BROOD YEAR REPORT
DWORSHAK NATIONAL FISH HATCHERY
SPRING CHINOOK SALMON
BROOD YEAR 1995
LIFE CYCLE COMPLETED IN 2000

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BROOD YEAR 1995 OVERVIEW

Life Stage	Number	% Survival
1995 Rack Return	**125**	**-**
Number of Females Spawned	**21**	**-**
Green Eggs Taken	**76,632**	**-**
Average Eggs per Female	**3,750**	**-**
Eyed Eggs	**51,250**	**66.9**
Smolts Released[1]	**53,084**	**84.0**
In-River Smolt Survival[2]	**-**	**41.0**
Adult Returns to the Hatchery[3]	**436**	**0.82[4]**
Adults Harvested in Idaho[5]	**265**	**-**
Known Adult Return to Clearwater River	**701**	**1.32**
Adults Collected at Other Locations[6]	**1**	

[1] Includes the low and high BKD status Kooskia NFH stock that were kept at Dworshak for rearing and release.
[2] Minimum survival to Lower Granite Dam based on PIT tag interrogations.
[3] I-Ocean, II-Ocean, and III-Ocean returns in 1998, 1999, and 2000 to the hatchery rack.
[4] Percent survival from smolt to adult.
[5] Tribal and Sport fisheries combined.
[6] Coded-wire tagged fish recovered at various other hatchery racks, dams, fish traps, etc. down river of Lower Granite Dam.

INTRODUCTION

This report provides data for Brood Year 1995 spring chinook salmon at Dworshak National Fish Hatchery (NFH) which completed its life cycle in 2000. Data on the adults that were spawned to create the brood year, egg production, nursery rearing, juvenile rearing, smolt releases, fish health, smolt out migration, adult contribution to fisheries, and adult returns to the hatchery are summarized. 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 Fishery Complex.

The reporting of production data for Brood Year 1995 spring chinook salmon for Dworshak NFH is complicated because of the adult holding, spawning, incubation, and nursery rearing of the spring chinook salmon from Kooskia NFH. Although the two programs were kept separate as much as possible, the data were not always reported separately for the two stocks and summaries provided in various production and activity reports for brood Year 1995 were for both stocks combined. In those sections where data for the two stocks are combined, it will be pointed out. Otherwise, data is for Dworshak NFH stock..

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 the mitigation goal of 9,135 adults returning to Lower Granite Dam from the ocean (Herrig 1990). Over the years, several changes have been made to the facility and the production program. For Brood Year 1995, the smolt release target was 1,135,000 smolts reared to a size of between 18 to 20 FPP. The reduction in the number of smolts to be released was based on the result of an evaluation of rearing density (Jones and Miller 1996).

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. Adults pass an electronic counter and enter a preliminary adult holding pond 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. The adult holding ponds are about 8,400 cubic feet in volume and can accommodate about 600 adult fish each. Fertilized eggs are incubated in Heath incubation trays. Dworshak NFH has 870 trays. Protocol calls for one female per tray giving the hatchery the

capacity to incubate nearly 3.0 million spring chinook salmon eggs. After hatching, fry are transferred to inside nursery tanks. Dworshak NFH has 64 cement tanks and 64 fiberglass 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. 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. Another bank of 10 raceways (C bank) are located adjacent to the adult holding ponds and are 8' X 63' X 2'. All the raceways are supplied with single pass ambient river water from the North Fork Clearwater River.

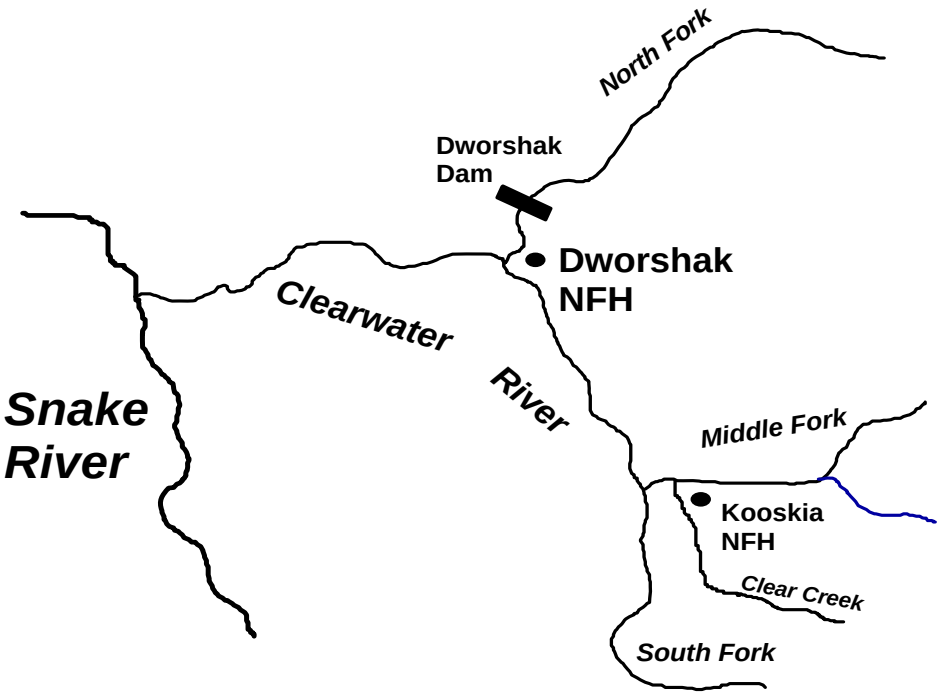

Figure 1. Location of Dworshak National Fish Hatchery (NFH) at the confluence of the North Fork and mainstem Clearwater River, Idaho

1995 ADULT SPRING CHINOOK SALMON RETURN TO DWORSHAK NFH

Pre-Season Assessment

The Idaho FRO uses a regression equation based on the I-Ocean (Jack) returns in the previous year to forecast or predict the return of II-Ocean adults the following year. In 1994, the I-Ocean return to Dworshak NFH was very low, only 3 fish, indicating that the II-Ocean return in 1995 would also be low. The prediction for adult returns to Dworshak NFH for the 1995 season was 74 total. The breakdown by age class for the predicted return is given below in **Table 1** (Idaho FRO 1994).

Table 1. Pre-season prediction of adult returns to Dworshak NFH by ocean age (Idaho FRO 1994).

Ocean Age	1995 Prediction
I - Ocean	19
II - Ocean	40
III - Ocean	15
Total	**74**

Total Rack Return

The 1995 adult spring chinook salmon return to Dworshak NFH was 125 adults the third lowest on record and only slightly higher than the pre-season prediction of 74 made in 1994 (**Table 2**). The II- and III- ocean returns were actually lower than predicted while the I-ocean component was significantly higher than predicted.

Table 2. Actual rack return of adult returns to Dworshak NFH by ocean age (Idaho FRO 1995).

