pacific Lamprey	71	222	3,135	

approximately one week later with 50% occurring by 13 May (Figure 11). Mean travel time to Bonneville Dam was 26 days. Detections in the Columbia River estuary occurred during May and mean travel time was 28 days.

Of 205 juvenile steelhead migrants captured and released at our South Fork trap between 12 October 2006 and 31 January 2007 (fall/winter tag group), 11.7% were detected at John Day Dam, and 7.3% at Bonneville Dam (Table 11). Detections at John Day Dam occurred during April and May with 50% occurring by 6 May 2007. Mean travel time from all release sites to John Day Dam was 181 days (Table 11). Detections at Bonneville Dam occurred during April and June with 50% occurring by 15 May. Mean travel time to Bonneville Dam was 180 days.

Of 4,052 juvenile steelhead migrants captured and released at our trapping and seining sites between 1 February and 22 June 2007 (spring tag group), 16% were detected at John Day Dam, 12.8% at Bonneville Dam, and 2% were detected in the Columbia River Estuary (Table 12). Detections at John Day Dam occurred from April to June with 50% occurring by 11 May 2007 (Table 11). Mean travel time from all release sites to John Day Dam was 16 days. Detections at Bonneville Dam were similar and 50% occurred by 17 May 2007. Mean travel time to Bonneville Dam was 19 days. Detections in the Columbia River estuary occurred from April to June 2007 and mean travel time was 22 days.

Table 11. Number detected (N), first and last detection dates, and mean, standard error (SE) and range of travel time (days) to detection at John Day Dam, Bonneville Dam, and the Columbia River Estuary during 2007 for spring Chinook and summer steelhead smolts PIT tagged in the John Day Basin during two periods (Fall/Winter, 12 October 2006 to 31 January 2007; Spring, 1 February to 22 June 2007).

Species	Tag Group	Detection Location	N	Detection Dates	Travel Time Mean	SE	Range
Spring Chinook	Spring	John Day Dam	1,407	4/11–6/17	25	0.4	4–88
		Bonneville Dam	372	4/21–6/26	26	0.7	6–82
		Estuary	62	5/4–5/25	28	1.6	9–66
Summer Steelhead	Fall/winter	John Day Dam	24	4/11–5/30	181	5.7	114–217
		Bonneville Dam	15	4/25–6/2	180	8.1	126–220
	Spring	John Day Dam	650	4/12–6/10	16	0.4	5–74
		Bonneville Dam	520	4/14–7/8	19	0.5	6–61
		Estuary	80	4/27–6/3	22	1.5	10–91

PIT-tag Detections of Adults at FCRPS Facilities

There were 83 detections of returning adult spring Chinook salmon at Bonneville Dam between April 10 and June 13, 2007. Twenty-six (31%) of the 83 Bonneville Dam detections occurred during April with 58% (48 fish) detected during May and 11% (9 fish) detected during June. Of the 83 detected at Bonneville Dam, 9 (10.8%) were also detected at McNary Dam, three (3.6% were detected at Ice Harbor Dam, and two (2.4%) were detected at Lower Granite Dam. Estimated smolt-to-adult returns (SAR) for spring Chinook from the trap sites in the John Day basin to the ocean and back to Bonneville Dam for the 2002 brood year was 2.08% for the spring tag group and 2.26% for the fall/winter tag group (Table 12). Return data for subsequent cohorts is not yet complete.

A total of 114 individual adult summer steelhead PIT tagged in the John Day Basin were detected at Bonneville over five months from June 29 to October 14, 2007. Of the 114 fish detected at Bonneville Dam 0.9% (one) were detected in June, 43.9% (50) in July, 51.8% (59) in August, 1.8% (two) in September, and 1.8% (two) in October.

Of the 114 returning adult summer steelhead, 82 were part of our effort to estimate summer steelhead SAR and 32 were from Oregon State University's tagging efforts. Of the 82 summer steelhead that were part of our seining effort, four were repeat spawners (two from 2004 and two from 2005 tagging years) and two were delayed migrants (Table 14). Estimated SAR for summer steelhead from the 2005 juvenile migration year was 2.27 % for the Fall/winter tag group and 1.57% for the spring tag group (Table 14). Preliminary summer steelhead SAR for the 2006 juvenile migration was estimated at 0.76% for Fall/winter migrants and 1.62% for spring migrants (Table 15). Of the 92 adult summer steelhead that returned during 2006 and 2007 from PIT tagging in 2005, 62% (57 fish) returned as one-ocean fish and 38% (35 fish) returned as two-ocean fish (Table 14). We will be unable to reconstruct cohort SARs for summer steelhead until we collect sufficient data on smolt age structure.

