

**BROOD YEAR REPORT
DWORSHAK NATIONAL FISH HATCHERY
SPRING CHINOOK SALMON
BROOD YEAR 1996
LIFE CYCLE COMPLETED IN 2001**

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BROOD YEAR 1996 OVERVIEW

| Life Stage | Number | % Survival |
|--|------------------|---------------------------|
| 1996 Rack Return | 963 | - |
| Number of Females Spawned | 338 | - |
| Green Eggs Taken | 1,267,500 | - |
| Average Eggs per Female | 3,459 | - |
| Eyed Eggs | 1,010,443 | 87.2 |
| Smolts Released¹ | 973,400 | 96.3 |
| In-River Smolt Survival² | - | 67.2 |
| Adult Returns to the Hatchery³ | 9,807 | 1.0075⁴ |
| Adults Harvested in Idaho⁵ | 4,756 | |
| Known Adult Return to Clearwater River | 14,563 | 1.9589⁶ |
| Adults Collected at Other Locations⁷ | 69 | |

¹From eye-egg to release.

² Minimum survival to Lower Granite Dam based on PIT tag interrogations.

³ I-Ocean, II-Ocean, and III-Ocean returns in 1999, 2000, and 2001 to the hatchery rack.

⁴ Percent survival from smolt to adult.

⁵ Tribal and Sport fisheries combined (minimum estimate based on incomplete data).

⁶ Percent survival from smolt to adult.

⁷ 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 1996 spring chinook salmon at Dworshak National Fish Hatchery (NFH) which completed its life cycle in 2001. 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 1996 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 1996 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 1996, 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.

1996 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 1995, the I-Ocean return to Dworshak NFH was 83 fish. The prediction for adult returns to Dworshak NFH for the 1996 season was 955 total. The breakdown by age class for the predicted return is given below in **Table 1** (Idaho FRO 1995).

Table 1. Pre-season prediction of adult returns to Dworshak NFH by ocean age (Idaho FRO 1995).

| Ocean Age | 1996 Prediction |
|--------------|-----------------|
| I - Ocean | 50 |
| II - Ocean | 900 |
| III - Ocean | 5 |
| Total | 955 |

Total Rack Return

The 1996 adult spring chinook salmon return to Dworshak NFH was 963 adults (**Table 2**), slightly higher than the pre-season prediction of 955 made in 1995. The I-ocean returns were considerably higher than predicted while the II-ocean component was significantly lower than predicted.

Table 2. Actual rack return of adult returns to Dworshak NFH by ocean age (Idaho FRO 1996).

| Ocean Age | Smolts Released | 1996 Rack Return |
|--------------|---------------------|------------------|
| I - Ocean | 1,311,455 (1995) | 275 |
| II - Ocean | 1,278,273 (1994) | 663 |
| III - Ocean | 467,222 (1993) | 25 |
| Total | | 963 |

Run Timing

The hatchery ladder was opened on May 24 and was closed on September 24, 1996 (Dworshak NFH. 1996). Records are not available to document the day the first and last fish entered the hatchery. The first inventory was taken on June 13. Inventories were taken periodically thereafter until the end of the season. Between May 24 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 1996.

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 5.8%, 68.0%, and 25.7%, and 0.5% unknown, respectively, for all years from 1984 to 1995 (**Table 3**). The return in 1996 was somewhat atypical, 28.5% I-Ocean, 68.9% II-Ocean, and 2.6% III-Ocean (**Table 3**), in that the percentage of I-Ocean adults was considerably higher than average while the III-Ocean adults were lower than average. Adult females were injected with Erythromycin 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 1996).

| 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 |
| Mean | 49 | 5.76% | 579 | 68.03% | 219 | 25.73% | 851 | 4 |
| 1996 | 275 | 28.56% | 663 | 68.85% | 25 | 2.6% | 963 | 0 |

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

Adult Tagging

A total of 1,108 adult spring chinook salmon were tagged using TYVEK tags. 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 24 to August 19, a total of 24 adult spring chinook salmon (2.5%) died: 8 females and 16 males (5 Jacks).

Mortality During Spawning - From August 20 through September 24, an additional 134 adults died (14.3%), 123 males and 10 females. Of the 123 males, 80 were jacks.

Spawning

Spawning was started on August 20. Nine egg takes were made with the last ripe females spawned on September 24. Three hundred and sixty-three males and 338 females were spawned.

On September 17, the last 11 females were injected with LH-RH hormone to induce maturation of the gametes. 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 1996 at Dworshak NFH (BY96 Data Files).

| Take Date | Males Spawned | Females Spawned | Green Eggs Taken ¹ |
|--------------|---------------|-----------------|-------------------------------|
| 8/20/96 | 8 | 8 | 30,000 |
| 8/26/96 | 21 | 18 | 67,500 |
| 8/29/96 | 37 | 37 | 138,750 |
| 9/03/96 | 123 | 121 | 453,750 |
| 9/06/96 | 53 | 50 | 187,500 |
| 9/09/96 | 26 | 27 | 101,250 |
| 9/12/96 | 40 | 31 | 116,250 |
| 9/17/96 | 42 | 36 | 135,000 |
| 9/24/96 | 13 | 10 | 37,500 |
| Total | 363 | 338 | 1,267,500 |

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

EGG PRODUCTION

Data on incubation, eye-up, and final incubation and hatching is found in Dworshak NFH annual reports for 1996 and 1997, as well as the spawning report for BY96 (Izbicki 1996).

Green Eggs Taken

Green eggs were not counted. However, the total number of green eggs taken was estimated at 1,267,500 by using an average of 3,750 eggs per female (**Table 4**).

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). Incubation temperatures at Dworshak NFH averaged 44°F using the water chillers. The eggs were given a 15 minute 1,667 mg/l formalin drip treatment three times a week (Izbicki 1996).

Percent Eggs Eyed

Eye-up was completed by the end of October, 1996. 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 1,158,765 or an average of 3,459 eggs per female (Dworshak NFH 1997). The number of eyed eggs counted was 1,010,443 for a percent survival of 87.2% from green egg to eyed egg.

To achieve a smaller smolt size, it was decided that eggs from those females that tested Low for BKD would be shipped to Kooskia NFH for final incubation and early rearing in order to take advantage of the colder water temperatures there. 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.

