

**BROOD YEAR REPORT
DWORSHAK NATIONAL FISH HATCHERY
SPRING CHINOOK SALMON
BROOD YEAR 1998
LIFE CYCLE COMPLETED IN 2003**

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BROOD YEAR 1998 OVERVIEW

Life Stage	Number	% Survival
1998 Rack Return	915	-
Number of Females Spawned	434	-
Green Eggs Taken¹	1,510,000	-
Average Eggs per Female	4,153	-
Eyed Eggs	1,517,820	78.3
Smolts Released²	1,017,873	67.1
In-River Smolt Survival³	-	55.1
Adult Returns to the Hatchery⁴	3,880	0.381⁵
Adults Harvested in Idaho⁶	1,561	-
Known Adult Return to Clearwater River	9,513	0.935⁷
Adults Collected at Other Locations⁸	133	-

¹ Estimate is not based on an actual count

² From eyed-egg to release.

³ Minimum survival to Lower Granite Dam based on PIT tag interrogations.

⁴ I-Ocean, II-Ocean, and III-Ocean returns in 2001, 2002, and 2003 to the hatchery rack.

⁵ Percent survival from smolt to adult.

⁶ Tribal and Sport fisheries combined (minimum estimate based on incomplete data).

⁷ Percent survival from smolt to adult.

⁸ Coded-wire tagged fish recovered at various other hatchery racks, dams, fish traps, etc. down river of Lower Granite Dam.

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 Clearwater River, data is provisional and subject to future revision and corrections, especially in regards to the adult returns to the rack and harvest. 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.

INTRODUCTION

This report provides data for Brood Year 1998 spring Chinook salmon at Dworshak National

Fish Hatchery (NFH) which completed its life cycle in 2003. 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 emmigration to the ocean, adult contribution to fisheries, adult returns to the hatchery, and estimated total adult return 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.

The reporting of production data for Brood Year 1998 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, these data were not always reported separately for the two stocks and summaries provided in various production and activity reports for brood Year 1998 were occasionally combined. In those sections where data for the two stocks are combined, it will be pointed out. Otherwise, data is for Dworshak NFH stock and production data for BY98 Kooskia NFH spring Chinook salmon will be found in the Brood Year Report for that hatchery.

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 1998, 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 a change in rearing density as a result of an evaluation by Jones and Miller (1996) and the criteria developed by 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 outplanted. 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. Dworshak NFH has 870 trays. Protocol calls for one female's eggs per tray giving the hatchery the capacity to incubate nearly 3.0 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 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, the production staff decided to transfer the fry directly into the outside rearing raceways, eliminating nursery rearing, in order to accommodate 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. 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.

1998 ADULT SPRING CHINOOK SALMON RETURN TO DWORSHAK NFH

Pre-Season Assessment

The Idaho Fishery Resource Office (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 1997, the I-Ocean return to Dworshak NFH was 12 fish providing a prediction of 810 adult returns to Dworshak NFH for the 1998 season. The breakdown by age class for the predicted return is given below in **Table 1** (Idaho FRO 1997).

Table 1. Pre-season prediction of adult returns to Dworshak NFH by ocean age (Idaho FRO 1997).

Ocean Age	1998 Prediction
I - Ocean	3
II - Ocean	311
III - Ocean	496
Total	810

For reasons unknown, our prediction to the rack was low. The prediction of returning II-Ocean fish was a little high, but the prediction for III-Ocean fish was about half of the actual return.

Total Rack Return

The total rack return is the number of adults that return to the hatchery and is not an accounting of the total return to the river. The 1998 adult spring Chinook salmon return to Dworshak NFH was 915 adults (**Table 2**), just over 12% higher than the pre-season prediction of 810 made in 1997.

Table 2. Actual rack return of adult spring Chinook salmon to Dworshak NFH by ocean age (Idaho FRO 1998).

Ocean Age	Smolts Released	1998 Rack Return
I - Ocean	53,078 (1997)	11
II - Ocean	102,903 (1996)	176
III - Ocean	1,311,445 (1995)	728
Unmeasured		0
Total		915

Run Timing

The hatchery ladder was opened on May 21 and was operated continuously through September 16, 1998 (Dworshak NFH 1998) . Records are not available to document the day the first and last fish entered the hatchery. The first inventory was taken on July 1. Inventories were taken weekly thereafter until the end of the season. Between July 1 and August 6, 798 adult fish or over 87% of the run entered the hatchery. The number of spring Chinook salmon entering the hatchery weekly is depicted in **Figure 2** and listed in **Table 3**. Inventories were conducted on the dates listed.

Figure 2.
Numbers of
adult spring
Chinook
salmon

entering the adult holding pond weekly at Dworshak NFH in 1998 (IFRO database files). Dates
Table 3. Number of spring Chinook salmon entering the hatchery ladder from May 21 through

September 16, 1998, by ocean-age class (IFRO database files). Numbers are weekly totals and do not include trap mortalities or unmeasured fish.

Date	I-Ocean	II-Ocean	III-Ocean	Total
July 1	0	45	213	258
July 9	2	35	176	213
July 16	0	7	36	43
July 23	3	11	39	53
July 30	1	13	112	126
August 6	3	27	75	105
August 13	1	8	23	32
August 20	0	11	21	32
August 27	1	9	19	29
September 3	0	6	10	16
September 10	0	3	4	7
September 15	0	1	0	1
Total	11	176	728	915

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 coded-wire tag (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%, 70%, and 24%, respectively, for all years from 1984 to 1997 (**Table 4**). The return in 1998 was somewhat atypical, 1.2 % I-Ocean, 19.2 % II-Ocean, and 79.6 % III-Ocean (**Table 3**), in that the percentage of I-Ocean adults was considerably lower than average while the III-Ocean adults were significantly higher than average.

Table 4. Number and percent of adult spring Chinook salmon that returned to Dworshak NFH since 1984, by ocean age (Idaho FRO 1998).

Return 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
1995	83	66.4%	36	28.80%	6	4.80%	125	0
1996	275	28.56%	663	68.85%	25	2.6%	963	0
1997	12	0.38%	2,380	75.98%	740	23.62%	3,132	18
Mean	62	6.09%	713	70.12%	242	23.79%	1,017	5
1998	11	1.21%	176	19.23%	728	79.56%	915	0

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

Adult Tagging

Because of space and water temperature limitations at Kooksia NFH, all the spring Chinook salmon collected for brood stock at that hatchery are transferred to Dworshak NFH for holding and spawning. To insure separation of stocks, all the Dworshak NFH adult spring Chinook salmon were marked with a left opercul punch and the adults from Kooksia NFH were marked with a right opercul punch.

Adult Holding and Mortality

Formalin treatments were administered to adults in all the holding ponds to retard fungus infection. Treatments began on May 29 and ended September 2, 1998. A total of 73 treatments were given, averaging 3 per week. Treatments consisted of dripping 200 mg/l into each pond over the course of an hour (Trock 1998).

Adult females were injected with Erythromycin to protect eggs from vertical transmission of *R. salmoninarum*. Each female received a dosage of 20 mg/kg of body weight. See **Fish Health Section** for details.

Despite efforts to the contrary, adult mortalities occur. Adult mortality is reported for two separate periods: pre-spawning (holding mortality) and mortality during spawning.

Pre-Spawning Mortality - From May 21 to August 18, a total of 27 adult spring Chinook salmon

(2.9 % of rack return) died: 17 females and 10 males (0 Jacks).

Mortality During Spawning - From August 19 through September 22, an additional 40 adults died (4.4 % of rack return), 37 males and 13 females. Of the 37 males, 1 was a jack.

Compared to previous brood years, the mortality rate of BY98 spring Chinook salmon adults during holding and spawning had improved. BY98 had the lowest mortality rate since BY95 (**Table 5**).

Table 5. Percent mortality of adult spring Chinook salmon during holding (pre-spawning) and during spawning at Dworshak NFH, 1995-1998 (Idaho FRO databases).

