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# LOWER SNAKE RIVER COMPENSATION PLAN

# LYONS FERRY EVALUATION PROGRAM

# 1986 ANNUAL REPORT

by

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## SECTION 1: INTRODUCTION

Congress authorized the Lower Snake River Fish and Wildlife

Compensation Plan (LSRCP) in 1976. As a result of that plan, Lyons Ferry Fish Hatchery (FH) was designed and is currently under operation. The objective of Lyons Ferry FH is to compensate for the loss of 18,300 adult fall chinook, Snake River stock, and 1,152 adult spring chinook, Tucannon River stock (U.S. Army, 1975). An evaluation program was initiated in 1984 to monitor the success of the Lyons Ferry FH in meeting the LSRCP compensation goal and to identify any production adjustments required to accomplish that objective. A specific list of the evaluation program's objectives is outlined in Appendix A. This report summarizes all activities performed by the Washington Department of Fisheries' (WDF) Lyons Ferry Evaluation Program from the time period 1 April 1986 through 31 March 1987. Section 2 of this report outlines the fall chinook operation and evaluation progress; Section 3 outlines spring chinook operation and evaluation progress.

## 1.1: Description of Facilities

The Lyons Ferry facility is located at the confluence of the Palouse River with the lower Snake River (Lower Monumental Pool; River Kilometer 90; Figure 1). At capacity, it is designed to raise 101,800 pounds (9,162,000 subyearling smolts at 90 fish per pound) of fall chinook and 8,800 pounds (132,000 yearling smolts at 15 fish per pound) of spring chinook (Table 1).

Table 1. Fall and spring chinook production objectives for Lyons Ferry and Tucannon Fish Hatcheries.

| Facility | Stock | Number produced | Pounds produced | Adult returns | Return rate (%) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Lyons Ferry | Fall | 9,162,000 | 101,800 | 18,300 | 0.20 |
| Tucannon | Spring | 132,000 | 8,800 | 1,152 | 0.87 |

The Lyons Ferry facility has a single pass wellwater system through the incubators, two adult holding ponds, and 28 raceways. A satellite facility is maintained on the Tucannon River (RK 61; Figures 1, 2) for collection of spring chinook adults and subsequent release of yearling progeny. It has an adult collection trap and one holding pond. Returning adult spring chinook are trapped and spawned at the Tucannon satellite facility. Progeny are incubated and reared to parr size at the Lyons Ferry facility, then trucked back to the Tucannon satellite for acclimation to river water and release. Fall chinook are hatched and reared at the Lyons Ferry facility and either released on station or barged downstream and released. Adult fall chinook will return to the fish ladder at the Lyons Ferry facility for spawning.

Figure 1. Lower Snake River Basin in southeast Washington, showing location of Lyons Ferry and Tucannon Fish Hatcheries.

Figure 2. Tucannon River Basin, showing location of Tucannon Fish Hatchery.

## SECTION 2: FALL CHINOOK PROGRAM EVALUATION

### 2.1: Broodstock Establishment

The Lyons Ferry FH has been building its broodstock since the facility was completed in 1984. Snake River fall chinook broodstock are currently obtained from three sources, and listed below in order of decreasing contribution over the past three years: [illegible]ng adults trapped at Ice Harbor Dam, 2) Snake River stock eyed eggs transported from the WDF Kalama Falls FH to Lyons Ferry FH, and 3) returns to the Lyons Ferry FH ladder.

2.1.1: Ice Harbor Dam trapping

Since 1977, returning adult fall chinook have been trapped at Ice Harbor Dam and transported to Dworshak and Tucannon hatcheries in conjunction with the Snake River Fall Chinook Egg Bank Program (Bjornn and Ringe 1986). Numbers of fish transported have averaged 456 adults (range: 212 - 663) and 57 jacks (range: 0 - 150). Since its completion in 1984, Lyons Ferry FH has been receiving the transported fall chinook. Numbers of adults trapped (and percent of total run past Ice Harbor Dam) in 1984, 1985, and 1986 were 663 (47 percent), 589 (28 percent), and 212 (7 percent) respectively (Table 2). Duration of trapping (and peak day of trapping) was 1 September to 5 October (11 September) in 1984, 31 August to 30 September (9 September) in 1985, and 4 September to 3 October (18 September) in 1986.

Table 2. Contribution of 1984, 1985, and 1986 fall chinook adult returns to Lyons Ferry Fish Hatchery from Ice Harbor Dam, Kalama Falls Fish Hatchery, to the Lyons Ferry fish ladder, and the total count past Ice Harbor Dam.

| Year | Collection point | Number collected | | Ice Harbor Dam count | |
|---|---|---|---|---|---|
| | | adults | jacks | adults | jacks |

| | | | | | |
|---|---|---|---|---|---|
| 1984 | Ice Harbor | 663 | 97 | 1410 | 642 |
| | Kalama Falls | 220 | 10 | | |
| | Lyons Ferry | - - | - -a | | |
| 1985 | Ice Harbor | 589 | 90 | 2046 | 7119 |
| | Kalama Falls | 952 | 2 | | |
| | Lyons Ferry | 6 | 4070a | | |
| 1986 | Ice Harbor | 212 | 23 | 3152 | 2665 |
| | Kalama Falls | | | | |
| | Lyons Ferry | 245 | 1125 | | |

[a] The first release from Lyons Ferry FH was in 1985 (1983 brood) therefore, first returns of hatchery-reared stock to Lyons Ferry FH were 2 year old jacks in 1985.

### 2.1.2: Kalama Falls egg transport

Prior to completion of the Lyons Ferry FH, a portion of the Snake River stock fall chinook adults were collected and reared at the WDF Kalama Falls FH on the lower Columbia River as part of the Snake River Fall Chinook Egg Bank Program. Since the completion of the Lyons Ferry facility, eyed eggs are transported from the Kalama Falls facility to Lyons Ferry for rearing and subsequent release. Hatchery staff transported 219,800 1984 brood eggs, 1,182,000 1985 brood eggs, and 749,355 1986 brood eggs from Kalama Falls FH (Table 2). Snake River stock fall chinook have not been released from Kalama Falls FH since spring 1984; all releases since that time will originate at Lyons Ferry.

### 2.1.3: Returns to Lyons Ferry Fish Hatchery

Numbers of fall chinook returning to the Lyons Ferry FH ladder are increasing each year because on-station releases underway since 1985 are returning as adults. In 1986, 245 adults and 1,125 jacks returned to the hatchery compared to 6 adults and 4070 jacks in 1985 (Table 2). First adult arrival to the rack was on 6 October; last arrival was on 14 November.

### 2.1.4: Fall chinook spawning ground surveys

During the period 9 to 18 November, program staff completed fall chinook spawning ground counts in the southeast Washington/ northern Oregon region. On 9 November, Oregon Department of Fish and Wildlife (ODFW) district biologist Witty and program biologist Bugert sighted seven redds in the mainstem Snake River from Hells Canyon Dam to Asotin. Visibility was poor because of high runoff below the dam. We believe a large number of redds were not seen, and this number should not be used as an indicator of fall chinook production in the mid-Snake River. Surveys were also made on the lower Grande Ronde River (confluence to Joseph Creek) on 9 November, and on the lower Tucannon River (confluence to Starbuck Dam) on 18 November. We found no evidence of fall chinook spawning activity in these streams. Basham (personal communication), however, observed 2 fall chinook carcasses on the Tucannon River near RK 3 on 24 December.

