Lyons Ferry Hatchery Evaluation: Fall Chinook

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Washington Department of
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FALL CHINOOK SALMON
1994 ANNUAL REPORT

by

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ABSTRACT

This report summarizes activities by the Washington Department of Fish and Wildlife's Lower Snake River Hatchery Evaluation Program from 1 April 1994 to 1 May 1995. This work was completed with Fiscal Year 1994 funds provided by the U.S. Fish and Wildlife Service under the Lower Snake River Compensation Plan (LSRCP). We describe the fall chinook salmon program at Lyons Ferry Fish Hatchery (FH), and related natural production in the Snake River. We also have incorporated information regarding salmon trapping at Lower Granite Dam (LGR).

Fall chinook salmon broodstock were obtained from two sources, voluntary returns to the Lyons Ferry FH ladder, and fish trapped and transported to Lyons Ferry FH from Lower Granite Dam. Only coded-wire tagged (CWT), blank wire tagged (BWT), and ventral fin clipped salmon were collected at Lower Granite Dam and transported to the hatchery. We estimated during collection that we had 1,310 adults and jacks as broodstock at Lyons Ferry in 1994. However, during spawning we processed 956 adults and jacks that had voluntarily returned to the hatchery and 325 salmon we had transported from trapping operations at Lower Granite Dam (1,281 total). Fish trapped at Lyons Ferry FH and Lower Granite Dam accounted for 30.8% and 10.6%, respectively, of the fall chinook salmon escapement above Ice Harbor Dam.

Recoveries of CWTs from salmon spawned at Lyons Ferry FH indicates a substantial number of fall chinook salmon from outside the basin strayed into the Snake River in 1994 , as in past years. Umatilla hatchery strays comprised 47.0% of the hatchery fall chinook salmon that escaped to Lower Granite Dam, and 12.0% of hatchery salmon that voluntarily returned to Lyons Ferry FH. Stray salmon from Klickitat and Methow hatcheries comprised 1.4% of the hatchery fish at Lower Granite Dam and 3.9% of the hatchery fish that voluntarily returned at Lyons Ferry FH. Salmon released as juveniles from Bonneville Dam continued to contribute less than 0.5% to the hatchery fish that escaped to either LGR or Lyons Ferry FH.

Fall chinook salmon were spawned at Lyons Ferry FH from 18 October to 6 December. Peak of spawning was 8 November. We read the CWTs of all marked hatchery fish before mating fish. Matings consisted of single female/single male lots (with a backup male). Only salmon verified to be of Lyons Ferry FH origin were used for broodstock. All Lyons Ferry origin salmon from the 1989 brood, marked (CWT) hatchery strays, and unmarked fish were spawned together as "strays". Total egg take from all fish was 1,532,404. Progeny from all stray and unmarked salmon were transferred to Klickitat FH (953,500 "eyed" eggs and 7,000 "green" eggs) for subsequent release there. The egg take from Lyons Ferry origin salmon was 567,104, with 536,422 of these eggs surviving until "eye up."

We continued with fertilization experiments for fresh, unfrozen held gametes, and cryopreserved semen from stray fall chinook salmon. Results will be included in subsequent reports. These techniques may provide us with management options to maintain population size and maximize genetic contribution for endangered fall chinook salmon.

Lyons Ferry FH released 309,949 yearling (1992 brood) fall chinook salmon directly from the hatchery on 18 April 1994. Another 293,712 yearling salmon were released at the hatchery on 19 April. All fish were adipose clipped (marked), coded-wire tagged and tagged with a red or yellow elastomer tag in the clear tissue behind the left eye. The 1993 brood fall chinook were released as yearlings (349,024 fish) at Lyons Ferry Hatchery on 17 April 1995. All of these fish also were marked with an adipose fin clip, CWT, and a red elastomer behind the left eye.

Mean egg-to-smolt survivals for brood years 1990-1994 were 85.65% for yearling and 88.13% for subyearling releases. Smolt-to-adult survivals for 1988-1990 brood years show greater than a 7-to-1 advantage for yearling releases. Mean survival was low for both release types (0.15% for yearlings and 0.02% for subyearling releases).

Sex, age, mean length and fecundity information was compiled for Lyons Ferry origin fall chinook salmon. Males have been more abundant in the younger ages classes of returning fall chinook salmon during the past four years. Few females return prior to age 4. Subyearling releases return larger adult fish then yearling releases at the same age, but substantially fewer fish. Most of the returning fish collected in 1994 were jacks and small males. Fecundity increased proportionally with age of female until age six, when a decrease was noticed. Fecundity and mean length of females decreased during the egg take.

We monitored fall chinook salmon spawning in the Tucannon and Palouse rivers. We observed 25 redds (2.6 redds/km below Fletcher's Dam) in the lower Tucannon River in 1994. We recovered 25 carcasses, three of which had CWTs and one fish had a BWT in the snout (all Lyons Ferry origin). Additionally, six RV clipped salmon were recovered (of Umatilla Hatchery origin). One other fish was adipose clipped but did not contain a wire tag. All other carcasses did not have wire tags or fin clips.

We are unable to account for approximately 32% (995 salmon) of the fall chinook escapement past Ice Harbor Dam in 1994. This estimate is calculated as the difference between the number of fish crossing Ice Harbor Dam and the numbers of fish entering Lyons Ferry FH, spawning in the Tucannon River, or crossing LGR.

We need improvements in fish size monitoring and release facilities at Lyons Ferry FH. We expect increased production at Lyons Ferry in the next few years because the 1989 brood (with high stray parentage) will not comprise a large proportion of the returning Lyons Ferry origin adults, and the 1991 and 1992 brood releases were relatively large. We will begin preparation for transfer, as well as monitoring and evaluation, of yearling releases at Pittsburg Landing in 1996.

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SECTION 1: INTRODUCTION

1.1: Program Objectives

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, constructed, and has been in operation since 1984. A partial objective of this hatchery is to compensate for the loss of 18,300 adult, Snake River stock, fall chinook salmon (U.S. Army Corps of Engineers 1975). An evaluation program was initiated in 1984 to monitor the success of Lyons Ferry FH in meeting the LSRCP compensation goals and to identify any production adjustments required to accomplish those goals.

The Washington Department of Fish and Wildlife (WDFW)[1] has two broad-based goals in its evaluation program: 1) monitor hatchery practices at Lyons Ferry FH to ensure quality smolt releases, high downstream migrant survival, and sufficient contribution to fisheries with escapement to meet the LSRCP compensation goals, and 2) gather genetic information which will help maintain the integrity of Snake River Basin fall chinook salmon stocks (WDF 1994). Specific program objectives are outlined in Appendix A.

This report partially summarizes the results and activities performed by the WDFW's LSRCP Fall Chinook Salmon Evaluation Program from 1 April 1994 through juvenile release in April 1995. Additional summarization and analyses may be reported in subsequent reports.

1.2: Description of Facilities

Lyons Ferry FH is located at the confluence of the Palouse and Snake Rivers at river kilometer (RK) 90 (Lower Monumental Pool, Fig. 1). Design capacity for the fall chinook salmon program was 101,800 pounds (9,162,000 subyearling smolts at 90 fish per pound). Lyons Ferry has a single pass well water system through the incubators, four adult holding ponds, and 28 raceways. Salmon[2] are hatched and reared at Lyons Ferry FH and have been released as yearlings or subyearlings, either on-station or barged downstream of Ice Harbor Dam. Broodstock are obtained from various sources (Section 2).

[1] All references to either the Washington Departments of Fisheries, or Wildlife, are listed here as WDFW: the agencies merged in March 1994.
[2] The term salmon in this report refers to fall chinook salmon.

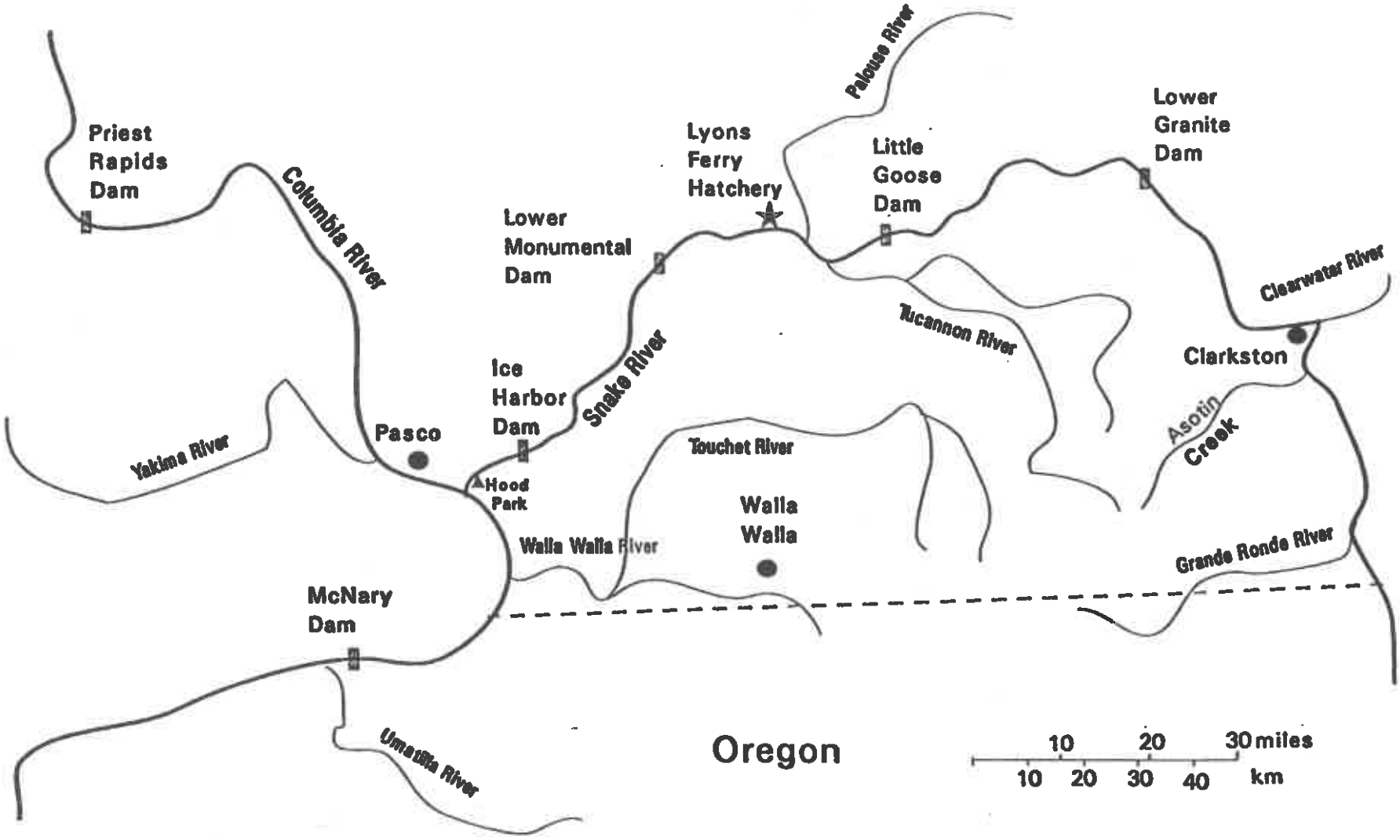

Figure 1. Lower Snake River Basin, showing the location of Lyons Ferry Fish Hatchery and major tributaries in the area.

