

**BROOD YEAR REPORT
DWORSHAK NATIONAL FISH HATCHERY
SPRING CHINOOK SALMON
BROOD YEAR 2006
LIFE CYCLE COMPLETED IN 2011**

PREPARED BY

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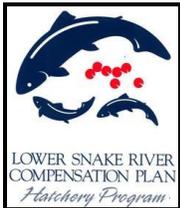
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BROOD YEAR 2006 OVERVIEW

Life Stage	Number
2006 Rack Return	1,354
Number of Females Spawned	440
Total Eggs Enumerated¹	1,155,892
Average Eggs per Female	3,853
Eyed Eggs	1,115,047
Smolts Released	939,000
In-River Smolt Survival²	74.3%
Adult Returns to the Hatchery³	1,736
Adults Harvested in Idaho⁴	3,242
Adult Return to Clearwater River	8,496
Adults Collected at Other Locations⁵	2,716
Total Adult Return to Columbia River	11,212

¹ Number based on only the number of live and dead eggs enumerated.

² Survival to Lower Granite Dam.

³ 1-Ocean, 2-Ocean, and 3-Ocean returns in 2009, 2010, and 2011 to the hatchery rack.

⁴ Tribal and Sport fisheries combined.

⁵ Estimated adults recovered at various other hatchery racks, dams, fish traps, etc. down river of Lower Granite Dam based on expanded coded-wire tag recoveries.

DISCLAIMER

Data in this report is as complete and accurate as possible at the time of printing. However, because of the life history complexity of spring Chinook salmon and the mixed stock fisheries in the Columbia, Snake, and Clearwater rivers, data is provisional and subject to future revision and corrections, especially in regards to the adult returns. All questions about the validity or precision of information in this report should be directed to the Idaho Fishery Resource Office, Dworshak Fisheries Complex, U.S. Fish and Wildlife Service, (208)476-7242.

Citation for this report

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ACKNOWLEDGMENTS

The Complex would like to acknowledge and extend great appreciation to all the other Administrative, Production, Maintenance, and Fish Health staff members at Dworshak Fisheries Complex who accomplish all the fundamental work of producing spring Chinook salmon at Dworshak National Fish Hatchery on an annual basis. From the time that adults are collected and spawned until the smolts are released almost two years later, the Production staff logs an incredible number of hours feeding, cleaning, and monitoring over a million fish on a daily basis. During that time, the Maintenance staff keeps a very complicated infrastructure of rearing containers, pumps, piping, electrical systems, and other equipment operational. The Fish Health staff provides continual testing and monitoring of infectious diseases and parasites. The Administrative Staff works behind the scenes to insure efficient and timely processing of all the necessary paper work required to keep everything operational. Your names might not be on the cover, but you are the people that are really responsible for all that the Complex accomplishes.

INTRODUCTION

This report provides data for Brood Year 2006 (BY06) spring Chinook salmon (SCS) at Dworshak National Fish Hatchery (NFH) which completed its life cycle in 2011. Data are summarized on the adults that were spawned to create the brood year, egg production, nursery rearing, juvenile rearing, smolt releases, fish health, smolt emigration to the ocean, adult contribution to fisheries, adult returns to the hatchery, and estimated total adult return to the Columbia River and to Lower Granite Dam. Evaluation projects and other research studies involving this brood year are only briefly described in this report and the reader is referred to the specific project reports for details. This Brood Year Report is one of several products called for in the Region One, U.S. Fish and Wildlife Service, Fisheries Vision Action Plan and is intended to provide a broad overview of stock performance and is a compilation of data from various other reports generated by the Dworshak Fisheries Complex.

Program Goal

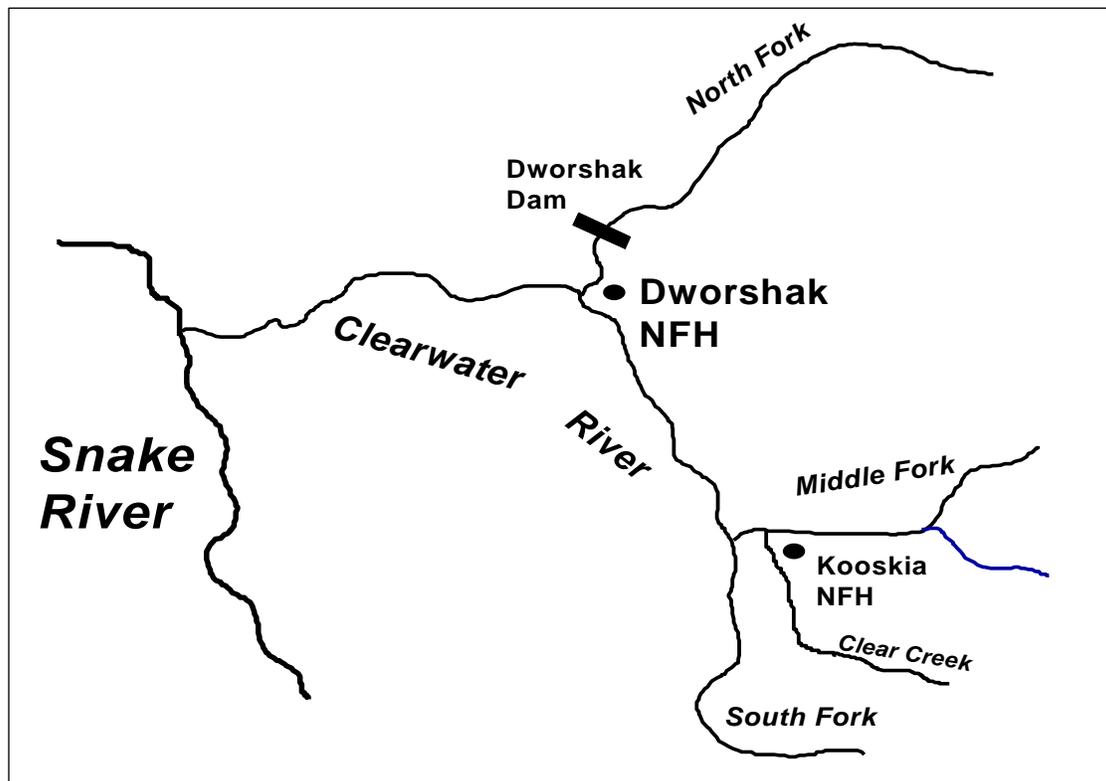
The spring Chinook salmon production program at Dworshak NFH was started in 1982 as part of the Lower Snake River Compensation Plan (LSRCP) and was originally designed to rear 1.4 million smolts to a size of 20 fish per pound (FPP) for direct release from the hatchery into the Clearwater River (U.S. Army Corps of Engineers 1981). This level of production was designed to meet a mitigation goal of 45,675 adults: 36,540 available for harvest in the lower Columbia and Snake Rivers and 9,135 adults past Lower Granite Dam (U.S. Army Corp of Engineers 1975; Herrig 1990). Over the years, several changes have been made to the facility and the production program. For BY06, the smolt release target was 1,050,000 smolts reared to a size of between 18 to 20 FPP. The reduction in the number of smolts to be released was based on a change in rearing density as a result of an evaluation by Jones and Miller (1996) and the criteria developed by the Integrated Hatchery Operation Team (IHOT).