## 2.2: Fall Chinook Stock Profile Investigations

### 2.2.1: 1986 Broodstock

From 5 September through 15 November 1986, 457 fall chinook adults and 1,148 jacks (fish less than 61 cm fork length) were collected at Lyons Ferry FH. Fish were spawned, and scales were sampled from 22 October to 17 December, with a total of scale samples (or percent) taken. Excluding the 2 year olds, age composition was percent 3 year olds, percent age 4, and percent age 5 (Table 3).

Table 3. Age composition by sex of fall chinook sampled at Lyons Ferry Fish Hatchery, 1986.

| Sex | Age 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|
| Male | | | | | |
| Female | | | | | |
| Total | | | | | |

Average fecundity for 1986 returning fall chinook adults was 4,386 eggs/female. Excluding jacks, the ratio of females to males was 0.48:1.00 (149 females and 308 males). This ratio differs markedly from the 1985 returning adult ratio of 1.79 females per male (382 females and 213 males) and the 1984 adult ratio of 2.09 females per male (474 females and 226 males). The length frequency distribution of the 1986 fall chinook returns excluding the age 2 jacks is presented in Figure 4. The age 2 jacks ranged in length from cm with a mean of .

Figure 4. Length frequency distribution of fall chinook spawned at Lyons Ferry Fish Hatchery in 1986.

### 2.2.2: Electrophoretic analysis

Program staff collected the following fall chinook electrophoretic samples during the study period: 1) 100 samples of 1986 adult returns to Lyons Ferry FH, 2) 100 samples from mid-Columbia River "bright" adults at the Priest Rapids FH, and 3) 100 samples from returning Snake River adults at Kalama Falls FH. Samples from adults include eye, liver, heart, and skeletal muscle tissue. Samples were maintained at $-80^{o}$ C prior to processing at the Genetic Stock Identification (GSI) Laboratory in Olympia, Washington. Juveniles were collected and frozen whole for processing. We collected otoliths from 30 Lyons Ferry adults to be retained for supplementary stock identification in the future (Neilson et al 1985).

Data from the electrophoretic analysis provide the following information:

1) compilation of a data base of genetic polymorphism among chinook stocks within the Snake River Basin.

2) discernment of genetic differences between lower Snake River and middle Columbia River fall chinook stocks.

3) a data base to observe any potential long-term genotypic changes in a wild chinook stock receiving hatchery enhancement.

## 2.3: Lyons Ferry Hatchery Practices

### 2.3.1: Spawning and rearing

The first take of 1986 brood fall chinook eggs was on 22 October; last take was on 16 December (Table 4). Peak of spawning was 11 November? Eggtake was 592,061, with 23,561 dead eggs picked off, resulting in a loss of 3.98 percent. Hatchery staff collected 749,355 Snake River stock eggs from Kalama Falls FH, adjusting total 1986 fall chinook eggtake to 1,341,416.

Table 4. Collection and spawning summary for 1986 fall chinook broodstock at Lyons Ferry Fish Hatchery.

| Week ending | Arrivals adult | Arrivals jacks | Mortality M | Mortality F | Mortality J | Spawned M | Spawned F | Spawned J | Estimated egg take |
|---|---|---|---|---|---|---|---|---|---|
| 09/06/86 | 1 | | | | | | | | |
| 09/13 | 25 | | | | | | | | |
| 09/20 | 95 | | | | | | | | |
| 09/27 | 71 | | | 1 | | | | | |
| 10/04 | 20 | | | | | | | | |
| 10/11 | 16 | | | | | | | | |
| 10/18 | 10 | | | | 1 | | | | |
| 10/25 | 1 | | | | | 1 | 1 | 1 | 5,493 |
| 11/01 | [illegible] | | [illegible] | | 45 | 29 | 3 | 198 | 44,727 |
| 11/08 | 9 | | | | 4 | 5 | 9 | 279 | 103,005 |
| 11/15 | 177 | | 2 | 2 | | | 25 | 21 | 205,825 |
| 11/22 | | | 1 | 1 | 1 | 9 | 48 | 161 | 122,213 |
| 11/29 | | | 3 | 2 | 3 | 123 | 31 | 116 | 71,040 |
| 12/06 | | | 9 | | 1 | 94 | 16 | 23 | 25,626 |
| 12/13 | | | | | | 12 | 6 | 2 | 14,132 |
| 12/20 | | | 2 | | 2 | 16 | 4 | 1 | |
| Total | 426 | 1148 | 19 | 6 | 57 | 289 | 143 | 752[a] | 592,061 |

[a] Three hundred thirty-nine jacks were donated unspawned to charities, adjusting total number of jacks to 1148.

### 2.3.2: Disease incidence

The 1984 brood had minor outbreaks of BKD, viral erythrocytic necrosis (VEN), low temperature disease, and chinook lateral line syndrome (CHILLS). Monthly mortality rates averaged 0.40 percent (range: 0.07 - 1.24). Overall mortality rate for the 1984 brood fall chinook was 5.88 percent. To prevent spread of infectious haematopoietic necrosis (IHN) disease, females were spawned in groups of five. Egg groups were reared separately until they were certified IHN negative. Four groups of the 1985 brood were found to have incidence of the IHN virus and consequently were destroyed. Table 9 outlines diseases of 1984 and 1985 brood fall chinook at Lyons Ferry FH and the treatments given for the diseases.

Table 9. Incidence, date, location, and treatment of diseases for 1984, 1985, and 1986 brood fall chinook contracted at Lyons Ferry Salmon Hatchery.

| Date | Brood year | Disease | Pond numbers | Treatment |
|---|---|---|---|---|
| 03/86 | 1984 | Bacterial kidney disease | 19-20-24-26 | Gallimycin |
| 04/86 | 1985 | Bacterial gill disease | 7 | Diquat |
| 08/86 | 1985 | Enteric redmouth disease | 14 | TM-50 |
| 09/86 | 1985 | Enteric redmouth disease | 14 | TM-50 |
| 11/86 | 1985 | Enteric redmouth disease | 11-12-[illegible]-14 | Romet-30 |
| 11/86 | 1986 | Fungus | Incubation room | Formalin |
| 12/86 | 1985 | Enteric redmouth disease | 11 through 28 | Romet-30 |
| 12/86 | 1986 | Fungus | Incubation room | Formalin |

## 2.4: Smolt Releases

Hatchery staff planted 481,950 yearling (1984 brood) fall chinook on 2, 4, and 8 April 1986 and 1,789,560 subyearling (1985 brood) fall chinook on 10 and 13 June 1986 (Table 5). Of the subyearling group, 247,392 fall chinook were transported by barge immediately downstream of Ice Harbor Dam on the Snake River for release. The remainder of the subyearlings (1,542,168) and all yearling fall chinook were released on station. Mean length and coefficient of variation for the yearling release were 167.4 mm and 8.06, respectively. Mean length and coefficient of variation for the subyearling release were 81.6 mm and 11.37, respectively. Both releases were on station. Length frequency distributions for the subyearling on-station and transported releases are presented in Figures 5 and 6, respectively. Figure 7 is the length frequency distribution for the on-station yearling release.

Figure 5. Length frequency distribution of subyearling fall chinook released from Lyons Ferry Fish Hatchery in June 1986.

Figure 6. Length frequency distribution of subyearling fall chinook transported below Ice Harbor Dam in June 1986.

Figure 7. Length frequency distribution of yearling fall chinook released from Lyons Ferry Fish Hatchery in April 1986.