Brood Year	Pre-Spawning Mortality	Spawning Mortality
1995	6.4%	27.2%
1996	2.5%	14.3%
1997	3.2%	9.9%
1998	2.9%	4.4%

Spawning

Details on the methods and procedures during spawning are provided in the Spawning Report for Brood Year 1998 (Trock 1998). Spawning was started on August 19, about a week earlier than 1997. Nine takes were made with the last ripe females for the Dworshak NFH program taken on September 22. A summary of the number of males and females spawned each week is presented in **Table 6**.

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. In 1998, the adult return was not sufficiently large enough to supply excess adults for this purpose and no adults were out-planted.

Table 6. Number of male and female spring Chinook salmon spawned during each egg take for Brood Year 1998 at Dworshak NFH (Trock 1998).

Take Date	Males	Females
-----------	-------	---------

	Spawned	Spawned
8/18/98	14	36
8/25/98	58	88
8/27/98	36	59
9/01/98	101	133
9/03/98	22	31
9/08/98	45	55
9/10/98	20	18
9/15/98	14	13
9/22/98	1	1
Total	311	434

EGG PRODUCTION AND INCUBATION

Data on early incubation, eye-up, and final incubation and hatching is found in Dworshak NFH annual reports for 1998 and 1999, the hatchery monthly production narratives, as well as the spawning report for BY98 (Trock 1998). Although eggs for Kooskia NFH spring Chinook salmon were initially incubated at Dworshak NFH, the data is not reported here and the reader is referred to the BY98 Brood Year report for Kooksia NFH.

Green Eggs Taken

Eggs are not enumerated until after eye-up. The number of green eggs taken initially is estimated using an average of 3,500 eggs per female. A total of 434 females were spawned, giving an initial estimate of 1.51 million green eggs (Dworshak NFH 1998).

Early Incubation (Dworshak NFH)

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 Enzyme-Linked Immunosorbant Assay (ELISA) tests (see **FISH HEALTH** section for detail). Water flow through the incubators was maintained at about 5 gal./min. Water temperatures averaged 44°F using the water chillers (Dworshak NFH 1998).

Eggs Culled for BKD

Generally, eggs from females that test high (≥ 1.0 ODU) for BKD are culled from production. The eggs from 30 females (6.9%) were removed in 1998 (Dworshak NFH 1998).

Eye-Up

Takes 1-7 completed eye-up in October while Takes 8 and 9 completed eye-up in early November, 1998. Eggs were shocked, dead eggs were removed, and eggs were enumerated by a mechanized egg picker. The total number of eyed eggs enumerated was 1,517,820, producing an average of 4,153 eggs per female, much higher than the average (**Table 7**). The reason for the higher number of eggs per female for this brood year was due to the exceptionally high number of III-Ocean females in the spawning population (older, larger females have a much higher number of eggs than younger, smaller females). Although the precise number of III-Ocean females spawned is not known, it is reasonable to assume that it was similar to the percent in the rack return, or about 80%. Thus, the program ended with about 151,000 excess eggs on hand. These eggs were given to the Idaho Department of Fish and Game and were transferred to the Clearwater Anadromous Hatchery in November 1998, leaving a total of 1,370,000 eggs for the Dworshak NFH program.

Final Incubation

In order to delay the time of hatching and reach the desired release size without resorting to a feed reduction program, the Dworshak Hatchery Evaluation Team recommended that all of Dworshak NFH's spring Chinook salmon eggs be transferred to Kooskia NFH for final incubation, hatching, and initial rearing. The water temperature available at Kooskia NFH was 39°F, which would delay hatching by about three months. Therefore, all 1,370,000 spring Chinook salmon eggs in the Dworshak NFH program were shipped to Kooskia NFH in October and November, 1998.

During December, 1998, about 300,000 surplus Dworshak NFH eggs were shipped back to Dworshak NFH from Kooskia NFH.

Tanking

After hatching, the fry were transferred to nursery tanks for early rearing prior to transfer to Dworshak NFH.

Table 7. Summary of egg take and eye-up for Dworshak NFH BY98 spring Chinook salmon (Trock 1998).

Take	No. of Females	No. of Females Culled	Eggs per Female	Eyed Eggs	Percent Enumerated Eye-up	Percent Total Eye-up
1	36	4	4,988	151,088	94.6	75.5
2	88	8	4,228	293,830	86.9	72.4
3	59	1	4,242	231,286	94.0	90.9
4	133	11	3,851	424,985	91.2	76.1
5	31	2	3,696	92,041	92.2	71.2
6	55	2	4,138	197,226	89.9	83.6
7	18	1	4,636	74,128	94.1	84.2
8	13	1	4,600	51,000	92.4	79.2
9	1	-	2,511	2,236	89.0	89.0
Total Ave	434	30	4,153	1,517,820	- 91.1	- 78.3

JUVENILE REARING

The following data and information was summarized from the 1998 and 1999 Annual Reports for Dworshak NFH, the Dworshak NFH monthly production narratives, and the Dworshak NFH monthly inventory summaries (MIS).

Transfers and Handling

The first group of Dworshak NFH BY98 spring Chinook salmon were transferred back to Dworshak NFH from Kooskia NFH the first week of April 1999. These were unfed fry that were moved about six weeks earlier than initially scheduled because of space constraints at Kooskia NFH. At the end of early rearing at Kooskia NFH in May 1999, the rest of Dworshak's spring Chinook salmon were transferred back to Dworshak from Kooskia and in contrast to previous years, were placed directly into outside rearing raceways instead of finishing early rearing in the inside nursery tanks. **Table 8** lists the dates that transfers were made, the numbers of fish, and the rearing container each group went into. Numbers of fish were estimated using the pound count method (Piper *et al.* 1992). In July 1999, about 274,000 excess fingerlings were transferred to the Nez Perce Tribe for out planting. All these fish were code-wire tagged by the Columbia River Fishery Program Office, but didn't receive any external marking or fin clip (see **Marking and Tagging** for details). All these were outplanted as pre-smolt fingerlings. On March 2, 2000, the remaining 101,018 Dworshak NFH smolts were transferred from Kooskia to Dworshak NFH for acclimation and release. The fish were about 22 fish per pound at the time of transfer.

Table 8. Date of transfer for various groups of spring Chinook salmon fry that were transported from Kooskia NFH to Dworshak NFH for final rearing (Dworshak NFH Monthly Production Summaries).

Date of Transfer	Number ¹	Rearing Container
April 2, 1999	233,906	Rcwy A 11
May 13-14, 1999	145,500	Rcwy A 06
May 22, 1999	116,113	Rcwy B 22
May 25, 1999	123,970	Rcwy A 04
	106,159	Rcwy A 02
May 26, 1999	115,897	Rcwy B 27
May 27, 1999	115,504	Rcwy B 17
	87,516	Rcwy B 29
Total	1,044,565	

¹ Numbers were estimated using the pound count method (Piper *et al.* 1992).

Growth and Mortality

Except for the first group transferred in April, the fry averaged about 291 fish per pound and were less than 2.3 inches in length by the end of May 1999. A record of daily growth and mortality, from the end of April 1999 until the time of release in April 2000, is listed in **Table 9**.

Growth was faster than was desired during the summer and in August 1999 the feeding regime was modified by reducing the number of feedings from 3 to 2 per day. On September 10, feeding was again modified by reducing the percent body weight fed from 1.5% to about 0.8%. The two per day feedings at the lower % body weight regime was continued through January 2000, and was discontinued on February 1, 2000.

In November 1999, BKD was diagnosed in several raceways and were treated with Erythromycin (See **FISH HEALTH SECTION** for details).

Table 9. Summary of monthly growth and mortality of Brood Year 1998 spring Chinook salmon during outside raceway rearing at Dworshak NFH . Compiled from monthly production narratives and monthly inventory summaries.