Site Description

Dworshak NFH is located at the confluence of the North Fork and the main stem of the Clearwater River near Ahsahka, Idaho (**Figure 1**). Adults enter the hatchery by a ladder located in the North Fork Clearwater River. Adults pass an electronic counter and enter an adult trap until they can be inventoried. Fish are mechanically crowded out of this pond, into a transfer channel and into the spawning room where they can be measured and sorted. From the spawning room, adults can be transferred to one of three long-term adult holding ponds until they are spawned or out-planted. The adult holding ponds are about 8,400 cubic feet in volume and can accommodate about 600-800 adult fish each. Fertilized eggs are incubated in Heath incubation trays. In 2011, Dworshak NFH increased the capacity for incubation to 1,856 trays. Protocol calls for one female's eggs per tray giving the hatchery the capacity to incubate nearly 6.8 million spring Chinook salmon eggs. In previous years, fry were transferred to inside nursery tanks after hatching. Dworshak NFH has 64 concrete tanks and 64 fiberglass nursery tanks that hold about 667 and 643 gallons of water, respectively. The source of water for both the incubation and nursery rooms is Dworshak Reservoir. However, starting with BY98, fry have been transferred directly into the outside rearing raceways, eliminating nursery rearing, in order to lessen the impact on the summer steelhead rearing program. Final rearing occurs in outside raceways. Dworshak NFH has 30 8' X 80' concrete raceways in two separate "banks" (A and B)

for juvenile Chinook rearing. Each bank has 15 raceways. During rearing of BY06 spring Chinook salmon, all the raceways were supplied with single pass ambient river water from the North Fork Clearwater River at a rate of about 500 gallons per minute (GPM).

Figure 1. Location of Dworshak National Fish Hatchery (NFH) at the confluence of the North Fork and main stem Clearwater River, Idaho.



2006 ADULT SPRING CHINOOK SALMON RETURN TO DWORSHAK NFH

The 2006 brood year was formed from the progeny of the adults that returned as brood stock to Dworshak National Fish Hatchery during the 2006 return year. This section provides information on the pre-season predictions compared to the actual returns (total returns to the Clearwater River), the ladder operations and inventory of adults, the age composition of the run, adult holding and mortality, spawning, and handling of adults that were excess to brood stock needs.

Pre-Season Assessment

The Idaho Fishery Resource Office (FRO) used a regression equation based on the 1-Ocean (Jack) returns in the previous year to predict the return of 2-Ocean adults to the Clearwater River the following year. In 2005, the 1-Ocean return to Dworshak NFH was originally estimated to be 79 fish (Idaho Fishery Resource Office 2006, Table 9). Using the regression model, we predicted a return of 1,216 2-Ocean adults for 2006 and a total adult return of 1,568 returning to the Clearwater River for the 2006 season (Idaho Fishery Resource Office 2006, Table 11). This number was much lower than the actual return. **Table 1** lists the predicted return, made in 2005, and the estimated returns of all three age classes of adults that returned in 2006 (Idaho Fishery

Resource Office 2012, Table 11 [the returns reported for 2006 in Idaho Fishery Resource Office {2007} were modified in 2012 based on new updated data on Tribal and Sport harvests]). Our prediction for the 1-Ocean return was very similar to the actual return, 79 vs. 86. The regression used for making our prediction gave a low estimate for 2-Ocean returns, 1,216 predicted vs. 2,050 actual. Our prediction for the 3-Ocean returns was higher than the actual return, 275 predicted vs. 199 actual. Although our total prediction was lower than the actual return, it was still useful for management planning purposes such as anticipating potential harvest opportunity, collecting sufficient brood stock, and planning for adult out-planting. We coordinated ladder operations to maximize the fishing opportunities and to minimize brood stock handling and holding.

Table 1. Pre-season prediction and actual adult returns of Dworshak NFH stock to the Clearwater River, by ocean age, for BY06.

Ocean Age ¹	2005 Prediction for 2006	Actual 2006 Return
1 - Ocean	79	86
2 - Ocean	1,216	2,050
3 - Ocean	273	199
Total	1,568	2,335²

¹ 1-Ocean are BY03, 2-Ocean are BY02, and 3-Ocean are BY01.

² Total return updated with more recent estimates of sport and Tribal harvest. (Idaho Fishery Resource Office 2012, Table 11) compared to data reported in the 2006 Annual Report.

Total Rack Return

The total rack return is the number of adults collected during trapping operations at the hatchery and is not an accounting of the total return to the river. The 2006 adult spring Chinook salmon return to Dworshak NFH was 1,354 adults (**Table 2**).

Table 2. Actual rack return of adult spring Chinook salmon to Dworshak NFH by ocean age.

Ocean Age	Smolts Released	2006 Rack Return
1 - Ocean	1,072,359 (2005)	62 ¹
2 - Ocean	1,078,923 (2004)	1136 ²
3 - Ocean	1,033,982 (2003)	156 ³
Total		1,354

¹ Appendix Table 13 (Idaho Fishery Resource Office 2012).

² Appendix Table 14 (Idaho Fishery Resource Office 2012).

³ Appendix Table 15 (Idaho Fishery Resource Office 2012).

Ladder Operations and Adult Inventories

Ladder operations at Dworshak NFH vary annually based on run strength and fishery management objectives. Once the ladder is opened, a fish counter monitors the number of adults entering the trap. The trap can optimally handle a maximum of about 900 adults. Once per week, or on a regular basis, the trap is emptied and the adults are inventoried and transferred to one of three adult holding ponds. The Dworshak fish ladder was opened June 1, 2006, and closed August 22, 2006 (Dworshak National Fish Hatchery 2006). **Table 3** lists the inventory dates and the numbers of adults collected during that time period by age.

Table 3. Number of spring Chinook salmon, by age class, on each inventory date from 6/28/06 to 9/07/06, including trap mortalities (2006 Salmon News, Idaho FRO Files).

Inventory Date	I-Ocean	II-Ocean	III-Ocean	Total
June 28	12	249	62	323
July 06	29	320	21	370
July 19	11	227	33	271
August 3	2	128	21	151
August 24	7	177	19	203
September 7	1	35	0	36
Total	62	1,136	156	1,354

Age Composition of Rack Return to Dworshak NFH

Age composition of spring Chinook salmon returning to the hatchery is based on fork length categories. These length categories were derived from known age/length/sex data from coded-wire tag (CWT) recovery databases. Ocean age categories are listed below:

- 1 - Ocean (Jacks) < 56 cm
- 2 - Ocean = 56 to 81 cm
- 3 - Ocean > 81 cm.

Adult spring Chinook salmon that return to Dworshak NFH are predominately 2-Ocean fish, those that spend two years in salt water before returning to freshwater to spawn. Based on size, the age composition for the 2006 return was estimated to be 5% 1-Ocean, 84% 2-Ocean, and 11% 3-Ocean, respectively. The five year mean percent returns in the rack for 1-Ocean, 2-Ocean, and 3-Ocean adults are 7%, 66%, and 27%, respectively, for all years from 2001 to 2005 (**Table 4**).

When comparing the percentages of the 2006 to the five-year mean, there is a higher percentage of 2-Ocean adults and a lower percentage of 1-Ocean and 3-Ocean adults. The return in 2005 was similar in structure to that of the 5-year mean, with 2-Ocean adults comprising most of the return (**Table 4**).

Table 4. Number and percent of adult spring Chinook salmon that returned to Dworshak NFH since 2001, by ocean age (Idaho Fishery Resource Office 2007, Table 4).

Return Year	I-Ocean		II-Ocean		III-Ocean		Total Return
2001	36	1%	3,235	80%	747	19%	4,018
2002	62	3%	1,480	69%	615	28%	2,157
2003	580	17%	478	14%	2,364	69%	3,422
2004	142	6%	2,077	88%	137	6%	2,356
2005	74	8%	686	78%	122	14%	882
Mean	179	7%	1591	66%	797	27%	2567
2006	62	5%	1,136	84%	156	11%	1,354

Adult Marking

Because of space and water temperature limitations at Kooskia NFH, all the spring Chinook salmon collected for brood stock at that hatchery are transferred to Dworshak NFH for holding and spawning. To ensure separation of stocks, all the Dworshak NFH adult spring Chinook salmon are marked with a left opercle V-notch while Kooskia salmon are notched on the right opercle.