Overall, straying by adult summer steelhead past Ice Harbor Dam was lower during 2007 than in previous years (Table 15). Of the 114 adult summer steelhead known to have passed Bonneville Dam, 60% (68) were detected at McNary Dam, 5.3% (6) were detected at Ice Harbor Dam. Two fish (1.8%) were detected at both Priest Rapids and Rock Island Dams (PTAGIS). PIT tagged John Day summer steelhead were also detected at Sherar's Falls in the Deschutes River and at McDonald's Ferry in the John Day River (Table 15). As of December 5, 2007 only 20 (17.5%) of 114 John Day PIT tagged adult summer steelhead detected at Bonneville Dam had returned to the John Day River (Table 15).

Table 12. Brood year, migration year, number of smolts PIT tagged, adult PIT tag return years, number and age of PIT tagged adults detected at Bonneville Dam during the return years, and estimated smolt-to-adult survival (SAR) of John Day spring Chinook salmon PIT tagged from 2000–2007.

Brood Year	Migration Year	# Smolts Tagged	Adult Detections						SAR
			Return Years	Age 3	Age 4	Age 5	Age 6	Total	
1998	2000	1,852	2001–2003	4	112	28		144	7.78%
1999	2001	3,893	2002–2005	7	80	15	1	103	2.65%
2000	2002	4,000	2003–2005	5	86	9		100	2.50%
2001	2003	6,147	2004–2006	5	110	13		128	2.08%
2002	2004		2005–2007						
	Fall/winter[a]	399		0	6	3		9	2.26%
	Spring[b]	4,036		5	62	17		84	2.08%
2003	2005		2006–2008						
	Fall/winter[a]	656		2	6			8	1.22%[c]
	Spring[b]	5,138		6	55			61	1.18%[c]
2004	2006								
	Spring	3,418	2007–2009	2					
2005	2007								
	Spring	4,056	2008–2010						

[a] Fall/winter tag group: juvenile spring Chinook captured and PIT tagged between September and 31 January.
[b] Spring tag group: juvenile spring Chinook captured and PIT tagged between 1 February and July.
[c] Preliminary SAR excludes age-5 adults.

Table 13. Detection year and number of PIT tagged adult spring Chinook tagged in the John Day River basin and detected at FCRPS dams from 2001–2007.

Year	Bonneville	McNary	Ice Harbor	Lower Granite
2001	4	No Detectors	No Detectors	No Detectors
2002	119	12	No detectors	7
2003	126	3	2	2
2004	106	1	1	0
2005	125	1	0	0
2006	89	6	5	3
2007	83	9	3	2

Table 14. Juvenile tag year, number PIT tagged as juveniles, adult return years, number returning by ocean residence, and number of delayed migrants that were detected at Bonneville Dam, and estimated smolt-to-adult return (SAR) of John Day summer steelhead from 2000–2007.

Tag year	Number tagged	Return years	One-Ocean	Two-Ocean	Repeat spawners[c]	Delayed migrants[d]	Total	SAR
2001	435	2002–2004	1	5		1	7	1.61%
2002	0							
2003	144	2004–2005	1	1			2	1.39%
2004		2005–2007						
Fall/Winter[a]	898		6	1			7	0.78%
Spring[b]	3,732		60	45[f]	3	2	107	2.87%
2005		2006–2007						
Fall/Winter[a]	573		8	5			13	2.27%
Spring[b]	4,913		49	28	2		77	1.57%
2006		2007–2008						
Fall/Winter[a]	1,048		8					0.76%[e]
Spring[b]	2,167		35					1.62%[e]

[a] Fall/winter tag group: juvenile summer steelhead captured and PIT tagged between September and January 31.
[b] Spring tag group: juvenile summer steelhead captured and PIT tagged between February 1 and July.
[c] Fish that spawned in a previous year.
[d] Delayed migrants did not migrate the year they were PIT tagged.
[e] Preliminary SAR excludes two-ocean fish.
[f] two adults detected at McNary Dam were not detected at Bonneville Dam.

Table 15. Detection year and number of summer steelhead PIT tagged in the John Day basin as juveniles and subsequently detected at PIT-tag detection facilities as adults from 2003–2007.