SECTION 2: BROODSTOCK COLLECTION AND MANAGEMENT

2.1: Broodstock Collection

Lyons Ferry FH has been developing its broodstock since the facility became operational in 1984. Salmon were obtained from two primary sources prior to 1991: 1) returns to the Lyons Ferry FH ladder, and 2) adults trapped at Ice Harbor Dam (IHR) and transported to Lyons Ferry FH (Bugert and Hopley 1991). From its inception through 1990, Lyons Ferry FH broodstock collection from these two sources has averaged 37% of total escapement to the project area; past Ice Harbor Dam (Bugert et al. 1991). During the period 1984-1986, "eyed" eggs were transported from Kalama Falls FH to Lyons Ferry FH as part of the Snake River Egg Bank Program. Broodstock collection from 1984-1990 and during the eggbank program (1977-1984) was summarized in Bugert and Hopley (1989) and Bugert et al. (1991). The first year of adult (≥3 years old) returns from Lyons Ferry FH production was 1986.

During 1990-1993, fall chinook salmon broodstock were obtained from voluntary returns to the hatchery, trapping at Ice Harbor Dam, and trapping at Lower Granite Dam (Table 1). National Marine Fisheries Service (NMFS) and WDFW personnel trapped adult and jack fall chinook salmon at these two dams to obtain information regarding stray hatchery salmon and collect broodstock for Lyons Ferry FH. However, in 1994 we did not trap fall chinook salmon at Ice Harbor Dam because of the high number of stray salmon collected there, as well as our concerns about personnel safety and salmon passage delay caused by trapping. Also in 1994, WDFW continued to honor a request by NMFS to transport all fin clipped hatchery salmon captured at the adult trap at Lower Granite Dam to Lyons Ferry FH (Mendel et al. 1994). This was an attempt to limit the number of known hatchery salmon that could spawn upstream of Lower Granite Dam.

Table 1. Contribution of fall chinook salmon returns to Lyons Ferry FH from Ice Harbor Dam, Lyons Ferry FH ladder, and from Lower Granite Dam. Total counts at Ice Harbor (IHR) and Lower Granite LGR) dams are included.

Year	Collection point	Number collected adults	Number collected jacks	Passage counts adults	Passage counts jacks [a]
1990	Lyons Ferry FH	521	602		
	Ice Harbor Dam	1,092	0	3,447	1,839
	Lower Granite Dam	49	0	385	190
1991	Lyons Ferry FH	863	675		
	Ice Harbor Dam	361	71	4,500	1,526
	Lower Granite Dam	37	0	630	397
1992	Lyons Ferry FH	898	176		
	Ice Harbor Dam	256	71	4,636	894
	Lower Granite Dam	178	26	855	102
1993	Lyons Ferry FH	714	157		
	Ice Harbor Dam	127[b]	-	2,805[c]	332[c]
	Lower Granite Dam	218	4	1,170	39
1994[d]	Lyons Ferry FH	956[b]	-	2,069[c]	1,033[c]
	Lower Granite Dam	328[b]	-	791[c]	255[c]

[a] Classification of adults and jacks is based upon size at collection (see footnote on page 6 - minijacks are not included in this table).
[b] Salmon were not classified by size at the time of collection.
[c] Excludes salmon counted by video camera or passing during November at IHR.
[d] Salmon were not trapped at IHR in 1994.

2.1.1: Snake River Dam trapping operations

Adult collections: For the first time in several years no salmon were trapped or collected from Ice Harbor Dam in 1994. We did however, collect wire tagged and fin clipped fall chinook salmon, in cooperation with NMFS personnel, at the one fish ladder that exists at Lower Granite Dam. Salmon with coded-wire tags (CWT), blank-wire tags (BWT), or other metal objects activated the gate and were captured at the adult trap in the south shore ladder. Also, fin clipped (right or left ventral; RV or LV) salmon without wire were captured and retained during times the trap door was kept open to sample 100% of the steelhead and salmon passing the dam. The NMFS had requested that WDFW cooperate with them in keeping all identifiable hatchery fall chinook salmon from passing upstream of Lower Granite Dam. In 1994, WDFW had requested that the NMFS pass externally identifiable salmon of Lyons Ferry origin upstream. This would help dilute the genetic

contributions of unidentifiable stray hatchery salmon (primarily from Umatilla Hatchery) that pass upstream of Lower Granite Dam and spawn naturally. However, our request was not approved. Adult and jack salmon collected at the trap were transported by WDFW personnel to Lyons Ferry FH for sorting and potential use as broodstock. This was the fifth year adults were collected at Lower Granite. It was the third year jacks were collected for broodstock and to obtain straying information. Salmon collected as broodstock were anesthetized, given numbered metal jaw tags, and transported in an approximately 1,200 L aerated, unrefrigerated tank truck, with water obtained from Lyons Ferry FH wells or the adult trap at Lower Granite. WDFW personnel collected salmon seven days per week.

The 1994 count of fall chinook salmon at Lower Granite Dam (18 August to 15 December) was 791 adults, 255 jacks, and 319 mini-jacks (< 30 cm; U.S. Army Corps of Engineers 1995). The adult count was substantially less than in 1993.

A dispute among parties included in the U.S. vs Oregon process delayed trapping at Lower Granite Dam until 12 September. During the period from 12-18 September, before a permit was secured from NMFS, salmon could only be examined and counted at the trap. By that time 17 marked (adipose clipped) fall chinook adults and two marked jacks had passed the trap. The trap was operated until 2 December, although no fall chinook salmon were collected after 27 November.

A total of 328 fall chinook salmon were collected at Lower Granite Dam and transported to Lyons Ferry FH as potential broodstock. These fish included 262 salmon that were marked, of which 256 also had readable CWTs. Twenty-nine unmarked salmon had BWTs in the snout (1989 brood, Lyons Ferry). This brood was uniquely identified with this tag and fin clip arrangement because the 1989 brood originated from parents composed of an unacceptably high proportion of strays from the Umatilla River. One other fish had a BWT in the right shoulder (Umatilla Hatchery). Eighteen fish had right ventral fin (RV) clips (Umatilla Hatchery). Nine salmon were unmarked and did not have wire tags. Three wire tags were lost from unmarked fish and three CWTs were recovered from unmarked fish. All three of these CWTs were from Umatilla Hatchery fish. Three other fish could not be accounted for at Lyons Ferry FH because they escaped or lost their jaw tags.

Collection of hatchery adult and jack[3] salmon enabled us to: 1) monitor adult salmon composition at the dam (also monitored during 1990-1993), 2) remove fin clipped and wire tagged stray salmon, and 3) supplement Lyons Ferry FH egg take. We collected 86.7% of the adjusted total adults and jacks with missing adipose fins (indicating CWTs) passing the counting window at Lower Granite (262 adults and jacks collected of 162 marked adults and 140 marked jacks counted).

Mark rates: WDFW personnel kept separate tallies of marked and unmarked fall chinook salmon adults (≥ 56 cm total length) and jacks (30-<56 cm) (from Steve Richards, WDFW, personal communications). Separate counts of marked and unmarked minijacks (<30 cm) were not available for Lower Granite Dam in 1994. The combined mark rate for adult and jack salmon observed at the counting window at Lower Granite Dam during the period of fall chinook salmon counts (18 August to 15 December) was 28.8% (302 of 1,047); well above the 7.5% observed in 1993. Separate mark rates for adults and jacks in 1994 were 20.3% (162 of 798) and 56.2% (140 of 249), respectively.

Twenty-nine of the 636 unmarked fall chinook salmon adults (4.6%) that passed the counting window at the dam had BWTs and were subsequently collected at the trap. No unmarked jacks with a BWT were captured at the trap, although 109 unmarked jacks were counted passing the dam.

2.1.2: Voluntary returns to Lyons Ferry FH

In 1994, 956 adults and jacks (marked and unmarked) voluntarily returned to Lyons Ferry FH in 1994. Duration of returns was 80 days, compared to the 1986-1990 average of 81 days (Table 2). The peak of voluntary returns in 1994 occurred on 13 November (80 salmon).

[3] Throughout this report, jacks collected in trapping operations and voluntarily returning to the hatchery were distinguished only by size at the time of collection. The length criterion for jacks collected at the dams was ≤ 56 cm total length in 1994, whereas the criterion at Lyons Ferry FH was ≤ 50 cm fork length.

Table 2. Voluntary returns of fall chinook salmon to Lyons Ferry Fish Hatchery, duration of returns, and peak day of returns from 1986 through 1994.

Year	Number of returns adults	jacks [a]	Duration of returns	Peak return day date	adults
1986	245	1,125	5 Sep - 15 Nov	18 Sep	24
1987	1,654	543	13 Sep - 12 Dec	26 Sep	202
1988	327	1,053	9 Sep - 5 Dec	16 Sep	95
1989	704	670	6 Sep - 4 Dec	1 Oct	56
1990	521	602	5 Sep - 14 Nov	7 Nov	57
1991	863	675	13 Sep - 4 Dec	1 Oct	54
1992	898	176	14 Sep - 7 Dec	19 Oct	181
1993	714	157	8 Sep - 7 Dec	11 Nov	42
1994[b]	1,310	- -	11 Sep - 29 Nov	13 Nov	80

[a] Jacks were classified by size (≤ 61 cm fork length) at the time of collection prior to 1994.
[b] Adults and jacks were not classified at the time of collection.

2.1.3: Salmon collection summary

Salmon collected at Lyons Ferry FH and Lower Granite Dam comprised 41.4% of the total estimated escapement (1,284 of 3,102) of adults and jacks past Ice Harbor Dam in 1994 (Table 1). Voluntary returns to Lyons Ferry FH (956 fish) represent 30.8% of the estimated escapement over Ice Harbor Dam. This was the first year we were able to assess the percent of the Ice Harbor passage that voluntarily entered the hatchery without the confounding factor of salmon collection at that dam. The NMFS upstream migrant trap at Lower Granite Dam collected 10.6% (328 fish) of escapement past Ice Harbor Dam.