Adult Holding and Mortality

During the period of holding prior to spawning, formalin treatments were administered under veterinary prescription to adults to retard fungus infection. All the Dworshak NFH stock was held in Holding Pond Two. Formalin treatments were administered as bath treatments for one hour per day, 3 days per week at a concentration of 1:6,000.

Adult mortality is reported for two separate periods: holding mortality that occurs prior to the start of spawning (pre-spawn mortality) and holding mortality that occurs after the start of spawning (spawning mortality). From June 1 to August 14, 17 adult spring Chinook salmon (1.3% of rack return) died. From August 15 through September 7, an additional 22 adults died (1.6 % of rack return). The mortality rate of BY06 spring Chinook salmon adults during holding was lower than the 5-year average, with the total mortality lower than any of the previous five years (**Table 5**).

Spawning

Details on the methods and procedures during spawning are provided in the Spawning Report for BY06 (Dworshak National Fish Hatchery 2006). Spawning was started on August 15, about the same time as in 2005. Four egg takes were made with the last ripe females for the Dworshak NFH program taken on August 29. A summary of the number of males and females spawned each week is presented in **Table 6**.

Table 5. Percent holding mortality of adult spring Chinook salmon prior to spawning and during spawning at Dworshak NFH, 2000-2005 (Dworshak National Fish Hatchery 2005, Table 9).

Brood Year	Pre-Spawning Holding Mortality	Holding Mortality During Spawning	Total
2001	4.2%	2.6%	6.8%
2002	4.9%	7.1%	12.0%
2003	4.9%	2.7%	7.6%
2004 ¹	1.5%	7.2%	8.8%
2005	3.1%	4.1%	7.1%
Five-Year Avg	3.7%	5.9%	9.6%
2006	1.3%	1.6%	2.9%

¹ Does not include 134 adults that died in Pond 9 on June 30, prior to being inventoried.

Table 6. Number of male and female spring Chinook salmon spawned during each egg take for BY06 at Dworshak NFH (Dworshak National Fish Hatchery 2006). Jacks are incorporated into the number of males spawned.

Egg Take Date	Males Spawned	Females Spawned
8/15/06	72	73
8/16/06	35	55
8/22/06	76	138
8/29/06	146	174
Total	329	440

Fish Health Treatments (Pre-Spawning)

Three weeks prior to spawning, all adult females which returned before start of spawning were injected with the antibiotic Erythromycin under veterinary prescription to decrease levels of *Renibacterium salmoninarum* (bacterial kidney disease) in the eggs. Each female injected received a dosage of 20 mg/kg of body weight.

Collection of Fish Health Information

One hundred and sixty-four out of 210 (78.1%) adults tested positive for Infectious hematopoietic necrosis virus (IHNV). Ovarian fluid samples were 3 pooled and spleens were 5 pooled. Spleen tissue was used for all males sampled for IHNV.

Results positive for IHNV by take:

Take 1: 69/72 ovarians, 10/25 male spleens

Take 2: 75/78 ovarians, 10/35 male spleens

All female adults were tested for Bacterial kidney disease (*R. salmoninarum*) by enzyme-linked immunosorbent assay (ELISA).

Results:

Not Detected - 403

Low - 37

Medium - 1

High- 1

Spring Chinook salmon adults were also found positive for the parasite *Ceratomyxa shasta* by examination of wet mounts from scrapes of the walls of the intestines.

Adult Out-Planting

In years where the return of adults exceeds the brood stock needs of the program, excess adults that enter the ladder have been transported to various streams within the Clearwater River and released to spawn naturally. These activities are coordinated with the Idaho Department of Fish and Game and the Nez Perce Tribe. The 2006 rack return to Dworshak NFH was greater than was needed to meet brood stock needs so arrangements were made with Nez Perce Tribal Fisheries Department to transport 403 excess adults and 31 jacks to the lower Selway River for supplementation purposes. An additional 11 adults and 1 jack were stocked into the main stem Clearwater River.

EGG PRODUCTION AND INCUBATION

Data on early incubation, eye-up, and final incubation and hatching is found in the Dworshak NFH spawning report (Dworshak National Fish Hatchery 2006).

Green Eggs Taken

Eggs are enumerated once they have reached the eye-up stage. The number of green eggs taken initially is estimated using an average of 3,750 eggs per female. A total of 440 females were spawned, giving an initial estimate of 1,650,000 green eggs.

Early Incubation

All eggs were incubated in Heath trays. Eggs from each female were incubated separately to segregate and track offspring by the bacterial kidney disease (BKD) status (low/medium/high) of the female parent based on ELISA tests. Water flow through the incubators was maintained at about 5 gal/m (Dworshak National Fish Hatchery 2006).

Eggs Culled for Bacterial Kidney Disease

Kidney samples were taken from all females to test for BKD. The eggs from 109 females tested high (≥ 0.085 ELISA O.D. level) for BKD were culled from production (Dworshak National Fish Hatchery 2006).

Eye-Up

At eye-up, eggs were shocked and dead eggs were removed. Live eggs were enumerated by a mechanized egg picker. A total of 40,845 dead eggs were counted. The total number of eyed eggs enumerated was 1,115,047, producing an average of 3,853 eggs per female (**Table 7**).

Table 7. Summary of egg take and eye-up for Dworshak NFH BY06 spring Chinook salmon (Dworshak National Fish Hatchery 2006, Table 2).

Take	Spawn Date 2006	# of Male ¹	# of Female	Female culled BKD ²	Tray Culled Dead	Trays Culled Extra	Dead Eggs Enum	Eyed Eggs Enum	Eggs for Research	Total Eggs	Eggs/Female	Percent Enum Eye-up
1	15-Aug	72	73	5	0	0	10,343	246,522	0	256,865	3,777	96.0
2	16-Aug	35	55	3	1	0	10,316	188,525	0	198,841	3,899	94.8
3	22-Aug	76	138	30	4	0	16,042	390,000	0	406,042	3,904	96.0
4	29-Aug	146	174	71	2	24	4,144	290,000	0	294,144	3,820	98.6
Tot/Ave		329	440	109	7	24	40,845	1,115,047	0	1,155,892	3,853	96.5

¹ Includes 24 jacks spawned during the season

² BKD culling above 0.085 ELISA testing for all Takes

Egg Transfers and Final Incubation

Dworshak eggs were incubated in A, B, and C-banks. Water temperature averaged 42.5°F for Takes 1-3 in A and B banks. The water temperature averaged 44.5°F for Take 4 in C bank throughout the incubation cycle. Water temperature was held at approximately 42°F in A and B banks until the Kooskia stock spring Chinook salmon eggs were shipped to Kooskia NFH. At that time, the temperature was reduced to 37-39°F for incubation of Dworshak stock over the winter.

Transfer from Incubation to Raceways

All the eggs had hatched by the end of January 2007 and remained in incubation trays until the release of BY05 smolts. BY06 was moved from the incubator trays to A-bank raceways April 9-11, 2007. There were 1,087,800 juveniles ponded at that time and these fish were started on feed within a few days of ponding. At the end of the month, there were 1,069,464 BY06 juveniles averaging 842 fish per pound (fpp) and 40 mm (1.6 inches) total length.

JUVENILE REARING

The following data and information was summarized from the hatchery production records at Kooskia NFH, the 2007 and 2008 Annual Reports for Dworshak NFH (Dworshak National Fish Hatchery 2007; Dworshak National Fish Hatchery 2008), the Dworshak NFH monthly production narratives, and the Dworshak NFH monthly inventory summaries (MIS).

Growth and Mortality

Growth was normal and as programmed, reaching the targeted size at release by March 2008. A record of monthly growth and mortality, from the end of April 2007 until the time of release in March 2008, is listed in **Table 8**.