### Transported releases

Fish were loaded into the barge on 12 June and were released adjacent to the lower Navigation wing wall at Ice Harbor Dam the following day; total transport time was 34 hours. Water temperature ranged from 15.2 to 16.0 C during transport. Water was continuously pumped through the barge during the transport to aid fish in olfactory acclimation to the Snake River.

### On-station releases

Table 6 describes the Snake River conditions at time of release.

Table 6. Lower Monumental Pool river conditions at time of Lyons Ferry Hatchery fall chinook releases in 1986.

| Date | Mean discharge (kcfs) | Mean spill (kcfs) | Mean water temperature (degrees C) |
|---|---|---|---|
| 2-8 April | | | |
| 10-13 June | | | |

# SECTION 3: SPRING CHINOOK PROGRAM EVALUATION

## 3.1: Broodstock Establishment

Hatchery personnel operated an adult trap adjacent to the Tucannon satellite facility to collect the spring chinook brood stock at Lyons Ferry FH. Operations design called for collection of fish on a one-to-one basis with those fish allowed to pass through the rack for natural spawning. First adult arrival to the rack was on 15 May; the last adult arrived on 30 June. Modal day of arrival was 27 May. We collected 116 adults to fulfill broodstock requirements, and passed 131 adults upstream, giving a total escapement of 247.

## 3.2: Spring Chinook Stock Profile Investigations

### 3.2.1: 1986 broodstock

Average fecundity for the Tucannon River spring chinook was 3,836 eggs per female. Length frequencies were taken from all fish collected at the rack (116 total; Figure 8). Chinook salmon spawned at the Tucannon Hatchery were mostly 4 years old, with two years of their life in the ocean ($4_2$), one three year jack

($3_2$) was recovered, and the remainder were 5 [illegible] olds having spent 3 years in the ocean ($5_2$; Table 7). We found the mean length of age 4 returning adults (72.3 cm) to be significantly less than age 5 adults (86.9 cm; unpaired t-test $p<0.05$). Lengths differed little from the 1985 returning adults of 74.5 cm for 4 year olds and 86.6 for age 5 adults.

Table 7. Sex, mean fork length [illegible] ...sions) of spring chinook spawned at the Tucannon Fish Hatchery, 1986.

| Sex | Fork length (SD, n) at given age: $3_2$ | $4_2$ | $5_2$ | Total number |
|---|---|---|---|---|
| Female | - - | 73 (4.0, 46)[a] | 86 (3.2, 11) | 57 |
| Male | 63 (-, 2) | 71 (4.4, 43) | 87 (3.7, 13) | 58 |
| Total | 2 | 89 | 24 | 115 |

[a] Fork length between two ages different at $p<0.05$.

Figure 8. Length frequency distribution of spring chinook adults collected at the Tucannon Hatchery in 1986.

### 3.2.2 Electrophoretic analyses

Program staff collected 100 electrophoretic and otolith samples from adult spring chinook collected at the Tucannon FH. Otoliths are retained as a possible supplement in stock identification (Neilson et al. 1985). We also retained all parr mortalities incurred during the electrofishing surveys and downstream migrant trap operations (114 total) from the Tucannon River for electrophoretic analysis (Appendix B). We collected morphometric measurements on these parr to be used also as a supplementary stock identification tool (Taylor 1986).

## 3.3: Lyons Ferry/Tucannon Hatchery Practices

### 3.3.1: Spawning and rearing

Tucannon River spring chinook were spawned at the Tucannon FH; eggs were immediately transported to Lyons Ferry FH for incubation and rearing. Spawning went from 3 September to 1 October, with peak of spawning on 17 September (Table 9). Eggtake was 187,958, with 3,793 dead eggs picked, resulting in a 2.01 percent loss. Fry were ponded in November and December 1986. Average weekly mortality rates since ponding is -.-- percent (range: -----------).

Table 9. Collection and spawning summary for 1986 spring chinook broodstock at Tucannon Fish Hatchery.

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### 3.3.2: Disease incidence

The 1985 brood had minor outbreaks of fungus and ERM (Table 10). Both the 1985 and 1986 broods were fed Gallimycin as prophylaxis for BKD. Monthly mortality rates averaged ----- percent (range: ) for the 1985 brood and percent (range: ) for the 1986 brood. Overall mortality rate for the 1985 brood fall chinook was percent.

Table 10. Incidence, date, location, and treatment of diseases for 1985 and 1986 brood spring chinook contracted at Lyons Ferry Salmon Hatchery.

| Date | Brood year | Disease | Pond numbers | Treatment |
|---|---|---|---|---|
| 09/86 | 1986 | Fungus | Incubation room | Formalin |
| 10/86 | 1986 | Fungus | Incubation | Formalin |

| | | | | |
|---|---|---|---|---|
| | | | | room |
| 12/86 | 1985 | Enteric redmouth | 1 | Romet-30 |

## 3.4: Wild Fish Production

The Tucannon River flows through varied habitat conditions that restrict distribution of salmonids in the watershed. To compare differences in rearing habitat quality within the Tucannon River, we designated 5 strata, based upon the predominant land use adjacent to the stream:

Lower (RK 0.0 - RK 17.9)

Marengo (RK 18.0 - RK 42.1)

Hartsock (RK 42.2 - RK 54.8)

HMA (RK 54.9 - RK 75.1)

Wilderness (RK 75.2 - Headwaters)

The Lower, Marengo, and Hartsock strata are within agricultural bottomland which receives limited water diversion for summer irrigation. Sections of the stream within these strata are characterized as having a poorly defined or braided stream channel. Banks are often unstable with limited riparian areas. Water temperatures often exceed the upper threshold of spring chinook tolerance. The HMA stratum is within WDG and U.S. Forest Service (USFS) owned and managed land that is forested; has relatively stable banks, and maintains water temperatures tolerable for spring chinook at all stages in the life cycle. The Wilderness stratum is in the Wenaha-Tucannon Wilderness Area, a part of the Umatilla National Forest.

We conducted electrofishing surveys from 29 July - 30

September; most surveys were conducted in the HMA stratum. Within each stratum, we designated several sample units as index sites, which are monitored yearly to determine trends in juvenile salmonid production. Selection of index sites was based upon logistics, minimum sample sizes required for statistical comparison, and whether a site represents the stream in general. We used the depletion method for population estimation (Zippin, 1958) and analyzed the data using the Burnham Maximum Likelihood method (Van Deventer and Platts, 1983).

### 3.4.1: Wilderness stratum electrofishing surveys

<u>Methods</u> Site selection and sample design for electrofishing surveys in the Wilderness stratum were the same as those used by program staff in 1985 (Seidel et al. 1985). These sites are to be sampled yearly to serve as indicators of relative parr abundance. In 1986, we sampled 8 of the 24 sites established.

<u>Results</u> Mean density and biomass of spring chinook parr for the 10.1 km long Wilderness stratum were 34.43 fish/100$m^2$ and 141.63 grams/100$m^2$, respectively (Table 4), and indicated an overall increase in densities from summer 1985 (Table 5). Spring chinook densities averaged 34.00 fish/100$m^2$ in the pools (n=4), 65.71 fish/100$m^2$ in the runs (or glides; n=2), and 4.00 fish/100$m^2$ in the riffles (n=2, Appendix C). We sampled a cumulative 121 meters (or 1.2 percent) of the total stream length. We did linear regression analyses on the wilderness sites for gradient vs. density and gradient vs. biomass. We found no significant correlation (p=0.05) for either.