During 1994, we estimated that we collected 1,310 salmon from voluntary returns to Lyons Ferry (982) and trapping at Lower Granite (328). However, a total of 798 adults and 483 jacks (1,281) were processed at Lyons Ferry FH. The difference between estimated collection and the number of salmon processed is primarily from misclassification of salmon and steelhead during trapping and sorting with the partially automated sorting system at Lyons Ferry FH. Also, small jacks can pass through the crowders and escape. Three fish from Lower Granite Dam could not be identified at Lyons Ferry FH and apparently they were processed with voluntary returns, or they escaped the hatchery. These problems have occurred nearly every year, but our procedures are continually revised to improve accounting during spawning.

We collected 25.0% (325 fish identified from Lower Granite) of the salmon processed at Lyons Ferry FH, and approximately 23% of the hatchery broodstock of known Lyons Ferry origin from Lower Granite Dam. The remaining 75% of the fish processed at the hatchery had voluntarily entered the facility, and they comprised 77% of the broodstock.

Broodstock were collected and spawned in 1994 according to our 1992 Broodstock Collection and Spawning Protocol (Mendel et al. 1994), with slight modifications (Appendix B).

2.2: Run Composition

In 1994, the majority of returning fish that voluntarily entered the hatchery had originated as juveniles at Lyons Ferry FH. Salmon from Lyons Ferry and Umatilla hatcheries comprised the majority of hatchery fish recovered at Lower Granite Dam (Tables 3 and 4). Voluntary returns to Lyons Ferry FH in 1994 were less than the 90-91% of Lyons Ferry origin documented in 1992 and 1993. The percentage of salmon returning to the hatchery that were of Lyons Ferry origin had increased for several years, but now has leveled off at 84-91%. The percentage of salmon obtained at Lower Granite that had originated at Umatilla FH was more than 45% of the total hatchery fish collected again in 1994, as in 1993, while the number of Lyons Ferry origin fish trapped at the dam remained near 50%.

Expansions for each CWT code from Lyons Ferry FH were based on the number of fish released on approximately the same dates (Appendix C). This expansion method accounts for fish from Lyons Ferry FH that were branded, or were otherwise untagged, that may not be included with the experimental tag groups in the Pacific States Marine Fisheries Commission (PSMFC) database. All other CWTs were expanded using data available in the PSMFC database. Expansions were based solely on mark rate and do not include sample rate. Sample rates can be applied to fish collected at Lower Granite Dam, but it is difficult to estimate a sample rate for voluntary returns to Lyons Ferry FH in 1994. Fish recovered with a BWT in the snout (1989 brood Lyons Ferry origin), BWT in the right shoulder, or ventral fin clip (Umatilla R. releases), were added to the number of salmon estimated in the CWT expansions (Tables 3 and 4). Expanded return or run composition estimates based on CWTs alone would substantially underestimate salmon of Lyons Ferry origin returning to Lyons Ferry FH or Lower Granite Dam.

Fin clips and wire tags enable fishery managers to identify and potentially prevent these fish from entering the Snake River above Lower Granite Dam or contributing to the broodstock at Lyons Ferry FH. The 1989 brood from Lyons Ferry was the progeny of broodstock comprised of an unacceptably high proportion of

hatchery strays. Therefore, the entire 1989 brood was marked with wire tags (CWTs and adipose clips, or BWTs and unclipped) so these fish would not contribute to spawning upon their return to the Snake River Basin. All salmon released from Lyons Ferry FH since the 1989 brood have been marked with CWTs and adipose clips.

The WDFW has estimated run composition from marked hatchery salmon collected at Lower Granite Dam during the past several years. Our estimate of run composition is based on CWTs and BWTs recovered from salmon processed during spawning at Lyons Ferry FH. We used adults and jacks trapped at Lower Granite for estimating run composition at the dam during 1990-1994 (LaVoy 1995), and we based our estimate of run composition at the dam solely on jacks from 1985 to 1988 (Bugert et al. 1991).

Some differences exist between our run composition estimates and those reported by LaVoy (1995). Our estimates are generally restricted to the composition of the hatchery portion of the run at Lower Granite and Lyons Ferry FH, and they do not include trapping efficiency estimates. LaVoy's estimates of run composition include hatchery and naturally produced salmon. Also, his run composition estimates are calculated with trap efficiency estimates at the dam included.

LaVoy (1995) used our 1994 CWT recovery data to estimate run composition to Lower Granite Dam and to spawning grounds upstream of the dam. His estimate includes trapping efficiency at the dam. He estimated total escapement past Lower Granite Dam to be 607 adult (792 counted - 185 collected) and 110 jack (245 - 143) fall chinook salmon in 1994. LaVoy (1995) estimated 406 adult and 78 jack salmon that passed Lower Granite Dam were of natural origin. Hatchery fish that passed the dam consisted of 20 adult (15 were 1989 brood) and 22 jack salmon of Lyons Ferry origin, as well as 175 adult and 10 jack salmon originating from Umatilla FH. Six salmon adults of unknown hatchery origin also are estimated to have passed upstream.

Table 3. Run composition (from CWT, BWT and fin clips) of 956 fall chinook salmon processed as voluntary returns at Lyons Ferry FH in 1994.

Origin	Number of tags recovered	Expanded contribution [a]	Percent of expanded
Lyons Ferry	753[b]	767[b]	83.7
Umatilla	74[c]	110[c]	12.0
Bonneville	3[d]	3	0.3
Other [e]	2	36	3.9
Lost [f]	17	--	--
Totals	849	916	99.9

[a] Expansion based on juvenile mark rate.
[b] Includes 20 BWTs from snouts (1989 brood Lyons Ferry).
[c] Includes fish with no wire and right (67) or left (1) ventral fin clips.
[d] One Columbia River release, zone R-2 (7/54/7), and two Bonneville Bypass Study fish (23/24/59, and 23/25/34).
[e] Two stray hatchery fish (Klickitat R.; 63/40/30, Methow R.; 63/56/14).
[f] Lost CWTs prior to reading. Plus 11 fish with adipose clips and no CWTs. Two additional fish had CWTs, but were not adipose clipped (7-56-1; Umatilla R. and 63/55/47; Lyons Ferry). Ninety-three additional fish were not adipose clipped and did not have wire, one other fish was not adipose clipped but the wire tag was lost prior to reading.

Table 4. Run composition (from CWT, BWT and fin clips) of 325 fall chinook salmon trapped at Lower Granite Dam and transported to Lyons Ferry FH in 1994 (two additional jacks and one adult trapped at Lower Granite could not be identified at LFH).

Origin	Number of tags recovered	Expanded contribution [a]	Percent of expanded
Lyons Ferry	222[b]	228[b]	47.0
Umatilla	79[c]	249[c]	51.3
Bonneville	1	1	0.2
Other [d]	2	7	1.4
Lost [e]	6	--	---
Totals	310	485	99.9

[a] Expansion based on mark rate.
[b] Includes 29 BWTs from snouts (1989 brood Lyons Ferry).
[c] Includes fish with BWT in the right shoulder (1) and RV clips (18), no wire.
[d] Recovery of two Klickitat River CWTs (63/40/31).
[e] Includes lost and unreadable CWTs. Three fish with CWTs (7/54/50, 7/55/62, 7/54/49) were not adipose clipped. Another three fish that were not adipose clipped had the CWT/BWTs lost prior to reading. Nine additional fish were not adipose clipped and no wire was found (one had hook in throat).

SECTION 3: HATCHERY OPERATIONS

3.1: Spawning and Egg take

3.1.1: Spawning operations

Salmon collected at Lower Granite Dam were held separately from voluntary returns to Lyons Ferry FH. Fish collected at Lower Granite Dam were given a numbered jaw tag when trapped, enabling us to identify their location and date of collection.

Salmon that voluntarily entered the trap at Lyons Ferry FH were directed into a holding pond several times each week. We did not mark these fish for identification of entry date into the hatchery because in previous years we found that the proportion of strays did not differ substantially by week of collection (Bugert et al. 1991, Mendel et al. 1992).

Ripe fish were killed and set aside during spawning operations. CWTs were removed from marked fish and read to determine the fish's origin prior to fertilization of the eggs. Fish were spawned in two distinct groups: Lyons Ferry origin fish verified through CWT analysis, and all others. This latter category included all unmarked fish, strays identified by CWT, and all 1989 brood (BWT and CWT) salmon from Lyons Ferry FH. Only known Lyons Ferry origin fish (from CWT) were mated together (excluding the 1989 brood) and retained for subsequent Snake River releases. All fish were mated as single male/single female pairs (with a back up male 15-30 seconds later). Fertilized eggs from known Lyons Ferry fish were incubated separately from those eggs known to be from stray or unmarked fish. Chilled water was used for eggs of Lyons Ferry origin fish so that all egg takes would hatch on approximately the same date.

Spawning occurred from 18 October through 6 December 1994 (Table 5). The peak of spawning was 8 November, when approximately 514,500 eggs were taken. This peak date is consistent with previous years, and coincides with the apparent peak date on the spawning grounds. The total egg take at Lyons Ferry FH (corrected after picking) was 1,532,404; initial mortality was 5.1% (Table 6). Lyons Ferry origin salmon produced 567,104 "green" eggs. Under authority of an interagency and tribal agreement, progeny of stray, unmarked and 1989 brood Lyons Ferry broodstock were transported to Klickitat FH (953,500 "eyed" eggs and approximately 7,000 eggs before "eye up") for hatching, rearing and release there. The remaining 536,422 eyed eggs were retained for Lyons Ferry FH production.

Table 5. Collection and spawning summary for fall chinook salmon broodstock at Lyons Ferry Salmon Hatchery, 1994.

Week ending	Salmon[a] Arrivals	Mortality			Spawned			Egg take[e]
		M	F	J	M[b]	F[c]	J[d]	
17 Sep	24							
24 Sep	131							
1 Oct	187	1	1					
8 Oct	221							
15 Oct	208	1	2					
22 Oct	136	1	1		4	5	102	19,000
29 Oct	131	1		2	43	41	158	136,500
5 Nov	72	2	1	2	57	77	63	262,500
12 Nov	71	1	2	2	107	150	72	514,500
19 Nov	98	2		2	99	71	55	238,000
26 Nov	20	5	2	2	74	31	15	108,500
3 Dec	11	1		5	11	2	3	7,000
10 Dec					1	1		3,500
Totals[f]	1,310	15	9	15	396[g]	378	468	1,289,500

[a] Escapement is estimated during collection. Numbers of adults and jacks were not estimated separately at the time of collection in 1994.

[b] Many males were live spawned early in the season.

[c] Includes ten females that had bad eggs, were not ripe when killed, or had spawned in pond; two females with bad eggs or not ripe on 25 October, one spawned out and one not ripe on 31 October, two not ripe and one with bad eggs on 8 November, one with bad eggs, one not ripe, and one spawned out on 15 November.