A total of 483,000 eggs from takes 1- 4 were shipped to Kooskia NFH on October 16 and the remaining 330,281 eggs from takes 5 - 9 were shipped to Kooskia on November 6, a total of 813,881 eggs of Low BKD status (Dworshak NFH 1997). The remaining 196,562 eggs of Medium and High BKD status were kept and incubated at Dworshak NFH. In addition, the remaining 29,527 Medium and High BKD eggs of Kooskia NFH stock were kept at Dworshak NFH in keeping with Fish Health policy and were incorporated into the Dworshak stock bringing the total number of eggs kept at Dworshak NFH up to 226,089.

Kooskia NFH - At Kooskia NFH, the eggs were re-inventoried and Kooskia NFH reported receiving 881,070 eyed eggs (Kooskia NFH 1998). However, this number may also include one group of about 34,000 eggs from Takes 5 and 6 of Kooskia NFH stock that were accidentally mixed with Dworshak NFH eggs and were included as part of the Dworshak stock (Izbicki 1996; Dworshak NFH 1996). This is a difference of about 67,000 eggs. All eggs were disinfected in

75 mg/l iodophor for ten minutes and then placed into vertical Heath trays and incubated at 38 °F (Kooskia NFH 1998A).

NURSERY REARING

The following data and information was summarized from the 1996 and 1997 Annual Reports and production narratives for Dworshak NFH and from the Kooskia NFH 1997 Annual Report.

Tanking

Dworshak NFH - A total of 245,946 swim up fry were moved from the incubation room to the nursery January 2 - 11. Fish began feeding the second week in January. By the end of January, fish averaged 1,073 fpp and 37 mm (TL).

Kooskia NFH - Because of the colder incubation water at Kooskia NFH, hatching was delayed and fry were not transferred to nursery rearing until April 14-21. A total of 829,809 Dworshak NFH fry were transferred from the incubation room to outside rearing tanks. Several days prior to being moved to the nursery, water temperature was gradually raised from 38 to 50 °F to acclimate the fry for outside rearing in rectangular tanks supplied with single-pass well water. One week after the last group of fry were transferred from the nursery to juvenile rearing tanks, the re-use system was started because demand for water was beginning to exceed the available supply (Kooskia NFH 1998A).

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 not available.

Table 5. Summary of monthly growth and mortality of Brood Year 1996 spring chinook salmon during nursery rearing at Dworshak NFH. Compiled from monthly Dworshak NFH production narratives and inventory summaries.

| Date (End of Month) | Number | Weight (lbs) | FPP | Mean Length (in.) | Mean Growth (in.) | Mortality (%) | Mean Water Temp (°F) |
|---------------------------|---------|-----------------|-------|-------------------------|-------------------------|------------------|-------------------------------|
| 1/97 | 242,599 | 226 | 1,073 | 1.5 | n/a | n/a | 41.2 |
| 2/97 | 240,735 | 308 | 782 | 1.6 | 0.1 | 0.8 | 39.8 |
| 3/97 | 239,541 | 530 | 452 | 1.9 | 0.3 | 0.5 | 39.9 |
| 4/97 | 238,580 | 640 | 373 | 2.1 | 0.3 | 0.4 | 42.9 |
| 5/97 | 238,094 | 1,402 | 170 | 2.7 | 0.6 | 0.2 | 44.5 |

JUVENILE REARING

The following data and information was summarized from the 1997 and 1998 Annual Reports for Dworshak NFH, Dworshak NFH monthly production narratives, and the 1997 and 1998 Annual Reports for Kooskia NFH.

Ponding

Dworshak NFH - On April 30, 324,999 spring chinook of low BKD status at Kooskia NFH (Dworshak stock) were transferred back to Dworshak NFH for final rearing and release. These fish were inventoried and stocked into the A-Bank chinook raceways at 108,333 fish per raceway. On June 3, the 205,287 spring chinook salmon in the Dworshak NFH nursery (10,273 Kooskia NFH stock) were moved into outside raceways as well and averaged 170 fpp at the time of transfer.

Kooskia NFH - All the remaining Dworshak NFH stock at Kooskia NFH were transferred from the outside rearing tanks to burrows ponds May 1-2, 1997. No data is available on size of fish at time of ponding.

Growth and Mortality

Dworshak NFH - Monthly growth and mortality from April 1997 to March 1998 is summarized in **Table 7**. Early rearing of most of Dworshak's stock occurred at Kooskia NFH. Six transfers from Kooskia NFH back to Dworshak NFH were made from April 1997 to February 1998. All of these fish were from Low BKD parentage and were kept segregated from the remaining

chinook from Medium or High BKD parentage. Starting in September, the chinook were placed on a feeding regime of fasting 7 days followed by 7 days of double feeding in order to slow the rate of growth. Growth rate ranged from 0.1 to 0.5 inches per month during the rearing period. Mortality was generally less than 0.1% but did reach as high as 0.29% in August 1997. On February 22, 1998, a 21-day erythromycin treatment was started on fish in raceways 29 and 30, high BKD status.

Kooskia NFH - Growth and mortality data for BY96 Dworshak NFH spring chinook being reared at Kooskia NFH from May 1997 to February 1998 are not available. About May 15, 1997, the chiller was put into operations to cool make-up water in the re-use system to keep growth rates slow enough to meet target sizes at release. The chiller was operated all summer and was not shut off until September 26, 1997. In August, 102,738 of the Dworshak NFH stock were transferred back to Dworshak NFH. Several other transfers of Dworshak NFH stock were made from Kooskia NFH to Dworshak NFH from September 1997 to February 1998. The remaining transfer of 199,295 fish was made in February 1998.

Table 7. Summary of monthly growth and mortality of Brood Year 1996 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) |
|---------------------------|----------------------|-----------------|-----|-------------------------|-------------------------|------------------|-------------------------------|
| 4/97 | 324,999 ¹ | 1,332 | 244 | 2.4 | n/a | n/a | 42 |
| 5/97 | 324,628 | 2,216 | 146 | 2.8 | 0.4 | 0.11 | 44.5 |
| 6/97 | 529,308 ² | 5,691 | 93 | 3.3 | 0.5 | 0.12 | 48.3 |
| 7/97 | 589,155 ³ | 8,318 | 71 | 3.6 | 0.3 | 0.10 | 48.3 |
| 8/97 | 615,698 ⁴ | 9,322 | 66 | 3.7 | 0.1 | 0.29 | 51.8 |
| 9/97 | 786,667 ⁵ | 15,775 | 50 | 4.1 | 0.4 | 0.22 | 53.6 |
| 10/97 | 776,617 | 19,458 | 40 | 4.4 | 0.3 | 0.05 | 47.4 |
| 11/97 | 776,318 | 24,243 | 32 | 4.7 | 0.3 | 0.04 | 48.9 |
| 12/97 | 776,027 | 27,994 | 28 | 4.9 | 0.2 | 0.04 | 44.2 |
| 1/98 | 775,752 | 31,607 | 25 | 5.1 | 0.2 | 0.04 | 41.8 |
| 2/98 | 974,492 ⁶ | 43,108 | 23 | 5.3 | 0.2 | 0.06 | 41.7 |
| 3/97 | 973,400 ⁷ | 46,645 | 21 | 5.4 | 0.1 | 0.11 | 42.7 |

¹ Transfer of Dworshak NFH stock from Kooskia NFH to Dworshak NFH.

