THE EFFECTS OF RELEASE TIME ON SMOLT DEVELOPMENT, MIGRATION TIME, SURVIVAL, AND ADULT RETURNS FOR SPRING CHINOOK SALMON

FINAL RESULTS FROM SEQUENTIAL SMOLT RELEASES MADE AT KOOSKIA NATIONAL FISH HATCHERY IN 1992 AND FROM DWORSHAK NATIONAL FISH HATCHERY IN 1993 AND 1994.

PROGRESS REPORT

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INTRODUCTION

Spring chinook salmon production at Dworshak National Fish Hatchery (NFH) started in 1982 as part of the Lower Snake River Compensation Plan program (LSRCP). The program at Dworshak NFH called for the rearing and release of 70,000 lbs of spring chinook salmon or about 1.4 million smolts at a size of about 20 fish per pound (COE 1981). This level of production was originally estimated to be sufficient to produce a return of 9,135 adult spring chinook salmon to Lower Granite Dam, the established mitigation goal for the program at Dworshak NFH.

The first spring chinook salmon eggs were brought to Dworshak NFH in 1981 and the first smolts were released in 1983. Except for three of the early years, the number of smolts released from Dworshak NFH each year from 1983 to 1991 exceeded 1.0 million. Despite the ability of the program to meet production goals in most years, the number of adults that returned never met the mitigation goal by even one-third (**Table 1**). During this time, several research and evaluation projects were conducted at Dworshak NFH to improve production and increase adult returns.

Research conducted at Dworshak NFH by Zaugg *et al.* (1991) showed that spring chinook salmon smolts released in 1989 had experienced little or no development of smolting characteristics by the time they were released. This was based on an analysis of a series of physiological parameters related to smoltification. The authors speculated that if spring chinook salmon smolts at Dworshak NFH had been held longer they would have observed significant increases in the parameters that they measured. The conclusion was that spring chinook salmon smolts at Dworshak NFH were probably being released too early before the fish had sufficiently developed physiologically and they were simply not ready for seaward migration. High mortality of spring chinook salmon smolts after release was the speculated result that was offered to explain low adult returns.

In 1992 at Kooskia NFH and in 1993 and 1994 at Dworshak NFH, spring chinook salmon smolts were released in April and May at two week intervals to evaluate smolt performance after release and adult returns. Although all three years were extremely similar in design and intent, they were not part of a single evaluation project. Each year was a separate effort at evaluating release time for spring chinook.

At Kooskia NFH in 1992, the project originally started out to evaluate effects of transporting smolts from Kooskia NFH to Lewiston, Idaho by tanker truck, transferring them to a barge and then transporting them from Lewiston, Idaho to Lower Granite Dam. Because of concerns about the possibility of adults straying on return, the project was not approved. Since preparations had already been made and the fish at Kooskia NFH had been marked, the project was redesigned to evaluate effects of release time. At Dworshak NFH in 1993, the Hatchery Evaluation Team intentionally designed a study to evaluate release time of spring chinook salmon to continue the efforts at Kooskia NFH. However, lack of project funds limited data collection and the experiment at Kooskia NFH could not be duplicated in all aspects. At Dworshak NFH in 1994, the project was conducted again, but this time by the National Fishery Research Center in Seattle. Here again, the experiments conducted in 1992 and 1993 were not

duplicated completely because of differences in objectives and reasons for conducting the experiment.
Despite the differences in the way that the work was conducted in each of the three years, there were a number of similarities that provided very useful data for evaluating the effects of release time on spring chinook salmon smolt releases. This report summarizes the data collected from all three years where aspects of the experiments were similar.

Common objectives for all three years were:

1. To determine if release time had a significant effect on smolt development;
2. To determine if release time had a significant effect on downstream migration time;
3. To determine if release time had a significant effect on smolt interrogation rates; and
4. To determine if release time had a significant effect on adult returns.

STUDY AREA

Dworshak NFH is located at the confluence of the North Fork and the main stem of the Clearwater River (**Figure 1**). Construction of the hatchery was included in the authorization for Dworshak Dam and Reservoir (Public Law 87-847, October 23, 1962) to mitigate for losses of anadromous steelhead (*Oncorhynchus mykiss*) caused by the dam and reservoir.