[d] Includes jacks (≤ 50 cm fork length) spawned on 25 October (6 jacks), 31 October (1), and 8 November (17), as well as jacks killed without spawning ("surplused").

[e] Corrected total egg take after shocking was 1,532,404 eggs. This includes eggs from stray females used for fertilization experiments at Lyons Ferry FH.

[f] The number of salmon that were accounted for during processing at Lyons Ferry FH was 1,281 adults and jacks.

[g] Includes three males on 18 October, 18 on 25 October, two on 31 October, six on 8 November, 36 on 15 November, and 34 on 22 November that were not ripe when killed.

Table 6. Duration and peak of spawning, egg take, and percent egg mortality at Lyons Ferry Fish Hatchery since it began operation.

Year	Spawning duration	Peak of spawning	Total Egg take	Percent egg loss
1984	8 Nov - 5 Dec	21 Nov	1,567,823	21.58
1985	2 nov - 14 Dec	7 Nov	1,414,342	3.99
1986	22 Oct - 17 Dec	19 Nov	592,061	3.98
1987	20 Oct - 14 Dec	17 Nov	5,957,976	3.82
1988	18 Oct - 6 Dec	12 Nov	2,926,748	3.41
1989	21 Oct - 16 Dec	11 Nov	3,518,107	5.75
1990	20 Oct - 8 Dec	6 Nov	3,512,571	8.28
1991	15 Oct - 10 Dec	12 Nov	2,994,676 [a]	8.30
1992	20 Oct - 8 Dec	21 Nov	2,265,557 [a]	5.96[b]
1993	19 Oct - 7 Dec	2 Nov	2,181,879	6.69[c]
1994	18 Oct - 6 Dec	8 Nov	1,532,404	5.09[d]

[a] *Plus 9,000 eggs from stray females given to Washington State Univ.*
[b] *Combined loss from both known Lyons Ferry and stray/other fish; known Lyons Ferry was 5.06, and stray/other was 9.29.*
[c] *Combined loss from both known Lyons Ferry and stray/other fish; known Lyons Ferry was 9.6%, and stray/other was 6.1%.*
[d] *Combined loss from both known Lyons Ferry and stray/other fish; known Lyons Ferry was 5.4%, and stray/other was 4.9%.*

3.1.2: Sperm cryopreservation and fertilization experiments

In 1994 we continued freezing semen for addition to our gene bank. We froze semen with cryogenic techniques from five known Lyons Ferry origin fall chinook salmon for future use. We believe cryopreservation is an important tool in fisheries conservation when used for gene banking. However, the use of cryopreservation for increasing genetic contribution and diversity in fish stocks at critically low population levels must be balanced with its effects on total population size. Currently, fertilization rates from cryopreserved semen are highly variable and thus, unpredictable.

Often at the beginning or end of a spawning season we find a disparity in the number of males or females ready to spawn at the same time. It is logistically difficult to mate these fish within the constraints of maintaining identified matings groups (eg. strays, and Lyons Ferry origin fish) while maximizing genetic contributions from all fish. We desire alternatives to cryopreservation that would provide us an appropriate "ripe" male when a female is ready to spawn. If we could hold semen one or two weeks and obtain better fertilization rates than with cryopreserved semen, this would help achieve our management goals

of maintaining high genetic contribution and maximum population levels.

In 1994 we conducted fertilization experiments using fresh eggs and semen, and frozen semen. Eggs and semen were collected the day before the experiments and held in a cooler with ice. Most experiments were performed using unfrozen eggs and semen to evaluate short term (one to two weeks) holding and delayed fertilization. The methods and results of these experiments will be included in a subsequent report.

Experiments performed in 1994:

1) Gamete holding: Eggs (with O_2 or antibiotics added) and semen (with O_2 added) were held separately up to two weeks in a refrigerator, and fertilization rates were compared with fresh gametes.

2) Reduction of the amount of semen applied to eggs: We wished to determine a lower limit of semen to be added to eggs to possibly free up semen for conservation uses.

3) Cryopreservation: We wanted to determine a range of fertilization rates to expect when using cryopreserved semen, and refrigerated semen held up to two weeks, and how those rates compared to fresh semen.

3.2: Incubation and Rearing

The 1992 brood consisted of 835,171 fish at ponding. On 24 June 1993, 206,775 subyearling juvenile salmon were released directly from the hatchery. Yearlings were marked in September with either red or yellow elastomer tags (VT) in the clear tissue behind the left eye. We expanded use of the elastomer tag instead of continuing with the BWT as an externally identifiable tag because the portable wand detectors used to find BWTs were unreliable. We intend to continue to use the elastomer mark for the 1996 release. This external mark is to enable us to determine the origin of returning adults quickly and accurately without killing the fish to extract a CWT.

The 1993 brood retained at Lyons Ferry FH consisted of 351,818 eyed eggs from known Lyons Ferry origin broodstock (verified with CWT). Eggs from one 1989 brood Lyons Ferry female were mistakenly fertilized with a known Lyons Ferry male and were included with fertilized eggs retained for Lyons Ferry production. Fry loss before ponding was 10,555 (3.0%). Total fry ponded were 341,263 (357 lbs). In September 349,805 all juveniles were marked with adipose clips and CWTs (see Appendix D) to identify salmon known to originate from Lyons Ferry FH upon their return as adults. Over 90% of the yearling releases were externally marked with a red elastomer tag in the clear tissue

behind the left eye. We will use the elastomer tag for quick identification of returning Lyons Ferry origin fish, as with the 1992 brood. Additionally, we will have a unique elastomer mark for fish to be released upstream of Lower Granite Dam so that only those returning hatchery fish will be passed upstream of the dam. In October, hatchery records were adjusted to add 11,311 fish so the totals would match the number of fish that were marked.

The final 1994 brood egg take was 1,532,404 eggs, of which 536,422 eyed eggs were from known Lyons Ferry origin broodstock and retained for hatchery production. Fry loss was 10,728 (2%) prior to ponding. Total fry ponded were 525,694 (490 lbs). Each fish will be marked with an adipose clip, CWT, and VT in September 1995.

3.3: Disease Incidence and Prophylaxis

The 1993 broodstock were given flush treatments of formalin 1:7,000) as prophylaxis for Saprolegnia sp. (fungus). Females were injected once with Erythromycin 200 (20 mg/kg of fish) to reduce infection levels of Renibacterium salmoninarum (causative agent of Bacterial Kidney Disease, BKD). Eggs were disinfected and water hardened for one hour in iodophor (1:100) and formalin (1:600) was added every other day to control fungus on the incubating eggs. Eggs were segregated based on the incidence of BKD in the parents (using ELISA techniques), but no group had a high incidence. Generally this brood has had no fish health problems during the report period and no other prophylaxis treatments were administered.

The 1994 broodstock and their progeny were treated the same as the 1993 broodstock and progeny. This brood had no disease problems.

3.4: Smolt Releases

In the past, the fall chinook salmon production goal for Lyons Ferry FH was to rear 800,000 yearlings for a mid-April release at 10 fpp (80,000 lbs). Roughly half the fish were to be transported downstream of Ice Harbor Dam, and half were to be released directly from the hatchery. If more eggs were available, they would be reared and released as subyearlings in early June, either on-station or transported downstream by barge. Subyearlings would be transported if Snake River flows and available spills were low. This strategy placed the fish in the highest survival potential (Bugert et al. 1991) in an effort to increase the number of returning adult fall chinook salmon to the Snake River. However, this strategy was modified in 1993. In June 1993, WDFW personnel released subyearling fall chinook salmon (1992 brood) directly into the Snake River from Lyons

Ferry FH. This subyearling release was part of a WDFW/tribal agreement. The remaining fall chinook (1992 brood) were released on-station as yearlings in April 1994. Another agreement was reached in the fall of 1994 under the **United States vs Oregon** process that Lyons Ferry FH would release enough yearling juveniles upstream of Lower Granite Dam in 1996 to replace (in adult equivalents) the adults and jacks collected at Lower Granite Dam in 1994. In early 1995 the hatchery program goal was again changed in negotiations with other agencies and tribes as part of the 1995 Management Agreement for Upper Columbia River Fall Chinook. The current fall chinook salmon goal for Lyons Ferry FH, beginning with the 1995 brood, is to produce 900,000 yearling fall chinook per year. Half of those fish would be released on-station, and the other half would be released from acclimation sites upstream of Lower Granite Dam. If egg take was short, the first priority will be the 450,000 yearlings to be released at the hatchery. However, progeny of adults collected at Lower Granite Dam can not be used for releases at Lyons Ferry FH. If additional production is available beyond the full yearling program, subyearlings will be reared for monitoring and research. Any additional production will be for subyearling releases at Lyons Ferry FH. WDFW's goal, however, is to emphasize yearling releases as a means to increase the run size of adult fall chinook salmon into the Snake River as quickly as possible.

3.4.1: 1992 brood yearlings

We marked (adipose clip and CWT) the entire 1992 brood prior to release (see Appendix D) to identify salmon known to originate from Lyons Ferry FH upon their return as adults. Over 90% of the yearling fish retained the external elastomer tag behind the left eye at release. All subyearlings and yearlings were coded-wire tagged and adipose clipped.

The 1992 brood yearlings were released in April 1994. On 18 and 19 April, 309,949 and 293,712 yearling fish, respectively, were released from the hatchery. Hatchery records indicate the average size of these fish was 11 fish per pound (fpp).

We sampled seven of 15 ponds of fish released directly into the Snake River from Lyons Ferry FH. We found mean fork lengths of fish were significantly different (ANOVA, $p<0.05$) among the ponds of fish released. However, samples sizes from some ponds were quite small (80-98 fish). Significant differences (ANOVA, $p<0.05$) were detected among the three ponds with large samples sizes of 168-194 fish. A Tukey Test indicated pond 30 had a significantly larger mean size than the other two ponds, but the sample size in pond 30 was also slightly larger than for the other ponds. Mean fork lengths (and standard deviations = STD) were 160.0 mm (19.10), 151.8 (18.86) and 149.8 (19.09) for ponds 30, 27, and 32, respectively. Coefficient of variation ranged

from 11.9-12.7. Mean weights (STD) were 46.7 g (16.18), 39.4 g (14.55), and 37.1 g (14.75) and fish per pound estimates for sampled fish were 9.7, 12.2, and 11.5 for ponds 30, 27, and 32, respectively. Condition factors ranged from 1.11-1.14.

3.4.2: 1993 brood

The 1993 brood yearlings (349,024 fish) were released directly into the Snake River from the lower battery of ponds (adult ponds) on 17 April 1995. This is the smallest number of juveniles in a cohort released from Lyons Ferry since 1985, the first release year at this facility. Hatchery records indicate the average size of this brood was 7.5-8 fish per pound (fpp).