Table 8. Monthly growth and mortality of BY06 spring Chinook salmon during raceway rearing at Dworshak NFH. Compiled from monthly production narratives and inventory summaries.

Date (End of Month)	Number	Weight (lbs)	FPP (Fish per Pound)	Mean Length (mm)	Mean Growth (mm)	Mortality (%)	Mean Water Temp (°F)
4/07	1,069,464	1,270	842.1	40	-	1.7	41.2
5/07	1,042,528	2,446	426.2	50	10	2.5	42.6
6/07	1,033,511	5,161	200.3	65	14	0.9	44.3
7/07	1,030,215	9,476	108.7	79	15	0.3	44.1
8/07	975,215	10,544	92.5	84	4	0.2	46.2
9/07	973,432	14,937	65.2	94	10	0.1	47.8
10/07	973,071	19,621	49.6	103	9	0.1	47.2
11/07	972,751	26,026	37.4	113	10	0.03	46.5
12/07	972,264	31,618	30.8	121	8	0.05	44.2
1/08	968,662	36,472	26.6	127	6	0.37	41.5
2/08	959,504	38,153	25.1	130	2	1.1	40.2
3/08	940,111	39,689	23.7	132	3	1.9	40.6

Fish Health Monitoring

Beginning in November 2007, 10 fish per month were sampled for BKD by ELISA.

Results:

11-20-07 – Not Detected: 10

12-18-07 – Not Detected: 10

1-22-08 – Not Detected: 10

2-25-08 – Not Detected: 10

3-12-08 -- Not Detected: 10

November – Light to moderate flashing of the fish was observed. Low levels of the parasites *Gryodactylus* and *Trichodina*, and heavy levels of the parasite *Epitheliocystis* were seen on the skin. Recommendations included formalin bath treatment at 167 ppm for 1 hour.

December – Low levels of the parasite *Epitheliocystis* were seen on the skin. Fish appeared healthy at this time.

January – Fish were examined three times this month due to swollen and very pale gills that progressed to heavy swelling, high levels debris, algae, and fungus mats on the gills. Fungus was also noted on the tails of some fish. The intestines were found positive for the parasite *Hexamita* and recommendations were made to clean ponds and to treat with Epsoms salt at 3% of the diet for 2-3 days. Kidney imprints showed very low levels *Renibacterium salmoninarum* (Bacterial Kidney Disease) in one fish. *Flavobacterium psychrophilum* (Bacterial Coldwater Disease) was detected from bacterial cultures of the kidneys in very low levels. Blood smears were negative for EIBS (Erythrocytic Inclusion Body Syndrome) and tests for virus were negative.

February –Low levels of the parasites *Epitheliocystis* and *Trichodina* were seen on the skin. Ponds were noted to still have high levels of feed on the bottom of the ponds. Gills were very swollen and pale with areas of fungus mats, much debris, some aneurysms and areas of bacteria. Also low to moderate levels of egg cysts of the blood fluke parasite *Sanguinicola* were seen in the gills. Recommendations were to clean ponds and treat with Chloramine-T 1 hour bath at 15 mg/L for 3 consecutive days for gill bacteria. Bacterial cultures and virus tests were negative.

March – Gills of the moribund fish were still severely swollen, much debris, and some areas of bacteria. Gills of fish from the general population of the pond were swollen. Low levels of the parasite *Trichodina* was seen on the skin. Low levels *Flavobacterium psychrophilum* (BCWD) were detected from kidney bacterial cultures. Recommendations were to re-evaluate the water quality of the ponds and to ensure that ponds are clean and that feed is not left on the bottom of the pond. Another Chloramine-T treatment may need to be considered in the near future if the fish continue to increase in mortality. In late March, gills were still very swollen with many aneurysms and some *Sanguinicola* (low levels). Recommendations included keeping 2 raceways off feed temporarily.

Marking and Tagging

Coded-Wire Tags and Adipose Fin Clips

Adipose fin clipping and coded wire tagging was conducted by the U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, in August 2007. A total of 124,371 (total number tagged) spring Chinook salmon fingerlings were coded-wired tagged to evaluate the contribution of Dworshak NFH to commercial, sport and tribal fisheries in the lower Snake and Columbia rivers as well as in the ocean (**Table 9**). All the spring Chinook salmon smolts on station were adipose fin clipped to identify them as hatchery fish. Coded-wire tag

retention rates were determined by sampling 250 fish from each tag code group in March 2008, prior to release. Tag code 054132 had a retention rate of 99.8% and tag code 054133 had a retention rate of 99.9%.

Table 9. Coded-wire tag release information for BY06 spring Chinook salmon released from Dworshak NFH in 2008.

Tag Code	Number of Tags ¹	Number of Fish Released ²	Mark Rate ³	Purpose
054132	58,664	417,858	0.14	Contribution, Raceways A8 and A9
054133	59,250	403,288	0.13	Contribution, Raceways B26 and B27

¹ The number reported is adjusted for mortality and tag loss.

² Number of Fish Released is the total number of tagged and untagged fish that the tag group represents.

³ Mark Rate is the number of tags divided by the number of fish released that the tag code represents.

PIT tags

49,381 PIT-tagged smolts were released at Dworshak NFH as part of the Comparative Survival Study conducted by the Fish Passage Center in January. See **SPECIAL STUDIES** section for details of the aforementioned study.

SMOLT RELEASES

The smolt release for BY06 was complicated by fish health issues that were first observed in January 2008. A noticeable increase in daily mortalities was observed by the production staff. Fish examined by the Idaho Fish Health Office had swollen gills and indications of bacterial gill disease. The Dworshak Complex Hatchery Evaluation Team (HET) met informally in late February to discuss the implications of deteriorating fish health to upcoming smolt releases potentially scheduled for late March or early April. Under the direction and recommendation of the Idaho Fish Health Office, several treatments with Chloramine-T were administered in February and March. In March 2008, the Idaho FRO began monitoring flows and river conditions in the main stem Clearwater River and at Lower Granite Dam (**Figures 3 and 4**) to aid in determining the optimum time for smolt releases. By the last part of March, flows were well below the levels considered normal or optimal for smolt emigration, further complicating timing of the smolt releases at Dworshak. A final Chloramine-T treatment was administered March 24-26 and the HET decided to release the fish April 2 and 3, 2008.

Dworshak NFH released 939,000 spring Chinook salmon smolts during two separate early evening releases into the North Fork Clearwater River on April 2 and 3, 2008. Mean total length at release was 118 mm; mean fish per pound was 23.5. Arrangements were made with the U.S. Army Corps of Engineers to increase flow in the North Fork Clearwater River from 1,200 cfs to 5,000 cfs on those days, to help move the fish into the main stem Clearwater River. Releases were made in the early evening to help avoid predation.