² 205,287 Dworshak NFH stock moved to outside raceways from the inside nursery.

³ An additional 102,738 Dworshak NFH stock were transferred from Kooskia NFH to Dworshak NFH..

⁴ An additional 136,797 Dworshak NFH stock were transferred from Kooskia NFH to Dworshak NFH.. During August, 143,577 fish were coded-wire tagged and the remaining chinook were marked with an ad-clip and inventoried.

⁵ An additional 172,389 Dworshak NFH stock were transferred from Kooskia NFH to Dworshak NFH. On Oct. 28, 9,600 fish of Kooskia NFH stock were transferred from Dworshak NFH to Kooskia NFH.

⁶ An additional 199,295 Dworshak NFH stock were transferred from Kooskia NFH to Dworshak NFH

⁷ Fish were releases on March 25 and 26.

Marking and Tagging

Coded-Wire Tags - All the Dworshak NFH stock spring chinook salmon at Dworshak NFH and Kooskia NFH were adipose clipped in August 1997. **Table 8** lists the numbers of fish marked and their size, by tag code, and the final numbers and size at release. On March 18, 1997, coded-wire tag retention was checked and observed to be 98.9 % (Dworshak NFH 1997)

PIT tags - A total of 47,740 Brood Year 1996 spring chinook salmon were PIT tagged during February and March 1998 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 8. Numbers of BY96 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) |
| 05-32-13 ¹ | 70,640 | 65 | 69,208 | 21.7 |
| 05-35-17 ¹ | 29,556 | 65 | 28,960 | 21.7 |
| 05-32-14 | 70,812 | 73 | 69,246 | 22.8 |
| 05-37-16 | 72,865 | 70 | 71,202 | 19.5 |
| Total | 243,873 | | 212,552 | |

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

SMOLT RELEASES

The general production release for Brood Year 1996 spring chinook smolts at Dworshak NFH occurred on March 25-26, 1998. The total release from Dworshak NFH was 973,400 smolts (Dworshak NFH 1998). A summary of release dates and numbers is provided in **Table 9**.

Table 9. Summary of spring chinook smolt release information for Brood Year 1996 at Dworshak NFH in 1998 (source: MIS final releases, March 1998).

| Group | Number | Mean Size (FPP) |
|-------------------|----------------|-----------------|
| Low BKD Status | 764,577 | 21.1 |
| Medium BKD Status | 149,307 | 19.8 |
| High BKD Status | 59,516 | 21.2 |
| Total | 973,400 | 20.9 |

FISH HEALTH

Adult Injections with Erythromycin

The 1995 season was the last year that the University of Idaho did any work on INAD 6430: Injectable Erythromycin. A veterinary prescription for extra label use was obtained for using erythromycin in 1996. Adult females were inoculated with Gallimycin about 3 weeks prior to the start of spawning. Fish were injected in the intra-peritoneal cavity with 20 mg/kg of body weight. (Dworshak FHC 1996).

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 10**). Results of these tests indicated that 23 females had high levels of *Rs* antigen and 50 females had moderate levels. Eggs samples from these fish were then tested to determine if erythromycin was present. Erythromycin was present in the vitellin of 67 of the 73 females at levels high enough to assure good protection from the pathogen.

The vitellin from 6 females did not contain detectable levels of the antibiotic. It was likely these fish were not injected with erythromycin. Because one female tested high for *Rs* antigen and erythromycin was not detected in the vitellin samples, we recommended that eggs from this female be culled. However, we did not believe it was necessary to destroy the eggs of the females with erythromycin levels above the minimum inhibitory concentration (MIC). This offered a good opportunity to further evaluate our risk assessment procedures and the efficacy of injecting brood stock with erythromycin. Erythromycin remains stable in the vitellin of eggs

during incubation and depletion seems to begin when the yolk is absorbed during early development. Based on this information, we recommended that progeny from the high ELISA females with detectable levels of erythromycin be reared segregated from other fish and monitored monthly for *Rs*.

Table 10. 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 INAD 9013. Adult SCS 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 formalin was added to the pond to achieve a concentration of 167 μ L/L. The treatment level was maintained for 1 h by adding formalin at a rate of 316 mL/m. A total of 57 L (15 gal) of formalin was required for each treatment. Fish were administered formalin 3 d/week between 26 June and 19 July 1996. The treatment interval was increased to 5 d/week on 22 July and continued at this dosing interval until treatments were completed on 20 September 1996.

Formalin appeared to be efficacious in the control of fungus on the 1996 SCS brood 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 recommendation of the Fish Health Center, formalin treatments for BY96 were continued regularly until spawning was complete. The result was that the mortality rate after spawning was started was only 14.3%. The main cause of pre-spawn mortality was BKD.

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 (Luteinizing Hormone-Release Hormone) was used to facilitate ripening these few females. AquaPharm Technologies Corp. currently has INAD #8061 for LHRH, injectable and implants. Implants were chosen for use through this INAD. On September 17, 11 females were injected with one RB250 implant each. On September 24, all eleven fish were ripe and were successfully spawned (Dworshak FHC 1996). Percent eye-up for these females was 89%, the second highest of all nine takes for BY96 (Dworshak NFH 1996).

Adult Disease Testing

Viral assays for 1996 SCS adults resulted in no isolation of IHNV from spawning fish sampled. Intestine samples from 1996 adult SCS were examined for *Ceratomyxa shasta*. Spores of the parasites were found in 31.3% of the fish examined. Last year the prevalence of *C. shasta* was 53.8%. Although spores are commonly detected in adult fish returning to Dworshak and Kooskia NFHs, there has never been an episode of ceratomyxosis in juvenile or yearling fish.

Monthly Disease Sampling

There was nothing remarkable found during the monthly disease monitoring for this brood year. BKD monitoring in the fall indicated less than 10% medium level ELISA in sampled fish and 25% low levels. The remainder were at levels not detectable.

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.