Date (End of Month)	Number	Weight (lbs)	FPP	Mean Length (in.)	Mean Growth (in.)	Mortality (%)	Mean Water Temp (°F)
4/99	232,303	261	890	1.6	-	0.01	42.0
5/99	1,271,567	4,280	297	2.2	0.6	-	50.0
6/99	1,262,562	7,092	178	2.7	0.5	0.10	47.0
7/99	1,126,569	10,329	109	3.1	0.4	0.12	51.6
8/99	942,627	11,349	83	3.4	0.3	0.15	48.0
9/99	941,186	14,273	66	3.7	0.3	0.15	48.1
10/99	939,710	17,222	55	3.9	0.2	0.16	48.5
11/99	937,116	20,349	46	4.2	0.3	0.28	47.4
12/99	934,780	22,780	41	4.3	0.1	0.25	44.0
1/00	933,129	26,385	35	4.6	0.3	0.18	42.8
2/00	929,928	31,592	29	4.8	0.2	0.34	42.1
3/00	953,180	39,477	24	5.2	0.4	0.46	41.7

Marking and Tagging

Coded-Wire Tags and Adipose Fin Clips- The 274,000 excess fingerlings transferred to the Nez Perce Tribe for out-planting were coded-wire tagged July 13-17, 1999 by the Columbia River

Fisheries Program Office staff. These fish were not adipose fin clipped and were released off-site into Meadow Creek, a tributary of the Selway River and into Newsome and Mill creeks of the South Fork of the Clearwater River. A total of 136,474 spring Chinook salmon fingerlings were coded-wire tagged during August 1999 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 10**). These fish as well as the remaining fish on station received an adipose fin clip to designate them as hatchery fish.

PIT tags - A total of 47,745 Brood Year 1998 spring Chinook salmon were PIT tagged during February 2000 to monitor travel time and estimate survival to Lower Granite Dam after release. These fish were part of the Comparative Survival Study (see **SPECIAL STUDIES** section for details).

Table 10. Numbers of BY98 Dworshak spring Chinook salmon that were adipose fin clipped and coded-wire tagged and the final numbers released, by tag code (Idaho FRO data base records).

Tag Code	Marked		Released	
	Number	Size (#/lb)	Number	Size (#/lb)
05-42-08	66,677	95	61,400	23.8
05-42-09	69,797	90	65,131	23.4
Total	136,474		126,531	

SMOLTS RELEASES

Idaho FRO began monitoring stream flows in the Clearwater River at the beginning of March, 2000 to coordinate spring Chinook salmon smolt releases with increases in the hydrograph. Mean daily flows stayed below the 10-year average during the latter part of March and began increasing steadily by the first of April (**Figure 3**). On March 22, 2000, Dworshak NFH conducted an early release of 65,468 smolts from raceways 29 and 30 to make room for BY99 coho being transferred out of the nursery. The general production release of 952,405 Brood Year 1998 spring Chinook smolts at Dworshak NFH occurred on April 5-6, 2000. Releases were made into the North Fork Clearwater River in the late afternoon and early evening to minimize avian predation. Arrangements were made with the Corp of Engineers to increase the release of water out of Dworshak Reservoir to help move the smolts out of the North Fork Clearwater River into the main stem. The total weight of fish released was about 42,395 lbs. The average number of fish per pound was 24 and the average length was 132 mm (Dworshak NFH 2000).

Figure 3. Mean daily stream discharge of the Clearwater River at the Orofino bridge, 2000. Vertical lines indicates the dates smolts were released. The release on May 22, 2000 was an early release of two raceways in order to make room for coho salmon being transferred out of the nursery.

FISH HEALTH

Adult Injections with Erythromycin: INAD 6430

The 1995 season was the last year that the University of Idaho did any work on INAD 6430: Injectable Erythromycin. A veterinary prescription for an extra label use was obtained for using erythromycin in 1998. Adult females were inoculated with Gallimycin about three weeks prior to the start of spawning. Fish were injected in the intra-peritoneal cavity at a dosage rate of 20 mg/kg of body weight (Idaho FHC 1998).

Adult Disease Testing

During spawning, all the adult females were sampled to test for infection with *Renibacterium salmoninarum* (*Rs*), the causative agent of BKD using Enzyme Linked Immunosorbent Assay (ELISA). Eggs from females were segregated based on the level of infection (**Table 11**). Results of these tests indicated that 30 females had high levels of *Rs* antigen, 67 females had moderate levels, 272 females had low levels, and 134 females had no level of detection. Because numbers of returning females were plentiful, a 0.40 OD level was used for culling. This resulted in 13.3% of the fertilized eggs being culled.

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 - 0.199
Medium	0.200 - 0.999
High	1.000 and above

Formalin as a Fungicide: INAD 9013

Adult spring Chinook salmon were treated with formalin during holding at Dworshak NFH prior to spawning to keep fungus infections at a minimum. Because formalin has not been approved for treatment of salmonids for fungus after the egg stage, administration was done under a veterinary prescription. Adult spring Chinook salmon were administered formalin using a charge and flow-through treatment regimen. The treatment volume was estimated by subtracting the volume of water displaced by fish from the total pond volume. To begin a treatment, water flow to the pond was reduced to about 1900 L/m and then 38.0 L of formalin was added to the pond to achieve a concentration of 167 ml/L. The treatment level was maintained for 1 hr by adding formalin at a rate of 316 ml/L. A total of 57 L (15 gal) of formalin was required for each treatment at this dosing interval until treatments were completed. Formalin appeared to be efficacious in the control of fungus on the BY98 spring Chinook salmon adults during the pre-spawn holding period. This was evident by the fact that there was little or no fungus on any of

the dead fish removed from the pond or fish remaining. In previous years, Dworshak NFH had discontinued formalin treatments once the spawning process had started. This was because of money and time involved in treating. Upon the recommendations of the Fish Health Center, formalin treatments for BY98 were continued regularly until spawning was complete.

LHRHa (ReproBoost): INAD 9709

Dworshak NFH usually has a few females that are not ripe and will die in the holding pond prior to spawning. This year, in order to maximize the egg take, LHRH (Lutenizing Hormone-Release Hormone) was used to facilitate ripening these females. AquaPahann Technologies Corp. currently

has INAD #8061 for LHRH, injectable and implants. Implants (Ovaplant) were chosen for use through this INAD. On September 3, 29 females were injected with one Ovaplant implant each. All fish became ripe in 5-12 days after being implanted. There were no adverse signs to treatment seen (Idaho FHC 1998).

Monthly Disease Sampling

There was nothing remarkable found during the monthly disease monitoring for this brood year. Bacterial kidney disease (BKD) monitoring through the fall indicated no increase in clinical BKD. This trend continued until release.

Erythromycin treatments

An outbreak of BKD was diagnosed in raceways 21-24 in November 1999. Fish in raceways 21, 23, and 24 received manufactured Erythromycin medicated feed for 21 days. The treatment ending by the end of November. The fish in raceway 22 received fish pills top coated with erythromycin using vegetable oil as a carrier. This treatment did not work as the fish refused to eat the feed. On November 27, raceway 27 was also diagnosed with BKD. This raceway and raceway 22 were placed on manufactured medicated feed on November 29 with the treatment ending on December 13.

Smolts Assessments

A total of 60 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*, viral agents, Enteric Red Mouth, *Aeromonas salmonicida*, and BKD. Severity of BKD based on ELISA were as follows: Not Detected = 30, Low = 17, Medium = 13, and High = 0. No other pathogens (bacterial, viral, or parasitic) were isolated prior to release. Fish were considered smolting and ready for release.

SMOLT EMIGRATION

The performance of spring Chinook salmon smolts is monitored and evaluated using 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 4**). PIT tags provide information on travel time and survival during emigration. PIT-tagged fish from 12 separate raceways were released in 2000 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 raceway travel time from Dworshak NFH to Lower Granite Dam ranged from 23.7 to 34.0 days (**Table 12**). The number of days for 25, 50, and 90 percent of the run to reach Lower Granite Dam were 23, 27, and 37 days, respectively. After being released on April 5/6, 90% had reached Lower Granite Dam by May 13. The shortest and longest travel times to Lower Granite Dam were 3.9 and 86.8 days, respectively.