Ocean Age	Smolts Released	1995 Rack Return
I - Ocean	1,278, 273 (1994)	83
II - Ocean	467,222 (1993)	36
III - Ocean	959,369 (1992)	6
Total		**125**

Run Timing

The hatchery ladder was opened on May 19 and was closed on September 25, 1995. Records are not available to document the day the first and last fish entered the hatchery. The first inventory was taken on June 22. Inventories were taken weekly thereafter until the end of the season. Between May 19 and July 13, 113 or over 90% of the run entered the hatchery. The number of spring chinook salmon entering the hatchery each week is summarized in **Figure 2**.

Figure 2. Number of adult spring chinook salmon entering the adult holding pond weekly at Dworshak NFH in 1995.

Age Composition of Return

Age composition of spring chinook salmon returning to the hatchery was based on fork length categories. These length categories were derived from known age/length/sex data from CWT recovery databases. Ocean age categories are listed below:

I - Ocean (Jacks) $\leq$ 56 cm
II - Ocean = 57 to 81 cm
III - Ocean > 81 cm.

Adult spring chinook salmon that return to Dworshak NFH are predominately II-Ocean fish, those that spend two years in salt water before returning to freshwater to spawn. The mean percent returns in the rack for I-Ocean, II-Ocean, and III-Ocean are 6.9%, 64.9%, and 27.5%, respectively, for all years from 1984 to 1994 (**Table 3**). The return in 1995 was extremely atypical, 66% I-Ocean, 29% II-Ocean, and 5% III-Ocean (**Table 3**). Adult females were injected with Erythromycin on July 31, 1995 to protect eggs from vertical transmission of *R. salmoninarum*. All adults were treated with formalin prior to spawning to reduce parasites and fungus (see FISH HEALTH section for details).

Table 3. Number and percent of adult spring chinook salmon that returned to Dworshak NFH since 1984, by ocean age (Idaho FRO 1995).

Year	I-Ocean		II-Ocean		III-Ocean		Total Return	Age Not Known[1]
1984	14	17.07%	52	63.41%	16	19.51%	82	0
1985	13	3.89%	281	84.13%	35	10.48%	334	5
1986	78	15.15%	346	67.18%	91	17.67%	515	0
1987	25	1.24%	1604	79.52%	376	18.64%	2017	12
1988	163	8.27%	569	28.85%	1240	62.88%	1972	0
1989	156	9.18%	1322	77.76%	221	13.00%	1700	1
1990	7	0.34%	1892	93.02%	135	6.64%	2034	8
1991	16	9.70%	77	46.67%	72	43.64%	165	0
1992	22	5.96%	286	77.51%	40	10.84%	369	21
1993	9	1.09%	452	54.92%	359	43.62%	823	3
1994	3	4.05%	30	40.54%	41	55.41%	74	0
Mean		6.90%		64.90%		27.50%		
1995	**83**	**66.40%**	**36**	**28.80%**	**6**	**4.80%**	**125**	**0**

[1] Unmeasured fish are those that escaped out of the preliminary adult holding pond without being inventoried prior to spawning.

Adult Tagging

About 99 adult spring chinook salmon were tagged with numbered opercal tags as they were inventoried. This is the third year of evaluating different types of tags in an attempt to develop a method allowing rapid and easy identification of individual fish after they have been initially inventoried upon entering the hatchery. See the **Special Studies Section** for details.

Adult Mortality

Adult mortality is reported for two separate periods: pre-spawning (holding mortality) and mortality during spawning.

Pre-Spawning Mortality - From May 19 to August 28, a total of 8 adult spring chinook salmon (6.4%) died: 3 females and 5 males.

Mortality During Spawning - From August 29 through September 25, an additional 34 adults died, 33 males and 1 female. Of the 33 males, 25 were jacks.

Spawning

Spawning was started on August 28. Six egg takes were made with the last ripe females spawned on September19. Twenty-three males and 21 females were spawned. Every female was sampled to determine the level of infection by *Renibacterium salmoninarum* (see Fish Health section for details). A summary of spawning is presented in **Table 4**.

Table 4. Number of male and female spring chinook salmon spawned during each egg take for Brood Year 1995 at Dworshak NFH (BY95 Data Files).

Take Date	Males Spawned	Females Spawned	Green Eggs Taken[1]
8/22/95	1	1	3,750
8/25/95	3	3	11,250
9/05/95	10	8	30,000
9/08/95	4	2	7,500
9/12/95	4	6	22,500
9/19/95	1	1	3,750
Total	**23**	**21**	**78,750**

[1] Estimated an average of 3,750 eggs/female.

EGG PRODUCTION

Green Eggs Taken

Green eggs were not counted. However, the total number of green eggs taken was estimated at 78,750 by using an average of 3,750 eggs per female (**Table 4**).

Incubation

The first four egg takes were incubated on chilled water to slow development so that eye-up would occur at relatively the same time for all seven takes. The eggs were incubated on chilled water ranging in temperature from 43.5 to 48.2 °F. 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 Enzyme-Linked Immunosorbant Assay (ELISA) tests (see FISH HEALTH section for detail).

Percent Eggs Eyed

Eye-up was completed by October 24, 1995. Eggs were shocked, dead eggs were removed and eggs were enumerated by a mechanized egg picker. The actual total number of eggs taken during spawning was 76,632. Eye-up was 66.9% successful resulting in 51,250 eggs (Dworshak NFH 1995). Of these, 40,750 eggs were from females that tested low for BKD (see FISH HEALTH for details of testing results) and were transferred to Kooskia NFH for final incubation and early rearing. At Kooskia NFH, eggs were placed into Heath trays and incubated at 38 °F (Kooskia NFH 1996).

The remaining 10,500 eggs from females that tested medium and high for BKD were kept at Dworshak NFH for incubation and rearing. In addition, 12,000 eyed eggs from Kooskia NFH stock were also kept at Dworshak NFH because they were from females that tested either medium or high for BKD. In keeping with the fish health policy at that time, only eggs from females testing negative or low were allowed to be reared at Kooskia NFH. Thus, the total number of eggs retained at Dworshak NFH was 22,500. These eggs were placed back into incubator trays at 5,000 eggs per tray with a flow of 5 to 6 gallons per minute through each stack. Eggs were disinfected for 10 minutes in a buffered 100 mg/L iodine solution prior to being transferred. Incubating eggs were given a 15 minute 1,667 mg/l formalin treatment three times weekly (Dworshak NFH 1995).

NURSERY REARING

Data are summarized in the 1995 and 1996 Annual Reports for Dworshak NFH and the 1996 Annual Report for Kooskia NFH..

Tanking

Dworshak NFH - Hatching occurred in December and January of 1996. The Fish Health Center transferred about 4,750 fry to their facilities for BKD studies (see SPECIAL STUDIES section for details) and the remaining fry (about 17,400) were transferred into two tanks in the nursery, segregated according BKD level (Dworshak and Kooskia stocks were mixed). Fry from those females that tested medium were placed into tank 716 and those that tested high for BKD were put into tank 816 (Dworshak NFH 1996).