Table 4. Comparison of spring chinook density and biomass (with sample size, mean, and standard deviation) by stratum, Tucannon River, Washington, 1986.

| Stratum | Sample size | Density (fish/100m2) mean | Density S.D. | Biomass (grams/100m2) mean | Biomass S.D. |
|---|---|---|---|---|---|
| Wilderness | 8 | 34.43 | 35.89 | 141.63 | 137.76 |
| HMA | 30 | 38.91 | 33.54 | 145.68 | 159.39 |
| Hartsock | 4 | 14.27 | 5.21 | 75.16 | 30.93 |
| Marengo | 1 | 0.79 | - - | 3.81 | - - |

Table 5. Comparison of 1985 and 1986 spring chinook rearing densities in selected index sites in the Wilderness stratum, Tucannon River, Washington

| Habitat type | Site | 1985 density (fish/100m2) | 1986 density (fish/100m2) | Percent difference |
|---|---|---|---|---|
| Pool | Wild 3.3 | 12.92 | 37.48 | +190.09 |
| | Wild 3.4 | 47.39 | 80.72 | + 70.33 |
| | Wild 7 | 5.20 | 6.14 | + 18.08 |
| | Wild 10 | 0.00 | 0.00 | - - |
| Run | Wild 2.2 | 34.51 | 96.65 | +180.06 |
| | Wild 2.4 | 45.01 | 41.22 | - 8.42 |
| Riffle | Wild 4.2 | 0.72 | 1.81 | +151.39 |

### 3.4.2: HMA stratum electrofishing surveys

Methods We developed a random systematic sampling design to identify and electrofish five distinct habitat types within the HMA stratum: riffles, runs, pools, side channels, and boulder sites. The latter habitat type is a series of artificial placements (average boulder size is 0.75 m3)? built by WDG to improve resident rainbow trout rearing habitat (Hallock and Mendel, 1985). Sampling originated at a random location near the downstream boundary of the stratum. We sampled six replicates of each habitat type, which were selected every 1000 m from the starting point and alternated in a random systematic order. Some or all of these sites will be monitored yearly.

<u>Results</u> Tucannon River spring chinook parr abundance appears to be highest in the HMA stratum; mean density and biomass for the 20.2 km reach of stream were 38.91 fish/100m$^2$ and 145.68 grams/100m$^2$, respectively (Table 4). Densities and biomass differed significantly among habitat types within the HMA stratum (Freidman's two-way ANOVA p<0.05; Table 6). Riffles and boulder sites contrasted against pools, runs, and side channels, using Wilcoxon sign-rank pairwise comparisons (p<0.05; Conover 1980). We found no correlation between rearing density or biomass with gradient or habitat score (least squares p=0.05).

Table 6. Comparison of spring chinook rearing densities and biomass for riffles, runs, pools, boulder sites, and side channels within HMA stratum in Tucannon River, Washington, August 1986.

| Habitat type | Site | Score | Density (fish/100m2) | Biomass (grams/100m2) |
|---|---|---|---|---|
| Riffle | HMA 1 | 5 | 23.37 | 73.85 |
| | HMA 5 | 6 | 24.10 | 84.35 |
| | HMA 9 | 4 | 11.77 | 39.55 |
| | HMA 13 | 6 | 17.35 | 63.67 |
| | HMA 18 | 6 | 13.87 | 41.89 |
| | HMA 20 | 5 | 18.37 | 58.05 |
| Run | HMA 3 | 6 | 24.75 | 82.91 |
| | HMA 6 | 7 | 19.91 | 80.64 |
| | HMA 10 | 6 | 20.72 | 51.18 |
| | HMA 14 | 9 | 96.68 | 322.91 |
| | HMA 19 | 5 | 48.94 | 318.11 |
| | HMA 24 | 7 | 92.45 | 277.35 |

| | | | | |
|---|---|---|---|---|
| Pool | HMA 4 | 7 | 12.14 | 23.55 |
| | HMA 8 | 8 | 10.53 | 46.12 |
| | HMA 12 | 10 | 38.73 | 154.53 |
| | HMA 16 | 8 | 67.43 | 262.98 |
| | HMA 21 | 9 | 60.89 | 281.92 |
| | HMA 22 | 7 | 126.23 | 807.87 |
| Boulder | HMA 2 | 8 | 8.95 | 31.95 |
| | HMA 7 | 6 | 13.68 | 41.31 |
| | HMA 11 | 6 | 12.99 | 35.07 |
| | HMA 15 | 7 | 12.79 | 44.25 |
| | HMA 17 | 7 | 22.96 | 94.37 |
| | HMA 23 | 7 | 17.73 | 47.87 |
| Side channels | HMAS-1 | 6 | 75.44 | 110.14 |
| | HMAS-2 | 7 | 23.79 | 87.07 |
| | HMAS-3 | 6 | 41.22 | 139.74 |
| | HMAS-4 | 6 | 35.23 | 148.67 |
| | HMAS-5 | 7 | 122.11 | 333.36 |
| | HMAS-6 | 5 | 53.20 | 185.14 |

### 3.4.3: Hartsock stratum electrofishing surveys

Methods We identified six index sites within the Hartsock stratum for annual electrofishing surveys to monitor relative changes in parr production. Two of these sites (Hart 2 and 5) were used in the electrofishing surveys of 1985 (Seidel et al. 1985). Program staff were only able to sample sites Hart 2, 3, 4, and 6 in 1986 because of weather constraints.

Results Mean spring chinook density and biomass for the Hartsock stratum were 14.27 fish/100m$^2$ and 75.16 grams/100m$^2$, respectively (n=4, Table 4).

### 3.4.4: Marengo Stratum electrofishing surveys

Program staff spent limited time surveying the Marengo stratum in 1986 because of the negligible spring chinook parr production we observed within that stratum in 1985. We sampled one site (a pool) at RK 41, and estimated the density and biomass to be 0.79 fish/100 m2 and 3.81 grams/100 m2, respectively (Table 4).

### 3.4.5: Tucannon tributaries surveys

We surveyed index sites on three tributaries of the Tucannon River: Sheep Creek (confluence with Tucannon at RK 83), Panjab Creek (RK 76), and Cummings Creek (RK 58). Index sites were selected and surveyed in 1985. Densities of spring chinook in all three streams decreased from summer 1985 (Table 16).

Table 16. Comparison of spring chinook density estimates for electrofishing sites on Tucannon River tributaries, 1985 and 1986, and the percent difference.

| Stream | Site | 1985 density (fish/100m2) | 1986 density (fish/100m2) | Percent difference |
|---|---|---|---|---|
| Sheep Creek | 1 | 2.55 | 0.00 | -- |
| | 2 | 2.20 | 0.00 | -- |
| | 3 | 0.00 | 0.00 | -- |
| | 4 | 0.00 | 0.00 | -- |
| Panjab Creek | 1 | 13.40 | 1.13 | -91.57 |
| | 2 | 6.88 | 0.00 | -- |
| | 3 | 3.87 | 0.00 | -- |
| Cummings Creek | 1 | 9.00 | 5.70 | -36.67 |
| | 2 | 0.00 | 2.79 | -- |

Table 15 compares Tucannon River spring chinook rearing densities with other Columbia River Basin estimates.