Mean lengths were not significantly different among the four ponds of yearling fish (ANOVA, and Tukey's Test, $p>0.05$), although variances appeared to be different among ponds. Mean fork lengths (and Standard deviation) were 169.5 mm (17.99), 173.6 (16.15), 172.60 (15.61) and 172.6 (18.82) for ponds 29, 30, 31, and 32, respectively, with an overall mean length of 171.7 mm. Coefficient of variation ranged from 9.1-10.9. Mean weights (STD) were 55.7 g (15.53), 60.6 g (14.84), 59.0 g (14.84), and 57.8 g (17.00), with an overall mean of 58.33 g. Fish per pound estimates were the same as indicated in hatchery records. Condition factors ranged from 1.14-1.16.

3.5: Survival Rates

We used the estimated number of eggs and fish present at various times, or life stages, in the hatchery for the 1990-1994 broods (Table 7) to estimate survival rates within the hatchery environment (Table 8). Mean egg-to-smolt survival rates are 85.65% (STD=3.32) for yearlings and 88.13% (STD=4.28) for subyearlings. Smolt-to-adult survivals for these same broods are generally incomplete at this time. However, we have documented that fall chinook smolt-to-adult survival rates from Lyons Ferry Hatchery are several times higher for yearling releases than for subyearling releases (Bugert et al. in prep.). A brief example of smolt-to-adult survival rates (for brood years 1987-1990) for salmon that returned to Lyons Ferry, or were captured and transported to the hatchery from Lower Granite Dam, shows yearlings return at a rate of greater than 7-to-1 over subyearlings (Table 9).

Table 7. Estimated salmon progeny from known Lyons Ferry origin adults, 1990-1994 brood years.

Brood Year	Total eggs	Eyed eggs	Fry ponded	Subyearling released	Yearlings marked[a]	Yearlings released
1990	1,103,745[b]	1,011,998[c]	958,241[d]	224,439[e]	694,388[f]	689,601
1991	906,411[b]	828,514	807,685	- -	765,207	760,018
1992	901,232	855,577	835,171	206,775[g]	611,107	603,050
1993[h]	400,490	363,129	352,574	- -	349,805	349,024
1994	567,104	536,422	525,694	- -	- -	- -

[a] Marking (CWT and adipose clip) generally occurs in late August through early October.
[b] Number of known Lyons Ferry origin eggs estimated by back calculating from the combined survival to eyed egg stage, and combined survival from eyed egg to fry (ponding).
[c] Total eyed eggs = 3,210,779, but only 1,171,058 were retained for rearing.
[d] Total fry ponded = 1,108,853, but 149,096 fry were shipped to Klickitat shortly after ponding (loss after ponding for this group was 1,516).
[e] Total group of subyearlings was 228,930 at ponding (loss was 4,491).
[f] This is the total number tagged with an elastomer or BWT, marking was completed earlier.
[g] Loss for subyearlings was 3,435; 210,210 fish ponded were later released as subyearlings (from 226,837 green eggs: estimated by using the overall survival for all eggs to ponding).
[h] Hatchery records show 389,179 green eggs taken and 351,818 eyed eggs. However, 11,311 fish too many (overage) were identified during counting as 349,805 fish were marked. Mortality was 2,769 fish before tagging in October and 10,555 fry died prior to ponding.

Table 8. Estimated survivals (%) between various life stages at Lyons Ferry Hatchery for fall chinook salmon of known Lyons Ferry origin.

Brood year	Egg-to-Fry[a]	Fry-to-smolt	Egg-to-smolt
1990	86.82[b]	94.55[c] 98.04[d]	82.09[c] 85.11[d]
1991	89.11[b]	94.74[c]	83.85[c]
1992	92.67	96.59[c] 98.37[d]	89.51[c] 91.16[d]
1993	88.04[b]	98.99[d]	87.15[d]
1994	92.70	- -	- -

[a] Total egg take ("green eggs").
[b] Based on back calculation to estimate green eggs taken.
[c] Estimate for yearlings.
[d] Estimate for subyearlings.

Table 9. Smolt-to-adult survival rates (%) for 1987-1990 brood year fall chinook salmon from Lyons Ferry Hatchery [a].

Release Group	Brood year 1987	1988	1989	1990	mean [b] (STD)
yearling	0.026	0.168	---	0.149	0.158 (0.0134)
subyearling	0.006	0.014	0.023	0.027	0.021 (0.0067)

[a] Returns are not complete for brood years 1987 (ages 4,5,6 represented) and 1990 (ages 2,3,4 represented).
[b] Means based on brood years 1988-1990 only. Brood year 1987 was omitted because a large component of the population (age 3) not represented. Age 5 fish are not included in the 1990 brood returns.

SECTION 4: STOCK PROFILE EVALUATION

4.1: Population Structure

4.1.1: Age and sex structure

Females dominate the older age classes of returning Lyons Ferry origin fall chinook salmon because few females return at age 3 or younger (Table 10). Few males are recovered at age 5 and older. Over 40% of the males that returned during 1991-1994 were age 2. Males tend to be smaller at the same age as females, at least in the younger age categories, and returning adults from subyearling releases tend to be larger than returning adults from yearling releases (Appendix E). Small males dominated the Lyons Ferry origin salmon processed at the hatchery in 1994 (Fig. 2). Stray hatchery fish were generally larger than 75 cm (Fig. 3). Length/weight relationships are presented in Appendix F.

4.1.2 Fecundity and egg size

We counted eggs, or we used three separate 100 egg weights and total egg weight, from Lyons Ferry origin females spawned at the hatchery to obtain the number of eggs per female. Mean fecundity for females increased by age group until age six (Table 11). Age 6 females had fewer eggs than age 5 females and eggs were smaller in size. Mean fecundity was correlated with mean length of fish (Figs. 4 and 5). We also found that fecundity decreased within an age group during the spawning season (Fig. 6). However, we believe this decrease is related to a decrease in fish size during the spawning season (Fig. 7).

Table 10. Age and sex of known (with CWT or BWT) Lyons Ferry origin salmon processed at Lyons Ferry FH (1991-1994).

Year sex	Age 2	3	4	5	6	7	Total
1991[a]							
male	257	201	74	65	9	0	606
female	0	5	134	120	10	0	269
percent	29.5	23.5	23.8	21.1	1.0	0	875
1992[a]							
male	153	128	164	22	0	0	467
female	0	60	255	34	3	1	353
percent	18.7	22.9	51.1	6.8	0.3	0.1	820
1993[b]							
male	102	101	105	61	1	0	370
female	0	22	176	104	0	0	302
percent	15.2	18.3	41.8	24.5	0.1	0	672
1994[b]							
male	377	284	83	16	4	0	764
female	0	4	154	44	10	0	212
percent	12.5	29.5	24.3	6.1	1.4	0	976
Total %	26.6	24.1	34.2	13.9	1.1	0.0	3,343
male %	40.2	32.3	19.3	7.4	0.6	0.0	2,207
female %	0.0	8.0	63.3	26.6	2.0	0.1	1,136

[a] From CWT recoveries and BWT estimated recoveries; in 1991, 85 BWTs were collected from Lower Granite and 136 volunteered into the hatchery - all were assumed to be males; in 1992, 127 were collected at LGR and 61 volunteered - 39 were estimated from sampling to be females.

[b] Includes both CWT and BWT recoveries.

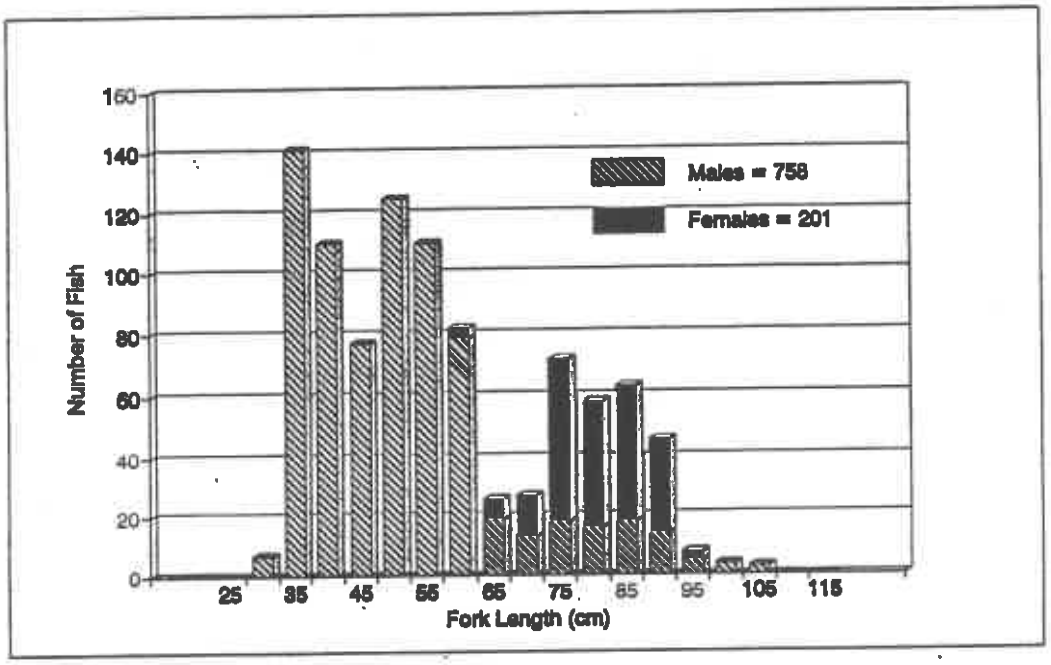

Figure 2. Length-frequency of Lyons Ferry origin salmon processed at the hatchery in 1994.