Year	Bonneville Dam	Sherar's Falls	McDonald's Ferry	Umatilla River	McNary Dam	Tucannon River	Ice Harbor Dam	Lower Granite Dam	Priest Rapids	Rock Island
2003	5				3		1			
2004	2				1		1			
2005	67				36		13	9		
2006	120[a]			4	67	3	15	8		
2007	114	1	20		68		6		2	2

[a] Two adults were not detected at Bonneville Dam but were detected at McNary Dam.

DISCUSSION

The abundance estimate for emigrating juvenile Chinook salmon past our Mainstem seining reach was the lowest during the past six years. Redd counts from the 2005 brood year were significantly lower than the previous five years (Carmichael, 2002; Ruzycki et al, 2002; Schultz et al, 2006 and 2007; Wilson et al 2002, 2005) likely resulting in fewer juveniles. In addition, our seining estimate and estimate for North Fork may have been biased low by a smaller than usual sample size.

Spring Chinook peak migration timing, mass, condition factor, percent detection at John Day and Bonneville Dams, and mean travel time to both John Day and Bonneville Dams were all within the range previously estimated (Carmichael et al 2002, Ruzycki et al 2002; Wilson et al, 2002, 2005, and 2007; and Schultz et al, 2006 and 2007). Mean fork length of all spring Chinook emigrants was larger than reported for 2004, 2005 and 2006. However, as in 2006, Chinook captured at the Mainstem trap were shorter than those caught at the Middle Fork trap. Fish captured in late May and June at the Mainstem trap were an average of 25 mm shorter than those caught earlier in the spring. A large number of these smaller fish moved past the Mainstem trap during the first two weeks of June (Figure 2). Some of these fish are likely large Chinook parr seeking unoccupied habitat. Our trap crew PIT tagged six fish (74 to 94 mm FL) between 23 May and 6 June that were later recaptured in Murderer's Creek and Black Canyon Creek (tributaries to the South Fork John Day River) during the subsequent summer by Oregon State University Staff. Fish of similar size were also PIT tagged during the same time period and later detected at John Day and Bonneville Dams (PTAGIS). Spring Chinook tagged at the Mainstem Trap that were < 100 mm FL were detected at a lower rate (12.6%) at the John Day Dam compared to larger fish (> 100 mm FL) detections (47.3%) that were also tagged at the Mainstem Trap. However, small fish from the Middle Fork < 100 mm FL were detected at similar rates at dams as larger fish captured there. Further, dam detections of Chinook < 100 mm FL captured while seining were also similar to detections of larger fish captured while seining. The presence of these putative large parr at our Mainstem trap has complicated our smolt/redd estimates above this site. We will continue to monitor these fish using size and age discrimination techniques to better determine their life-history strategy.

As in the previous three years, the Upper Mainstem produced twice as many juvenile steelhead migrants as were produced in the Middle Fork. Mean FL, mass, and condition factor were greater at all trap sites than previously reported and there were fewer fall summer steelhead migrants captured at the South Fork Trap than in previous years. Juvenile steelhead abundance estimates and detection rates at John Day and Bonneville Dams were within the range of previous years. As in 2005 and 2006, the age structure of spring-migrating steelhead differed among the three trap sites. Age-2 summer steelhead composed a larger percentage of fish that migrated past the Middle Fork and Mainstem traps than at the South Fork Trap. Unlike the previous two years, age-3 fish composed half as many of the emigrants at the Middle Fork Trap.

Our estimated spring Chinook SAR for the 2002 brood year (2.08%) was similar to 2001— both being the lowest we have reported for the John Day basin (Table 12). Our summer steelhead SAR from the 2005 migratory year (1.57%) is lower than the previous year but within the range of previously reported SAR estimates.

Straying by both PIT-tagged adult John Day Spring Chinook and summer steelhead past McNary Dam was higher than in the previous five years (Table 15). Over half of our PIT-tagged adult summer steelhead detected at Bonneville Dam in 2005, 2006, and 2007 were also detected at McNary Dam indicating that at least half of all adult summer steelhead returning to spawn in the John Day River basin bypass the mouth of the John Day River. A new PIT tag detector installed in the John Day River near McDonald's Ferry (rkm 33) has confirmed that some adult summer steelhead that ascend the McNary Fish ladders are returning to the John Day River. However, during 2007, only 17.5% (20 fish) of the 114 PIT tagged adult steelhead detected at Bonneville Dam had returned to the John Day River and only seven of the 70 adults detected at McNary Dam from March to December 2007 have subsequently returned to be detected in the John Day River (PTAGIS). Spring kelt PIT tag detections confirm that John Day summer steelhead are straying into the Umatilla River and Snake River Basin upstream of Lower Granite Dam (PTAGIS). Adult John Day summer steelhead were also detected in the Deschutes River at Sherar's Falls and in the Columbia River at Priest Rapids and Rock Island Dams for the first time this year (PTAGIS).