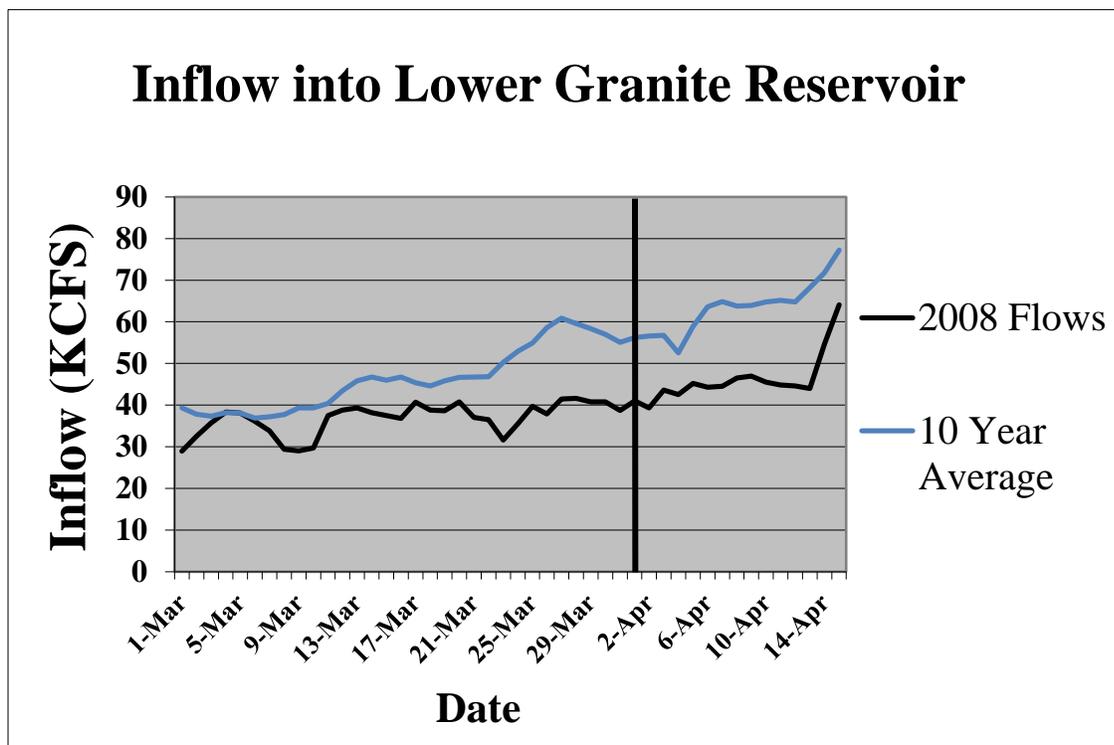


Figure 3. Mean daily flow in Lower Granite Reservoir during March – April 2008, compared to the 10 year average. Vertical line indicates the dates smolts were released.

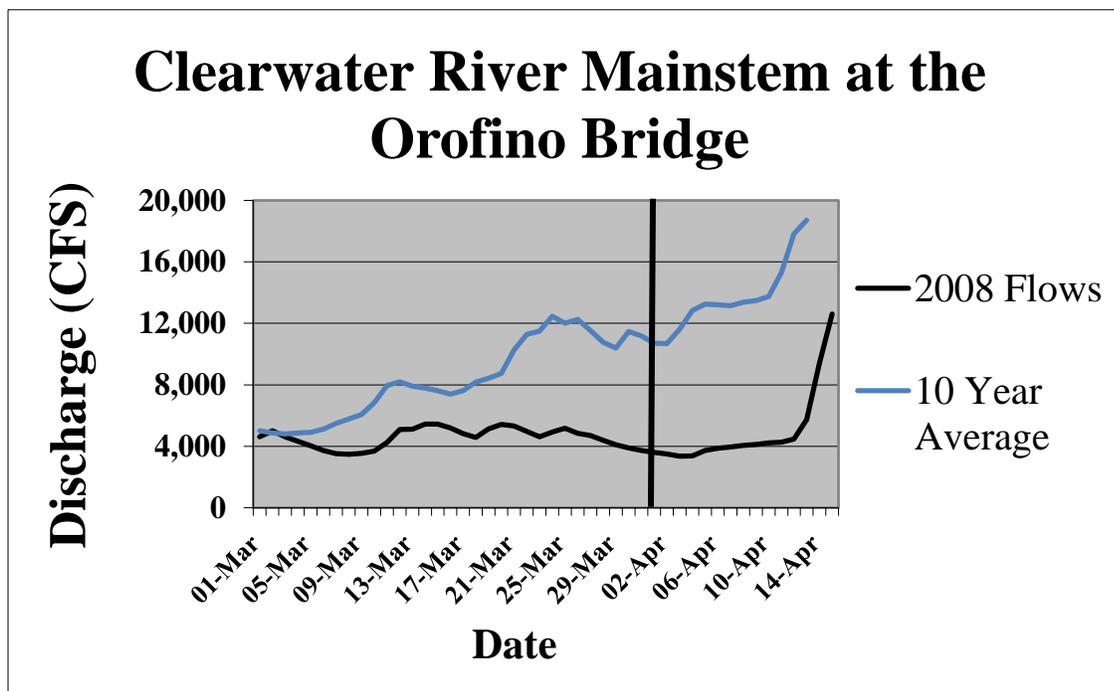


Figure 4. Mean daily stream discharge of the Clearwater River at the Orofino Bridge, 2008, compared to the 10-Year Average. Vertical line indicates the dates smolts were released.

Fish Health Pre-release exam

60 fish, collected on 3-26-08.

ELISA Results: Not detected – 60

Low - 0

Medium - 0

High - 0

Viral assays - negative

Bacterial assays - 12-5 pools (from virals) 1 colony of *Flavobacterium psychrophilum* (Bacterial Cold Water Disease) was detected.

Hematocrits - 20 samples, all in normal range.

SMOLT EMIGRATION

The performance of spring Chinook salmon smolts was monitored and evaluated using PIT tags after they were released from the hatchery. Because the smolts are tagged as part of the Comparative Survival Study, the tags are assigned to Separation by Code with 70% of the tags assigned to monitor mode and 30% assigned to return to river. Smolt emigration estimates are based on the cumulative survival of both transported and return to river fish. The tags were interrogated at Lower Granite, Little Goose, and Lower Monumental dams on the Lower Snake River and at McNary, John Day, and Bonneville dams on the lower Columbia River (**Figure 5**). PIT tags provide information on travel time and survival during emigration.

Travel Time

Travel time for BY06 spring Chinook smolts released from Dworshak NFH through the Federal Columbia River Power System was monitored using PIT tag interrogations at the juvenile bypass facilities (**Figure 6**). The migration time to Lower Granite Dam ranged from 5.6 days to 88.3 days with a mean travel time of 33.6 days (n= 6,812). Ten percent arrived at Lower Granite Dam within 18.3 days; 50% and 90% arrived within 34.6 days and 45.08 days, respectively. Smolts that migrated through the hydropower system arrived at Bonneville Dam on average 52.1 days after release.

River Flows

Flows in the Lower Snake River were lower than the 10-year average until May 7 (**Figure 7**). Inflow into Lower Granite Reservoir peaked at 197,800 cubic feet per second (cfs) on May 20, and remained above 100,000 cfs for the rest of the emigration period.