Table 12. Summary of travel time, and associated statistics, to Lower Granite Dam for PIT-tagged BY98 spring Chinook salmon released from Dworshak NFH in 2000.

Raceway	N	Minimum	Maximum	Mean	SD
A01	889	5.9	73.4	33.1	9.1
A02	1,071	8.9	72.8	30.4	7.6
A03	1,247	3.9	63.3	30.5	8.4
A04	1,339	6.2	61.9	29.1	7.4
A05	1,291	4.0	71.2	28.5	7.6
A06	1,297	8.9	65.8	28.1	6.9
A07	1,216	5.3	63.0	26.5	6.8
A08	1,311	5.4	62.8	26.6	6.8
B17	1,187	6.4	54.8	23.7	6.0
B19	1,224	5.5	49.4	23.7	6.5
B20	1,259	5.4	86.8	24.4	7.0
B29	452	11.0	69.6	34.0	10.1

River Flow

Flows in the Lower Snake River were higher than the 10-year average during most of the smolts

emigration period of April and May (**Figure 5**). Inflow into Lower Granite Reservoir exceeded 100,000 cubic feet per second (cfs) in late March prior to smolt releases from Dworshak NFH. The flows decreased to below 80,000 cfs at the time of release (April 5-6) and then increased to above 100,000 cfs before the end of April. Before 90% of the smolts had reached Lower Granite Dam on May 13, flows had again dropped to nearly 80,000 cfs.

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 1998 spring Chinook salmon was 55.1 %. (**Table 13**).

Table 13. Number of unique interrogations of PIT-tagged BY98 spring Chinook salmon released from Dworshak NFH as part of the transportation study and interrogated at downstream dams in 2000 .

Raceway	Number of Tags Released	Number of Unique Interrogations				Total	Percent of Total Detected
		Lower Granite Dam	Little Goose Dam	Lower Monumental Dam	McNary Dam		
A01	3,515	889	499	165	177	1,680	47.8
A02	3,634	1,071	473	174	166	1,884	51.8
A03	4,340	1,247	596	219	225	2,287	52.7
A04	4,656	1,339	652	259	292	2,542	54.6
A05	4,422	1,291	645	276	268	2,480	56.1
A06	4,258	1,297	555	221	229	2,302	55.1
A07	4,131	1,216	618	235	242	2,311	55.9
A08	4,101	1,311	661	207	228	2,407	58.7
B17	4,183	1,187	713	281	236	2,417	57.8
B19	4,073	1,224	770	252	227	2,473	60.7
B20	4,130	1,259	753	245	243	2,500	60.5
B22	2,302	452	351	131	90	1,024	44.5

Figure 4. Dams on the lower Snake and Columbia rivers. Lower Granite, Little Goose, Lower Monumental, and McNary dams are PIT-tag interrogation facilities for monitoring smolts emigration.

Figure 5. Mean daily inflow to Lower Granite Reservoir from March 19 through June 25, 2000 during spring Chinook salmon emigration after release from Dworshak NFH (solid line). The extremely high flows in 1997 (dashed line) are shown for perspective.

ADULT RETURNS

Rack Return to Dworshak NFH

Brood Year 1998 spring Chinook salmon smolts released in 2000 returned as adults in 2001 (I-Ocean), 2002 (II-Ocean), and 2003 (III-Ocean). The total adult return to the hatchery rack was 3,880 fish, a smolt-to-adult rate of return of 0.38 % (**Table 14**).

Table 14. Summary of adult returns to Dworshak NFH for Brood Year 1998 spring Chinook salmon (Idaho FRO 2004). A total of 1,017,873 smolts were released from Dworshak NFH in 2000.

Return Year	Ocean Age	Number of Returns	Smolts to Adult Return Rate (%)
2001	I	36	0.0035
2002	II	1,480	0.1454
2003	III	2,364	0.2322
	Total Return	3,880	0.3812

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 BY98 spring chinook salmon occurred in 2001 (I-Ocean fish), in 2002 (II-Ocean fish) and in 2003 (III-Ocean fish). Harvest in tribal and sport fisheries for those three return years is reported below.

Idaho Tribal Fisheries - The Tribal fishery in the North Fork Clearwater River occurs almost exclusively near the Dworshak NFH fish ladder. Data on the age composition of the harvest is generally not available. For that reason, it is assumed that the age composition of the harvest is similar to the age composition of the rack return to Dworshak NFH. Total harvest reported in 2001 was 830, of which 18 were estimated to be I-Ocean fish. Total harvest in 2002 was reported to be 794, of which 545 were estimated to be II-Ocean fish. Total harvest in 2003 was reported to be 1,445, of which 998 were estimated to be III-Ocean fish. The total harvest of BY98 spring Chinook salmon adults in Tribal fisheries was 1,561. A summary by Ocean Age Class is provided in **Table 15**.

Table 15. Estimated number of adult spring Chinook salmon harvested by the Nez Perce Tribe, reported by Ocean Age from 2001-2003.

Harvest Year	Ocean Age	Number Harvested
2001	I	18
2002	II	545
2003	III	998
Total		1,561

Idaho Sport Fisheries - Because of the mixed stock fishery in the Clearwater River, it is difficult to estimate the number of Dworshak NFH origin spring Chinook salmon harvested. Discrimination and determination of origin is based on coded-wire tag recovery data which is generally not available before this report is completed. Therefore, the data reported here is provisional and subject to future revision based on more complete information. Sport fishing occurred in 2001, 2002, and 2003. A summary of the number harvested by Ocean Age Class is provided in **Table 16**.

Table 16. Estimated number of adult spring Chinook salmon harvested by sports fishermen, reported by Ocean Age from 2001-2003.

Harvest Year	Ocean Age	Number Harvested
2001	I	75
2002	II	1,830
2003	III	1,568
Total		3,473

The Idaho Department of Fish and Game reported a total estimated harvest of 8,355 Dworshak NFH origin adult salmon in 2001, 75 of which were estimated to be I-Ocean fish. In 2002, the total estimated sport harvest was 2,667 (revised from 8,267 in the BY96 report) of which 1,830 were estimated to be II-Ocean fish. In 2003, the total estimated sport harvest was 1,788 of which 1,568 were estimated to be III-Ocean fish. The total harvest of BY98 spring Chinook salmon by sport fishermen was estimated to be 3,473.

Estimated Minimum Total Adult Return Above Lower Granite Dam

The estimated minimum total 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. For BY98, the estimated minimum total is 9,513 (4,479 rack return and 5,034 harvested) giving a smolt to adult return rate, for accountable fish, of 0.935 %. At the present, we have no way of estimating the stray rate of Dworshak NFH spring Chinook salmon that cross Lower Granite Dam.

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 Regional Mark Information System. Thus, data reported here is up to date as of May 2004. For Brood Year 1998, a total of 133 coded-wire tags were recovered outside the Clearwater River basin. Thirty-six were collected in Tribal subsistence and ceremonial fisheries in Zone 6 (Bonneville Pool upstream to McNary Pool). Fifty-six were collected in Columbia River sport fisheries. The remainder were collected as strays to various hatcheries or other collection facilities throughout the Columbia River basin and in commercial fisheries below Bonneville Dam. **Table 17** provides a summary of recoveries by location and recovery year. Data on recoveries for individual tag codes is available from the IFRO office upon request.

SPECIAL STUDIES

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. 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 47,745 PIT-tagged BY98 spring Chinook salmon smolts in 2000. With PIT tags as part of the Service's contribution to the project. The goal of the project is to evaluate adult returns and determine whether transportation provides any survival advantage over in-river emigration.

Table 17 . Number of coded-wire tagged Brood year 1998 Dworshak NFH spring Chinook salmon that were recovered as adults from various locations in the Columbia and Snake rivers.