CONCLUSIONS

During future migrations, our seining crews should resume the capture of a larger number of spring Chinook smolts (~ 3,000) to ensure an adequate sample size for the John Day basin abundance estimate. In addition, we will need to sample scales from juvenile spring Chinook under 99 mm at the Mainstem trap site during May and June in an effort to identify large parr and differentiate them from the smolt per redd estimates.

Our PIT tagging efforts from trap and seine operations provide the only measure of freshwater production of Chinook and steelhead in the John Day River. This tagging also enables us to estimate SAR that allows for an out-of-basin survival estimate. Abundance estimates and the ratio of smolts per redd should continue to be monitored to detect a fish production response to new and maturing riparian habitat restoration projects implemented in the John Day basin. Real-time data from these long term monitoring activities such will guide restoration and adaptive management in the region, and aid in evaluating the success of alternative management practices on other salmon and steelhead stocks in the Columbia Basin. Continued monitoring of straying by wild adult John Day summer steelhead and Chinook will also provide valuable data for the evaluation of Mainstem Columbia River operations.

REFERENCES

Carmichael, R., G. Claire, J. Seals, S. Onjukka, J.R. Ruzycki, W.H. Wilson. 2002. "John Day Basin Spring Chinook Salmon Escapement and Productivity Monitoring; Fish Research Project, Oregon", 2000-2001 annual report, project no. 199801600, 62 electronic pages, (BPA Report DOE/BP-00000498-2), http://www.efw.bpa.gov/Publications/A00000498-2.pdf

DART. Data access in real time. School of Aquatic and Fishery Sciences. University of Washington. http://www.cbr.washington.edu/dart/dart.html

Hart, P.J.B and T. J. Pitcher. 1969. Field trials of fish marking using jet inoculators. Journal of Fish Biology. 1:383-385.

Jonasson, Brian C., V. D. Albaladejo, R. W. Carmichael. 1999. Oregon Department of Fish and Wildlife, Annual Progress Report July 17, 1998 to June 30, 1999 to Bonneville Power Administration, Portland, OR, Contract 98BI11646, Project 98-016-00, 31 electronic pages (BPA Report DOE/BP-11646-1), http://www.efw.bpa.gov/Publications/I11646-1.pdf

Keefe, M. L. and five co-authors. 1998. Investigations into the early life history of naturally produced spring Chinook salmon in the Grande Ronde River basin. Oregon Department of Fish and Wildlife, La Grande, OR. Annual Progress Report to Bonneville Power Administration. Project No. 92-026-04 (http://www.efw.bpa.gov/Environment/EW/DOCS/REPORTS/HABITAT/H33299-4pdf).

Lindsay, R. B., W. J. Knox, M. W. Flesher, B. J. Smith, E. A. Olsen and L. S. Lutz 1986. Study of wild spring Chinook salmon in the John Day River system. Final Report of Oregon Department of Fish and Wildlife to Bonneville Power Administration (Contract DE-A19-83BP39796), Portland, OR. (http://.efw.bpa.gov/Environment/EW/EWP/DOCS/REPORTS/HABITAT/H39796-1.pdf).

Nicholas, J.W., and L. Van Dyke. 1982. Straying of adult Coho salmon to and from a private hatchery at Yaquina Bay, Oregon Department of Fish and Wildlife, Information Report (Fish) 82-10, Portland, OR.

PTAGIS. 1999. The Columbia Basin PIT Tag Information System. PIT Tag Operations Center. Pacific States Marine Fisheries Commission.

Ruzycki, J.R., W.H. Wilson, R. Carmichael, B. Jonasson. 2002. "John Day Basin Spring Chinook Salmon Escapement and Productivity Monitoring", 1999-2000 annual report, project no. 199801600, 62 electronic pages, (BPA Report DOE/BP-00000469-1). http://www.efw.bpa.gov/Publications/A00000498-1.pdf
Project No. 1998-01600, 41 electronic pages, (BPA Report DOE/BP- 00000498-1), http://www.efw.bpa.gov/Publications/A00000498-1.pdf

Saltzman B. 1977. Manual for Fish Management. Oregon Department of Fish and Wildlife. Portland, OR.