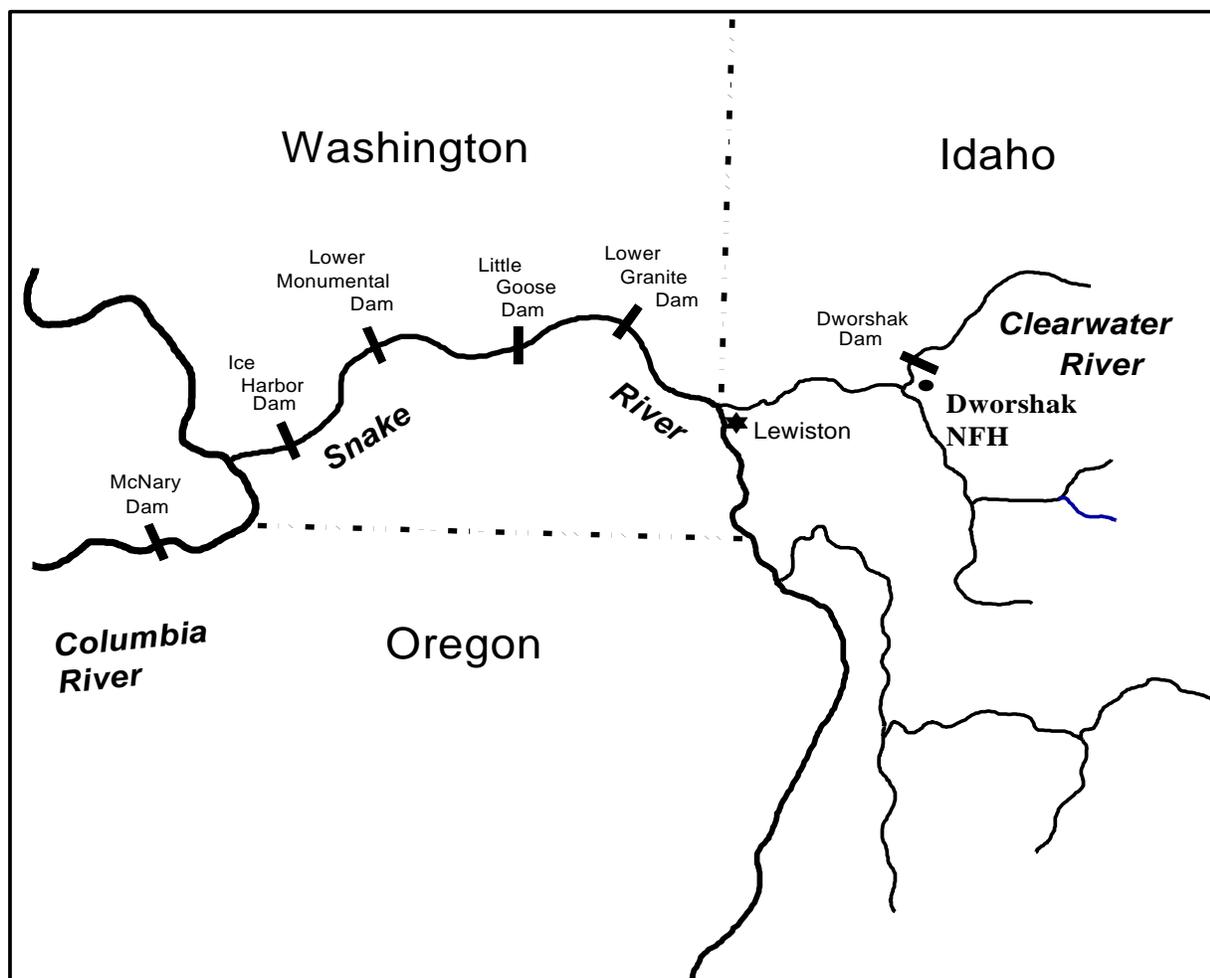


Figure 5. Dams on the lower Snake and Columbia rivers that have PIT tag interrogation facilities for monitoring smolt emigration and adult returns. John Day and Bonneville dams are not shown.

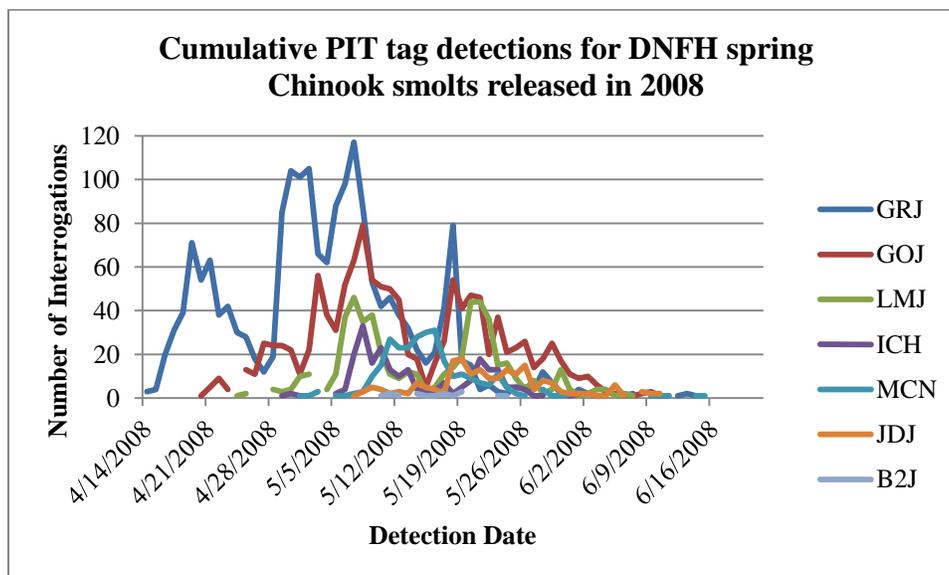


Figure 6. Cumulative PIT tag detections for BY06 Dworshak NFH spring Chinook smolts at juvenile bypass facilities in the Lower Snake and Columbia rivers.

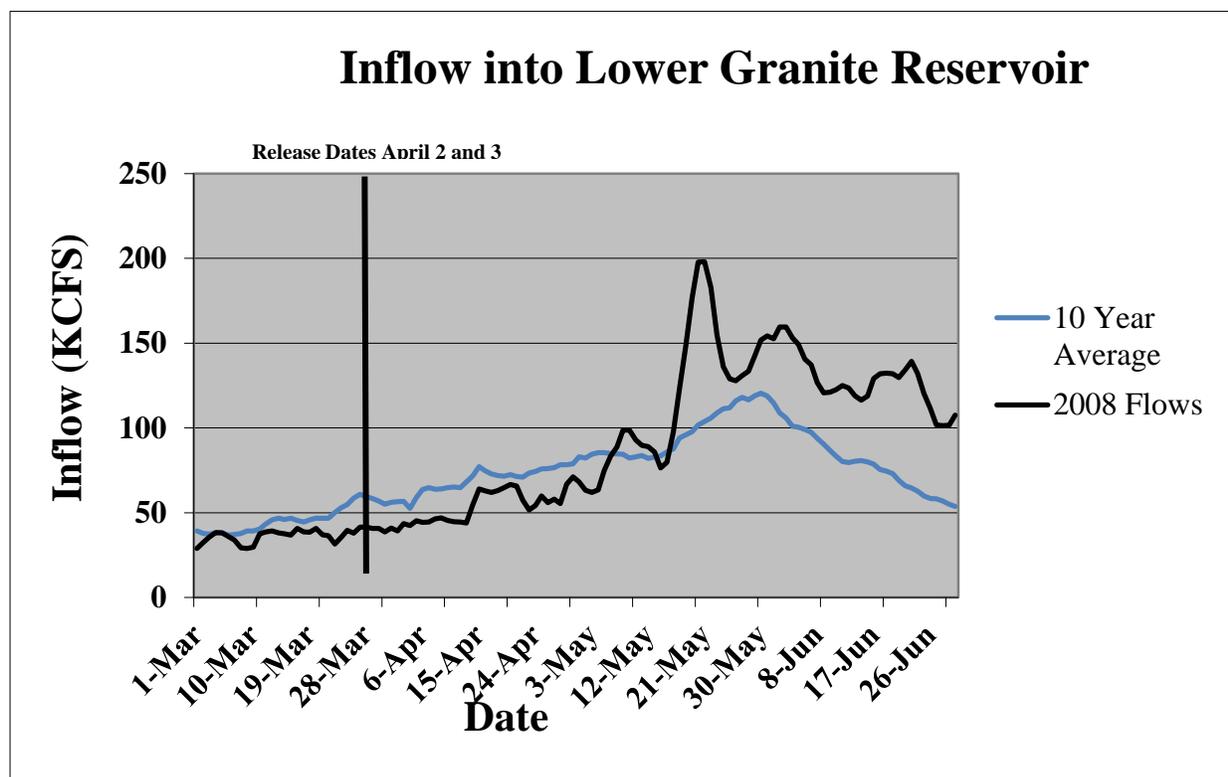


Figure 7. Mean daily inflow to Lower Granite Reservoir from March 1 through June 30, 2008 during spring Chinook salmon emigration after release from Dworshak NFH. The 10 year average is shown for perspective.