Fishery/Location of Recovery	Recovering Agency	Recovery Year		
		2001	2002	2003
Columbia River, Tongue Point	ODFW ¹	-	1	-
Bonneville Pool Umatilla Tribe	ODFW	-	2	-
Powerdale Dam Trap	ODFW	-	1	-
Bonneville Pool Net	ODFW	-	14	6
Columbia R. Sport Fishery Wash	ODFW	-	15	14
Columbia R. Sport Fish Oregon	ODFW	-	13	13
Dalles Pool Net	ODFW	-	18	2
Coumbia R. Net Zones 1-5	ODFW	1	18	14
John Day Pool Net	ODFW	-	8	2
Dalles Pool upr	ODFW	-	-	3
John Day Pool upr	ODFW	-	1	-
Wind River	WDFW ²	-	1	-
Snake River Mainstem	WDFW	-	3	-
Tucannon River	WDFW	-	1	-
Totals		1	78	54

¹ Oregon Department of Fish and Wildlife

² Washington Department of Fish and Wildlife

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APPENDIX I

**Adult Spring Chinook Salmon Returns
to Dworshak Fishery Complex in 1998
and Prognosis for 1999**

Idaho Fishery Resource Office

APPENDIX A

ADULT SPRING CHINOOK SALMON RETURNS TO DWORSHAK-KOOSKIA NFH COMPLEX IN 1998 AND PROGNOSIS FOR 1999

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Introduction

Dworshak National Fish Hatchery (NFH) is 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 steelhead (*Oncorhynchus mykiss*) caused by the dam and reservoir.

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

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, temperature considerations, and other factors; Dworshak NFH holds and spawns spring chinook salmon adults trapped at Kooskia NFH. Kooskia NFH eggs and juveniles are often held at Dworshak NFH as well. In 1995, Kooskia NFH was included as part of the Dworshak Fishery Complex.

This report includes a summary of the 1998 adult returns of spring chinook salmon to Dworshak and Kooskia NFHs. Our predictions for the 1998 returns are reviewed and predictions for the 1999 adult returns are presented.

Stock description

The Dworshak NFH spring chinook salmon program was initially started using chinook salmon stock from the Leavenworth and Little White Salmon NFH programs. Eggs were transferred from these facilities and made up the smolt releases from 1983 to 1986 (**Table 1**). Since these stocks were very strongly influenced by transfers to their programs from Carson NFH, the early Dworshak chinook stock was considered a Lower Columbia River Carson derivative. The chinook programs for brood years 1985 and 1986 consisted entirely of eggs that had been transferred from Rapid River State Fish Hatchery (SFH), which used chinook returning to the Snake River at Hells Canyon Dam. Thus, smolts released in 1987 and 1988

Table 1. Genetic background of Dworshak NFH spring chinook salmon smolts directly released from the hatchery, 1983-1998. (RR = Rapid River, KK = Kooskia, DW = Dworshak, LE = Leavenworth, LW = Little White Salmon)

Release Year	Genetic Background
1983	75% LW, 12% RR, 13% LE
1984	100% LE
1985	68% LW, 32% LE
1986	100% LE
1987	100% RR
1988	100% RR
1989 - 1994	100% DW
1995	66% DW, 34% KK
1996 - 1998	100% DW

were entirely Rapid River Stock, shifting the program away from using the Lower Columbia River Carson chinook stock. Since that time, Dworshak NFH has maintained its program from returns to its own rack. In some years when returns are too low to meet broodstock needs, Dworshak NFH has back filled its program using excess eggs from Kooskia NFH or Rapid River SFH. The recent returns to Dworshak NFH (1989 and later) are referred to as Dworshak stock, since they are progeny of returns to Dworshak NFH, rather than direct products of transfers of Rapid River stock. The Kooskia NFH spring chinook salmon program was started using a wide variety of stocks from the Lower Columbia River and Rapid River SFH. However, from 1973 through 1980, smolt releases had a very strong Carson stock influence. Egg transfers of Carson type stock from Dworshak NFH in 1985 and 1986 resulted in smolt releases in 1987 and 1988 that were a mixed stock, referred to as Clearwater stock (**Table 2**). Since the Kooskia NFH program already had stock made up primarily of Carson derivatives, the resultant program (1989 and later) is still considered a Carson type stock, and is referred to as Kooskia stock. Length frequency data, ocean age class at return time information, and allele frequencies (Elliot and Pascho 1994) all support a distinction between Dworshak and Kooskia stocks.

1998 Run Size

The 1998 spring chinook salmon return to Dworshak NFH rack was 915, the sixth best rack return in the program history (**Table 3**). The Idaho Department of Fish and Game (IDFG) opened a limited sport fishing season for spring chinook salmon and estimated a total sport harvest of 99 adult Dworshak NFH fish from the North Fork Clearwater River

in 1997. This was the second significant sport harvest since 1990. The Nez Perce tribe estimated a subsistence harvest in the North Fork of 182 fish. The spring chinook salmon return to Kooskia NFH was 408. This was the twelfth best return recorded (**Table 4**). The Nez Perce tribe estimated a subsistence harvest of 20 fish from Clear Creek.

Age Composition

Age composition of the run is presently based on fork length categories. The length categories were derived from known age/length data from coded-wire tag (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. Usually, the majority of spring chinook salmon returning to both Dworshak and Kooskia NFHs are II-salts with fewer III-salts (**Table 3**). The 728 III-salt fish that returned to the Dworshak NFH rack were a surprise and the second best III-salt return since the switch to Rapid River stock (**Table 5**).

Survival

The III-salt returns in 1998 complete the adult returns from the 1,311,445 smolts released at Dworshak NFH (**Table 6**) and the 722,906 smolts released at Kooskia NFH in 1995 (**Table 7**). Total returns to the North Fork Clearwater from the 1995 release were 275 I-salts, 3,571 II-salts, and 952 III-salts for a return rate of 0.3659 percent (**Table 6**). Total returns to Kooskia NFH from the 1995 release were 86 I-salts, 1,523 II-salts, and 207 III-salts for a hatchery return survival rate of 0.2512 percent (**Table 7**).

Coded-Wire Tag Recoveries

We have significantly increased spring chinook salmon marking from the contribution-only level (1987 release year, at Dworshak NFH, one CWT group) to the several-studies level

Table 2. Genetic background of Kooskia NFH spring chinook salmon smolts directly released from the hatchery, 1971-1998. (RR = Rapid River, KK = Kooskia, LE = Leavenworth, SS = South Santiam, CL = Clearwater, LW = Little White Salmon, CA = Carson, WR = Wind River.)

Release Year	Genetic Background
1971	86% RR, 14% WR
1972	100% RR
1973	100% CA
1974	100% CA
1975	58% RR, 42% CA
1976	100% SS
1977	84% CA, 11% KK, 5% LW
1978	75% RR, 25% CA
1979	69% KK, 31% CA
1980	31% KK, 69% CA
1981	64% CA, 19% KK, 17% RR
1982	100% CA
1983	65% KK, 35% LE
1984	89% KK, 11% RR
1985	100% KK
1986	100% KK
1987	100% CL
1988	100% CL
1989 - 1998	100% KK

Table 3. Hatchery rack returns and age composition of spring chinook salmon for Dworshak NFH, 1984-1997.

Year	I-Salt	II-Salt	III-Salt	Unmeasure d	Total Return
1984	14	52	16	0	82
1985	13	281	35	5	334
1986	78	346	91	0	516
1987	25	1,604	376	12	2,017
1988	163	569	1,240	0	1,972
1989	156	1,322	221	1	1,700
1990	7	1,892	135	8	2,042
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
1996	275	663	25	0	963
1997	12	2,380	740	18	3,150
1998	11	176	728	0	915

Table 4. Hatchery rack returns and age composition of spring chinook salmon for Kooskia NFH, 1972-1998.

Year	I-Salt	II-Salt	III-Salt	Unmeasured	Total Return
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	2,539	154	0	3,026
1978	23	1,676	336	0	2,035
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	1,141
1991	10	98	350	9	467
1992	14	239	38	21	312
1993	11	749	409	11	1,180
1994	1	96	135	0	232
1995	83	36	6	0	125
1996	86	113	3	0	202
1997	7	1,523	127	0	1,657
1998	1	200	207	0	408

Table 5. Age composition of spring chinook salmon returning to Dworshak Fishery Complex, 1998.