Table 15. Tucannon river spring chinook standing crop with density comparisons to other studies. Production data obtained (with permission?) from Bonneville Power Administration.

| Stream<br>Stratum | Citation | Density (fish/100m2) |
|---|---|---|
| Tucannon | This study | |

| | | |
|---|---|---|
| Wilderness | | 8.69 |
| HMA | | 4.17 |
| Salmon River | Platts and Partridge 1978 | 1.10 |
| Lemhi River | Bjornn 1974 | 38.30 |
| Icicle Creek | Mullan and McIntyre 1986 | 18 |
| Wenatchee River | Griffith 1978 | 1.20-38.30 |

The length frequency distribution of the 1825 fish captured and measured during the survey indicated a predominant age class (Figure 8). We obtained scales from ten spring chinook over 90mm fork length for age determination. Of these, two were yearlings. We compared mean lengths among the Wilderness, HMA, and Hartsock strata (Appendix E) and found....

Figure 8. Length frequency distribution of juvenile spring chinook collected in Tucannon River electrofishing surveys, 1986.

### 3.4.6: Asotin Creek electrofishing surveys

Program staff used a random systematic sampling design to identify and electrofish 10 index sites on the North Fork of Asotin Creek. The first two sites were identified and sampled in 1985, the remaining sites were established and surveyed in 1986. Mean spring chinook density and biomass were .........

Table 17. Density and biomass estimates of spring chinook

on the North Fork Asotin Creek, July 1986.

| Site | Habitat type | Score | Density (fish/100m2) | Biomass (grams/100m2) |
|---|---|---|---|---|
| NA2? | Pool | | 3.04 | |
| NA3 | Run | | | |
| NA4 | Riffle | 5 | 0.00 | |
| NA5 | Run | 10 | 1.53 | |
| NA6 | Pool | | | |
| NA7 | Riffle | | 0.00 | |
| NA8 | Run | | | |
| NA9 | Pool | 8 | 2.19 | |
| NAS-1 | Side channel | | | |
| NAS-2 | Side channel | | | |

### 3.4.7: Stream temperature studies

Program staff deployed 7 continuous-reading thermographs on the Tucannon River to monitor heat loading throughout the summer. Locations of the thermographs were as follows:

1) 300 m downstream of the Panjab Creek confluence (RK 75)
2) next to the inlet at Curl Lake (RK 68)
3) near the downstream outlet of Big Four Lake (RK 66)
4) near the downstream outlet of Beaver-Watson Lakes (RK 64)
5) near the downstream outlet of Deer Lake (RK 61)
6) 100 m downstream of the Cummings Creek confluence (RK 57)
7) 500 m downstream of the Tumalum Creek confluence (RK 53)

We also placed six? maximum-minimum recording thermometers at the following locations:

1) 100 m downstream of the Sheep Creek confluence (RK 83)
3) at the downstream migrant trap (RK 2)

The thermographs were surplus equipment on loan from the USFS. All thermographs collected reliable, but incomplete recordings during the period of operation (17 June to 30 September?) We collected data from the maximum-minimum thermometers only when a staffmember could conveniently check and reset them. Stream temperatures do not appear to increase at any given point; rather temperatures gradually increase as distance from the heavily-forested Wilderness Area increases (Appendix F). Both Cummings and Tumalum Creeks do not appear to significantly add to the heat loading.

### 3.4.8: Spawning ground surveys

Tucannon River We surveyed spawning grounds on the upper Tucannon River to determine the temporal and spatial distribution of spawning, to assess the abundance and density of spawners, and to collect biological data from spent fish. Spawning grounds were surveyed on 25 August, and 2, 9, 16, 23, and 30 September. Person-days required for the surveys were 5, 6, 13, 8, 8, and 5, respectively. The 16 September count encompassed all known spring chinook spawning areas within the Tucannon River.

Total numbers of redds in the Tucannon River in 1986 were 200 (Table 18). The number of redds sighted in the Tucannon River increased from the estimated previous 5 year average of 148 redds and 20 year average of 121 redds (Figure 9), but is most likely a result of the additional stream area covered by a larger survey crew this year. We found no redds in the Tucannon tributaries Sheep, Little Tucannon, or Cummings Creeks. One redd was found in Panjab Creek; to our knowledge this is the first known sighting of spring chinook spawning activity in this tributary.

Figure 9. Numbers of spring chinook redds counted in Tucannon River during the period 1958-1986.

Table 18. Results of 1986 Tucannon River spring chinook spawning

ground surveys.

| Stratum | River kilometer | Number of redds | Number of recovered carcasses females | males |
|---|---|---|---|---|
| Wilderness | 87 - 76 | 53 | 4 | 4 |
| Panjab Cr. | | 1 | 0 | 0 |
| HMA | 76 - 69 | 43 | 8 | 5 |
| | 69 - 64 | 30 | 3 | 10 |
| | 64 - 55 | 44 | 7 | 6 |
| Hartsock | 55 - 48 | 19 | 4 | 6 |
| | 48 - 43 | 10 | 2 | 0 |
| Marengo | 43 - 41 | 0 | 0 | 0 |
| Total | | 200 | 28 | 31 |

From the 6 counts on the Tucannon River, we concluded that the peak spawning date for spring chinook varied by river kilometer; peak of spawning was 1 September for the furthest upstream reach (Wilderness Stratum), 5 September for the HMA Stratum, and 18 September for the Hartsock Stratum. Twenty adults had spawned by the 25 August survey, and virtually all adults had spawned by the 30 September count, indicating the duration of spawning to be at least 36 days.

Fifty-three redds were sighted in the Wilderness stratum of the Tucannon River, which has 10.1 km of stream, resulting in a density of 5.25 redds/km. This density is lower than we found in the 1985 counts (8.32 redds/km). We sighted 104 redds in the 19.7 km HMA stratum, indicating a 5 28 redds/km density, which deviated little from the 1985 density of 5.33 redds/km. This would suggest that the majority of adults trapped for broodstock collection were bound for spawning grounds in the Wilderness

Stratum. 1986 was the first year we surveyed the Hartsock Stratum for spring chinook spawning activity. We found 42 redds within this 12.7 km stratum, resulting in a density of 3.31 redds/km. Distribution of these redds was primarily in the upstream 5 km. We also surveyed the upper 2 km of Marengo Stratum and found no redds. Table 19 compares these data to densities from other Columbia River Basin spring chinook studies.

Table 19. Comparison of upper Tucannon River spring chinook spawning ground densities and midpoint of spawning to that of other Columbia River Basin streams.

| River / Survey area | Source | Density (redds/km) | Spawning midpoint |
|---|---|---|---|
| <u>Tucannon</u> | This study | | |
| Wilderness | | 5.25 | 1 Sept. |
| HMA | | 5.28 | [illegible] Sept. |
| Hartsock | | 3.31 | 18 Sept. |
| Total | | 4.71 | |
| <u>John Day</u>[a] | Burck et al. 1979 | 5.80 | 7-17 Sept. |
| <u>Wenatchee</u>[b] | Easterbrooks, pers. comm. | | |
| Wenatchee R. | | 2.31 | 20-25 Aug. |
| Icicle Cr. | | 9.83 | |
| Chiwawa R. | | 16.24 | |
| White R. | | 7.29 | |
| L.Wenatchee R. | | 6.36 | |
| Nason Cr. | | 13.67 | |
| <u>Entiat</u>[c] | | 13.72 | 25-31 Aug. |
| <u>Methow</u>[d] | | | |
| Methow R. | | 8.37 | 20-31 Aug. |
| Lost R. | | 9.31 | 20-31 Aug. |
| Chewack R. | | 8.31 | 20-31 Aug. |
| Twisp R. | | 10.28 | 15-25 Aug. |
| Early Winters Cr. | | 1.41 | 20-31 Aug. |
| <u>Imnaha</u>[e] | Witty, pers. comm. | 13.28 | |
| <u>Wallowa</u>[e] | | 1.36 | |

| | |
|---|---|
| Upper Minan | 16.66 |
| Lower Minan | 5.59 |

a Five-year average 1974 - 1978.
b Twenty-five year average 1961 - 1985.
  Wenatchee R., N.S. (No Survey) 1968 - 1971.
  N.S. 1975 and 1983.
c Twenty-six year average 1960 - 1985.
d Twenty-six year average 1960 - 1985.
  Chewack R., N.S. 1967.
  Early Winters Cr., N.S. 1962 - 1967.
  N.S. 1972 and 1976.
e Five-year average 1980 - 1984.