Estimated Smolt Survival

Survival probabilities through the Federal Columbia River Power System (FCRPS) were calculated using SURvival under Proportional Hazards 2.1 (SURPH) (Lady *et al.* 2001) (**Table 10**).

Table 10. Cumulative survival estimates of BY06 spring Chinook smolts released from Dworshak NFH as they pass juvenile bypass facilities in the Lower Snake and Columbia rivers.

River Reach	Survival Estimate	Standard Error
Release (NF Clearwater) – Lower Granite Dam	0.743	0.0101
Lower Granite Dam – Little Goose Dam	0.883	0.0187
Little Goose Dam – Lower Monumental Dam	0.880	0.0234
Lower Monumental Dam – Ice Harbor Dam	0.961	0.00325
Ice Harbor – McNary Dam	0.956	0.0375
McNary Dam – John Day Dam	0.909	0.0609
Overall	0.482	0.0293

River reach survival for spring Chinook smolts ranged from 0.74 (SE= 0.0101) to 0.96 (SE= 0.0325). The lowest survival occurred between Dworshak NFH and Lower Granite Dam and the highest survival occurred between Lower Monumental and Ice Harbor dams. Overall survival to Bonneville Dam was 0.48 (SE=0.00293), lower than BY03 through BY05 (**Figure 8**).

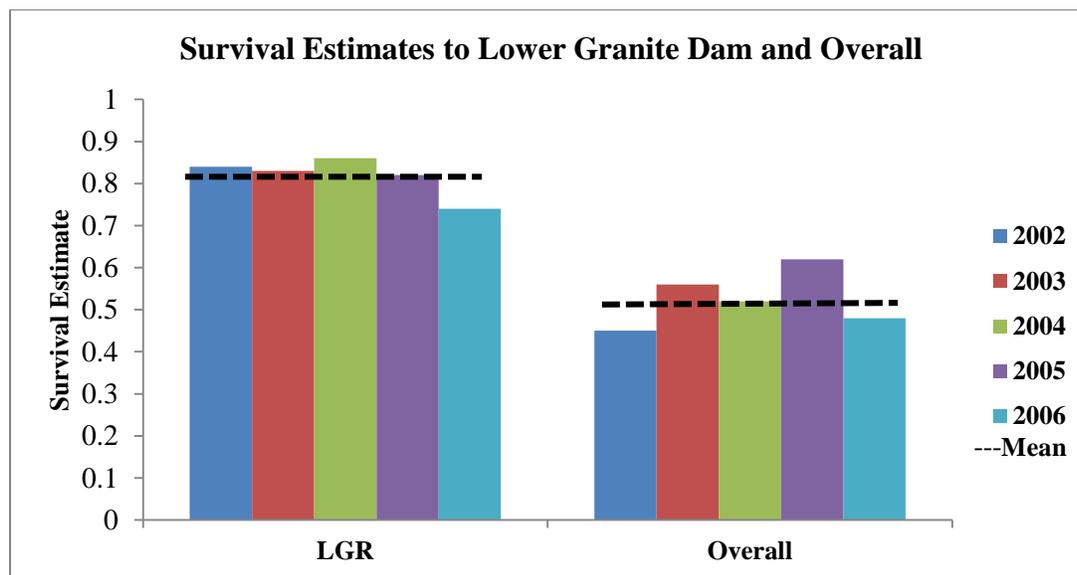


Figure 8. Mean survival estimates to Lower Granite Dam and overall survival estimate through the Federal Columbia River Power System, BY02-BY06.

ADULT RETURNS

Estimating the numbers of Dworshak NFH Chinook salmon that return from the ocean is challenging. BY06 adults, released as smolts in 2008, return as 1-Ocean adults in 2009, 2-Ocean adults in 2010, and 3-Ocean adults in 2011. Adult Chinook salmon that enter the Columbia River are subject to extensive harvest pressure during their upstream migration. Also, those fish that escape to the Clearwater River each year originate from programs at Dworshak NFH, Kooskia NFH, Idaho Department of Fish and Game (IDFG) facilities at Powell, Red River, and Crooked River, and Nez Perce Tribal Hatchery program releases in Lolo Creek, Newsome Creek, and the Selway River.

Estimates of the numbers of adult salmon that are harvested (commercial, sport, and Tribal) or are collected in other fishery programs are based on CWT information. Coded-wire tags are used to help identify Dworshak NFH adult salmon in the mixed stock fisheries of the Columbia, Snake, and Clearwater rivers. The coded-wire tag data is obtained from the Regional Mark Information System maintained by the Pacific States Marine Fisheries Commission. The number of coded-wire tags collected in a sample is first expanded by the sampling rate to provide an estimate of the total number of tags that would have been collected if the sampling rate had been 100%. The total number of adults harvested or collected in various sections of the Columbia and Snake Rivers is then estimated by dividing the total number of tags collected by the tagging rate (Jones *et al.* 2012). Estimates for various fisheries are provided below.

Ocean and Lower Columbia River Below Bonneville Dam

Very few adults are reported harvested in the ocean and the lower Columbia River below Bonneville Dam, although in years when returns are high, some are reported from various Oregon and Washington sport and commercial fisheries. From 2009 to 2011, an estimated 945 Dworshak NFH BY06 adults were harvested below Bonneville Dam, 718 in sport fisheries and 227 in non-tribal commercial net fisheries (**Table 11**).

Columbia River from Bonneville Dam to McNary Dam

The Columbia River from Bonneville Dam to McNary Dam is the section designated for Tribal Treaty commercial, ceremonial, and subsistence harvest, although Oregon and Washington sport harvest occurs there also. From 2009 to 2011, an estimated 1540 Dworshak NFH BY06 adults were reported harvested in Zone 6, 24 in sport fisheries and 1,514 in Tribal fisheries (**Table 11**).

Columbia Above McNary Dam and Snake River Below LGD

Both sport and Tribal harvests occur in this area historically, although Dworshak NFH has contributed very few spring Chinook salmon to these fisheries historically. For 2009, 2010, and 2011, 114 Dworshak NFH Chinook were reported harvested in sport fisheries in these sections (**Table 11**).

Strays in the Columbia River

For purposes of adult return accounting, strays are defined as fish that are collected or harvested in any fishery or are captured at any hatchery rack or tributary weir outside the normal adult migration corridor. Historically, there have been very few strays of Dworshak NFH adults

outside the Clearwater River, although some do occur. Over the years, Dworshak NFH adults have been collected at various hatcheries, fish weirs, fish ladders, or harvested in tributary sport and Tribal fisheries outside the normal migration corridor. From 2009 to 2011, 119 BY06 Dworshak NFH adult strays were collected in the Columbia River (**Table 11**).

Lower Snake River from the Mouth to Lower Granite Dam

Very few Dworshak NFH adults are reportedly harvested from the mouth of the Snake River up to Lower Granite Dam and those that are have historically been caught in sport fisheries reported by Washington. There were no BY06 strays reported in this section from 2009 to 2011 (**Table 11**).

Table 11. Summary of BY 2006 adult Dworshak NFH spring Chinook salmon collected in various fisheries in the Columbia and Lower Snake Rivers.