The hatchery was designed and constructed by the U.S. Army Corps of Engineers (COE) and has been administered and operated by the U.S. Fish and Wildlife Service (FWS) since the first phase of construction was completed in 1969. Additional construction was completed in 1982 under the Lower Snake River Compensation Plan program (LSRCP) to provide rearing facilities for spring chinook salmon (*O. tshawytscha*). A total of 30 8-foot by 80-foot raceways were constructed to rear 1.4 million spring chinook salmon smolts (70,000 lbs.) at 20 fish/lb. (Corps of Engineers 1981). In 1986, 12 8-foot by 75-foot raceways were converted from rainbow trout rearing to chinook salmon rearing. This increased the rearing capacity of the hatchery to 1.7 million smolts or 90,000 lbs. In 1993, two of these raceways were converted to an adult holding pond. In an effort to improve fish health and quality, the rearing density for the 30 LSRCP raceways was reduced to 35,000 fish/raceway. Density in the additional 10 raceways was reduced to 30,000 fish/raceway. Thus, production capacity of the hatchery at that time was about 1.35 million smolts at 18-20 fish/lb. or 67,500 lbs.

Kooskia NFH is located about 1.5 miles southeast of Kooskia, Idaho, near the confluence of Clear Creek and the Middle Fork of the Clearwater River (**Figure 1**). The hatchery was built by the FWS in 1966 for rearing and releasing spring chinook salmon into the Middle Fork Clearwater River (U.S. Fish and Wildlife Service 1983). Kooskia NFH has six Burrows ponds that can be used on a chilled re-use system. Twelve 8-foot by 80-foot raceways and 32 rectangular figerglass tanks provide additional rearing space. The present production capacity of Kooskia NFH is about 600,000 smolts at 20 fish/lb. or about 30,000 lbs.

Because of production constraints, disease considerations, and other factors, Dworshak NFH has provided holding and spawning of spring chinook salmon adults returning to Kooskia NFH, as well as incubation of eggs and rearing space for juveniles. With the inception of the LSRCP program for spring chinook salmon at Dworshak NFH, transfers between hatcheries have occurred frequently and for several years, the programs were combined. Recently, because of stock concerns, the programs have been separated and adults and offspring are being held and reared separately.

Figure 1. Location of Dworshak and Kooskia National Fish Hatcheries in the Clearwater River drainage, Idaho, and PIT-tag detection sites at Lower Granite, Little Goose, Lower Monumental, and McNary dams.

METHODS

Experimental Design

Three releases (Early, Mid, and Late) were scheduled at two-week intervals during April and May. At Kooskia NFH, releases were scheduled for April 7, April 21, and May 5, 1992. Two groups from two Burrows ponds and two corresponding raceways were designated for each release date. At Dworshak NFH, releases were scheduled for April 8, April 22, and May 6 for both 1993 and 1994. Eight raceways with about 16,000 fish each were set up for each release date in 1993. Three raceways with about 24,000 fish each were set up for the three release dates in 1994.

Smolt Development

Smolt development was determined by measuring gill (Na+K+) ATPase. Analysis was performed by the Columbia River Research Laboratory USGS-BRD (formerly the USFWS Columbia River Field Station) at Cook, Washington, using the micro-assay method developed by Schrock *et al.* (1994). At Kooskia NFH on March 27, 1992, 12 fish were collected and sampled from the Early and Late release groups to establish baseline gill ATPase levels prior to the first release. Several days prior to each release, 12 fish were collected and sampled from the ponds designated for that release and the Late release. All fish collected were killed, measured, weighed, and sampled for gill filaments. Gill filaments were clipped from the left side of the fish, were preserved, and shipped to the Columbia River Research Laboratory on dry ice. At Dworshak NFH in 1993, sampling was started on March 8. Five fish were collected from each raceway on a bi-weekly schedule until all three groups of fish were released. Each fish was measured for fork length and a small sample of gill filament was taken non-lethally. In 1994, sample size consisted of 10 fish per raceway. Sampling was started on March 2 by sampling the Early release raceways. On March 15, the Early and the Mid release raceways were sampled. On March 31, all the raceways in all three release groups were sampled. On April 8 the Early release group was released. On April 21, only the Mid and Late release raceways were sampled and the Mid release group was released that same day. On May 5, the Late release group raceways were sampled before release.