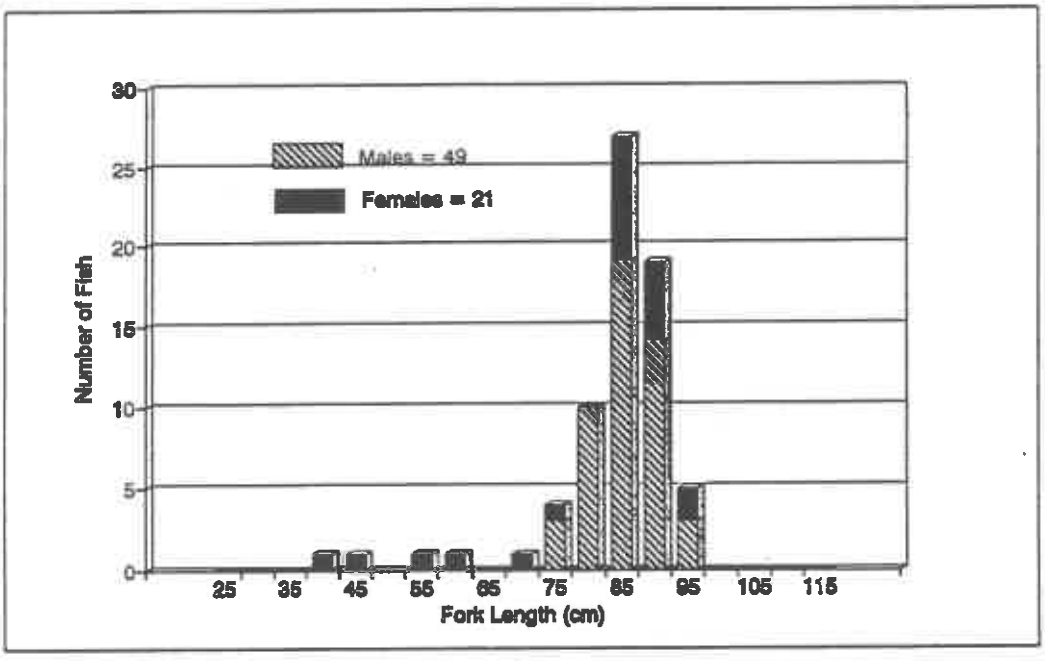

Figure 3. Length-frequency of stray hatchery salmon processed at Lyons Ferry FH in 1994.

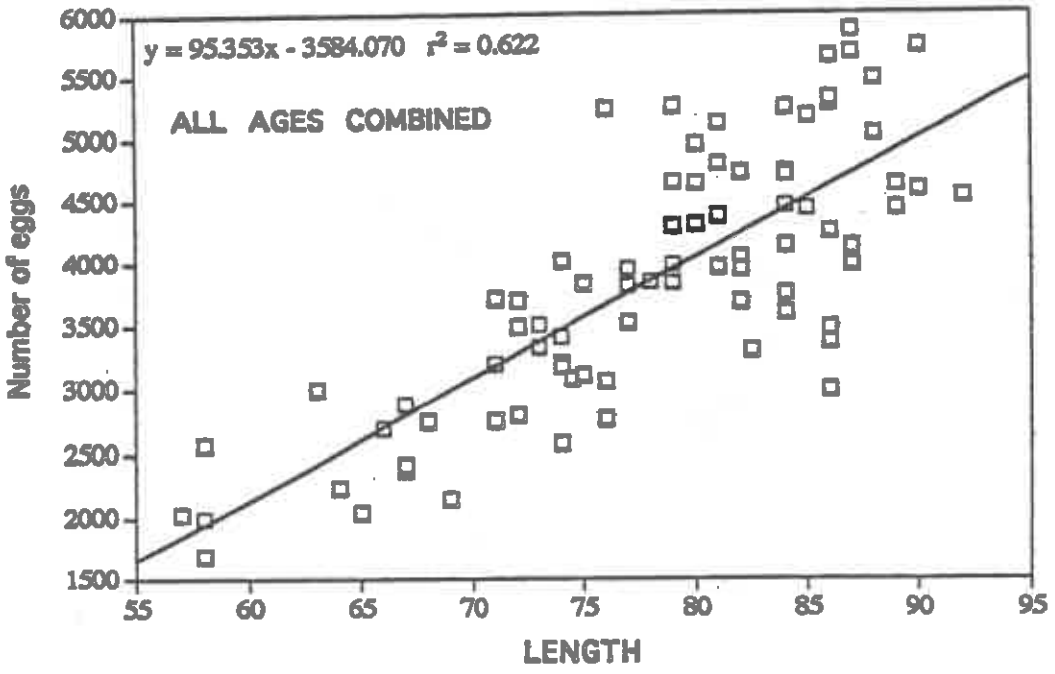

Figure 4. Relationship of female length (fork length - cm) and number of eggs (estimated by weight samples) for Lyons Ferry origin fall chinook salmon spawned at Lyons Ferry in 1994 (all ages combined; peak of spawning was 8 November).

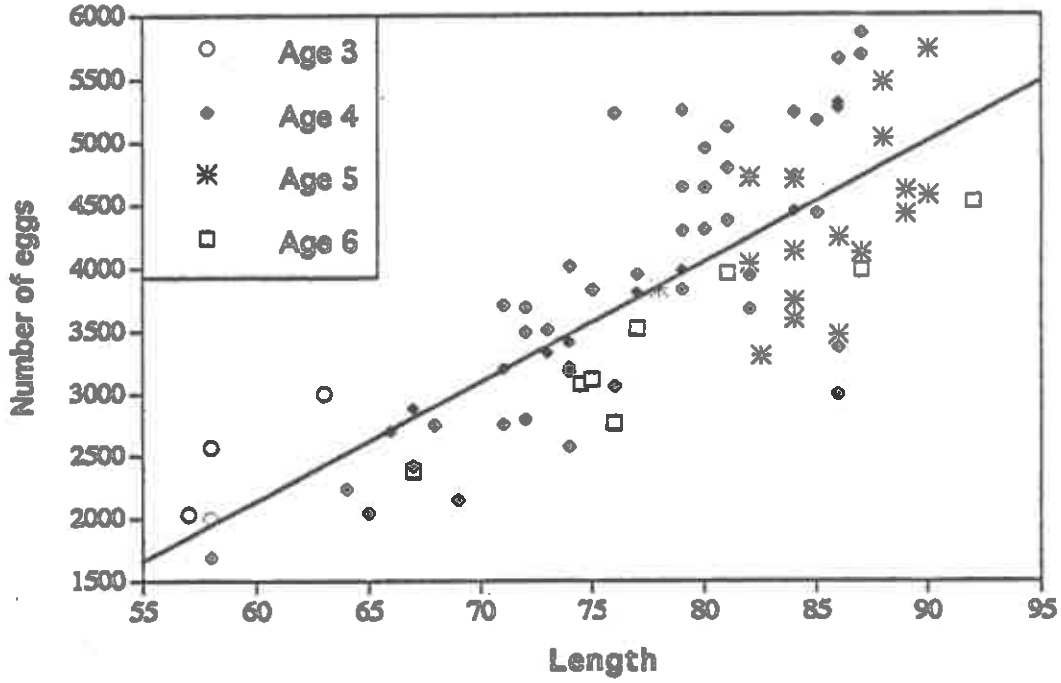

Figure 5. Relationship of female length (fork length - cm) and number of eggs (estimated by weight samples) for Lyons Ferry origin fall chinook salmon spawned at Lyons Ferry in 1994 (by age).

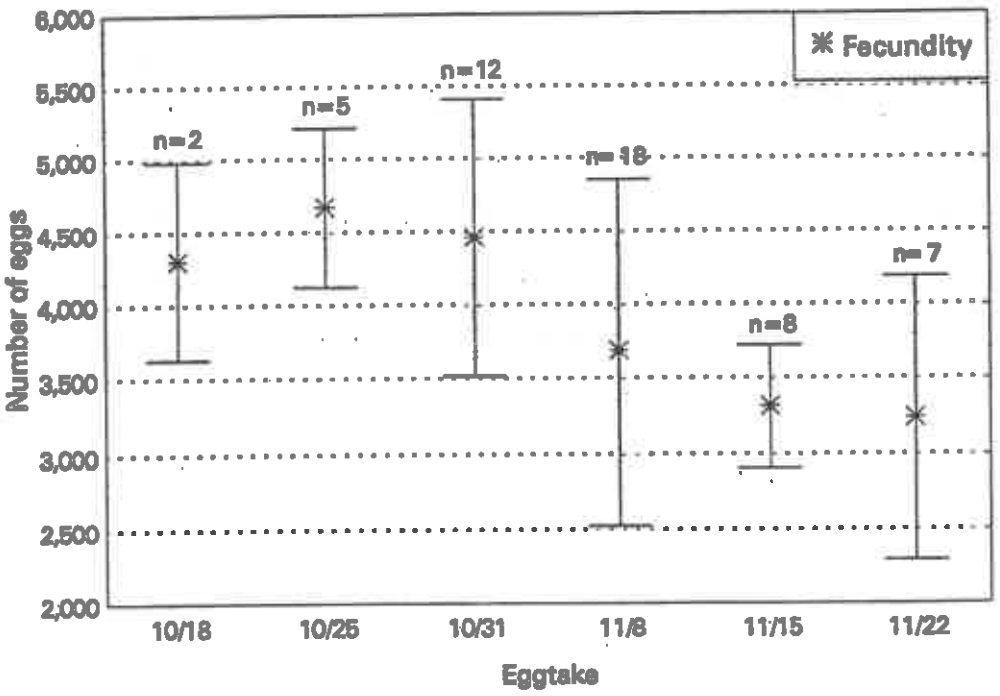

Figure 6. Fecundity of age 4 Lyons Ferry fall chinook salmon during the 1994 spawning season (means number of eggs, plus or minus one standard deviation).

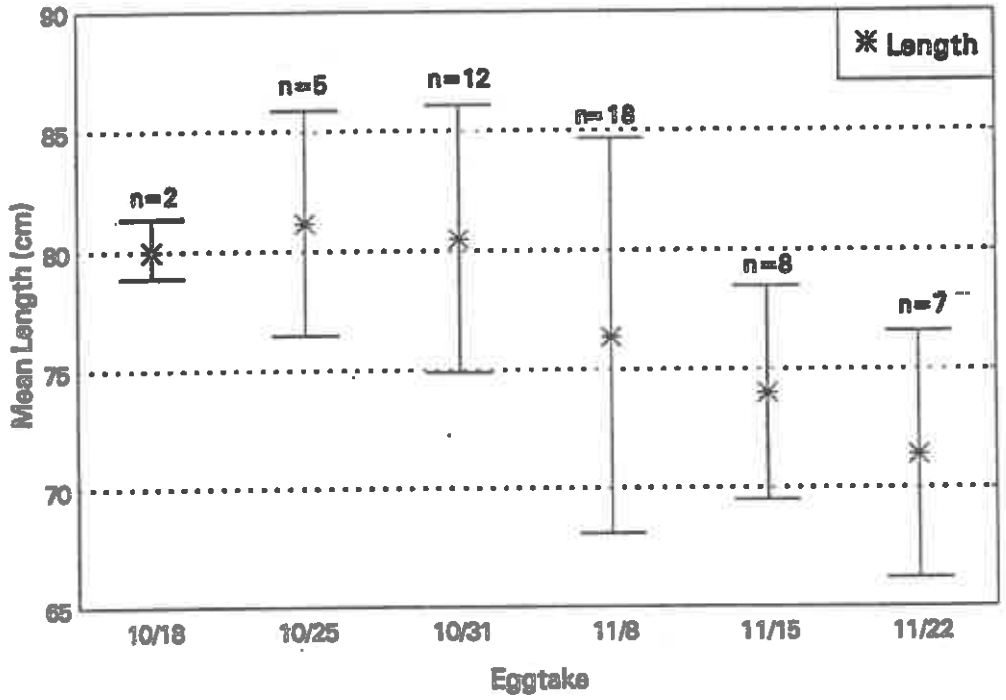

Figure 7. Relationship of fecundity and length for age 4 Lyons Ferry fall chinook salmon during the 1994 spawning season (means length, plus or minus one standard deviation).