Schaller H. A., C. E. Petrosky, and O. P. Langess. 1999. Contrasting patterns of productivity and survival rates for stream-type Chinook salmon populations of the Snake and Columbia River. Canadian Journal of Fisheries and Aquatic Resources 56:1031-1045.

Schultz, T, W. Wilson, J. Ruzycki, R. Carmichael, J. Schricker, D. Bondurant 2006. Escapement and productivity of Spring Chinook and Summer Steelhead in the John Day River Basin. 2003-2004 Annual Report. Project No. 199801600,101 electronic pages, (BPA Report DOE/BP-00005840-4).

http://pisces.bpa.gov/release/document/documentviewer.aspx?doc=00005840-4
Schultz, T, W. Wilson, J. Ruzycki, R. Carmichael, J. Schricker. 2007. Escapement and productivity of Spring Chinook and Summer Steelhead in the John Day River Basin. 2005-2006 Annual Report. Project No. 199801600 (BPA contract 25467).
Steinhorst, K., Y. Wu, B. Dennis, and P. Kline 2004. Confidence intervals for fish out-migrant estimates using stratified trap efficiency methods. Journal of Agricultural, Biological, and Environmental Statistics 9:284-299.
Thedinga J. F., M. L. Murphy, S. W. Johnson, J. M Lorenz and K. V Koski. 1994. Determination of slamonid smolt yield with rotary screw traps in the Situk River, Alaska, to predict effects of glacial flooding. North American Journal of Fisheries Management. 14:837-851.
Wilson, W. H., T. J. Seals, T. Goby, J. R. Ruzycki, R. W. Carmichael, S. Onjukka, and G. O'Connor. 2002. "John Day basin Chinook salon escapement and productivity monitoring," 2001-2002 annual report, project no. 199801600, 124 electronic pages, (BPA Report DOE/BP-00005840-1) http://www.efw.bpa.gov/Publications/A00005840-1.pdf
Wilson, W.H., T.L. Schultz, T. Goby, J.R. Ruzycki, R.W. Carmichael, S. Onjukka, G. O'Connor. 2005. "John Day basin Chinook salmon escapement and productivity monitoring," 2002-2003 annual report, project no. 199801600, 165 electronic pages, (BPA Report DOE/BP-00005840-2), http://www.efw.bpa.gov/Publications/A00005840-2pdf
Wilson, W. H, T.L. Schultz, J. R. Ruzycki, R. W. Carmichael, J. Haire, J. Schricker. 2007 "Escapement and Productivity of Spring Chinook and Summer Steelhead in the John Day River Basin", 2004 - 2005 Technical Report, project no. 199801600, 98 electronic pages (BPA Report DOE/BP-00020364-1). http://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=00020364-1

APPENDIX

2007 Mainstem John Day Seining Sites and Catch Statistics

Appendix Table A-1. Geographic location, % of overall smolt captures, number of seines pulled at each site, and catch-per-unit effort (CPUE: #smolts/seine haul) at sites sampled during our 2007 seining effort on the Mainstem John Day River between Kimberly and Spray, OR.

Site Name	Latitude and Longitude	% of total catch		Number of Seines	CPUE	
		Chinook	Steelhead		Chinook	Steelhead
Backwater Hole	N 44° 48' 20.73" W 119° 43' 42.79"	6	3	18	5	< 1
Balogna	N 44° 46' 41.1" W 119° 40' 46.3"	9	53	12	12	2
Bass Hole	N 44° 49' 07.4" W 119° 45' 21.3"	1	6	15	2	< 1
Bullhead Hole	N 44° 49' 24.3" W 119° 44' 12.9"	13	0	31	7	0
Dam Hole	N 44° 48' 21.7" W 119° 43' 57.7"	18	3	41	7	0
Deadfish	N 44° 48' 26.9" W 119° 43' 28.4"	6	8	18	5	< 1
Juniper Hole	N 44° 47' 42.67" W 119° 42' 19.16"	19	0	27	12	0
Log Hole	N 44° 49' 11.6" W 119° 46' 58.4"	2	0	24	2	0
Lower House Hole	N 44° 48' 57.12" W 119° 47' 19.40"	7	6	33	4	0
Slippery Shelf	N 44° 46' 9.03" W 119° 40' 16.62"	11	0	11	17	0
Spider Hole	N 44° 48' 18.74" W 119° 43' 42.10"	5	0	15	5	0
Spray Boat Ramp	N 44° 49' 34.9" W 119° 47' 34.9"	2	14	28	1	< 1
Other Sites	---	2	8	55	< 1	< 1