Non-Infectious Disease Incidence

In August and September 1997, water temperature selection from Dworshak Reservoir was limited because of work being done on Dworshak Dam. The hatchery was given the option to select water temperatures for their production program either in the low 40's or in the 60's (°F). Management was faced with the dilemma of using lower water temperatures and protecting the spring chinook from possible stress and the potential for disease, or using the higher water

temperatures to insure faster growth for the summer steelhead. Either decision would have some kind of negative effect on one of the programs. Recommendations were made by the Fish Health Center and Complex personnel to select the lower water temperatures in favor of protecting the spring chinook salmon. This would probably sacrifice faster steelhead growth and risk not meeting the targeted release size. The decision was made to select temperatures in the upper range in order to insure optimum growth on the steelhead and take the chance that the spring chinook would not be negatively affected. In order to slow the growth of the spring chinook salmon during this period, they were marked and were put on a feed/fast growth regime.

Water temperatures were raised and at times reached 62 degrees (°F) or higher. Unfortunately, the chinook did become stressed. One high BKD progeny group experienced elevated mortality to BKD that required a regime of Erythromycin treatment. Clinical BKD was seen in all groups of chinook, not just the high progeny. Several ponds experience increased mortality due to EIBS, IHNV, and BKD. EIBS had not been seen at this hatchery in over 5 years. IHNV in chinook had not been seen since 1990.

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 3**). PIT tags provide information on travel time and survival during emigration. PIT-tagged fish from 12 separate raceways were released in 1998 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 23.8 to 30.9 days. The number of days for 25, 50, and 90 percent of the run to reach Lower Granite Dam were 22.7, 28.1, and 37.5 days, respectively. The longest travel time to Lower Granite Dam was 116 days.

Table 10. Summary of migration statistics to Lower Granite Dam for PIT-tagged BY96 spring chinook salmon released from Dworshak NFH in 1998.

| Raceway | N | Minimum | Maximum | Mean | SD |
|---------|-------|---------|---------|------|-----|
| A05 | 1,224 | 3.8 | 61.4 | 30.9 | 9.3 |
| A07 | 1,296 | 4.7 | 61.8 | 30.7 | 7.2 |
| A08 | 1,285 | 5.1 | 56.6 | 29.2 | 7.0 |
| A09 | 1,342 | 4.2 | 57.5 | 28.8 | 7.3 |
| A10 | 1,353 | 5.1 | 60.4 | 28.8 | 6.9 |
| A11 | 1,377 | 3.8 | 116.0 | 28.8 | 7.4 |
| A12 | 1,383 | 6.2 | 55.4 | 28.2 | 7.0 |
| B16 | 1,289 | 4.1 | 75.1 | 24.4 | 7.8 |
| B17 | 1,200 | 2.8 | 51.5 | 24.5 | 7.9 |
| B18 | 1,276 | 2.8 | 77.7 | 24.0 | 8.7 |
| B19 | 1,201 | 4.1 | 52.4 | 23.8 | 8.4 |
| B20 | 1,193 | 3.1 | 77.9 | 24.3 | 7.9 |

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 from Dworshak NFH at the end of March. However, flows increased quite sharply by the end of April to over 100,000 cfs. By that time, nearly 50% of the fish had arrived at Lower Granite Dam and did not benefit from the flows of nearly 200,000 cfs by the end of May. Daily mean flows remained over 100,000 cfs until the end of June. Flows during 1998 were lower but very similar to the high flow of (**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 1996 spring chinook salmon was 67.2 %. (**Table 11**).

Table 11. 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 in 1998 (BY96).

| Raceway | Number of Tags Released | Number of Unique Interrogations | | | | Total | Percent |
|---------|-------------------------|---------------------------------|------------------|----------------------|------------|-------|---------|
| | | Lower Granite Dam | Little Goose Dam | Lower Monumental Dam | McNary Dam | | |
| A05 | 3,991 | 1,124 | 873 | 329 | 166 | 2,592 | 64.9 |
| A07 | 4,019 | 1,296 | 839 | 325 | 232 | 2,692 | 67.0 |
| A08 | 4,026 | 1,285 | 856 | 318 | 222 | 2,681 | 66.6 |
| A09 | 4,010 | 1,342 | 798 | 314 | 216 | 2,670 | 66.6 |
| A10 | 4,005 | 1,353 | 787 | 287 | 223 | 2,650 | 66.2 |
| A11 | 4,012 | 1,377 | 786 | 312 | 237 | 2,712 | 67.6 |
| A12 | 4,011 | 1,383 | 785 | 298 | 273 | 2,739 | 68.3 |
| B16 | 4,006 | 1,289 | 741 | 338 | 323 | 2,691 | 67.2 |
| B17 | 4,000 | 1,200 | 806 | 351 | 344 | 2,701 | 67.5 |
| B18 | 3,998 | 1,276 | 745 | 360 | 363 | 2,744 | 68.6 |
| B19 | 4,004 | 1,201 | 739 | 382 | 335 | 2,657 | 66.4 |
| B20 | 3,658 | 1,193 | 692 | 315 | 330 | 2,530 | 69.5 |

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, 1998 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 1996 spring chinook salmon smolts released in 1998 returned as adults in 1999 (I-Ocean), 2000 (II-Ocean), and 2001 (III-Ocean). The total adult return to the hatchery rack was 4,244 fish and is summarized in **Table 12**. The smolt to adult return rate was 0.4360%.

Table 12. Summary of adult returns to Dworshak NFH for Brood Year 1996 spring chinook salmon (IFRO 2001). A total of 973,400 smolts were released from Dworshak NFH in 1997.

| Return Year | Ocean Age | Number of Returns | Smolt to Adult Return Rate (%) |
|-------------|---------------------|-------------------|--------------------------------|
| 1999 | I | 670 | 0.0688 |
| 2000 | II | 2,827 | 0.2904 |
| 2001 | III | 747 | 0.0767 |
| | Total Return | 4,244 | 0.4360 |

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 BY96 spring chinook salmon occurred in 1999 (I-Ocean fish), in 2000 (II-Ocean fish) and in 2001 (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 57 I-Ocean spring chinook salmon out of the North Fork in 1999. In 2000, the Tribe reported harvesting 1,173 spring chinook, 1,036 of which were estimated to be II-Ocean fish based on the age composition of the rack return to Dworshak NFH. In 2001, the reported harvest was 812, of which 151 were estimated to be III-Ocean fish, again based on the age composition of the rack return to Dworshak NFH. Therefore, the total Tribal harvest of BY96 spring chinook salmon is estimated to be 1,244 fish (57 I-Ocean, 1,036 II-Ocean, and 151 III-Ocean).