Ocean Age	Dworshak NFH		Kooskia NFH	
	Number	Percent	Number	Percent
I - Salt	11	1.2	1	0.3
II - Salt	176	19.2	200	49.0
III - Salt	728	79.6	207	50.7
Total	915	100.0	408	100.0

Table 6. Return vs. release numbers for adult spring chinook salmon returns to Dworshak NFH, 1988-1997. Includes sport and tribal harvest estimates when there were monitored fisheries (1990, 1997, and 1998).

Release Year	Smolts Released ¹	I-Salt (% Return)	II-Salt (% Return)	III-Salt (% Return)	Total (% Return)
1988	1,547,219	156 (0.0101%)	2,709 (0.1751%)	72 (0.0047%)	2,937 (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%)	25 (0.0054%)	64 (0.0137%)
1994	1,278,273	83 (0.0065%)	663 (0.0517%)	1,110 (0.0868%)	1,856 (0.1452%)
1995	1,311,445	275 (0.0210%)	3,571 (0.2723)	952 (.0726%)	4,798 (.3659%)
1996	102,903	18 (.0175%)	230 (.2235%)		
1997	53,078	14 (.0264%)			

¹ Releases at hatchery only and does not include off-site releases or fry/fingerling

Table 7. Return vs. release numbers for adult spring chinook salmon returns to Kooskia NFH, 1988-1997.

Release Year	Smolts Released ¹	I-Salt (% Return)	II-Salt (% Return)	III-Salt (% Return)	Total (% Return)
1988	778,407	107 (0.0137%)	921 (0.1183%)	350 (0.0450%)	1,378 (0.1770%)
1989	384,235	11 (0.0029%)	98 (0.0225%)	38 (0.0096%)	147 (0.0077%)
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%)	119 (0.0164%)
1993	343,437	13 (0.0003%)	7 (0.0020%)	3 (0.0009%)	11 (0.0032%)
1994	305,813	21 (0.0069%)	113 (0.0360%)	127 (0.0415%)	261 (0.0853%)
1995	722,906	86 (0.0119%)	1,523 (0.2107%)	207 (.0285%)	1,816 (.2512%)
1996	333,794	7 (.0021%)	200 (.0599%)		
1997	16,598	1 (.0060%)			

¹ Releases at hatchery only and does not include off-site releases or fry/fingerling releases.

(1988-1994 release years, 9 to 24 CWT groups). At Kooskia NFH, we released CWT groups less often (1984, 1990, 1992-1998). Since 1993 all hatchery spring chinook were fin clipped to allow discrimination between hatchery and natural or wild stocks. The increased marking in recent years has enlarged the spring chinook salmon 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.

Rack recoveries in previous years have included strays from several other hatcheries and also National Marine Fisheries Service transportation study marks, which were probably not strays (**Table 8**). Since we took four times as many snouts in 1997 as any previous year, and had another banner CWT harvest in 1998, processing is not completed at this time.

1998 Run Predictions

Dworshak NFH-1998

The 1998 spring chinook salmon return to Dworshak NFH surpassed expectations. IDFG estimated the sport harvest was 99 fish. The harvest biologist for the Nez Perce Tribe estimated that the tribe harvested 182 fish. Therefore, the total return to the North Fork Clearwater was over 1,196. The jack count in the 1997 rack indicated that 1998 would not be a large return. Our projection was conservative for III-salts but we over estimated the II-salt return (**Table 9**).

Kooskia NFH-1998

The 1998 spring chinook salmon return to Kooskia NFH did not meet projections (**Table 10**). It was the twelfth best return out of 27 years of operation.

1999 Run Predictions

Our forecast for the 1999 spring chinook salmon returns to Dworshak and Kooskia NFHs is given in **Table 11**. The combined forecast for 1999 is for 622 spring chinook salmon to return to the Dworshak Fishery Complex. Broodstock requirements (1,700) will not be met. Our equation method works well for II-salt returns but not for III-salt returns. Therefore, the II-salt projections are from the regression equation of jacks to II-salts, but the I-salt and III-salt estimates were generated from average return rates.

Table 8. Summary of CWT recoveries for adult spring chinook salmon in the Dworshak NFH rack, 1987-1998.

Rack Year	Hatchery Tags Recovered ¹	Total Tags Recovered
1987	19	25
1988	49	55
1989	47	77
1990	302	306
1991	10	30
1992 ²	177	183
1994 ²	449	449
1995 ²	95	95
1996 ²	508	515
1997	Not Completed	1,937
1998	Not Completed	777

¹ Includes both Dworshak and Kooskia NFHs.

² Recoveries include fish tagged at Kooskia NFH.

Table 9. Predicted and actual rack returns of spring chinook salmon to Dworshak NFH by ocean age class, 1998.

Ocean Age Class	Prediction	Total Return
I - Salt	3	14
II - Salt	311	230
III - Salt	496	952
Total	810	1,196

Table 10. Predicted and actual rack returns of spring chinook salmon to Kooskia NFH by ocean age class, 1998.

Ocean Age Class	Prediction	Rack Return
I - Salt	1	1
II - Salt	225	200
III - Salt	265	207
Total	491	408

Table 11. Predicted returns of spring chinook salmon to the Dworshak Fishery Complex by ocean age class, 1999.

Ocean Age Class	Dworshak NFH	Kooskia NFH
I - Salt	210	4
II - Salt	251	100
III - Salt	42	15
Total	503	119

Literature Cited

Elliot, D.G. and R. J. Pascho. 1994. Juvenile fish transportation: Impact of bacterial kidney disease on survival of spring/summer chinook salmon stocks. Annual Report. U.S. Army Corps of Engineers. Contract E86920048. 79p.

APPENDIX II

**SPAWNING REPORT
Spring Chinook Salmon
Brood Year 1998**

**U.S. Fish and Wildlife Service
Dworshak-Kooskia National Fish Hatchery Complex Ahsahka, Idaho**

SPAWNING REPORT

BROOD YEAR 1998
Spring Chinook Salmon

December 9, 1998

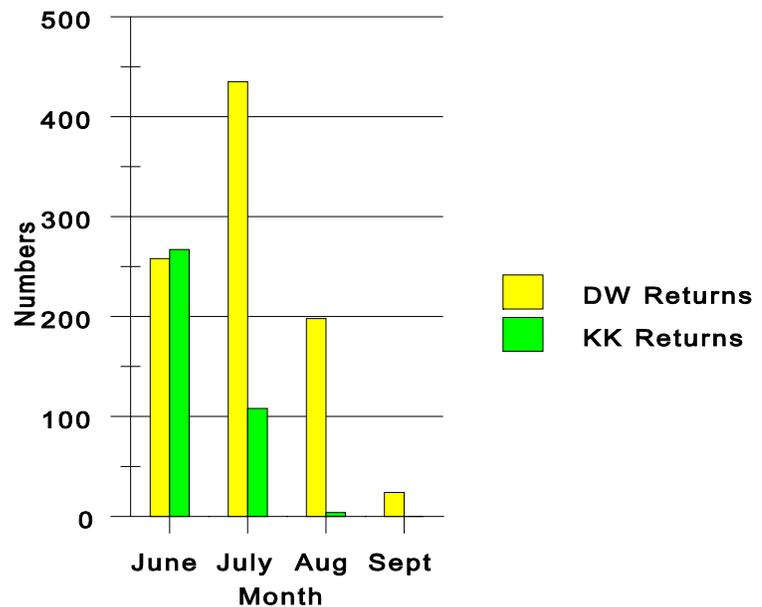
U.S. Fish & Wildlife Service
Dworshak-Kooskia National Fish Hatchery Complex
Ahsahka, Idaho