Kooskia NFH - Because the eggs transferred to Kooskia NFH were kept on chilled water, moving fry into the nursery at Kooskia did not take place until April 3-8. Several days prior to being moved to the nursery, water temperature was gradually raised from 38 to 50 °F to acclimate the fry for nursery rearing (Kooskia NFH 1996).

Growth and Mortality

Growth and mortality for fry during nursery rearing at Dworshak NFH is summarized in **Table 5.** Growth and mortality data for the Dworshak stock reared at Kooskia NFH is summarized in **Table 6**.

Table 5. Summary of monthly growth and mortality of Brood Year 1995 spring chinook salmon during nursery rearing at Dworshak NFH.

Date (End of Month)	Number	Weight (lbs)	FPP	Mean Length (in.)	Mean Growth (in.)	Mortality (%)	Mean Water Temp (°F)
1/96	17,403	16	1,088	1.4	-	0.55	40.8
2/96	16,486	20	824	1.6	0.2	5.27	37.7
3/96	16,091	22	731	1.7	0.1	2.00	39.0
4/96	15,920	45	354	2.1	0.4	1.00	42.6

Table 6. Summary of monthly growth and mortality of Brood Year 1995 spring chinook salmon

during nursery rearing at Kooskia NFH.

Date (End of Month)	Number	Weight (lbs)	FPP	Mean Length (in.)	Mean Growth (in.)
4/96	38,692	90	429	1.9	-
5/96	38,761	173	223	2.5	0.6
6/96	35,596	315	122	3.0	0.5
7/96	37,514[1]	483	78	3.5	0.5

[1] Actual number based on a complete inventory during fin-clipping and coded-wire tagging.

JUVENILE REARING

Ponding

Dworshak NFH - A total of 19,225 (estimated based on pound counts) spring chinook salmon were transferred from the nursery to outside raceways at Dworshak NFH on May 21, 1996. These fish averaged 179.0 fish per pound (fpp) and 67 mm (2.6 inches) total length at the time of transfer.

Kooskia NFH - For the Dworshak spring chinook that were being reared at Kooskia NFH, transfer from nursery tanks to outside rearing facilities was completed in July. Fingerlings were coded-wired tagged as they were moved outside and placed on the same chilled well water as the circular tanks inside (Kooskia NFH 1996).

Growth and Mortality

Dworshak NFH - Growth varied from month to month, with July through October (1996) growth averaging over 0.4 in., while growth from November through March (1997) averaged below that (**Table 7**). By June 1996, chinook were larger than planned in order to meet the targeted size at release of between 18-20 fish per pound. In order to slow growth, the chinook were put on a modified feeding schedule of five days on feed and two days off. Cold water releases from Dworshak Reservoir into the North Fork also aided in slowing growth. On September 21 chinook were returned to a regular feeding schedule of seven days a week. During October, routine exams conducted by the Fish Health Center revealed that most fish had very little pyloric caeca fat. The production staff prepared a brief for the Hatchery Evaluation Team which met several times to consider whether any action should be taken. Concern was expressed that the lack of fat may affect downstream survival after release because of little or no energy reserves. The Team recommended to the Managers that rations be increased (See letter in FRO Brood year file - Rearing Data). During outside rearing, erythromycin was administered prophylactically to reduce BKD (see the Fish Health section for details).

Table 7. Summary of monthly growth and mortality of Brood Year 1995 spring chinook salmon (medium and high BKD status) during outside raceway rearing at Dworshak NFH .

Date (End of Month)	Number	Weight (lbs)	FPP	Mean Length (in.)	Mean Growth (in.)	Mortality (%)	Mean Water Temp (°F)
6/96	19,211[1]	259	74.2	3.55	-	-	49.8
7/96	16,153[2]	321	50.3	4.04	0.49	-	52.0
8/96	16,133	448	36.0	4.52	0.48	0.12	49.5
9/96	16,116	684	24.0	4.95	0.47	0.11	55.0
10/96	16,096	1,383	12.0	6.59	1.64	0.12	53.6
11/96	16,069	1,496	10.7	6.77	0.18	0.17	48.4
12/96	16,063	1,625	9.9	6.96	0.19	0.01	44.1
1/97	16,017	1,639	9.8	6.97	0.31	0.29	41.1
2/97	15,948	1,644	9.7	6.96	-0.01	0.43	39.5
3/97	15,883	1,910	8.3	7.33	0.37	0.41	39.5
4/97	15,872	1,941	8.2	7.78	0.45	0.07	-

[1] The difference in numbers between the end of nursery rearing and the beginning of outside rearing is due to inventory procedures.
[2] Actual adjusted number based on coded-wire tagging results.

Kooskia NFH - Growth and mortality data for Dworshak NFH spring chinook being reared at Kooskia NFH are not available. However, by the end of September 1996, there were 37,486 fish at 25.7 fish per pound, 1,460 lbs total. The fish were transferred back to Dworshak NFH at the end of January 1997 for final rearing and release in April. Data on growth and mortality from January to April 1997 is summarized in **Table 8.**

Table 8. Summary of monthly growth and mortality of Brood Year 1995 spring chinook salmon (low BKD status) during outside raceway rearing at Dworshak NFH .

Date				Mean	Mean	Mortality	Mean

(End of Month)	Number	Weight (lbs)	FPP	Length (in.)	Growth (in.)	(%)	Water Temp (°F)
1/97	37,331	1,668	22.4	5.3	-	-	41.1
2/97	37,225	1,891	19.7	5.5	0.20	0.28	39.5
3/97	37,219	2,191	17.0	5.8	0.30	0.02	39.5
4/97	37,212	2,237	16.6	5.8	0.00	0.02	-

Marking and Tagging

Coded-Wire Tags - The Dworshak stock spring chinook was divided between Dworshak and Kooskia NFHs at the time of marking and tagging. Those at Dworshak NFH were processed July 15 while those at Kooskia were processed July 10-12. A total of 53,759 spring chinook salmon were processed. **Table 9** lists the numbers of fish marked by tag code and the final numbers released. On March 18, 1997, coded-wire tag retention was checked and observed to be 98.9 % (Dworshak 1997)

PIT tags - A total of 14,080 Brood Year 1995 spring chinook were PIT tagged on February 5, 6, 12, and 13, 1997 to monitor travel time and estimate survival to Lower Granite Dam after release. Only spring chinook with a low BKD status were tagged and all PIT tagging was conducted at Dworshak NFH.

Table 9. Numbers of BY95 Dworshak spring chinook salmon that were ad clipped and coded-wire tagged and the final numbers released, by tag code (from IFRO data base records).