Table 11. Mean number and standard deviation (STD) of eggs taken per Lyons Ferry origin female during fall chinook salmon spawning at Lyons Ferry Hatchery, as determined by weight samples and actual counts, 1994.

Age	Actual count	Standard dev. (sample size)	Weight sample	Standard dev. (sample size)	Mean weight/ 100 eggs (g)
3	2,397	522.2 (4)	2,399	477.3 (4)	21.2
4	3,765	1,137.5 (36)	3,852[a]	1,050.8 (50)	28.0
5	4,306	638.4 (18)	4,921[b]	418.2 (4)	35.2
6	3,480	738.9 (9)	3,505	722.1 (9)	32.6

[a] Mean number of eggs per female count or weight sample was 3,733 (STD=1,157.3) and 3,790 (STD=1,149.6) respectively, for the same 34 females.
[b] Mean number of eggs per female count or weight sample was 4,834 (STD=420.3) and 4,921, respectively, for the same 4 females.

4.2: Stock Profile Sampling

We collected 100 electrophoretic samples from adult fall chinook salmon of Lyons Ferry origin in 1994. We also collected electrophoretic samples from 100 juveniles from the 1992 brood. Electrophoretic samples were not collected from 1993 brood juvenile salmon. We did not collect morphometric or meristic data from any fall chinook during this contract year. At time of release we collected organosomatic data from both the 1992 brood subyearlings (30 fish) yearlings (20 fish), as well as from the 1993 (80 fish) brood year. Results from these collections will be included in subsequent reports.

SECTION 5: NATURAL PRODUCTION

We no longer conduct cooperative spawning surveys upstream of Lower Granite Dam. Personnel from Idaho Power and the U.S. Fish and Wildlife Service (USFWS) jointly survey spawning grounds in the upper Snake, Grande Ronde and Imnaha rivers (Garcia et al. 1995). Personnel from the Nez Perce Tribe conduct spawning surveys in the Clearwater and Salmon rivers (Bill Arnsberg, personal communication). Additionally, intensive spawning surveys are conducted in the tailraces of the four Snake River dams (Dauble et al. 1994).

Personnel from WDFW surveyed the Tucannon River on foot about once a week from 19 October to 13 December 1994. Surveys encompassed the river from the its mouth (above slackwater) upstream to Highway 12 (RK 22.0) during most weeks. A survey on 13 December included the river from Enrich Bridge (RK 28.0) downstream to Highway 12. Survey conditions were fair to good during survey dates, except on 6 December when conditions were poor due to high turbidity.

Twenty-five redds, 30 live salmon and 25 carcasses were observed in the Tucannon River during spawning surveys in 1994 (Table 12). One salmon carcass was found upstream of Fletcher's Dam (RK 9.6) in 1994. This is the third year fall chinook salmon have been observed upstream of the dam, which was identified as a passage impediment before 1992 (Mendel et al. 1992). The dam was modified in 1992 to improve salmon passage (Mendel et al. 1994). Spawning ground density was 1.6 redds/mile (2.6 redds/km) downstream of Fletcher's Dam in 1994. Redd densities peaked in 1990 and have remained relatively constant since then (Table 13). Redd densities listed here (Table 13) are corrections of those previously reported were revised because of previous calculation errors. Few redds or salmon have been observed upstream of Fletcher's Dam in spite of passage improvements in 1992.

We recovered 25 carcasses (seven hatchery and 10 wild females, and four males each of wild and hatchery origin) in the Tucannon River. Three carcasses were marked (CWTs 63/41/43, 63/55/44, 63/41/60) and one fish had a BWT in the snout. All these fish were of Lyons Ferry origin. Additionally, six RV clipped salmon carcasses were found (presumably from the Umatilla River). One hatchery fish did not contain any wire but it was adipose clipped. Carcasses of two wild and one hatchery salmon had evidence of having been killed illegally during the steelhead fishing season. One of these fish was found on the bank with two hooks in it.

We surveyed the Palouse River from slackwater to Palouse Falls on 18 November. No redds, live salmon or unmarked carcasses were observed. Survey conditions were poor because of high turbidity. A few redds and salmon have been seen here in past years, but conditions are usually poor for observations (Mendel et al. 1994).

Table 12. Date, location surveyed, number of redds, and carcasses found during Tucannon River fall chinook salmon spawning surveys in 1994.

Survey date	River kilometer [a]	Redds	Live fish	Carcasses [b] Females	Carcasses [b] Males
10-19	20.1 - 7.1	No redds or fish seen (live or dead).			
10-24	7.1 - 0.0	No redds or fish seen (live or dead).			
11-04	22.2 - 17.7	No redds or fish seen (live or dead).			
11-07	20.1 - 12.7	No redds or fish seen (live or dead).			
11-10	12.7 - 0.0		1[c]		
11-14	22.2 - 9.6				
	9.6 - 7.1	2	1		
	7.1 - 3.5				
	3.5 - 0.0		3		
11-21	22.2 - 9.6				
	9.6 - 7.1		4		
	7.1 - 3.5	3	4	1	
	3.5 - 0.0		1		1
11-28	9.6 - 7.1	5	1		
	7.1 - 3.5	3	5	1	2
	3.5 - 0.0	8	7	7	
11-30	22.2 - 9.6				
12-06	7.1 - 3.5	1	3	2	1
	3.5 - 0.0	2		2	1
12-13	28.0 - 17.7				
	17.7 - 12.7				1
	12.7 - 9.6				
	9.6 - 7.1	1			
	7.1 - 3.5			3	
	3.5 - 0.0			1	2
Totals		25	30	17	8

[a] River landmarks were as follows: Marengo (Rk 39.9), Enrich Bridge (Rk 28.0), Highway 12 Bridge (Rk 22.2), Krouse's Bridge (Rk 20.1), Kessel's Bridge (Rk 17.7), Smith Hollow Bridge (Rk 17.7), Smith Hollow Bridge (Rk 12.7), Fletcher's Dam (Rk 9.6), Starbuck Bridge (Rk 7.1), Highway 261 Bridge (Rk 3.5), Tucannon River mouth (Rk 0.0).

[b] Two hatchery males were found on 11/28 (1 Rv clip) and two on 12/13. One hatchery female was found on 11/21, and six on 11/29 (3 RV clip, 1 BWT).

[c] Below Fletcher's Dam, about 100 m upstream of Starbuck Bridge.

Table 13. Number of redds and redd densities, in the lower Tucannon River, and below Fletcher's Dam (upstream of Starbuck), 1985-1994. (Note: some densities reported in this table are corrections of densities reported in Mendel et al. 1992, 1993, 1994).

Year	Total redds	Redds below dam	Redds/ km [a]	Redds/ mile [a]
1985	0	0	0	0
1986	0	0	0	0
1987	16	16	1.7	2.7
1988	26	26	2.7	4.4
1989	48	48	5.0	8.0
1990	61	61	6.4	10.2
1991	50	50 [b]	5.2	8.4
1992	23	21	2.2	3.5
1993	28	21	2.2	3.5
1994	25	25	2.6	4.2

[a] We estimate 9.6 km (5.96 miles) from the mouth to the dam. We do not survey the lower 1.3 km because it is deep and poor habitat; we assume no spawning there.

[b] We observed several other redds during the last survey that were not counted because of high turbidity and uncertainty whether they had been counted before. Thus, this should be considered a minimum estimate.

SECTION 6: LOSSES UPSTREAM OF ICE HARBOR DAM

As in past years, a large proportion of fall chinook counted at Ice Harbor Dam were not accounted for upstream. Approximately 32% of fall chinook salmon escapement upstream of Ice Harbor Dam in 1994 was not accounted for with our standard summation methods (Table 14). This estimated loss is similar to the 27% loss obtained in 1993, but substantially below the 56% that could not be accounted for in 1992. Total salmon not accounted for consists of the difference between the Ice Harbor Dam counts and counts or estimates at various locations up to Lower Granite Dam. Possible disposition of these missing fish includes fall back at Ice Harbor Dam, mortality, or spawning in tributaries or tailraces of the lower Snake River dams. Limited spawning was documented below Lower Granite and Little Goose dams in 1993 and 1994 (Dauble et al. 1994, and Dauble personal communications). Also, we have documented fall back of fall chinook salmon at Ice Harbor Dam with radio telemetry (Mendel et al. 1993), but improved fall back estimates are needed to assist with accounting for all salmon passing Ice Harbor Dam.

Table 14. Fall chinook salmon (adults and jacks) accounted for upstream of Ice Harbor Dam, 1994.

	Number of adult and jack salmon
Counted at Ice Harbor Dam	3,072
Collected at Ice Harbor Dam	- 0
Voluntary returns to Lyons Ferry FH	- 956
Spawning escapement to Tucannon and Palouse rivers[a]	- 75
Counted at Lower Granite Dam	-1,046
Total not accounted for	995

[a] Twenty-five redds with an estimated 3 adults per redd; no adults or redds in the Palouse River.

SECTION 7: CLOSING COMMENTS

We need to develop a reliable sampling method to monitor fish sizes at the hatchery that will assist us with accurately comparing fish size and growth among raceways. We will continue to evaluate sampling methods and fish size for juvenile salmon reared at Lyons Ferry FH. We are not satisfied that current agency hatchery monitoring protocols can provide accurate data for maintenance of fish at the same average size and coefficient of variation in different raceways or ponds. Juvenile fall chinook released in 1995 (1993 brood) were larger than desired. Additional sampling is needed during rearing to meet target sizes. Mark groups should have the same mean size, variance, and fish density to reduce confounding factors for us to evaluate the possible differences in treatment effects (eg. survival rates for different release locations).

Survival of fall chinook salmon from Lyons Ferry Hatchery is very poor for both yearling and subyearling release groups. Changes to facilities at Lyons Ferry FH are needed to enable us to release juvenile salmon directly from the hatchery. The hatchery was not designed for volitional or direct stream releases. Fish must be pumped from the upper raceways to the river or released from the adult ponds through a vertical pipe at the end of the crowding channel. Fish from the adult ponds are subject to injury because of high water velocity and collisions with the grating at the top of the exit pipe. We recommend that the grating be modified, or a new release system be put in place, as soon as possible. These modifications should receive top priority.

We found that egg weight samples accurately estimated total eggs. However, egg weight samples should be taken for each individual female, not with grouped eggs from several females, because egg size and fecundity vary by fish length and age. We will continue evaluating fecundity of known Lyons Ferry origin salmon from the 1995 broodstock. We will review hatchery egg count protocol make recommendations to improve estimates of egg take and fecundity.