Fish released from Kooskia NFH in 1992 were subsequently collected at Lower Granite and McNary dams and were sampled for gill ATPase analysis by the Columbia River Research Laboratory. Fish released from Dworshak NFH in 1994 were also collected at Lower Granite Dam for gill ATPase analysis. Fish released in 1993 were not sampled after release.

Mean gill ATPase levels were compared between treatment groups using two-sample T-Tests (Wilkinson 1990) to detect significant differences for various sampling and release dates. Mean gill ATPase levels for individual treatment groups were examined for trends over time.

Migration Time

Smolt migration times to Lower Granite, Little Goose, Lower Monumental (1993 and 1994 only), and McNary dams were determined using PIT-tags. At Kooskia NFH in 1992, about 400 fish

were PIT-tagged in each release group. At Dworshak NFH in 1993 and 1994, about 1,500 and 6,000 fish in each release group were PIT-tagged, respectively. Fish were randomly collected, anesthetized with MS-222, injected with PIT-tags, and measured for fork length.

ANOVA (Wilkinson 1990) was used to test the null hypothesis that migration times were not significantly different between release groups. A significance level of 0.05 was used to reject the null hypothesis. Tests were conducted for each recovery site. Those tests where significant differences were found were further examined by post-hoc pair wise comparisons of means using the Tukey HSD Test.

Survival - PIT-tag Interrogation Rates

The cumulative interrogations at Lower Granite, Little Goose, Lower Monumental (1993 and 1994 only), and McNary dams were used as a minimum estimate of survival to Lower Granite Dam. A chi-square test for goodness-of-fit (Conover 1971) was used to test the null hypothesis that interrogation rates were not significantly different between release groups. The null hypothesis was rejected at the 0.05 level.

Adult Returns

Coded-wire tags were used to evaluate adult returns. At Kooskia NFH, two groups of about 60,000 fish each were coded-wire tagged and freeze branded in each release group. At Dworshak NFH in 1993, two groups of about 64,000 fish each were marked in each release group with different tag codes. In 1994, one group of about 64,000 fish was marked in each release group with different tag codes and all the fish were freeze-branded.

Smolt-to-adult survival was expressed as percent yield and was calculated by dividing the total number of coded-wire tagged adults that returned by the number of coded-wire tagged smolts released for each tag code, multiplied by 100. Statistical comparisons for significant differences were not made between release times because the number of replicate coded-wire tags groups for each release was not sufficient.

RESULTS

Releases for all three years were made on schedule. Smolts released from Kooskia NFH were somewhat smaller than those released from Dworshak NFH, averaging about 18 fpp (**Table 2**). Fish at Kooskia NFH were not all the same size at time of release because of the additional growth incurred between the first and last releases. In order to eliminate size at time of release as a variable, release groups at Dworshak NFH in 1993 and 1994 were put on separate growth schedules so that size at time of release would be as similar as possible.

Gill ATPase Levels - Smolt Development

Kooskia NFH 1992 - The Early release group was sampled twice before release, the Mid release group was sampled only once, and the Late release group was sampled five times. The samples collected from the Late release group prior to the May 5 release at the hatchery became contaminated and were discarded. As a result, gill ATPase activity for the Late release group at the time of release is unknown. In addition to the three treatment groups, one regular production group was sampled prior to its release on April 15. The Late release group was sampled at the same time as the regular production group for comparison.

For each sampling date, no significant differences in mean gill ATPase levels were observed between treatment groups (**Table 3**). No significant difference was observed on April 15 between the regular production group and the Late release group prior to the regular production releases from the hatchery. These data indicate that the rate of gill ATPase development for all the fish on the hatchery was about the same and there was no treatment effect on gill ATPase development prior to release.