Tag Code	Marked		Released	
	Number	Size (#/lb)	Number	Size (#/lb)
05-30-08[1]	34,424	110	33,763	16.6
05-42-13[1]	3,137	110	3,076	16.6
05-29-62	16,198	75	15,656	8.1
Total	53,759		52,495	

[1] Early rearing and marking occured at Kooskia NFH but transferred back to Dworshak NFH for release.

SMOLT RELEASES

The general production release for Brood Year 1995 spring chinook smolts at Dworshak NFH

occurred on April 7, 1997. The total release from Dworshak NFH was 53,084 smolts (Dworshak NFH 1997). A summary of release dates and numbers is provided in **Table 10**.

Table 10. Summary of spring chinook smolt release information for Brood Year 1995 at Dworshak NFH in 1997 (source: MIS final releases, May 1997).

Date	Group	Number	Mean Size (FPP)
April 7	Low BKD Status	37,212	16.3
April 7	Medium BKD Status	7,253	9.5
April 7	High BKD Status	7,100	8.4
April 11	High BKD Status	1,519	4.7
	Total	53,084	12.7

FISH HEALTH

Adult Injections with Erythromycin (INAD 6430)

Using procedures in accordance with the Investigational New Animal Drug (INAD) 6430, adult females were inoculated with Gallimycin about 4 weeks prior to the start of spawning. Fish were injected in the intra-peritoneal cavity with 20 mg/kg of body weight. This was the last year for the INAD. Subsequent use of erythromycin will be administered under veterinary prescription (Dworshak FHC 1995).

Adult Formalin Treatments (INAD 9013)

The use of formalin to reduce pre-spawning mortality of spring chinook salmon from fungal infections was evaluated in a clinical field trial at Dworshak NFH for BY95 spring chinook salmon adults. Adult chinook being held in holding pond 1 were treated with formalin to control external fungus and reduce pre-spawning mortality. Beginning on June 5, fish were treated three to five times a week with a flow-through bath of 167 mg/L formalin for 60 minutes. During treatment flow in the holding pond was reduced to 500 gpm. Ten gallons of formalin were added to "charge" the system to 167 mg/L and five gallons of formalin were dripped into the pond at 315 ml/min for a 60 minute treatment duration. Treatments ended August 20, 1995. The formalin treatments appeared to be efficacious in the control of fungus during pre-spawn holding. See the 1995 Annual Report for details (Dworshak FHCr 1995).

Adult Disease Testing

During spawning, all the adult males and females were sampled to test for infection with

Renibacterium salmoninarum, the causative agent of BKD using ELISA. Eggs from females were segregated based on the level of infection (**Table 11.**) The results are presented in **Table 12**.

Table 11. Categories of infection with *R. salmoninarum* for spring chinook salmon as determined by ELISA.

Level of Infection	Optical Density Units (ELISA)
Negative	0.000 - 0.099
Low	0.100 - 0.249
Medium	0.250 - 0.449
High	0.450 and above

Table 12. Number of Dworshak NFH BY95 spring chinook salmon sampled and tested for *R. salmoninarum* by the ELISA (Dworshak FHC 1995).

Sex	Sample Size	*R. salmoninarum* Infection Level (percent affect)			
		Not Detected	Low	Medium	High
Male	29	44.8	27.6	10.3	17.2
Female	23	30.4	43.5	13.0	8.7

At spawning, all samples taken were assayed for *Aeromonas salmonicida*, *Myxobolus cerebralis*, and *Yersinia ruckeri*. Viral assays (IHNV, IPNV, and VHSV) were run on kidney samples as well as ovarian fluid. Samples were negative for the previously mentioned bacteria and virus. Over 53% of the adults examined were positive for the parasite *Ceratomyxa shasta*.

Monthly Disease Sampling

No pathogens were isolated during monthly monitoring. It should noted that the fish that were the progeny of high ELISA females showed no signs of clinical BKD during rearing in the

hatchery.

Erythromycin treatments

This Brood Year was fed erythromycin for 21 days in February-March 1997.

Smolt Assessments

A total of 90 fish were sampled for pre release assessment. Samples were split between four raceways, targeting the general population, not moribund fish. Exams included checking for *Myxobolus cerebralis*. ELISA values resulted in the following: Not detected - 36, low - 46, medium - 5, and high - 3. No other pathogens (bacterial, viral, or parasitic) were isolated prior to release.

SMOLT EMIGRATION

The performance of spring chinook salmon smolts is monitored and evaluated PIT tags after they are released from the hatchery. The tags are interrogated at Lower Granite, Little Goose, and Lower Monumental dams on the Lower Snake River and at McNary Dam on the lower Columbia River (**Figure 3**). PIT tags provide information on travel time and survival during emigration. One group of PIT-tagged fish were released in 1997 as part of a study to evaluate the effects of transportation on survival. The goal of the project is to evaluate adult returns and determine whether transportation affords a survival advantage during spring emigration to the ocean. (See **Special Studies Section** for details)

Travel Time

Mean travel time from Dworshak NFH to Lower Granite Dam varied considerably. Travel time ranged from 3 to 136 days to Lower Granite Dam with a mean of 31 days. The number of days for 25, 50, and 90 percent of the run to reach Lower Granite Dam were 21, 32, and 41 days respectively. The longest travel time to Lower Granite Dam was 136 days. Five fish had travel times over 100 days to Lower Granite Dam.

River Flow

Flows in the Lower Snake River were very high during the smolt emigration period of April, May, and June (**Figure 4**). Inflow into Lower Granite Reservoir was less than 100,000 cubic feet per second (cfs) at the time of the releases. However, flows increased quite sharply by mid-April to over 150,000 cfs. Daily mean flows increased to over 200,000 cfs during mid-May and did not return to near 100,000 cfs until the end of June. Flows during 1997 were one of the highest flow years on record since 1980 (**Figure 4**).

Estimated Smolt Survival

A minimum estimate of smolt survival to Lower Granite Dam is calculated by summing the cumulative number of unique PIT-tag interrogations at Lower Granite, Little Goose, Lower Monumental, and McNary dams. The rate of estimated survival for PIT-tagged Brood Year 1995 spring chinook salmon was 41.0 %. (**Table 13**).

Table 13. Number of unique interrogations of PIT-tagged spring chinook salmon released from Dworshak NFH as part of the transportation study and interrogated at downstream dams in1997 (BY95).