Idaho Sport Fisheries - Sport fishing occurred in 2000 and 2001. Returns were too low in 1999 to open a sport harvest season. The Idaho Department of Fish and Game reported a total estimated harvest of 3,908 adult salmon in 2000, 3,512 of which was estimated to be II-Ocean fish. The total estimated sport harvest in 2001 was 8,267 in the Clearwater River. However, the total harvest has not been separated out by stock based on coded-wire tag returns, so the proportion of the total harvest comprised of Dworshak NFH stock has not been estimated yet. Therefore the total number of BY96 Dworshak spring chinook salmon harvested can not be

estimated. A minimum estimate of 3,512 is obtained simply using the number of II-Ocean adults.

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 BY96, the estimated minimum total is 8,990 (4,244 rack return and 4,756+ harvested) giving a smolt to adult return rate of 0.9235 %. This is the third best rate of return for any brood year on record at Dworshak NFH.

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 July 2002. For Brood Year 1996 spring chinook released from Dworshak NFH as smolts in 1998, a total of 69 coded-wire tag were recovered outside the Clearwater River basin. Fifty-three were collected in Tribal subsistence and ceremonial fisheries in the Bonneville Pool. **Table 13** 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.

Table 13 . Number of coded-wire tagged Brood year 1992 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 | | |
|---------------------------------|----------------------|---------------|------|------|
| | | 1999 | 2000 | 2001 |
| Bonneville Pool Umatilla Tribe | ODFW ¹ | - | 32 | - |
| Bonneville Pool Ceremonial | ODFW | - | 21 | - |
| Dalles Pool | ODFW | - | 2 | - |
| Youngs Bay | ODFW | 1 | - | - |
| Wells W Ladder Trap | WDFW ² | - | 1 | - |
| Willamette River Lwr Bts | ODFW | - | 1 | - |
| Round Butte Trap | ODFW | - | 6 | - |
| Little White Salmon NFH | FWS ³ | 1 | - | - |
| Lower Granite Dam Tailrace | ODFW | - | 2 | - |
| Klickitat Hatchery | WDFW | - | 1 | - |
| Wenaha River | ODFW | - | 1 | - |
| Totals | | 2 | 67 | 0 |

¹ Oregon Department of Fish and Wildlife

² Washington Department of Fish and Wildlife

³ U.S. Fish and Wildlife Service

⁴ Idaho Department of Fish and Game

SPECIAL STUDIES

Adult Tagging

After three years of evaluations and testing, in 1996 we discovered a material called TYVEK that was very flexible, yet extremely durable. We decided that the difficulties encountered in 1995 with the plastic tags might be eliminated or significantly reduced by using tags manufactured from TYVEK and not crimping the staples. This year of the study was designed to evaluate the utility and durability of numbered TYVEK tags for managing spring chinook salmon broodstock at Dworshak NFH. This was the fourth and final year for this study (Jones and Rhine 1997).

A total of 1,108 adult spring chinook salmon were tagged using TYVEK tags. Six hundred and sixty-one males were tagged, primarily I- and II-Ocean fish. Four hundred and fourteen females were tagged, almost all were II-Ocean fish. Only thirty-three of the tagged fish could not be definitively sexed because of losing the tag before the fish was spawned. At the end of spawning, a total of 1,105 of the tagged fish were accounted for and were used in the analyses. A total of 973 fish retained their tags for an overall tag retention rate of 88.1%. A total of 132 fish lost their tags. Tag loss was minimal until we started handling fish regularly for spawning which began on August 20. The primary reason for tag loss during spawning was attributed to tags catching on the fish baskets in the spawning room, physically ripping the tags off the operculum as the fish slid out of the baskets onto the sorting table.

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 contributed 47,740 BY96 spring chinook salmon smolts in 1998 for marking 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 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 1996
and Prognosis for 1997**

Idaho Fishery Resource Office

APPENDIX A

ADULT SPRING CHINOOK SALMON RETURNS TO DWORSHAK-KOOSKIA NFH COMPLEX IN 1996 AND PROGNOSIS FOR 1997

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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. At that time, the hatchery had 25 Burrows ponds on a reuse system and 59 ponds on single-pass for rearing steelhead. In 1972, a second phase of construction placed all ponds on the reuse system with the option of operating some ponds on either reuse or single pass. 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-ft by 80-ft raceways were constructed. (In 1993, two of these raceways were converted to adult holding ponds). In 1986, 12 8-ft by 75-ft raceways were converted from rainbow trout rearing to chinook salmon rearing.

In 1995 Kooskia NFH was included when the Dworshak Fishery Complex was formed. 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 holds and spawns spring chinook salmon adults returning to Kooskia NFH. Kooskia NFH eggs and juveniles are often held at Dworshak NFH as well. This report includes a summary of the 1996 adult returns of spring chinook salmon to Dworshak and Kooskia NFHs and also includes predictions for the 1997 adult returns.

A low return prediction in 1996 for Clearwater River spring chinook salmon, led to the sport fishery not opening.

Stock description

The initial Dworshak NFH spring chinook salmon program utilized a variety or mix of stocks for release years 1983-86 (Table 1). Leavenworth and Little White Salmon stocks have both been strongly influenced by Carson stock transfers to their programs. The two release years of Rapid River stock (1987-1988) indicate a complete shift from Carson type stocks to rearing smolts from eggs transferred from Rapid River State Fish Hatchery. For those two release years, the eggs taken at Dworshak NFH and Kooskia NFH returns were transferred to Kooskia NFH.

This mix was referred to as Clearwater stock (**Table 2**). In fact, the Kooskia NFH program already had stock made up primarily of Carson derivatives. So the resultant Kooskia stock (1989 and later) is still considered a Carson type stock. 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 products of Rapid River 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.

Table 1. Genetic make-up of Dworshak NFH spring chinook salmon smolts directly released from the hatchery, 1983-1996.