The Early release group exhibited a significant (P <0.00) increase in mean gill ATPase from 4.8 on March 27 to 9.6 at the time of release on April 7 (**Table 3**). After release, the Early release group was sampled on three different dates at Lower Granite Dam. Mean gill ATPase increased significantly (P <0.00) from 9.6 at the time of release to 15.7 on the first date that samples were collected at Lower Granite Dam on April 17 (**Table 4**). A significant increase (P <0.01) to 19.9 was observed for samples collected on April 20-21. From April 20-21 to April 27, mean gill ATPase increased but not significantly. However, the sample size on April 27 was only 2 which may have affected the t-test. Between the last sampling day at Lower Granite Dam on April 27 and the first sampling day at McNary Dam on May 5-6, mean gill ATPase increased significant (P <0.01) from 22.3 to 38.2 (**Table 4**). The group was sampled three times at McNary Dam. Mean gill ATPase continued to increase at McNary Dam through May 12 but the increase was not statistically significant.

The Mid release group was sampled only once at the hatchery prior to release and once at Lower Granite Dam. The group exhibited a significant (P <0.02) increase in mean gill ATPase from 13.6 to 25.1 between the time of release on April 21 to arrival at Lower Granite Dam on May 12-13. The first samples of the Mid release were 40.0 at McNary Dam on May 14 and were significantly (P <0.01) higher than at Lower Granite Dam just two days prior. The group was sampled five times at McNary Dam. Although mean gill ATPase continued to increase at

McNary Dam through May 18, the increase was not significant and samples taken subsequently exhibited a decreasing trend from 47.6 on May 18 to 29.6 on May 29 (**Table 4**).

At the hatchery, the Late release group exhibited a significant ($P< 0.00$) increase in mean gill ATPase from 5.1 on March 27 to 11.2 on April 7, a decrease to 10.2 on April 15, and a significant ($P <0.00$) increase to 17.2 on April 21 prior to release (**Table 3**). Although no data are available on gill ATPase levels of the the Late release group at the time of release, data on condition factors indicated that smolt development had probably continued. Condition factors for all three release groups decreased from the time prior to release at the hatchery and their subsequent capture at both Lower Granite and McNary dams. Decreases in condition factors of spring chinook salmon at Dworshak NFH and other Columbia River hatcheries after release have been significantly correlated with increases in gill ATPase activity measured at downstream dams (Beeman *et al.* 1990; Beeman *et al.* 1991). From April 21 to May 12-13, the first days that samples were collected at Lower Granite Dam for the Late release group, mean gill ATPase did not show any meaningful increase. Mean gill ATPase levels increased significantly ($P <0.00$) from 18.0 on May 12-13 to 26.6 on May 18-19. Samples collected May 25-27 decreased to 24.7, indicating that levels were starting to decrease (**Table 4**). However, samples collected at McNary Dam on May 28 indicated that mean gill ATPase levels had significantly ($P <0.01$) increased over levels at Lower Granite Dam. Subsequent samples at McNary Dam showed a clear decreasing trend.

Dworshak NFH 1993 - Between March 9 and May 5, gill ATPase ranged from 5.4 to 8.6 **(Table 3**). For each sampling date no significant differences were observed between release groups. Except for one occasion, gill ATPase levels for all treatment groups did not change significantly between sampling dates. From March 9 to March 22, gill ATPase activity levels for all three treatment groups decreased significantly ($P<0.00$). Levels increased significantly ($P< 0.00$) to their previous levels by April 5 and stayed relatively unchanged until all groups were released.

Dworshak NFH 1994 - At Dworshak NFH in 1994, the only significant difference in gill ATPase observed between treatment groups was on March 31 when the Early release group had a significantly ($P<0.05$) lower level of gill ATPase than the Mid or Late release groups **(Table 3**). Changes in gill ATPase over time was not consistent between release groups. Gill ATPase levels for the Early release group increased significantly ($P< 0.00$) from March 2 to March 15 but then decreased by March 31 prior to release. The Mid release group exhibited no significant changes in gill ATPase from March 15 to April 21. The Late release group was the only one that exhibited significant ($P<0.05$) increases in ATPase over time.

The Early release group was sampled on four different dates at Lower Granite Dam from May 6 through May 18 (**Table 5**). Sample sizes were very small, only one fish on two occasions. Although gill ATPase levels had increased after the group was released from the hatchery, levels at Lower Granite Dam exhibited an erratic pattern of development. However, this may have been due to small sample sizes.