Pond	Number of Tags Released	Number of Unique Interrogations					Percent
		Lower Granite Dam	Little Goose Dam	Lower Monumental Dam	McNary Dam	Total	
A10	14,080	2,393	2,173	1,001	210	5,777	41.0

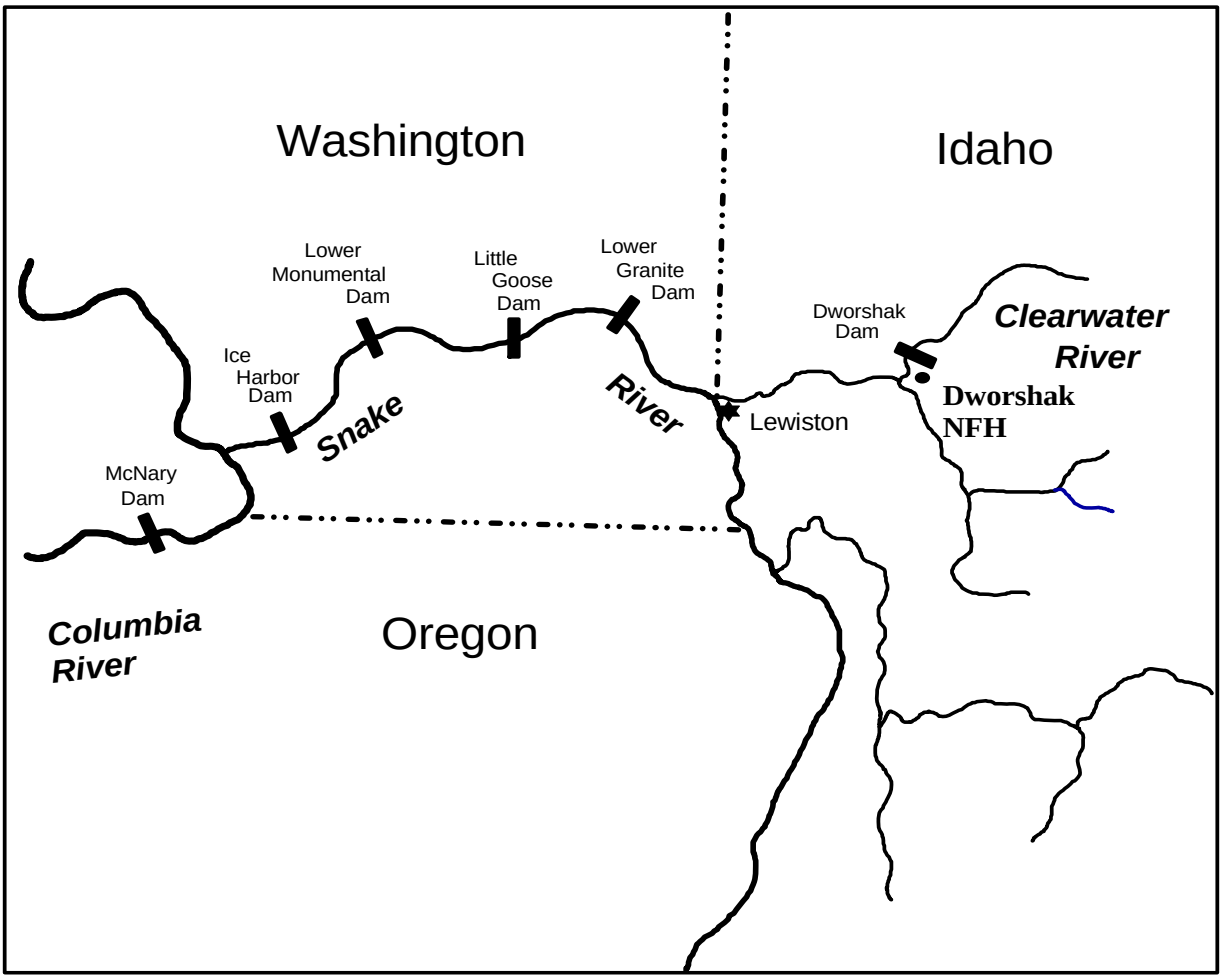

Figure 3. Dams on the lower Snake and Columbia rivers where PIT-tag interrogation facilities are located for monitoring smolt emigration.

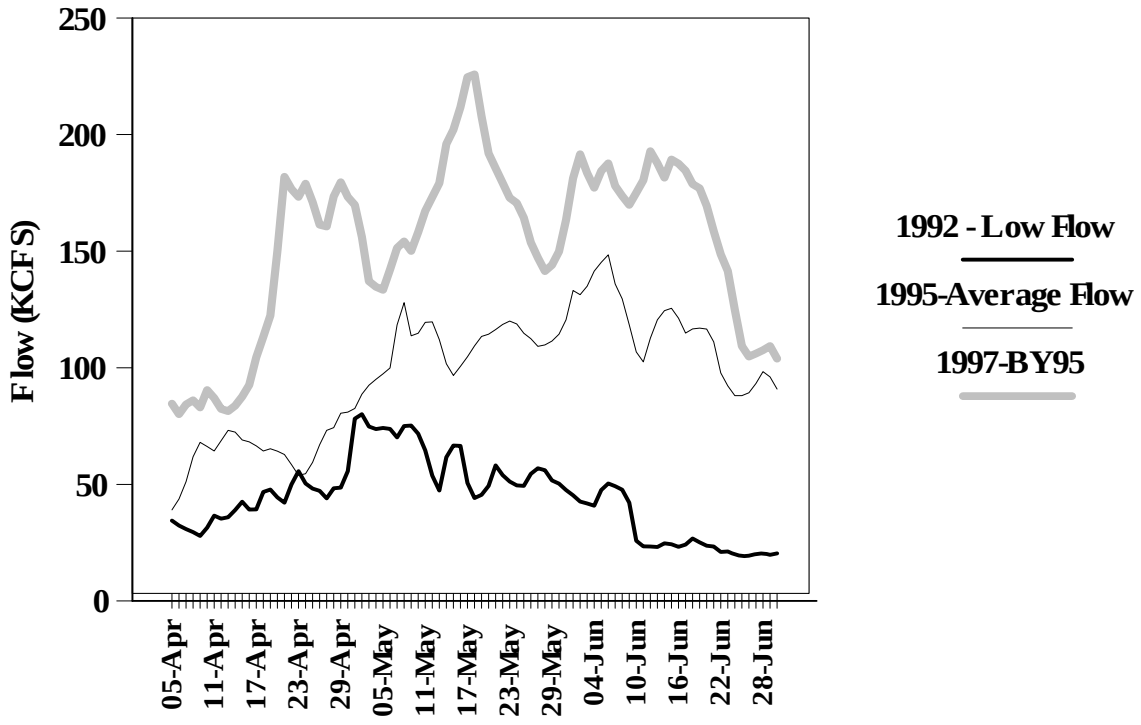

Figure 4. Mean daily inflow to Lower Granite Reservoir from April through June, 1997 during spring chinook salmon emigration after release from Dworshak NFH. The years 1992 (low flows) and 1995 (average flows) are included for perspective.

ADULT RETURNS

Rack Return to Dworshak NFH

Brood Year 1995 spring chinook salmon smolts released in 1997 returned as adults in 1998 (I-Ocean), 1999 (II-Ocean), and 2000 (III-Ocean). The total adult return to the hatchery rack was 436 fish and is summarized in **Table 14**.