		Ocean	Below Bonn		Zone 6			Above McNary							
		HARVEST											STRAYS		
Ocean Age	Return Year	Ocean	Zone 1-5 Sport	Zone 1-5 Tribal	Zones 1-5 non-tribal Net	Zone 6 Sport	Zone 6 Tribes	Zone 6 Tribal	Columbia above MCN	Snake Below LGD	Snake above LGD sport	Snake above LGD tribal	Columbia Below MCN	Columbia above Mcn	Snake below LGD
1	2009	0	114	0	0	0	0	0	0	0	0	0	24	24	0
2	2010	0	540	0	227	8	16	1,452	0	81	0	0	8	63	0
3	2011	0	64	0	0	0	0	62	0	32	0	0	0	0	0
Totals		0	718	0	227	8	16	1,514	0	114	0	0	32	87	0

Lower Snake and Clearwater River above Lower Granite Dam

An estimate of fish that returned to the Clearwater River was made based on the Dworshak NFH rack returns, the Nez Perce Tribal subsistence harvests, and the sports harvests that occurred in 2009, 2010, and 2011.

Escapement is composed of those fish that do not return to a project area or weir, or are not captured in the sport or Tribal harvests, and escape to the natural environment where they may attempt to spawn. Assessment of the rack return, sport and Tribal harvest, escapement, and the total return to Lower Granite Dam are provided below.

Rack Return to Dworshak NFH

The total adult return to the hatchery rack was 1,736 fish. The number in each Ocean Age Class is presented in **Table 12**.

Idaho Tribal Fisheries

The Nez Perce Tribal Department of Fisheries Resource Management is responsible for reporting harvest data in the Tribal fishery. Harvest occurs primarily in the North Fork of the Clearwater River near the ladder at Dworshak NFH. Data on the age composition of the harvest is generally not available. For that reason, in years when it is not available from harvest sampling, it is assumed that the age composition of the harvest is similar to the age composition of the rack return to Dworshak NFH. The total estimated Tribal harvest was 1,009 BY06 Dworshak NFH adults and is reported by estimated age class each year in **Table 12**.

Idaho Sport Fisheries

The Idaho Department of Fish and Game (IDFG) is responsible for collecting and reporting information on sport harvest. Estimates of the numbers of adults and jacks harvested in the sport fishery are based on expanded numbers of coded-wire tags collected during sport fish harvest surveys by the IDFG. These tags are expanded by tagging and sample rates, across multiple creel survey river sections (J. Cassinelli, IDFG personal communication). Sport harvest of BY06 spring Chinook salmon occurred in 2009 (1-Ocean fish), in 2010 (2-Ocean fish) and in 2011 (3-Ocean fish). Based on IDFG reports, a total estimated harvest of 2,233 BY06 Dworshak NFH origin adult salmon were taken in the sport harvest. A summary of the number harvested by Ocean Age Class is provided in **Table 12**.

Escapement

Currently, escapement is estimated through a process of elimination. The Idaho FRO and IDFG have recently cooperated in developing a method to use adult PIT tag returns at Lower Granite Dam to estimate the total adult return of Dworshak NFH spring Chinook salmon to Lower Granite Dam using expansion factors (Peery *et al.* 2012). Escapement is estimated by subtracting the rack return and the total harvest from the estimated adult return to Lower Granite Dam. We estimated that the BY06 escapements for the 2009, 2010, and 2011 returns were 280, 2,692, and 546, respectively (**Table 12**).

Minimal Estimate of Adult Return to Lower Granite Dam

Based on the rack return, the estimated sport and Tribal harvests, and partial escapement, the minimum estimated adult return to Lower Granite Dam for BY06 is 8,496 (**Table 12**). The estimated number of adult spring Chinook salmon returning above Lower Granite Dam is calculated by combining the number of adults returning to the hatchery rack with the estimated numbers harvested in Tribal and sport fisheries, and the estimated escapement. For BY06, the estimated minimum total is 8,496 (1,736 rack return, 3,242 harvested, and 3,518 escapement) giving a smolt to adult return rate, for accountable fish, of 0.905 % (Idaho Fishery Resource Office 2012).

Table 12. Summary of adult returns to Dworshak NFH for BY06 spring Chinook salmon in tables 13, 14, and 15 in Idaho Fishery Resource Office (2012).

Return Year	Ocean Age	Rack Return	Sport Harvest	Tribal Harvest	Escapement	Strays ¹	Total
2009	1	726	744	97	280	32	1,847
2010	2	798	1,397	779	2,692	23	5,666
2011	3	212	92	133	546	8	983
Total		1,736	2,233	1,009	3,518	63	8,496

¹ Strays are not included in the total and are reported here only for information purposes.

Strays

Sixty-three BY06 Dworshak NFH adults were identified as strays in the Snake River and its tributaries above Lower Granite Dam. The estimated strays are not included in the above analysis in order to maintain consistency in the reported data between the 2009 Annual Report and this report. Strays are not accounted for in the annual reports because the coded-wire tag data needed for making the estimate is not available at that time.

Fish Health Information on the Rack Return

I-Ocean Adults (2009 Return)

Sixty-one out of 210 (29.05%) adults tested positive for IHNV (Infectious Hematopoietic Necrosis Virus). Ovarian fluid samples were 3 pooled and spleens 5 pooled. Spleen tissue was used for all males sampled for IHNV.

Results positive for IHNV by take:

Take 1: 30/77 ovarians, 5/40 male spleens

Take 2: 21/73 ovarians, 5/20 male spleens

All female adults were tested for BKD (*Renibacterium salmoninarum*) by ELISA

Results:

Not Detected - 350

Low - 45

Medium - 2

High- 1

SCS adults were also positive for the parasite *Ceratomyxa shasta* by examination of wet mounts from scrapes of the walls of the intestines.

II-Ocean Adults (2010 Return)

Six out of 212 (2.8%) adults tested positive for IHNV (Infectious Hematopoietic Necrosis Virus).

Ovarian fluid and spleen samples were 1 pooled (tested individually). Spleen tissue was used for all males sampled for IHNV.

Results positive for IHNV by take:

Take 1: 2/72 ovarians, 0/15 male spleens

Take 2: 0/72 ovarians, 0/15 male spleens

Take 3: 0/8 ovarians, 4/30 male spleens

All female adults were tested for Bacterial Kidney Disease (*Renibacterium salmoninarum*) by ELISA (Enzyme-Linked Immunosorbent Assay)

Results:

Not Detected - 250

Low - 90

Medium - 3

High- 2

SCS adults were also positive for the parasite *Ceratomyxa shasta* by examination of wet mounts from scrapes of the walls of the intestines.

III-Ocean Adults (2011 Return)

Eighty-one out of 472 (17.2%) adults tested positive for IHNV (Infectious Hematopoietic Necrosis Virus).

Ovarian fluid and spleen samples were 1 pooled (tested individually). Spleen tissue was used for all males sampled for IHNV.

Results positive for IHNV by take:

Take 1: 4/43 ovarians, 3/34 male spleens

Take 2: 6/132 ovarians, 14/17 male spleens

Take 3: 5/119 ovarians, 4/9 male spleens

Take 4: 45/118 ovarians

All female adults were tested for Bacterial Kidney Disease (*Renibacterium salmoninarum*) by ELISA (Enzyme-Linked Immunosorbent Assay)

Results:

Not Detected - 189

Low - 205

Medium - 19

High- 4

SCS adults were also positive for the parasite *Ceratomyxa shasta* by examination of wet mounts from scrapes of the walls of the intestines.

SPECIAL STUDIES

Comparative Survival Study

The Dworshak Fishery Complex has been cooperating with the Fish Passage Center in a Comparative Survival Study (CSS) of hatchery PIT-tagged spring Chinook salmon since 1997. This study examines the migration time and survival of hatchery spring Chinook salmon emigrating through the Lower Snake River compared to those that are transported. A pilot study was started in 1997. Dworshak NFH released 49,381 PIT-tagged BY06 spring Chinook salmon smolts in 2008 as part of the CSS. The goal of the project is to evaluate adult returns and determine whether transportation provides any survival advantage over in-river emigration. Results of the CSS can be found at <http://fpc.org>.

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