The Mid release group was sampled on six dates at Lower Granite Dam and exhibited a moderate increase in gill ATPase from 9.0 prior to release to 13.4 on the first sampling date at Lower Granite Dam (**Tables 3** and **5**, respectively) but the increase was not significant. From May 6

through May 18, there was an overall general increase in mean gill ATPase levels but the change was not significant.

The Late release group was sampled only twice at Lower Granite Dam **(Table 5**) and exhibited no significant change in mean gill ATPase between the time of release from Dworshak NFH and the first sampling date at Lower Granite Dam. Although mean gill ATPase increased between May 16 and 18, it was not a significant increase.

Migration Time

In general, migration times to the dams after release were not very dissimilar between years. Releases made later had faster migration times to most of the dams than releases made earlier (**Table 6**). At Kooskia NFH in 1992, mean migration time from the hatchery to Lower Granite Dam for the Early release group was 16 days and was significantly ($P< 0.00$) slower than the Mid or Late release groups which were 13 and 12 days, respectively. This trend was similar for Little Goose and McNary dams as well. There was no significant differences in mean migration times between the Mid and Late release groups to any of the dams in 1992.

At Dworshak NFH in 1993, mean migration time from the hatchery to Lower Granite Dam was 23 days for the Early release group and was significantly ($P<0.00$) slower than either the Mid or Late release groups which were 13 and 10 days, respectively **(Table 6**). The same pattern was true for mean migration times to Little Goose and McNary dams. Although the Mid release group traveled significantly *(*$P<0.00$) slower than the Late release group to both Lower Granite and McNary dams, there was no significant difference in mean migration time between these two groups to Little Goose Dam.

At Dworshak NFH in 1994, mean migration time from the hatchery to Lower Granite Dam was 25 days for the Early release group and was significantly ($P<0.00$) slower than the Mid or Late release groups which were 18 and 11 days, respectively (**Table 6**). This trend was similar for Little Goose and McNary dams as well. Similarly, the Mid release group traveled significantly (*P* 0.00) slower to all three dams than the Late release group.

Interrogation Rates

For the releases made at Kooskia NFH in 1992, cumulative interrogation rates ranged from 47% for the Late release group to 56% for the Mid release group and did not differ significantly between groups. For the releases made at Dworshak NFH in 1993, cumulative interrogation rates ranged from 55% for the Mid releases to 50% for the Early releases. For the releases made at Dworshak NFH in 1994, cumulative interrogation rates ranged from 48% for the Late releases to 53% for the Mid releases. The Mid releases for both 1993 and 1994 had significantly ($P< 0.05$) higher cumulative interrogation rates than the Early or Late release groups.

Adult Returns

For all three release years, the percent yield for the Early release group was significantly ($P<0.05$) higher than for the Mid or Late release groups (**Table 8**).

DISCUSSION

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Table 1. Number of spring chinook salmon smolts released from Dworshak NFH each year from 1983 to 1991 and the number of adults that returned by age class.

Release Year	Smolts Released	Adult Returns			
		I-Ocean	II-Ocean	III-Ocean	Total
1983	520,903	14	281	91	386
1984	259,589	13	346	376	735
1985	1,137,139	78	1604	1240	2922
1986	506,320	25	569	221	815
1987	1,710,710	163	1322	193	1678
1988	1,547,219	156	2709	72	2937
1989	1,651,472	10	77	40	127
1990	1,251,427	16	286	359	661
1991	1,094,884	23	452	41	516

Table 2. Spring chinook salmon smolt release summary for serial releases at Kooskia NFH in 1992 and at Dworshak NFH in 1993 and 1994.