Table 14. Summary of adult returns to Dworshak NFH for Brood Year 1995 spring chinook salmon (IFRO 2000). A total of 53,078 smolts were released from Dworshak NFH in 1997.

Return Year	Ocean Age	Number of Returns	Smolt to Adult Return Rate (%)
1998	I	14	0.0264
1999	II	78	0.1470
2000	III	344	0.6481
	Total Return	**436**	**0.8214**

Harvest

The spring chinook salmon production program at Dworshak NFH is designed to provide opportunities for harvest that were lost after the construction of four dams on the lower Snake River downstream from Lewiston, Idaho. Harvest of BY95 spring chinook salmon would have occurred in 1998 (I-Ocean fish), in 1999 (II-Ocean fish) and in 2000 (III-Ocean fish). Harvest in tribal and sport fisheries for those three return years is reported below.

Idaho Tribal Fisheries - The Nez Perce Tribe reported harvesting 182 spring chinook in 1998. Based on age composition of the run in that year and applying it to the harvest, that would mean that the tribe harvested 2 I-Ocean fish. In 1999, the Tribe reported harvesting 93 spring chinook, 22 of which were estimated to be II-Ocean fish. In 2000, the reported harvest was 1,173, of which 38 were estimated to be III-Ocean fish. Therefore, the total Tribal harvest of BY95 spring chinook salmon is estimated to be 62 fish (2 I-Ocean, 22 II-Ocean, and 38 III-Ocean).

Idaho Sport Fisheries - Sport fishing occurred in 1997 and 2000. Returns were too low in 1998 to open a sport harvest season. The Idaho Department of Fish and Game reported a total estimated harvest of 99 adult salmon in 1998, one of which was estimated to be a I-Ocean fish. The total estimated sport harvest in 2000 was 3,908, 202 of which were estimated to be III-Ocean fish for a total sport harvest of 203 BY95 spring chinook salmon of Dworshak NFH origin.

Estimated Minimum Total Adult Return Above Lower Granite Dam

The estimated minimum total number of adults 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. For BY95, the estimated minimum total is 701 (436 rack return and 265 harvested) giving a smolt to adult return rate of 1.3206%. While the actual return is far below the mitigation goal of 9,135 adults to Lower Granite Dam, the smolt to adult return

rate is one of the highest on record.

Other Adult Recoveries

Spring chinook salmon from Dworshak NFH have been recovered from a number of locations throughout the Columbia and Snake rivers. The only way to positively identify these fish is by recovering coded-wire tags. In some cases, coded-wire tag recoveries are expanded to estimate totals, but only actual recoveries are reported here. The data was obtained from the Pacific States Marine Fisheries Commission's (PSMFC) Regional Mark Information System. Thus, data reported here is up to date as of April 2001. For Brood Year 1995 spring chinook released from Dworshak NFH as smolts in 1997, only one coded-wire tagged adult was recovered outside the basin. It was a II-Ocean adult collected in 1998 at Entiat NFH. There have been no recoveries reported from tribal fisheries in Zone 6. No other adults were reported being recovered from various state or federal hatcheries in the Columbia and Snake rivers.

SPECIAL STUDIES

Adult Tagging

About 99 adult spring chinook salmon were marked during initial inventory with small plastic tags that were attached to the operculum using two stainless steel staples. Initially, this tag performed well, but tag loss increased as the spawning season progressed. The primary reason for the tag loss was due to the rigidity (i.e., stiffness) of the plastic tags. Fish handling and processing at Dworshak NFH is very mechanical and tags were easily snagged and ripped off during the crowding and handling operations. A contributing factor to the tag loss was the flattening (crimping) of the staples with pliers. Staples were crimped to reduce potential gill filament erosion, but this action inadvertently weakened the operculum bone and contributed to the tag loss. Although tag loss was unacceptable, we were hesitant to abandon this type of tag because it was easy to apply, very visible, and caused minor damage to the gill filaments. This was the third year in a four year study. Results of the study can be found in Jones and Rhine (1977).

BKD Studies

Of the 10,500 medium/high BKD status eggs that were kept at Dworshak NFH for hatching and rearing, 4,750 of the fry that hatched were transferred to the Idaho Fish Health Center for a special BKD study. Eggs samples from females testing high and medium using ELISA were transferred to the University of Idaho to determine if Erythromycin was present in the egg. Erythromycin was present in the vitelline of 7 of the 8 females at levels high enough to assure good protection from the pathogen. The vitelline from one female did not contain detectable levels of antibiotic. It is likely that the fish entered the hatchery after July 31 and was not injected with erythromycin. This female's eggs were culled. We did not believe it necessary to cull the eggs of the remaining 7 females with erythromycin levels above the minimum inhibitory concentration. This was a good opportunity to further evaluate the risk assessment procedures

and the efficacy of injecting broodstock. Erythromycin remains stable in the vitelline of eggs during incubation and depletion seems to begin when the yolk is absorbed during early development. Monitoring and pre-release testing did not indicate any difference in clinical or sub-clinical BKD levels in any of the groups.

Comparative Survival Study

The Dworshak Fishery Complex has been cooperating with the Fish Passage Center in a Comparative Survival Rate Study of hatchery PIT-tagged spring chinook salmon since 1997 to examine 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 contributed 14,080 spring chinook salmon smolts that year for marking with PIT tags. Since then, the Complex has provided about 45,000 spring chinook salmon to the program for PIT tagging each year from 1998 to 2000. The goal of the project is to evaluate adult returns and determine whether transportation affords a survival advantage during spring emigration to the ocean.

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APPENDIX I

ADULT SPRING CHINOOK SALMON RETURNS TO DWORSHAK-KOOSKIA NFH COMPLEX IN 1995 AND PROGNOSIS FOR 1996

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Introduction

Dworshak NFH is part of the Dworshak Fishery Complex located at the confluence of the North Fork and the main-stem of the Clearwater River near Ahsahka, Idaho. Construction of the hatchery was included in the authorization for Dworshak Dam and Reservoir (Public Law 87-847, October 23, 1962) to mitigate for losses of anadromous steelhead (*Oncorhynchus mykiss*) caused by the dam and reservoir.

The hatchery was designed and constructed by the U.S. Army Corps of Engineers (COE) and has been administered and operated by the U.S. Fish and Wildlife Service since 1969. Additional construction was completed in 1982 under the Lower Snake River Compensation Plan to provide rearing facilities for spring chinook salmon (*O. tshawytscha*). A total of 30 8-foot by 80-foot raceways were constructed. In 1986, 12 8-foot by 75-foot raceways were converted from rainbow trout rearing to chinook salmon rearing (In 1993, two of these raceways were converted to an adult holding pond).