We did not collect data on spent carcasses because samples taken from wild spring chinook carcasses at the hatchery were of better quality.

### 3.4.9: Downstream migrant trap operations

On 3 March 1986, program staff installed a floating inclined plane downstream migrant trap on the Tucannon River 2.5 kilometers upstream from the Snake River confluence. The smolt trap (Figure 10) consists of two 29 ft long by 3 ft wide by 3 ft deep pontoons placed 5 ft apart with decks fore and aft. The trap is located between the pontoons and strains a 4 x 4 ft section of stream [illegible] fully lowered. Approximately 100 cfs of flow are strained through the trap during optimum trapping conditions. Seiler et al. (1981) give a detailed description of floating trap operations. The trap was operated continuously (24 hours a day, 7 days a week) at that location until 28 June. On 18 November, we moved the trap upstream to RK 21, a location that has higher stream gradient and a narrower, well-defined channel which improved our trapping efficiency. We operated the trap intermittently from 18 November to 23 February, we have operated the trap continuously since that date.

Figure 10. Side view of floating inclined-plane smolt trap.

Our objectives in the downstream migrant trapping project are:

1) Provide an estimate of the magnitude, duration, periodicity, and peak of spring chinook migration.
2) Assess downstream migrant quality at migration (degree of smoltification, descaling, condition factor, and a subjective index of fish health).
3) We placed the trap as far downstream as possible to determine if fall chinook rear in the lower Tucannon River.
4) Provide supplemental data for stream population estimates derived from electrofishing and spawning ground surveys.
5) Use objective 4 to assess overwinter survival.

Methods To calibrate trapping efficiency, we marked (pelvic fin-tip clipped) captured smolts and transported them in an aerated live box from 300 to 10,000 m upstream of the trap for release. The percent of marked fish captured indicate percent total downstream migrants trapped. With these data, we used the standard Peterson mark-recapture method (Chapman, 1948) to estimate spring chinook and steelhead outmigrants from the Tucannon River Basin. Predetermined groups of fish were marked differentially; date, time, and location of release were recorded for these groups, allowing us to determine both travel time and trap efficiency. Water temperature, flow, velocity, and clarity, moonphase, and photoperiod were recorded daily to be used as covariates in explaining the variability in smolt migrations. The form used for smolt trap data collection is in Appendix C.

In the early 1950s, Mains and Smith (1955) trapped downstream migrants with two fyke nets, at the mouth of the Tucannon River, and at RK 23. These are the approximate locations of our present trap sites. The upstream trap was operated continuously from March 1954 through June 1955, with the exception of June and July of 1954. Methods for trapping were analogous to ours, allowing us to draw comparisons.

Spring 1986 trapping Spring chinook and steelhead were trapped daily from 11 March through the end of the trap operations (28 June). Numbers trapped were lower than anticipated primarily because of low water velocities at the trap site. Mean length (with sample size, standard deviation, maximum, and minimum) of spring chinook outmigrants trapped was xx mm (x.xx; Figure x). The length range of chinook outmigrants caught in 1954 and 1955 was 60 - 102 (Mains and Smith, 1955). We found no correlation between numbers of spring chinook or steelhead outmigrants caught and water temperature, flow, photoperiod, or moon phase using stepwise multiple linear regressions ($p=0.05$). Mains and Smith (1955) found numbers of outmigrants to be a function of water temperature and moon phase. During March and early April most spring chinook outmigrants trapped were classified as transitional in their degree of smoltification; thereafter, they were predominantly fully smolted. The majority (89 percent) of outmigrants were collected between 2201 hours and 0600 hours, 7 percent were trapped between 1401 and 2200, and 4 percent were trapped between 0601 and 1400.

A large number of steelhead parr began appearing at the trap on 21 May and continued to be trapped daily until the end of trap operations on 28 June. We collected large numbers of incidental fish also; Appendix D lists species caught, and their relative abundance.

A 2x3 foot smolt trap was placed and operated by WDG biologists at RK 25 of Asotin Creek. Data taken on collected spring chinook outmigrants was the same as on the Tucannon River smolt trap.

Fall 1986/winter 1987 trapping

## REFERENCES

Basham, L. Fish Passage Center, Portland, Oregon, USA.

Bjornn, T.C. 1978. Survival, production, and yield of trout and chinook salmon in the Lemhi River, Idaho. Bulletin Number 27, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, Idaho, USA.

Bjornn, T.C., and R.R. Ringe. 1986. Fall chinook trapping at Ice

Harbor Dam in 1986. Completion Report, Cooperative Agreement Number 14-16-0009-1559, Research Work Order Number 7 to U.S. Fish and Wildlife Service, Washington, D.C., USA.

Burck, W.A., R.B. Lindsay, B.J. Smith, and E.A. Olsen. 1979. Spring chinook studies in the John Day River. Federal Aid to Fisheries Progress Report, Contract Number DE-AC79-80BP18234, Oregon Department of Fish and Wildlife, Portland, Oregon, USA.

Chapman, D.G. 1948. A mathematical study of confidence limits of salmon populations calculated from sample tag ratios. International Pacific Salmon Fisheries Commission, Bulletin II, pages 67-85.

Easterbrooks, J. Washington State Department of Fisheries, Yakima, Washington, USA.

Mains, E.M., and J.M. Smith. 1955. Determination of the normal stream distribution, size, time, and current preferences of downstream migrating salmon and steelhead trout in the Columbia and Snake Rivers. Contract Report DA35026-ENG-20571, U.S. Army Engineer District, Walla Walla, Washington, USA.

Mullan, J.W., and J.D. McIntyre. 1986. Growth and survival of salmon and steelhead in a controlled section of Icicle Creek. Information Report FRI/FAO-86-14. U.S. Fish and Wildlife Service, Leavenworth, Washington, USA.

Neilson, J.D., G.H. Geen, and B. Chan. 1985. Variability in dimensions of salmonid otolith nuclei: implications for stock identification and microstructure interpretation. Fishery Bulletin 83(1):81-89.

Peterson, P. Washington State Department of Fisheries, Yakima, Washington, USA.

Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. Fish hatchery management. United States Department of the Interior, Fish and Wildlife Service, Washington, D.C., USA.

Platts, W.S., W.F. Megahan, and G.W. Minshal. 1983. Methods for evaluating stream, riparian, and biotic conditions. General Technical Report INT-138. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah, USA.