**Brood Year 1998 Spring Chinook Salmon
Dworshak National Fish Hatchery**

Adult Collection

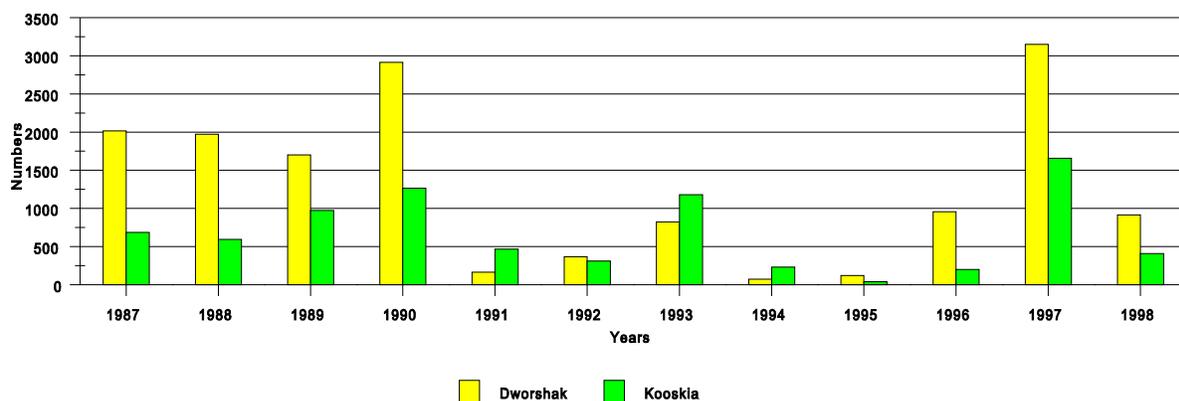
The Dworshak fish ladder was opened May 21, 1998 and closed September 16 for collection of spring chinook salmon (SCS). Chinook began returning to Dworshak in June. Chinook returning in 1998 to Dworshak and Kooskia totaled 915 and 408 fish, respectively. The returns from June-September are illustrated in Figure 1.

There were 11 jacks returned to Dworshak and one jack to Kooskia. Kooskia transported 377 fish to Dworshak for spawning and passed 27 fish over the weir. Four fish died in the trap.



Dworshak adult returns for brood year (BY98) SCS consisted of 728 (80 percent) three-ocean adults. Since 1984, records indicate III-ocean SCS returns average 24 percent of the run. Figure 2 displays the SCS returns to Dworshak since 1987.

Spawning Season



The BY98 Dworshak/Kooskia SCS spawning season began August 18, 1998, approximately one week earlier than in 1997. Spawning ended on September 22, one week later than in 1997, although only one fish was spawned that week. Dworshak adults were held in holding ponds (HP) 1 and 2, Kooskia's stock held in HP3. Fish from each HP were sorted and spawned once/week along with new fish coming up the ladder into HP9.

Spawning Procedure

The spawning procedure was similar to past years: adults were crowded from the holding ponds into a crowding channel, moved into a channel basket, and placed into an anesthetic bin. Each anesthetic bin was prepared with 130 grams/bin of Tricaine methanesulfonate (MS-222). Pro-Polyaqua was added (250 ml per bin) to reduce stress and susceptibility to infection. Oxygen was provided at a rate of one L/minute. Spinal columns of ripe females were severed using a pneumatic knife. The females were then placed on a table for 3-20 minutes for blood drainage. The ventral side was then cut open using a spawning knife and eggs were collected in disinfected colanders. After ovarian fluid was drained, the eggs were poured into a clean bucket. Milt from ripe males was stripped into Styrofoam cups and a one-percent saline solution was added to assist in milt motility. The milt solution was poured onto the eggs and swirled for more complete fertilization. After sufficient time had elapsed for fertilization to take place (one to two minutes), the eggs were rinsed of sperm, blood, and other organic matter.

After fertilization, eggs were placed in Heath incubator trays at approximately 4,000 eggs per tray (1 female). In the tray was a 75 mg/l iodophor solution buffered with sodium bicarbonate. Eggs were maintained in this solution for approximately 30 minutes. This was done as a precaution against disease transmission. The egg trays were then pushed into the incubator. Water flow rate was approximately five gallons/minute and temperature averaged 44.0⁰F.

Dworshak Fish Health Center (DFHC)

Kidneys were sampled for BKD from all females spawned and from a representative sample of males. The DFHC also took ovarian fluid from all females spawned for viral inspection. The adult females tested 6.9 percent (30 out of 434) high BKD (ELISA >1.0) for Dworshak and 5.8 percent (9 out of 154) for Kooskia. Final culling was at 1.0 ELISA and above for Dworshak stock. Because Kooskia eggs were in short supply this spawning year, only two trays were culled from this stock. These two sets of eggs had both high ELISA and little or no antibiotic present.

Personnel from DFHC injected all Dworshak stock females with erythromycin on July 23. All Kooskia stock females were given a combination injection of erythromycin and rifampin. The DFHC will compare egg retention of the antibiotic in both groups and the long term survival of high BKD offspring from fish with this combination injection.

Cryopreservation Study/University of Idaho

Dworshak coordinated with researchers from the University of Idaho in cryopreservation of salmonid gametes. Rolf Ingermann and David Bencic are studying the relationship between ATP content regarding the motility and viability of the sperm. Dworshak provided 15 ml milt from 16 males and approximately 400 eggs from 11 females. These gametes were from excess spawning requirements at Dworshak.

Idaho Supplementation Study (ISS)

There were 23 females and 15 males collected from the Kooskia trap which were spawned for the ISS program. These fish yielded 99,104 green eggs which had an 86 percent survival for a

total of 85,602 eyed eggs. These eggs were isolated during initial incubation at Dworshak and were transferred to Kooskia in October, 1998, for final incubation and rearing.

Incubation

Combining both Dworshak and Kooskia, there were 588 females and 426 males spawned (1:1.4 ratio). After culling 32 females for BKD and 9 females due to dead egg trays, there was a total of approximately 2.2 million green eggs produced. Because there was an unusually high percentage of III-ocean females returned (80 percent), the fecundity averaged 4,000 eggs/female, up from the usual 3500 eggs/female expected from Dworshak return SCS.

Dworshak spawned 434 females of Dworshak stock which, after culling 30 females for high BKD and three for dead egg trays, yielded 1.5 million eyed eggs for it's program.

There were 154 females spawned of Kooskia stock, providing 467K eyed eggs for the Kooskia program. Although nine out of 154 females were high BKD from this stock, only two females were culled due to the low number of females returned/spawned. Because Kooskia has the capability to delay hatching by chilling incubation water to approximately 39⁰F, all BY98 SCS eggs were shipped to Kooskia in October, 1998, after eye-up and enumeration at Dworshak.

Upon eye-up (approximately 46 days after fertilization at 44.0⁰F), the eggs were shocked. The next day the eggs were enumerated and sorted using an electronic egg picker and counter (Van Gaalen Model N-100). Eyed eggs were then transferred to Kooskia a few days after enumeration. Any high BKD eggs from Kooskia will be transferred back to Dworshak after hatching for early rearing. This will keep the high BKD progeny out of the reuse water system at Kooskia. These fish will be transferred back to Kooskia in September, 1999.

Water temperature in the incubation room at Dworshak averaged 44.0⁰F. Temperatures were kept the same for all Takes to facilitate eye-up and hatching to be approximately one week apart. The cold water line from Dworshak Reservoir was used as the sole water source during incubation at Dworshak.

Use of 39⁰F chilled water allows for a reduction in egg development so that smolts will be a target size of 15-20 fpp at release in the Spring of 2000. This delay in egg development is being undertaken to reduce the length of the chinook feeding program from 17 months to 14 months. With this shortened feeding program, chinook will need to be fasted for a shorter period of time than if the incubation water were not chilled. It is believed the fish will be in better condition for smoltification under this hatching and rearing plan. Tables 1 and 2 summarize the egg Take and survival for both Dworshak and Kooskia BY98 SCS. Most of Dworshak fry should be transferred from Kooskia to Dworshak raceways in June of 1999. There will be approximately 220K fry shipped about April 1, 1999, from Kooskia to Dworshak. These are fish which will be in excess of Kooskia's tanking capacity.