Release Year

Genetic Make-up*

| | |
|------|----------------------------|
| 1983 | 75.1% LW-12.3% RR-12.6% LE |
| 1984 | 100% LE |
| 1985 | 67.8% LW-32.2% LE |
| 1986 | 100% LE |
| 1987 | 100% RR |
| 1988 | 100% RR |
| 1989 | 100% DW |
| 1990 | 100% DW |
| 1991 | 100% DW |
| 1992 | 100% DW |
| 1993 | 100% DW |
| 1994 | 100% DW |
| 1995 | 65.6% DW-34.4% KK |
| 1996 | 100% DW |

*RR - Rapid River
 LW - Little White
 LE - Leavenworth
 DW - Dworshak
 KK - Kooskia

Table 2. Genetic make-up of Kooskia NFH spring chinook salmon smolts directly released from the hatchery, 1971-1996.

| Release Year | Genetic Make-up* |
|--------------|--------------------------|
| 1971 | 85.6% RR - 14.4% 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 | 100% KK |
| 1990 | 100% KK |
| 1991 | 100% KK |
| 1992 | 100% KK |
| 1993 | 100% KK |
| 1994 | 100% KK |
| 1995 | 100% KK |
| 1996 | 100% KK |

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

1996 Run Size

Rack Returns

The 1996 adult spring chinook salmon return to Dworshak NFH was 963, the best since 1990 although still well short of the runs of the late 1980's and 1990 (**Table 3**). The adult spring chinook salmon return to Kooskia NFH was 202. Although better than last years run of 125, it is still the third lowest run recorded (**Table 4**).

Table 3. Hatchery rack returns and age composition of spring chinook salmon for Dworshak NFH, 1984-1996.

| Year | I-salt | II-salt | III-salt | Unmeasured | Total Return |
|------|--------|---------|----------|------------|--------------|
| 1984 | 14 | 52 | 16 | 0 | 82 |
| 1985 | 13 | 281 | 35 | 5 | 334 |
| 1986 | 78 | 346 | 91 | 0 | 516 |
| 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 |
| 1996 | 275 | 663 | 25 | 0 | 963 |

Table 4. Hatchery rack returns and age composition of spring chinook salmon for Kooskia NFH, 1972-1996.

| 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 | 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 |

Table 4. cont.

| Year | I-salt | II-salt | IIT-salt | Unmeasured | Total Return |
|------|--------|---------|----------|------------|--------------|
| 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 | 83 | 36 | 6 | 0 | 125 |
| 1996 | 86 | 113 | 3 | 0 | 202 |

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 majority of spring chinook salmon returning to both Dworshak and Kooskia NFHs are II-salts with very few III-salts (**Table 5**).

Table 5. Age composition of spring chinook salmon returning to Dworshak Fishery Complex, 1996.

| Ocean Age | Dworshak NFH | | Kooskia NFH | |
|----------------|--------------|---------|-------------|---------|
| | Number | Percent | Number | Percent |
| I-Salt | 275 | 28.6 | 86 | 42.6 |
| II-Salt | 663 | 68.8 | 113 | 55.9 |
| III-Salt | 25 | 2.6 | 3 | 1.5 |
| Total Measured | 963 | 100.0 | 202 | 100.0 |

Survival

The III-salt returns in 1996 complete the returns from the 467,222 smolts released at Dworshak NFH and the 343,437 smolts released at Kooskia NFH in 1993. Total returns to the North Fork of the Clearwater from the 1993 release were 3 I-salts, 36 II-salts, and 25 III-salts for a hatchery return survival rate of 0.0137 percent (**Table 6**). Total returns to Clear Creek from the 1993 release were 1 I-salt, 7 II-salts, and 3 III-salts for a hatchery return survival rate of 0.0032 percent (**Table 7**).

Table 6. Return vs. Release numbers for adult spring chinook salmon returns to Dworshak NFH, 1988-1995.

| Release Year | Smolts Released at Hatchery* | I-salts (% return) | II-salts (% return) | III-salts (% return) | Total (% return) |
|--------------|------------------------------|--------------------|---------------------|----------------------|--------------------|
| 1988 | 1,547,219 | 156 (0.0101%) | 2,709 (0.1751%) | 72 (0.00476%) | 2,937 (0.1898%) |
| 1989 | 1,651,472 | 10 (0.0006%) | 77 (0.00476%) | 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 (0.00549%) | 64 (0.0137%) |
| 1994 | 1,278,273 | 83 (0.0065%) | 663 (0.0517%) | | |
| 1995 | 1,311,445 | 275 (0.0210%) | | | |

*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, 1988-1995.

| Release Year | Smolts Released at Hatchery* | I-salts (% return) | II-salts (% return) | III-salts (% return) | Total (% return) |
|--------------|------------------------------|--------------------|---------------------|----------------------|------------------|
| 1988 | 778,407 | 107 | 921 | 350 | 1,378 |

| | | | | | |
|------|---------|-----------------|-------------------|------------------|------------------|
| | | (0.0137%) | (0.1183%) | (0.0450%) | (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%) | 7451 (0.2026%) | 135 (0.0365%) | 898 (0.2430%) |
| 1992 | 727,251 | 11 (0.0015%) | 96 (0.0132%) | 12 (0.0017%) | (0.0164%) |
| 1993 | 343,437 | 1 (0.0003%) | 7 (0.0020%) | 3 (0.0009%) | 11 (0.0032%) |
| 1994 | 305,813 | 21 (0.0069%) | 113 (0.0360%) | | |
| 1995 | 722,906 | 86 (0.0119%) | | | |

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

Coded-Wire Tag (CWT) 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 (1988-1994 release years, 9 to 24 CWT groups).

At Kooskia NFH, we released CWT groups less often (1984, 1990, 1992, 1993, and 1994). In 1993 and 1994 all hatchery fish were marked in order to discriminate 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.

CWT recoveries from spring chinook salmon in the Dworshak NFH rack shows seven 1996 recoveries were from salmon released from facilities other than Dworshak NFH or Kooskia NFH (**Table 8**). Rack recoveries in

previous years have included strays from several other hatcheries and also National Marine Fisheries Service transportation study marks.

Table 8. Summary of CWT recoveries for adult spring chinook salmon in the Dworshak NFH rack, 1987-1996.

| Rack Year | Total Recoveries | Recoveries of Dworshak/Kooskia 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 | 95 |
| 1996* | 515 | 508 |

*1992, 1993, 1994, 1995, and 1996 recoveries include fish tagged at Kooskia NFH.

1996 Run Predictions

Dworshak NFH-1996

The 1996 spring chinook salmon return to Dworshak NFH was 963 salmon, very close to our prediction total. Our II-salt estimate was a little high, while our I-salt estimate was very low (**Table 9**). The I-salt return was nearly double the previous record high. The following numbers include only Dworshak NFH rack returns. The Nez Perce Tribal estimated harvest was 24 adults and 5 jacks. A number of Dworshak NFH and Kooskia NFH CWT's were taken in a number of other racks.