Seidel, P., R. Bugert, R.S. Kirby, and L. Ross. 1985. Annual Report, Lower Snake River Compensation Plan, Lyons Ferry Evaluation Project, to U.S. Fish and Wildlife Service, Cooperative Agreement 14-16-0001-85072. Washington Department of Fisheries, Olympia, Washington, USA.

Seiler, D., S. Neuhauser, and M. Ackley. 1981. Upstream/ downstream salmonid trapping project, 1977-1980. Progress Report Number 144. Washington State Department of Fisheries, Olympia, Washington, USA.

Taylor, E.B. 1986. Differences in morphology between wild and hatchery populations of juvenile coho salmon. The Progressive Fish Culturist 48:171-176.

U.S. Army Corps of Engineers, June 1975. Special Report: Lower Snake River Fish & Wildlife Compensation Plan. Walla Walla, Washington, USA.

Van Deventer, J.S., and W.S. Platts. 1983. Sampling and estimating fish populations from streams. Transactions of the North American Wildlife and Natural Resources Conference. 48: 349-354.

Wasserman, L., J. Hubble, and B. Watson. 1985. Yakima River Spring Chinook Enhancement Study. Contract Number DE-A179-83BP39461, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon, USA.

Witty, K. Oregon Department of Fish and WIldlife. Enterprise, Oregon, USA.

Zippin, C. 1958. The removal method of population estimation. Journal of Wildlife Management. 22(1):82-90.

## APPENDIX A: Long-Term Objectives of Lyons Ferry Hatchery Evaluation Program

The following list outlines nine WDF objectives of the LSRCP Lyons Ferry Hatchery Evaluation Program. These objectives are interrelated in scope, and are not set in priority.

1) **Document juvenile fish output for Lyons Ferry and Tucannon FH.** Records will be compiled and summarized by numbers of fish produced at each facility, categorized by stock, size, weight, and planting location. Fish condition and survival rates to planting will be noted.

2) **Maintain records of adult returns to the Snake River Basin**

for each rearing program, categorized by stock and brood year. Data are collected at hatchery racks and spawning grounds by program staff.

3) Document contributions of each rearing program to the various fisheries through coded-wire tag returns. Pacific Coast states, Federal, and Canadian agencies cooperate in returning tags and catch data to the agency of origin. We will attempt to tag sufficient fish to represent each rearing program.

4) An initial objective was to document downstream survival to National Marine Fisheries Service (NMFS) sampling points on the lower Columbia River for each rearing program. However, this type of sampling has been discontinued by NMFS. We hope that cooperating agencies will continue monitoring survival of downstream migrants. As this type of information becomes available, program staff will retrieve and summarize data for the Lyons Ferry/Tucannon facilities and for basin-wide fall chinook. Survival rate comparisons for each rearing program will be made. This data could then be used to improve downstream migrant survival.

5) Quantify genetic variables that might be subject to alteration under hatchery production strategies. Utilizing and maintaining native stocks is an important element of the LSRCP. We plan to identify and quantify as many genetic variables as possible in all available Snake River chinook populations. Similar data for other chinook populations which may overlap with Snake River [illegible] the lower Columbia River will also be

developed. These data include qualitative loci analysis through electrophoresis, and quantitative analysis of such factors as adult size, run timing, and disease susceptibility.

6) Determine the success of any off-station enhancement projects, and determine the impact of hatchery fish on wild stock. Data gathered from objective 5 could allow us to develop genetic marks (qualitative or quantitative) which could provide techniques for evaluating interactions of wild and hatchery fish in the Tucannon River system.

7) Evaluate and provide management recommendations for major hatchery operational practices, including:

A. Optimum size and time-of-release data will be sought for both spring and fall chinook. Existing size, time and return data for other Columbia River Basin programs will be reviewed to determine the experimental possibilities which would have the most likelihood of success. Continual experimentation may be necessary in some cases.

B. Selection and maintenance of brood stock will be done in conformance with LSRCP goals. Criteria will be developed to program genetic management as determined by objective 5.

C. Disease investigations or other special treatments on experimental hatchery practices often require mark-release-return groups to facilitate evaluation. Program staff will coordinate the development of experimental designs, direct the marking, and analyze the results.

8) **Evaluate and provide management recommendations for Snake River fall chinook distribution programs basin-wide.** As Lyons Ferry FH goals are reached, egg-taking needs for off-site distribution to supplement natural production will be specified along with priorities for off-site distribution. Evaluation and updating the distribution plan will be an on-going process.

9) **Coordinate research and management programs with hatchery capabilities.** Advance notice to the hatchery for specific study groups of marking programs will allow a more efficient use of hatchery facilities and reduce handling and stress on the fish. Research and management programs will be reviewed to determine if the hatcheries will have the capabilities to meet program goals.

## APPENDIX B

Allele frequencies at polymorphic loci for Snake River fall chinook collected at Lyons Ferry FH, Snake River fall chinook collected at Kalama Falls FH, Upper Columbia River fall chinook collected at Priest Rapids FH, and Tucannon River spring chinook.

Populations:
1. Lyons Ferry Hatchery adults: N=187
2. Priest Rapids Hatchery adults: N=91
3. Tucannon River adults: N=25
4. Kalama Falls adults: N=101
5. Tucannon River 1984 brood juveniles: N=119
6. Lyons Ferry Hatchery Kalama Falls 1984 brood juveniles: N=95
7. Lyons Ferry Hatchery Snake River 1984 brood juveniles: N=153