Table 1. Dworshak BY98 SCS egg take and survival.

Take	No of Female	Females culled	Females culled	Dead Eggs	Eyed Eggs	Total Eggs	Eggs/ Female	Percent Enum	Percent Total
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		BKD>1.0	grn eggs					Eye-up	Eye-up
1	36	4	-	8,541	151,088	159,629	4,988	94.6	75.7
2	88	8	-	44,419	293,830	338,249	4,228	86.9	72.4
3	59	1	-	14,724	231,286	246,010	4,242	94.0	90.9
4	133	11	1	40,973	424,985	465,958	3,851	91.2	76.1
5	31	2	2	7,740	92,041	99,781	3,696	92.2	71.2
6	55	2	-	22,109	197,226	219,335	4,138	89.9	83.6
7	18	1	-	4,679	74,128	78,807	4,636	94.1	84.2
8	13	1	-	4,194	51,000	55,194	4,600	92.4	79.2
9	1	-	-	275	2,236	2,511	2,511	89.0	89.0
Tot/ Ave	434	30	3	147,65 4	1,517,820	1,665,474	4,153	91.1	78.3

All eggs shipped to Kooskia for incubation

Percent enumerated eye-up = does not include eggs/females culled before enumeration

Percent total eye-up = includes eggs/females culled before enumeration

Source: Egg Enumeration and Disposition Summary BY98 SCS

FHC BKD ELISA testing results BY98 SCS

Table 2. Kooskia BY98 SCS egg take and survival.

Take	No of Female	Females culled BKD>1.0	Females culled grn eggs	Dead Eggs	Eyed Eggs	Total Eggs	Eggs/ Female	Percent Enum Eye-up	Percent Total Eye-up
1	10	-	-	1,744	39,273	41,017	4,102	95.7	95.7
2	31	-	-	18,086	87,616	105,702	3,410	82.9	82.9
3	10	0	2	3,292	21,654	24,946	3,118	86.8	57.9
4	42	0	4	23,272	127,379	150,651	3,965	84.6	69.8
5	5	-	-	1,430	15,210	16,640	3,328	91.4	91.4
6	26	1	-	7,445	88,350	95,795	3,832	92.2	85.4
7	15	1	-	10,617	41,209	51,826	3,702	79.5	69.6
8	15	-	-	10,915	46,552	57,467	3,831	81.0	81.0
Tot/ Ave	154	2	6	76,801	467,243	544,044	3,726	85.9	77.4

*Only cull 2 BKD high eggtrays due to low return numbers. All eggs shipped to Kooskia for incubation.
 Source: Egg Enumeration and Disposition Summary BY98 SCS. FHC BKD ELISA testing results BY98 SCS

Table 3 illustrates the egg shipments for BY98 SCS. There were 151K excess Dworshak stock eggs which were shipped to IDFG at Clearwater Hatchery.

Table 3. BY98 SCS egg shipments from Dworshak.

Date Shipped 1998	Take #	Dworshak stock to Kooskia	Kooskia stock to Kooskia	Dworshak stock to Clearwater H	Date shipped
Oct 7	1	151,088	39,273		
Oct 15	2	293,830	87,616		
Oct 16	3	231,286	21,654		
Oct 22	4	424,985	127,379		
Oct 23	5	92,041	15,210		
Oct 28	6	97,226	88,350	100,000	Nov 4
Oct 28	7	49,128	41,209	25,000	Nov 4
Nov 3	8	25,000	46,552	26,000	Nov 4
Nov 10	9	2,236			
Total		1,366,820	467,243	151,000	

Source: SC98EGEN.wk4 pg 2

Kooskia will incubate both Dworshak and Kooskia stock BY98 SCS eggs at approximately 39⁰F over the winter of 1998-99. There will be approximately 1.83 million eggs incubating at Kooskia.

The Kooskia high BKD fry (7 females, approximately 25,000 fry) will be incubated at Kooskia but shipped to Dworshak for initial tanking and rearing. These will be returned to Kooskia in the fall of 1999, when this hatchery is no longer on the reuse water supply.

Initial Pond Loading

Dworshak will be at full rearing capacity with BY98 SCS. Initial loading will be approximately 44,000 fish per RW. Due to tanking space restrictions at Kooskia, 230K extra Dworshak stock SCS will be transferred from Kooskia to one RW at Dworshak in April, 1999. The remaining BY98 SCS (1.1 million) will be moved from Kooskia to Dworshak's outside RWs in June, 1999. Fish moved from Kooskia to Dworshak in June should be approximately 300 fpp in size. Coded wire tagging and adipose fin clipping of BY98 SCS will begin the first week of August, 1999.

Diet

Most of Dworshak stock SCS fry will be transferred from Kooskia to Dworshak the beginning of June, 1999. The type of feed and feed-size change are outlined in Table 4 below. The hatchery currently uses feed exclusively from Bioproducts, Inc. There will no longer be a 28-day

prophylactic treatment of medicated feed containing erythromycin given to BY98 SCS. This medicated feeding usually took place a few weeks before the fish are released.

Table 4. Feed changeover, SCS BY98.

Feed No.	Feed Type	Feed Name	Abbrev.	Start fpp	End fpp
4	Biomost Grower	BMG 1.3 mm	BG13	300	200
5	Biomost Grower	BMG 1.5 mm	BG15	200	100
6	Biomost Grower	BMG 2.5 mm	BF25	100	50
7	Biomost Grower	BMG 3.0 mm	BF30	50	18

Source: FCTBSCDW.wk1 - 05/17/94

Growth Projection

The expected monthly growth rates and general target lengths for the BY98 chinook program are presented in Table 5. This growth regime allows for producing smolts the targeted size of 15-20 fpp.

Table 5. Growth projection for SCS BY98, Dworshak NFH.

Date	Temperature °F	FPP	Length (in)	Growth this month (in)
Jun 1	45	300	2.23	0.24
Jul 1	51	220	2.47	0.47
Aug 1	51	130	2.95	0.48
Sep 1	52	83	3.42	0.53
Oct 1	50	54	3.95	0.42
Nov 1	49	40	4.37	0.39
Dec 1	44	31	4.76	0.22
Jan 1	41	27	4.98	0.20

Feb 1	40	24	5.18	0.15
Mar 1	40	22	5.33	0.17
Apr 1	41	20	5.50	0.09
Apr 16	41	19	5.60	

Source:GRPR99SC.wk4

Smolt Disposition

All smolts produced from the Dworshak stock will be released from Dworshak hatchery into the North Fork of the Clearwater River in the spring of 2000. At Kooskia, smolts from the pond containing ISS fish will be released upstream in Clear Creek (approximately 80,000 fish). All other smolts produced from Kooskia stock will be released from Kooskia hatchery on Clear Creek. This creek is a tributary to the Middle Fork of the Clearwater River.

The extra 230,000 Dworshak stock eggs will be incubated at Kooskia, transferred to Dworshak in April, 1999, reared at Dworshak until the fall of 1999, then transported to Kooskia for rearing. In the spring of 2000, these fish will be transferred back to Dworshak and stocked in the settling pond for acclimation before release.

Program Objectives

Projected release numbers for BY98 SCS program are summarized in Table 6.

Table 6. Program objectives for BY97 SCS, Dworshak Complex.

Rearing location	Fish stock	Number at Release	Release Site	Type of release	FPP at release	Date of release
Dworshak	Dworshak	1,000,000	Dworshak	Smolt	15-20	Apr 99
DW/KK	Dworshak	210,000	Dworshak	Smolt	15-20	Apr 99
Kooskia	Kooskia	430,000	Kooskia	Smolt	15-20	Apr 99
Total smolts		1,640,000			15-20	

Historical eyed egg to smolt survival has been 92% (1998 Annual Report)

Adult Disposition

Twenty one days before the first spawning date, erythromycin injections were given to the female SCS. Due to these injections and the deteriorated condition of the adults after spawning, carcasses were unfit for human consumption and were subsequently transferred to the landfill.