Dworshak NFH formed a "Complex" with Kooskia NFH on April 9, 1978. All administrative responsibilities and operations for both hatcheries were assigned to the Manager at Dworshak NFH. In 1995, both hatcheries, the Dworshak Fish Health Center, and the Idaho Fishery Resource Office were combined to form the Dworshak Fishery Complex. Kooskia NFH is located about 1.5 miles southeast of Kooskia, Idaho, near the confluence of Clear Creek and Middle Fork of the Clearwater River. Because of production constraints, disease considerations, and other factors, Dworshak NFH has held and spawned spring chinook salmon adults returning to Kooskia NFH, as well as incubated eggs and reared juveniles. With the inception of the Lower Snake River Compensation Plan (LSRCP) program for spring chinook salmon at Dworshak NFH, transfers between hatcheries have occurred frequently and for several years, the programs were combined. Presently, the programs are separate and adults and offspring are being handled separately.

This report includes a summary of the 1995 adult returns of spring chinook salmon to Dworshak and Kooskia NFHs and predictions for the 1996 adult returns.

Since a low return was predicted in 1995 for Clearwater River spring chinook salmon, a sport fishery season was not opened and the Nez Perce Tribe did not open a subsistence season.

Stock Description

The initial Dworshak NFH spring chinook program utilized eggs and fish from several different hatcheries for release years 1983-1986 (Table 1). Eggs were obtained primarily from Leavenworth and Little White Salmon National Fish Hatcheries, although a small percentage of stock was obtained from Rapid River State Fish Hatchery in 1983. Stocks at both Leavenworth and Little White Salmon NFHs have been strongly influenced by transfers from Carson National Fish Hatchery. The spring chinook stock at Carson NFH was originally started from adults

that were taken from the ladder at Bonneville Dam on the lower Columbia River. Thus, stock used at Dworshak NFH during those early years is referred to as a lower Columbia River or Carson type stock.

In 1987 and 1988, the program at Dworshak NFH shifted completely away from the Carson type stock and released smolts that were reared from eggs transferred from Rapid River State Fish Hatchery in 1985 and 1986. The Rapid River stock was originally obtained from adults that were trapped in the Snake River near Hell's Canyon Dam. The eggs taken from adults that returned to Dworshak NFH in 1985 and 1986 (the last adult returns of Carson stock) were transferred to Kooskia NFH. The recent returns to Dworshak NFH (1989 and later) are progeny of adult returns to Dworshak NFH and are derivatives of Rapid River stock. Eggs were again transfered to Dworshak from Rapid River in 1992. Thus, the stock at Dworshak NFH is a Rapid River type stock, although it is referred to as Dworshak stock.

Table 1. Genetic make-up of Dworshak NFH spring chinook salmon smolts directly released from the hatchery.

Release Year	Genetic Make-up*	% Rack Return
1983	75.1% LW	0.0741
	12.3% RR	
	12.6% LE	
1984	100% LE	0.2831
1985	67.8% LW	0.2570
	32.2% LE	
1986	100% LE	0.1610
1987	100% RR	0.0981
1988	100% RR	0.1898
1989	100% DW	0.0077
1990	100% DW	0.0528
1991	100% DW	0.0471
1992	100% DW	0.0047

RR - Rapid River
LW - Little White Salmon
LE - Leavenworth
DW - Dworshak

Kooskia NFH has had a very wide variety of stocks contribute to the spring chinook salmon program over the years. Releases during the early years of 1971 through 1975 were primarily made up of Rapid River stock and Carson stock from Carson NFH. In 1976, releases were made up of stock from the South Satiam hatchery in Oregon. After 1977, releases almost always contained progeny of adults that had actually returned to Kooskia NFH although up to 1982 Carson NFH continued to made significant contributions to the program. In some years, stock was contributed from Little White Salmon and Leavenworth NFHs, but even these hatcheries are considered to be Carson derivatives. Releases in 1987 and 1988 were in part from eggs transfered to Kooskia from Dworshak NFH. However, even the eggs from Dworshak were from adults of Carson heritage. The mix of Kooskia and Dworshak stocks that were released in 1987 and 1988 was referred to as Clearwater stock (Table 2) but has remained almost exclusively a Carson stock derivative. Length frequency data, ocean age class at return time information, and allele frequencies (Elliot and Pascho 1994) all support a distinction between the stock at Dworshak, a Rapid River stock derivative, and the stock at Kooskia, a Carson derivative.

Table 2. Genetic make-up of Kooskia NFH spring chinook salmon smolts directly released from the hatchery.

Release Year	Genetic Make-up*	% Rack Return
1971	85.6% RR - 14.4% CA	0.0343
1972	100% RR	0.0698
1973	100% CA	0.0798
1974	100% CA	0.1498
1975	58% RR - 42% CA	0.4094
1976	100% SS	0.2338
1977	84% CA - 11% KK - 5% LW	0.0088
1978	75% RR - 25% CA	0.0123
1979	69% KK - 31% CA	0.0327
1980	31% KK - 69% CA	0.0336
1981	64% CA - 19% KK - 17% RR	0.0390
1982	100% CA	0.0272
1983	65% KK - 35% LE	0.0970
1984	89% KK - 11% RR	0.0533
1985	100% KK	0.2721
1986	100% KK	0.1483
1987	100% CL	0.1263
1988	100% CL	0.1770
1989	100% KK	0.0300
1990	100% KK	0.1630
1991	100% KK	0.2430
1992	100% KK	0.0164

*RR - Rapid River
LE - Leavenworth
CL - Clearwater
LW - Little White Salmon
KK - Kooskia
CA - Carson
SS - South Santiam

1995 Run Size

Rack Returns

The spring chinook adult return to Dworshak NFH for 1995 was 125, the third lowest return on record (Table 3). The adult SCS return to Kooskia NFH was 40, the lowest return since 1982 (Table 4). The only positive note for this year's return is the number of I-Ocean returns. Although not exceedingly high, it is an indication of a better return for 1996.

Table 3. Hatchery rack returns and age composition of spring chinook salmon for Dworshak NFH, 1984-1995.

Year Return	I-salt	II-salt	III-salt	Unmeasured	Total
1984	14	52	16	0	82
1985	13	281	35	5	334
1986	78	346	91	0	515
1987	25	1604	376	12	2017
1988	163	569	1240	0	1972
1989	156	1322	221	1	1700
1990	7	1892	135	8	2042
1991	16	77	72	0	165
1992	23	286	40	21	370
1993	9	452	359	3	823
1994	3	30	41	0	74
1995	83	36	6	0	125

Table 4. Hatchery rack returns and age composition of spring chinook salmon for Kooskia NFH, 1972-1995.