Table 9. Predicted and actual rack returns of spring chinook salmon to Dworshak NFH by ocean age class, 1996.

| Ocean Age Class | Prediction | Rack Return |
|-----------------|------------|-------------|
| I-salt | 50 | 275 |
| II-salt | 900 ± 200 | 663 |
| III-salt | <u>5</u> | <u>25</u> |
| Total | 955 ± 200 | 963 |

Kooskia NFH-1996

The 1996 spring chinook salmon return to Kooskia NFH was disappointing. The total return was only 202 salmon. Our II-salt estimate was **very** high (**Table 10**).

Table 10. Predicted and actual rack returns of spring chinook salmon to Kooskia NFH by ocean age class, 1996.

| Ocean Age Class | Prediction | Rack Return |
|-----------------|------------|-------------|
| I-salt | 20 | 86 |
| II-salt | 300 ± 100 | 113 |
| III-salt | <u>5</u> | <u>3</u> |
| Total | 325 ± 100 | 202 |

1997 Run Predictions

Our forecast for the 1997 spring chinook salmon returns to Dworshak and Kooskia NFHs is given in **Table 11**. These estimates are for total return including whatever sport and tribal harvest occurs.

Table 11. Predicted returns of spring chinook salmon to the Dworshak Fishery Complex by ocean age class, 1997.

| Ocean Age Class | Dworshak NFI4 | Kooskia NFH |
|-----------------|---------------|-------------|
| I-salt | 6 | 20 |
| II-salt | 2,725 ± 300 | 720 ± 100 |
| III-salt | <u>100</u> | <u>20</u> |
| TOTAL | 2,831 ± 300 | 760 ± 100 |

The combined forecast for 1997 is for 3,591 ± 400 spring chinook salmon to return to the Dworshak Fishery Complex. We predict broodstock requirements (**1,700**) will be met for the first time in several years. There should be a substantial harvestable surplus! However, the estimated return will still be short of the our mitigation goal of 9,135 adults to Lower Granite Dam.

Literature Cited

Elliot, D.G. and R. J. Pascho. 1994. Juvenile fish transportation: Impact of b

APPENDIX II

**SPAWNING REPORT
Spring Chinook Salmon
Brood Year 1996**

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

SPAWNING REPORT

Brood Year 1996
Spring Chinook Salmon

Prepared by:

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Dworshak Production

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

Adult Returns

The fish ladder was opened to receive returning adult chinook on May 24, and was closed on September 12. During this period, a total of 952 Dworshak chinook were collected. Kooskia NFH transported adults to Dworshak NFH between June 20 and August 16. A total of 196 Kooskia adult chinook were collected.

| Table 1. Dworshak adult returns-rack summary BY96 SCS | | | | | | |
|---|------------|------------|-----------|------------|------------|----------|
| DATE FISH EXAMINED | I-Ocean | II-Ocean | III-Ocean | WEEK TOTAL | CUMULATIVE | % OF RUN |
| 6/13/96 | 0 | 3 | 0 | 3 | 3 | 0.3 |
| 6/25/96 | 56 | 89 | 3 | 148 | 151 | 15.9 |
| 7/02/96 | 81 | 140 | 3 | 224 | 375 | 39.4 |
| 7/10/96 | 50 | 207 | 8 | 265 | 640 | 67.3 |
| 7/18/96 | 35 | 94 | 3 | 132 | 772 | 81.2 |
| 7/29/96 | 23 | 48 | 1 | 72 | 844 | 88.7 |
| 8/12/96 | 8 | 26 | 0 | 34 | 878 | 92.3 |
| 8/19/96 | 5 | 10 | 2 | 17 | 895 | 94.1 |
| 8/22/96 | 1 | 7 | 1 | 9 | 904 | 95.1 |
| 8/26/96 | 1 | 9 | 0 | 10 | 914 | 96.1 |
| 8/29/96 | 1 | 1 | 0 | 2 | 916 | 96.3 |
| 9/3/96 | 3 | 9 | 2 | 14 | 930 | 97.8 |
| 9/6-9/9 | 6 | 15 | 0 | 21 | 951 | 100.0 |
| TOTAL | 270 | 658 | 23 | 951 | 951 | |

-one II-Ocean mort found in trap brings the total to 952

| Table 2. Kooskia adult returns-rack summary BY96 SST | | | | | | |
|--|---------|----------|-----------|------------|------------|----------|
| DATE FISH EXAMINED | I-Ocean | II-Ocean | III-Ocean | WEEK TOTAL | CUMULATIVE | % OF RUN |
| 6/20/96 | 29 | 15 | 0 | 44 | 44 | 22.4 |
| 6/28/96 | 23 | 24 | 0 | 47 | 91 | 46.4 |
| 7/03/96 | 13 | 18 | 1 | 32 | 123 | 62.8 |
| 7/11/96 | 18 | 26 | 1 | 45 | 168 | 85.7 |
| 7/17/96 | 4 | 2 | 0 | 6 | 174 | 88.8 |
| 7/23/96 | 0 | 15 | 0 | 15 | 189 | 96.4 |
| 8/2/96 | 0 | 1 | 0 | 1 | 190 | 96.9 |
| 8/7/96 | 1 | 1 | 0 | 2 | 192 | 98.0 |
| 8/12/96 | 1 | 2 | 0 | 3 | 195 | 99.5 |
| 8/16/96 | 0 | 1 | 0 | 1 | 196 | 100.0 |

Table 2. Kooskia adult returns-rack summary BY96 SST

| | | | | | | |
|--------------|-----------|------------|----------|------------|------------|--|
| TOTAL | 89 | 105 | 2 | 196 | 196 | |
|--------------|-----------|------------|----------|------------|------------|--|

Adult Holding

Dworshak stock was kept in holding pond 1 and Kooskia stock was held in holding pond 2. All of the fish received numbered opercular tags in order to distinguish stocks. Formalin treatments were administered in order to retard fungus infection. The formalin treatments to the adults began on June 26 with three treatments per week at 200 mg/l. On July 22, the treatments were then stepped up to five days per week. Treatments continued until September 20. The treatments appeared to be quite effective, as fungus did not become a problem. Incoming fish were also injected with erythromycin as a preventative for BKD.

Adult Mortality

Pre spawning mortality of BY 96 adult chinook was 2.5% for Dworshak stock and .5% for Kooskia stock. During spawning, losses were 14.1% for Dworshak stock and 19.4% for Kooskia stock.