Year	Date	Release Time	Number Released	Release Size		Water Temp. (^{O}C)	Marked Releases		
				Length (mm)	FPP [1]		PIT-tags	CWT [2]	FB [3]
1992	April 7	1400	205, 214	-	22	6.7	400	111, 879	87, 873
	April 21	1115	190, 483	-	18	8.9	400	113, 423	87, 512
	May 5	1500	193, 136	-	16	16.7	400	97,637	96, 278
1993	April 8	1000	129, 366	147	17	5.0	1, 494	121, 929	-
	April 22	1000	129, 330	147	17	6.7	1, 486	119, 297	-
	May 6	1000	126, 611	152	18	5.6	1, 479	105, 988	-
1994	April 8	1200	69, 642	151	16	5.5	5, 990	66, 014	59, 866
	April 22	1200	84, 654	149	16	6.4	5, 998	61, 840	77, 777
	May 6	1200	74, 500	156	14	6.9	5,999	68, 211	61, 412

[1] Fish Per Pound
[2] Coded-Wire Tags
[3] Freeze Brands

salmon smolt release groups at Kooskia NFH in 1992 and Dworshak NFH in 1993 and 1994.

Sample Date	Release Group	ATP-ase N	Mean	SD	Min	Max
3/27/92	Early	12	4.8	1.8	1.7	8.2
	Late	12	5.1	1.3	2.8	7.5
4/07/92	Early	24	9.6	2.4	4.2	15.4
	Late	12	11.2	2.4	7.6	16.2
4/15/92	Late	6	10.2	3.3	6.7	14.8
	Prod	5	10.9	0.9	9.9	12.2
4/21/92	Mid	8	13.6	2.8	8.2	18.1
	Late	4	17.2	2.4	14.6	20.9
3/09/93	Early	37	7.4	3.0	0.7	16.4
	Mid	38	7.7	2.1	3.4	12.2
	Late	37	8.6	2.7	2.8	14.3
3/22/93	Early	40	5.4	1.5	2.1	8.6
	Mid	39	6.2	2.2	2.7	11.5
	Late	39	6.0	2.3	2.2	11.8
4/05/93	Early	40	7.8	2.4	3.3	13.6
	Mid	36	8.0	2.1	4.7	13.7
	Late	39	8.4	1.9	4.7	11.9
4/19/93	Mid	36	7.5	2.2	3.7	11.5
	Late	39	8.1	2.2	3.4	15.0

		40				
3/02/94	Early		5.6	1.7	2.8	9.3
		25				
3/15/94	Early		9.0	1.8	6.5	15.3
		23				

Table 3. Continued.

Sample Date	Release Group	ATP-ase				
		N	Mean	SD	Min	Max
	Mid	28	8.5	2.0	4.7	14.2
3/31/94	Early	28	7.9	1.2	5.9	10.4
	Mid	30	8.9	1.9	4.8	11.7
	Late	29	8.9	1.8	4.5	11.6
4/21/94	Mid	24	9.0	2.0	6.1	14.5
	Late	25	9.2	2.6	5.3	16.3
5/03/94	Late	24	11.1	2.2	7.4	15.3

Table 4. Statistical summary of gill ATPase levels for spring chinook salmon smolt released from Kooskia NFH in 1992 and sampled at Lower Granite and McNary dams.

Sample Date	Release Group	ATP-ase				
		N	Mean	SD	Min	Max
Lower Granite						
4/17/92	Early	23	15.7	5.2	5.5	25.7
4/20-21/92	Early	18	19.9	4.2	12.1	31.3
4/27/92	Early	2	22.3	2.5	19.8	24.9
5/12-13/92	Mid	4	25.1	5.0	18.8	31.5
5/12-13/92	Late	12	18.0	4.9	12.2	28.6
5/15/92	Late	13	18.9	3.1	14.3	24.6
5/18-19/92	Late	11	26.6	10.5	11.7	47.7
5/25-27/92	Late	3	24.7	4.5	20.8	29.6
McNary						
5/05-06/92	Early	18	38.2	11.5	26.3	65.3
5/08/92	Early	20	42.4	8.1	30.1	63.5
5/11-12/92	Early	21	44.2	10.8	18.2	68.5
5/14/92	Mid	10	40.0	9.9	26.0	58.2
5/18/92	Mid	6	47.6	12.0	32.1	70.0
5/20/92	Mid	4	46.9	6.3	36.5	52.0
5/27/92	Mid	6	41.9	9.2	23.9	52.0
5/29/92	Mid	3	29.6	0.9	28.5	30.6
5/28/92	Late	10	38.4	9.2	21.1	53.7

		10				
6/05-06/92	Late		27.4	4.3	23.6	37.2
		7				
6/12/92	Late		16.4	4.6	11.6	22.7
		3				

Dworshak NFH in 1994 and sampled at Lower Granite Dam.