Year Return	I-salt	II-salt	III-salt	Unmeasured	Total
1972	5	0	0	0	5
1973	5	45	0	0	50
1974	16	35	2	0	53
1975	15	284	27	0	326
1976	409	286	106	0	801
1977	333	2539	154	0	3026
1978	23	1676	336	0	2035
1979	11	100	264	0	375
1980	9	55	3	0	67
1981	1	168	78	0	247
1982	3	116	139	0	258
1983	1	231	141	0	373
1984	55	80	206	0	341
1985	26	449	54	0	529
1986	21	159	103	0	283
1987	16	607	64	0	687
1988	39	363	193	0	595
1989	107	717	142	7	973
1990	11	921	209	0	1141
1991	10	98	350	9	467
1992	14	239	38	21	312
1993	11	749	409	11	1180
1994	1	96	135	0	232
1995	21	7	12	0	40

Age Composition

Age composition of the run is presently based on fork length categories. The length categories were derived from known age/length/sex data from CWT recovery databases. I-salts are 56 cm or less, II-salts are 57 through 81 cm, and III-salts are larger than 81 cm. The age composition for the 1995 adult return is displayed in Table 5.

Survival

The III-salt returns in 1995 complete the returns from the 959,369 smolts released at Dworshak NFH and the 727,251 smolts released at Kooskia NFH in 1992. Total returns to the North Fork of the Clearwater from the 1992 release were 9 I-salts, 30 II-salts, and 6 III-salts for a hatchery return survival rate of 0.0047 percent (Table 6). Total returns to Clear Creek from the 1992 release were 11 I-salts, 96 II-salts, and 12 III-salts for a hatchery return survival rate of 0.0164 percent (Table 7).

Table 5. Age composition for 1995 spring chinook salmon returning to Dworshak-Kooskia NFH Complex.

	Dworshak NFH			Kooskia NFH	
Age	Number	Percent	Age	Number	Percent
I-salt	83	66.4	I-salt	21	52.5
II-salt	36	28.8	II-salt	7	17.5
III-salt	6	4.8	III-salt	12	30.0
TOTAL MEASURED	**125**	**100**	**TOTAL MEASURED**	**40**	**100**

Table 6. Return vs. release numbers for adult spring chinook salmon returns to Dworshak NFH.

Release Year	Smolts Released at Hatchery*	I-salts (% return)	II-salts (% return)	III-salts (% return)	Total (% return)
1988	1,547,219	156 (0.0101%)	2709 (0.1751%)	72 (0.0047%)	2937 (0.1898%)
1989	1,651,472	10 (0.0006%)	77 (0.0047%)	40 (0.0024%)	127 (0.0077%)
1990	1,251,247	16 (0.0013%)	286 (0.0229%)	359 (0.0287%)	661 (0.0528%)
1991	1,094,884	23 (0.0021%)	452 (0.0413%)	41 (0.0037%)	516 (0.0471%)
1992	959,369	9 (0.0009%)	30 (0.0031%)	6 (0.0007%)	45 (0.0047%)
1993	467,222	3 (0.0006%)	36 (0.0077%)		
1994	1,278,273	83 (0.0065%)			

*Includes smolt releases at hatchery only. Does not include off-site releases or fry/fingerling releases.

Table 7. Return vs. release numbers for adult spring chinook salmon returns to Kooskia NFH.

Release Year	Smolts Released at Hatchery*	I-salts (% return)	II-salts (% return)	III-salts (% return)	Total (% return)
1988	778,407	107 (0.0137%)	921 (0.1183%)	350 (0.0450%)	1378 (0.1770%)
1989	384,235	11 (0.0029%)	98 (0.0255%)	38 (0.0096%)	147 (0.0383%)
1990	403,701	10 (0.0025%)	239 (0.0590%)	409 (0.1013%)	658 (0.1630%)
1991	396,619	14 (0.0038%)	749 (0.2026%)	135 (0.0365%)	898 (0.2430%)
1992	727,251	11 (0.0015%)	96 (0.0132%)	12 (0.0017%)	
1993	343,437	1 (0.0003%)	7 (0.0020%)		
1994	305,813	21 (0.0069%)			

*Includes smolts released at hatchery only. Does not include off-site releases or fry/fingerling releases.

Coded-wire Tag (CWT) Recoveries

Our facilities have significantly increased SCS marking. From one CWT group at Dworshak for the 1987 release year (contribution only) to a range of from 9 to 24 CWT groups representing multiple evaluation studies for the 1988-1995 release years. At Kooskia NFH, we released CWT groups less often (1984, 1990, 1992, 1993, 1994, and 1995). In 1993, 1994, and 1995 all hatchery fish were marked with at least an adipose fin clip in order to discriminate between hatchery and natural or wild stocks. The increased marking in recent years has enlarged the SCS CWT recovery database to a point where it is much more useful for hatchery evaluation. It also dramatically increased the workload for CWT sampling, recovery, and data processing.

A summary of adult SCS recoveries in the Dworshak NFH rack is shown in Table 8. All recoveries at the Dworshak rack were Dworshak NFH marks this year. Rack recoveries in previous years have included strays

from other hatcheries and National Marine Fisheries Service transportation study marks.

Table 8. Summary of CWT recoveries for adult spring chinook salmon in the Dworshak NFH rack (1987-1995).

Rack Year	Total Recoveries	Recoveries of Dworshak Marks
1987	25	19
1988	55	49
1989	77	47
1990	306	302
1991	30	10
1992*	183	177
1993*	449	449
1994*	51	28
1995*	95	68

* recoveries include fish tagged at Kooskia NFH. Previous recoveries were only fish tagged at Dworshak NFH.

1995 Run Predictions

Dworshak NFH-1995

Even though the 1995 SCS return to Dworshak NFH was disappointing, the total return was higher than we predicted. Both the II- and III-Salt predictions were high, but were not unreasonable. The I-Salt prediction was significantly underestimated.

1995 Run Prediction		1995 Rack Return	
I-salt =	19	I-salt =	83
II-salt =	40	II-salt =	36
III-salt =	15	III-salt =	6
Total n =	**74**	**Total run =**	**125**

Kooskia NFH-1995

The 1995 SCS return to Kooskia NFH was even more disappointing. The only prediction that was close was for the I-Salt fish. Both the II- and III-salt predictions were vastly overestimated.

1995 Run Prediction		1995 Rack Return	
I-salt =	14	I-salt =	21
II-salt =	80	II-salt =	7
III-salt =	40	III-salt =	12
Total n =	**134**	**Total Run =**	**40**

1996 Run Predictions

The following is our prediction for the 1996 SCS run to Dworshak and Kooskia NFHs.

Dworshak NFH		Kooskia NFH	
I-salts	50	I-salts	20
II-salts	900±200	II-salts	300±100
III-salts	5	III-salts	5
TOTAL	**955±200**	**TOTAL**	**325±100**

Total predicted to return both hatcheries in 1996 is 1280±300 . The total hatchery spring chinook salmon predicted to return to Dworshak and Kooskia NFH's in 1996 will not meet the complete broodstock requirements. The number of adults needed for supplying eggs to fill both hatcheries is estimated at 1,700. Actual number needed varies, depending on number of eggs per female (which varies with size and age of fish returning) and sex ratio of any particular run. The estimated return will also be far short of our LSRCP mitigation goal of 9,135 adults returning to Lower Granite Dam.

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