Table 3. Mortality of adult spring chinook salmon, BY 96, held from June 1996 through spawning, September 1996.

| Type Mortality | Dworshak | | Kooskia | | Total | |
|-----------------------------|------------|-------------|-----------|-------------|-----------------|-------------|
| | Number | Percent | Number | Percent | Number | Percent |
| Pre-spawning ¹ | 24 | 2.5 | 1 | .5 | 25/1148 | 2.2 |
| During spawning | 134 | 14.1 | 38 | 19.4 | 172/1148 | 15.0 |
| Total (through 9/19) | 158 | 16.6 | 39 | 19.8 | 197/1148 | 17.2 |

¹Mortality picked from holding ponds from July 11 through first spawn on August 20. Adults held: Dworshak - 952, Kooskia - 196.

Table 4. Comparison of BY 1996 total holding mortality percentages with previous five brood years - combined stock, Kooskia/Dworshak NFHs.

| Brood Year | -----Type Mortality----- | | |
|-----------------------|--------------------------|---------------------|-------------|
| | Pre-spawning (%) | During spawning (%) | Total (%) |
| 1991 | 20.8 | 4.0 | 23.7 |
| 1992 | 19.4 | 5.1 | 23.3 |
| 1993 | 7.4 | 6.1 | 13.2 |
| 1994 | 7.8 | 3.2 | 11.0 |
| 1995 | 6.1 | 1.2 | 7.3 |
| 5 Year Average | 12.3 | 3.9 | 15.7 |
| 1996 | 2.2 | 15.0 | 17.2 |

Spawning

Spawning began on August 20 with the first of nine egg takes. On September 17, the eleven remaining females were injected with LH-RH hormone to induce spawning, and the final spawning took place on September 24. A total of 383 females were spawned, 338 from dworshak stock and 45 from Kooskia stock. Dworshak males spawned numbered 363, and 49 Kooskia males were spawned. This resulted in spawning sex ratios (male/female) of 1.1:1.0 for Dworshak spawners and 1.1:1.0 for Kooskia spawners.

| Table 5. Dworshak Egg take information-brood year 96 spring chinook. | | | | | | |
|--|------------------|----------------|------------------|--------------|------------|-------------|
| Take | Eyed | Dead | Total | % Survival | # Females | Fecundity |
| 1 | 27,710 | 5,209 | 32,919 | 84.2% | 8 | 4115 |
| 2 | 40,182 | 16,262 | 56,444 | 71.2% | 18 | 3136 |
| 3 | 116,096 | 20,474 | 136,570 | 85.0% | 37 | 3691 |
| 4 | 383,250 | 52,284 | 435,534 | 88.0% | 121 | 3599 |
| 5 | 142,971 | 10,964 | 153,935 | 92.9% | 50 | 3079 |
| 6 | 80,599 | 13,346 | 93,945 | 85.8% | 27 | 3479 |
| 7 | 96,296 | 11,990 | 108,286 | 88.9% | 31 | 3493 |
| 8 | 105,469 | 15,983 | 121,452 | 86.8% | 36 | 3374 |
| 9 | 26,872 | 3,310 | 30,182 | 89.0% | 10 | 3018 |
| Total | 1,019,445 | 149,822 | 1,169,267 | 87.2% | 338 | 3459 |

| Table 6. Kooskia Egg take information-brood year 96 spring chinook. | | | | | | |
|---|----------------|---------------|----------------|--------------|-----------|-------------|
| Take | Eyed | Dead | Total | % Survival | # Females | Fecundity |
| 1 | 18,655 | 7,702 | 26,357 | 70.8% | 8 | 3295 |
| 2 | 8,902 | 3,544 | 12,446 | 71.5% | 3 | 4149 |
| 3 | 29,500 | 4,793 | 34,293 | 86.0% | 9 | 3810 |
| 4 | 25,833 | 4,141 | 29,974 | 86.2% | 9 | 3330 |
| 5,6 | 42,586 | 7,929 | 50,515 | 84.3% | 14 | 3608 |
| 7 | 3,110 | 232 | 3,342 | 93.1% | 1 | 3342 |
| 9 | 3,100 | 402 | 3,502 | 88.5% | 1 | 3502 |
| Total | 131,686 | 28,743 | 160,429 | 82.1% | 45 | 3565 |

note: Kooskia takes 5 and 6 mixed with Dworshak eggs and will be considered Dworshak stock.

Spawning Procedures

Adults were anesthetized with MS-222 and checked for ripeness. Males were sent directly to the spawning table while ripe females were killed using a pneumatic knife and bled for 5 to 10 minutes in a spawning rack. Green males and females were sent back to the holding ponds. Spawning adults were identified with numbered pins if they were sacrificed, which is necessary for later identification and segregation/culling of eggs according to disease status. Sperm was collected in disposable styrofoam cups and kept on ice until needed. Females were cut and eggs collected in disinfected colanders to drain ovarian fluid. Gametes from both males and females were mixed with the addition of a small amount of a 1% saline solution. After approximately two minutes, fertilized eggs were thoroughly rinsed and placed into incubators where they were disinfected with 75 mg/L iodine for 30 minutes. Females were swabbed with iodine before spawning. Males were not swabbed with iodine to avoid contaminating the milt. Iodine solutions of 500 mg/L were used to disinfect equipment and workers' hands.

Incubation

All eggs were incubated in Heath trays. Incubation temperatures averaged 44°F using the water chillers. The eggs were given a 15 minute 1,667 mg/l formalin drip treatment three times a week.

In order to achieve a smaller smolt size, it was decided that brood year 96 eggs would be shipped to Kooskia NFH. Kooskia's incubation temperature runs at a cooler 38°F versus 44°F for Dworshak's incubators. Dworshak takes 1 through 4 and Kooskia takes 1 through 6 were shipped to Kooskia on October 16. The remaining takes were held at Dworshak until November 14, at which point all of the temperature units on the eggs at both Dworshak and Kooskia were equal. All Dworshak stock which originated from medium or high BKD parents were not shipped and will be raised entirely at Dworshak. The Dworshak fish will be raised at Kooskia until they reach a size of 250 fish per pound, at which point they will be shipped back to Dworshak to be raised until release.

Approximately 27,000 Kooskia eggs (Kooskia takes 5 and 6) were accidentally mixed with Dworshak eggs and will be considered as Dworshak stock. Also a tray containing high BKD eggs (Dworshak stock) was accidentally mixed with a group of 25,000 low BKD eggs. (also Dworshak stock) This entire group of 30,000 eggs will now be considered high BKD and will be raised entirely at Dworshak.

Production Program Objectives

The 1,019,445 Dworshak stock eyed eggs should result in 935,000 smolts for release in April '98. This is assuming a survival from eyed eggs to smolt of 91.7%, the average survival for brood years '91 through '93. If the survival rates are similar for Kooskia fish, those 131,686 eyed eggs should result in 121,000 smolts.