Sample Date	Release Group	ATP-ase				
		N	Mean	SD	Min	Max
5/6/94	Early	1	18.6	-	-	-
	Mid	6	13.4	6.7	8.5	26.6
5/9/94	Mid	11	16.5	2.7	13.2	20.4
5/11/94	Early	6	24.7	5.5	15.3	30.0
	Mid	4	15.5	4.6	9.2	15.5
5/16/94	Early	1	10.0	-	-	-
	Mid	5	16.9	3.6	11.3	21.1
	Late	4	14.2	8.1	7.4	23.6
5/18/94	Early	3	22.0	11.1	9.9	31.8
	Mid	3	20.3	2.4	18.9	23.0
	Late	15	18.6	5.1	10.2	29.8

1992 and Dworshak NFH in 1993 and 1994 that were interrogated at Lower Granite, Little Goose, and McNary dams on the Lower Snake and Columbia rivers.

Release	Lower Granite			Little Goose			McNary		
Date	N	Mean[1]	SD	N	Mean[1]	SD	N	Mean[1]	SD
04/07/92	100	16[a]	5	72	21[a]	6	41	28[a]	3
04/22/92	102	13[b]	6	64	18[b]	8	55	26[b]	8
05/05/92	117	12[b]	8	37	15[b]	8	37	23[b]	6
04/08/93	522	23[a]	11	201	27[a]	11	87	31[a]	7
04/22/93	357	13[b]	5	218	17[b]	6	55	26[b]	8
05/06/93	401	10[c]	6	138	16[b]	6	94	20[c]	6
04/08/94	1326	25[a]	9	682	34[a]	10	1399	43[a]	8
04/22/94	1438	18[b]	6	644	26[b]	5	1553	33[b]	7
05/06/94	818	11[c]	6	874	17[c]	5	1440	25[c]	8

[1] Means with different letters are significantly different ($P<0.05$.) Comparisons are valid only within release year.

Table 7. Number (N) and percent (%) of PIT-tagged spring chinook salmon smolts released from Kooskia NFH in 1992 and from Dworshak NFH in 1993 and 1994 that were interrogated at Lower Granite, Little Goos, Lower Monumental, and McNary dams on the Lower Snake and Columbia rivers.

Release	Lower Granite		Little Goose		Lower Monumental		McNary		Total	
Date	N	%	N	%	N	%	N	%	N	%
04/07/92	100	25	72	18	N/A	N/A	41	10	213	53
04/21/92	102	26	64	16	N/A	N/A	55	14	221	56
05/05/92	117	29	37	9	N/A	N/A	37	9	191	47
04/08/93	422	28	201	13	84	6	46	3	753	50
04/21/93	513	34	154	10	93	6	58	4	818	55
05/06/93	401	27	138	9	60	4	94	6	693	47
04/08/94	1326	22	484	8	467	8	613	10	2890	49
04/22/94	1438	24	495	8	417	7	807	14	3157	53
05/06/94	818	14	761	13	427	7	832	14	2838	48

Table 8. Number of coded-wire tags recovered for each age group of adult spring chinook salmon returning to Kooskia and Dworshak NFHs by release year and release group.

Release Year	Release Group	CWT Fish Released	CWT Recoveries				Total Returns	Percent Yield
			0-Salts [1]	I-Salts	II-Salts	III-Salts		
1992	Early	111,879	0	4	17	1	22	0.020
	Mid	113,423	0	0	4	1	5	0.004
	Late	97,637	0	0	1	0	1	0.001
1993	Early	121,929	1	1	15	1	17	0.014
	Mid	119,297	0	0	6	1	7	0.006
	Late	105,988	0	1	3	0	4	0.004
1994	Early	66,014	47	11	37		(48)	(0.073)
	Mid	61,840	38	4	24		(28)	(0.045)
	Late	68,211	165	1	27		(28)	(0.041)

[1] Smolts that return to the rack and do not spend a complete year in the ocean. These fish are not included in the total return or percent yield.