| | | Alleles | | | | |
|---|---|---|---|---|---|---|
| LOCUS | POP. | A | B | C | D | E |
| Ada-1 | 1 | .997 | .003 | 0 | 0 | 0 |
| | 2 | .995 | .005 | 0 | 0 | 0 |
| | 3 | .960 | .040 | 0 | 0 | 0 |
| | 4 | .990 | .010 | 0 | 0 | 0 |
| | 5 | .979 | .021 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .993 | .007 | 0 | 0 | 0 |
| Ada-2 | 1 | 1.000 | 0 | 0 | 0 | 0 |
| | 2 | 1.000 | 0 | 0 | 0 | 0 |
| | 3 | .980 | .020 | 0 | 0 | 0 |
| | 4 | .995 | .005 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | 1.000 | 0 | 0 | 0 | 0 |
| Dpep-1 | 1 | .967 | .033 | 0 | 0 | 0 |
| | 2 | .989 | .011 | 0 | 0 | 0 |
| | 3 | .935 | .065 | 0 | 0 | 0 |
| | 4 | .974 | .026 | 0 | 0 | 0 |
| | 5 | .860 | .140 | 0 | 0 | 0 |
| | 6 | .968 | .032 | 0 | 0 | 0 |
| | 7 | .979 | .021 | 0 | 0 | 0 |
| Tpi-3 | 1 | .994 | .006 | 0 | 0 | 0 |
| | 2 | 1.000 | 0 | 0 | 0 | 0 |
| | 3 | .860 | .140 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | .891 | .109 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .992 | .008 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gpi-2 | 1 | .997 | .003 | 0 | 0 | 0 |
| | 2 | .995 | .005 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | .985 | .015 | 0 | 0 | 0 |
| | 5 | .996 | .004 | 0 | 0 | 0 |
| | 6 | .963 | .037 | 0 | 0 | 0 |
| | 7 | .971 | .029 | 0 | 0 | 0 |
| Gpi-3 | 1 | .995 | .005 | 0 | 0 | 0 |
| | 2 | .995 | .005 | 0 | 0 | 0 |
| | 3 | .979 | .021 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .993 | .007 | 0 | 0 | 0 |
| Gpi-H | 1 | .989 | .011 | 0 | 0 | 0 |
| | 2 | .967 | .033 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | .990 | .010 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .980 | .020 | 0 | 0 | 0 |
| Gr | 1 | .995 | .005 | 0 | 0 | 0 |
| | 2 | .984 | .016 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | .960 | .040 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .995 | .005 | 0 | 0 | 0 |
| Idh-2 | 1 | .987 | .013 | 0 | 0 | 0 |
| | 2 | 1.000 | 0 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .997 | .003 | 0 | 0 | 0 |
| Idh3,4 | 1 | .968 | .030 | .002 | 0 | 0 |
| | 2 | .887 | .105 | .008 | 0 | 0 |
| | 3 | .802 | .032 | .166 | 0 | 0 |
| | 4 | .963 | .030 | .007 | 0 | 0 |
| | 5 | .930 | .002 | .068 | 0 | 0 |
| | 6 | .947 | .053 | 0 | 0 | 0 |
| | 7 | .950 | .045 | .005 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ldh-5 | 1 | .989 | .011 | 0 | 0 | 0 |
| | 2 | .995 | .005 | 0 | 0 | 0 |
| | 3 | .980 | .020 | 0 | 0 | 0 |
| | 4 | .985 | .015 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | .995 | .005 | 0 | 0 | 0 |
| | 7 | .990 | .010 | 0 | 0 | 0 |
| Tapep | 1 | .874 | .126 | 0 | 0 | 0 |
| | 2 | .764 | .236 | 0 | 0 | 0 |
| | 3 | .980 | .020 | 0 | 0 | 0 |
| | 4 | .872 | .128 | 0 | 0 | 0 |
| | 5 | .936 | .064 | 0 | 0 | 0 |
| | 6 | .750 | .250 | 0 | 0 | 0 |
| | 7 | .849 | .151 | 0 | 0 | 0 |
| Capep | 1 | – | – | – | – | – |
| | 2 | .981 | .019 | 0 | 0 | 0 |
| | 3 | – | – | – | – | – |
| | 4 | .925 | .075 | 0 | 0 | 0 |
| | 5 | .992 | .008 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | – | – | – | – | – |
| Mdh-1,2 | 1 | .999 | 0 | .003 | 0 | 0 |
| | 2 | 1.000 | 0 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | 1.000 | 0 | 0 | 0 | 0 |
| Mdh-3,4 | 1 | .986 | .007 | .007 | 0 | 0 |
| | 2 | .984 | .013 | .003 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | .977 | .010 | .013 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | .987 | .008 | .005 | 0 | 0 |
| | 7 | .975 | .010 | .015 | 0 | 0 |
| Mpi | 1 | .749 | .251 | 0 | 0 | 0 |
| | 2 | .720 | .280 | 0 | 0 | 0 |
| | 3 | .600 | .400 | 0 | 0 | 0 |
| | 4 | .752 | .248 | 0 | 0 | 0 |
| | 5 | .870 | .130 | 0 | 0 | 0 |
| | 6 | .711 | .289 | 0 | 0 | 0 |
| | 7 | .692 | .308 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Pgk-2 | 1 | .534 | .466 | 0 | 0 | 0 |
| | 2 | .593 | .407 | 0 | 0 | 0 |
| | 3 | .060 | .940 | 0 | 0 | 0 |
| | 4 | .640 | .360 | 0 | 0 | 0 |
| | 5 | .088 | .912 | 0 | 0 | 0 |
| | 6 | .695 | .305 | 0 | 0 | 0 |
| | 7 | .578 | .422 | 0 | 0 | 0 |
| Pgm-1 | 1 | 1.000 | 0 | 0 | 0 | 0 |
| | 2 | 1.000 | 0 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .993 | 0 | 0 | .007 | 0 |
| Sod-1 | 1 | .658 | .332 | .008 | 0 | .003 |
| | 2 | .517 | .478 | .006 | 0 | 0 |
| | 3 | .896 | .083 | .021 | 0 | 0 |
| | 4 | .663 | .337 | 0 | 0 | 0 |
| | 5 | .826 | .174 | 0 | 0 | 0 |
| | 6 | .656 | .344 | 0 | 0 | 0 |
| | 7 | .563 | .433 | 0 | 0 | .003 |
| Ah-4 | 1 | .872 | .126 | .003 | 0 | 0 |
| | 2 | .876 | .124 | 0 | 0 | 0 |
| | 3 | .940 | .060 | 0 | 0 | 0 |
| | 4 | .931 | .059 | .010 | 0 | 0 |
| | 5 | .932 | .068 | 0 | 0 | 0 |
| | 6 | .921 | .079 | 0 | 0 | 0 |
| | 7 | .902 | .098 | 0 | 0 | 0 |
| Hagh | 1 | .995 | .005 | 0 | 0 | 0 |
| | 2 | 1.000 | 0 | 0 | 0 | 0 |
| | 3 | .840 | .060 | .100 | 0 | 0 |
| | 4 | .939 | .061 | 0 | 0 | 0 |
| | 5 | .943 | .057 | 0 | 0 | 0 |
| | 6 | .945 | .055 | 0 | 0 | 0 |
| | 7 | .992 | .008 | 0 | 0 | 0 |
| Adh | 1 | - | - | - | - | - |
| | 2 | - | - | - | - | - |
| | 3 | - | - | - | - | - |
| | 4 | - | - | - | - | - |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | .879 | .121 | 0 | 0 | 0 |
| | 7 | .967 | .033 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ck-5 | 1 | - | - | - | - | - |
| | 2 | - | - | - | - | - |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | .925 | .070 | .005 | 0 | 0 |
| | 5 | .910 | .090 | 0 | 0 | 0 |
| | 6 | .975 | .043 | 0 | 0 | 0 |
| | 7 | .936 | .064 | 0 | 0 | 0 |
| mMdh-1 | 1 | .975 | .025 | 0 | 0 | 0 |
| | 2 | .984 | .016 | 0 | 0 | 0 |
| | 3 | .796 | .204 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | .714 | .286 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .987 | .013 | 0 | 0 | 0 |
| bGa-1 | 1 | .991 | .009 | 0 | 0 | 0 |
| | 2 | 1.000 | 0 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | .987 | .013 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .988 | .012 | 0 | 0 | 0 |
| Fbald-4 | 1 | 1.000 | 0 | 0 | 0 | 0 |
| | 2 | - | - | - | - | - |
| | 3 | - | - | - | - | - |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | .980 | .020 | 0 | 0 | 0 |
| Ck-2 | 1 | 1.000 | 0 | 0 | 0 | 0 |
| | 2 | .992 | .008 | 0 | 0 | 0 |
| | 3 | 1.000 | 0 | 0 | 0 | 0 |
| | 4 | 1.000 | 0 | 0 | 0 | 0 |
| | 5 | 1.000 | 0 | 0 | 0 | 0 |
| | 6 | 1.000 | 0 | 0 | 0 | 0 |
| | 7 | 1.000 | 0 | 0 | 0 | 0 |
| Gapdh-3 | 1 | .988 | .012 | 0 | 0 | 0 |
| | 2 | - | - | - | - | - |
| | 3 | - | - | - | - | - |
| | 4 | - | - | - | - | - |
| | 5 | - | - | - | - | - |
| | 6 | - | - | - | - | - |
| | 7 | - | - | - | - | - |