We intend to continue to refining our cryogenics and delayed fertilization techniques. These tests are critical for enabling us to make informed management decisions to maintain high genetic variability and maximum genetic contributions, while maintaining high production of listed stocks. We must have an agency commitment that ensures we are able to obtain appropriate stocks for further testing of these techniques.

Fall chinook production from Lyons Ferry Hatchery should substantially increase in the next few years because production will not be limited by returning adults that have mixed parentage

(1989 brood). Therefore, we should be able to retain most of the eggs we take from Lyons Ferry fish and the returns to the Snake River should begin to increase over the next few years. Therefore, salmon stocks from the Columbia River that are reared at Lyons Ferry may soon have to be moved to other facilities.

We will prepare for release of fish at Pittsburg Landing in 1996. These fish will be uniquely marked so they can be identified with internal and external tags. This release group will be released directly from Lyons Ferry if acclimation facilities are not available in 1996. We will continue to work with the Corps of Engineers, the Tribes, and the Production Advisory Committee (PAC) to locate suitable acclimation sites for additional releases of Lyons Ferry fall chinook in 1997 (up to 450,000 yearlings). We intend to monitor and evaluate releases from Pittsburg Landing and compare their success with those released from Lyons Ferry using our current activities and marking plans. Also, we have submitted a joint proposal with the U.S. Fish and Wildlife Service and the Nez Perce Tribe for expanded monitoring and evaluation for three years of releases at Pittsburg Landing and several additional years of returns.

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APPENDIX A

Washington Department of Fish and Wildlife objectives for the LSRCP Hatchery Evaluation Program. These objectives are interrelated and are not listed in priority.

1) Document juvenile fish production for Lyons Ferry and Tucannon FH. Records will be compiled and summarized by numbers of fish produced at each facility and 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, and compared with escapement to other hatcheries and streams throughout the Columbia River Basin.

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 a central database or the agency of origin. We will attempt to tag sufficient fish to represent each rearing program, and to avoid duplication with contribution studies from other hatcheries.

4) Document downstream movement to Fish Passage Center and National Marine Fisheries Service sampling points on the Snake River and/or lower Columbia River for each rearing program. Program staff will retrieve and summarize data for the Lyons Ferry/Tucannon facilities. Survival rates will be compared for each rearing program. We will use these data to modify hatchery releases to improve downstream migrant survival.

5) Quantify genetic variables that might be subject to alteration under hatchery production strategies. We plan to identify and quantify as many genetic variables as possible in all available Snake River chinook salmon populations. Similar data for other populations which may overlap with Snake River chinook salmon in the lower Columbia River are being developed. These data include qualitative loci analysis through electrophoresis, and quantitative analysis of such factors as meristics, adult and juvenile body morphometry, adult size, run timing, and disease susceptibility.

6) Maintain genetic integrity of indigenous Snake River salmon stocks. Use and maintenance of native stocks is an important goal of the LSRCP. We plan to protect these stocks through two strategies: a) identify stray adults at Lyons Ferry and Tucannon FH for removal from the broodstock, and b) mark all smolts prior to release for their proper identification upon return.

7) Determine the success of any off-station enhancement projects, and determine the impact of hatchery fish on wild stock. Our emphasis will be to evaluate changes in natural production in response to hatchery enhancement, and to develop escapement goals based upon optimum natural and hatchery production. We will study interactions at both the juvenile and adult life stages. We may use information obtained from Objective 5 to develop genetic marks (qualitative or quantitative) which could provide techniques for evaluating interactions of wild and hatchery fish in the Tucannon River system.

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

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

B. Selection and maintenance of broodstock will be done in conformance with LSRCP goals. Criteria will be developed to program genetic management as determined by Objectives 5 and 6, and in accordance with tribal agreements.

C. Loading densities, feeding regimes, disease investigations, or other special treatments on experimental hatchery practices often require mark-release-return groups to facilitate evaluation. Program staff will develop the experimental designs, direct the marking, and analyze the results.

9) Evaluate and provide management recommendations for Snake River salmon distribution programs basin-wide. As Lyons Ferry FH and Tucannon FH goals are reached, egg take needs to supplement natural production in other streams will be specified. We will set priorities for off-site distribution, based upon current escapement levels, habitat quality, and agreements with co-managing agencies and tribes. Evaluation and improvement of the distribution plan will be an on-going process.

10) Coordinate research and management programs with hatchery capabilities. Advance notice to the hatcheries 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 D. continued.

Release year Age (brood yr)	Release type[a]	Date[b]	Number CWT	CWT code[c]	Adipose only marked	Number unmarked	lbs	fish/ lb
subyearling (87)	direct	6/1	124,345	52/14	374	839,682	18,196	53
			124,394	52/16	374	840,018	18,202	53
						79,961[i]	1,509	53
			248,739		748	1,759,661	37,907	
subyearling (87)	barge	6/8	122,850	52/11	2,125	21,246	2,759	53
			122,899	52/13	2,125	21,254	2,760	53
						271,500	3,879	70
						886,300	8,953	99
						1,114,000	8,984	124
			245,749		4,250	2,314,300	27,335	
1989								
yearling (87)	direct	4/14	57,594	47/56	58	69,249	12,690	10
			57,756	47/52	58	69,443	12,725	10
						39,044[j]	3,904	10
			115,350		116	177,736	29,319	
yearling (87)	barge	4/20	59,609	47/55	299		5,991	10
			59,608	47/50	299		5,991	10
			119,217		598		11,982	
subyearling (88)	direct	6/8	113,285	02/28	2,076	18,244	1,485	90
			113,193	02/26	2,075	18,244	1,483	90
						828,485	8,663	96[k]
						39,991[l]	580	69
						40,025[l]	580	69
			226,478		4,151	944,989	12,791	
subyearling (88)	barge	6/14	117,168	52/07	3,128	21,207	1,887	75
			116,935	52/04	3,121	21,208	1,884	75
						173,595	2,755	63
						125,091	1,061	118
						88,378	982	90
			234,103		6,249	429,479	8,569	
1990								
yearling (88)	direct	4/16	56,597	02/37	502	83,264	15,596	9
			55,922	02/35	496	83,264	15,520	9
			112,519		998	166,528	31,116	
yearling (88)	barge	4/17	58,988	02/31	458	18,708	7,105	11
			58,989	02/32	458	18,708	7,105	11
			117,977		916	37,416	14,210	
subyearling (89)	direct	6/6	123,233	55/47	3,601		2,306	55
			123,640	55/44	3,662		2,315	55
		6/6				79,676[m]	1,035	77
		6/6				303,255[n]	4,332	70
		6/18				793,349[n]	10,868	73
		6/25				604,205[n]	8,757	69
		7/2				534,174[n]	7,524	71
		7/2				768,312[n]	10,821	71
		7/12				227,413[n]	2,707	84
			246,873		7,263	3,310,384	50,665	
subyearling (89)	barge	6/8	118,104	55/49	4,716		1,981	62
			119,941	55/50	4,787		2,012	62
			238,045		9,503		3,993	

APPENDIX D

Lyons Ferry fall chinook salmon releases and number marked or unmarked (coded-wire tagged) by release year and type since the hatchery began operation in 1984.

Release year Age (brood yr)	Release type[a]	Date[b]	Number CWT	CWT code[c]	Adipose only marked	Number unmarked	lbs	fish/ lb
1985								
yearling (83)	direct	4/17	250,831	21/52	1,769	235,125	48,773	10
			83,611	32/18	589	78,375	16,468	10
			334,442		2,358	313,500	65,241	
subyearling (84)	direct	6/6	78,064	32/27	235	100,900	2,354	76[d]
			78,504	32/28	236	101,400	2,369	76[d]
			78,417	32/26	236	101,400	2,367	76[d]
			234,985		707	303,700	7,090	
1986								
yearling (84)	direct	4/2&3	258,355	28/41	1,821	181,500	55,210	8
		4/4&8				40,274[e]	5,035	8
						181,500	22,688	8
			258,355		1,821	403,274	82,933	
subyearling (85)	direct	6/10	49,325	36/38	468		859	58
			49,325	36/39	468		859	58
			49,325	36/40	468		859	58
			49,325	36/41	468		859	58
			49,325	36/42	468		859	58
						81,003[e]	1,157	70
						1,212,200	13,933	87
			246,625		2,340	1,293,203	19,385	
subyearling (85)	barge	6/13	49,112	36/33	366		900	55
			49,112	36/34	366		900	55
			49,112	36/35	366		900	55
			49,112	36/36	367		900	55
			49,112	36/37	366		900	55
			245,560		1,831		4,500	
1987								
yearling (85)	direct	4/14	152,479	41/56	1,075		25,592	6
						39,906[f]	4,425	9
						36,300	3,862	9
						653[g]	69	9
			152,479		1,075	76,859	33,948	
yearling (85)	barge	4/16	156,036	41/59	470		22,682	7
subyearling (86)	direct	6/1	126,076	42/59	2,836		2,686	48
			125,570	42/61	2,824		2,675	48
						80,484[h]	1,059	76
			251,646		5,660	80,484	6,420	
subyearling (86)	barge	6/2	128,283	44/01	1,034		1,821	71
			127,715	42/62	1,030		1,836	71
						78,200	745	105
			255,998		2,064	78,200	4,402	
1988								
yearling (86)	direct	4/14	58,970	44/13	237	64,369	15,447	8
			58,735	44/11	236	64,112	15,385	8
						39,952[i]	4,994	8
			117,705		473	168,433	35,826	
yearling (86)	barge	4/19	60,523	44/07	213		7,592	8
			60,281	44/08	212		7,562	8
			120,804		425		15,154	

APPENDIX C: continued.

Table 2. Recoveries of stray CWTs at Lyons Ferry Hatchery in 1994 (data matches PSMFC data). a

VOL	LG	TOTAL	CWT CODES			RELEASE LOCATION	BROOD YEAR	NUMBER CWT (T)	NUMBER AD-ONLY (A)	NUMBER UNMARKED (U)	EXPANSION RATE ((T+A+U)/T)	EXPANDED RECOVERY VOL	LG	TOTAL
1	7	8	7	0	16	Umatilla River	90	48,301	1,431	49,493	2.05	2	14	16
1		1	7	2	55	Umatilla River	92	23,699	2,396	207,534	9.86	10	0	10
	1	1	7	14	16	Tanner Creek/Bonnev	90	96,085	4,089	16,837	1.22	0	1	1
1		1	7	14	61	Umatilla River	91	23,239	1,635	17,721	1.83	2	0	2
1	2	3	7	52	25	Umatilla River	90	52,252	269	1,290,790	25.71	26	51	77
	3	3	7	52	26	Umatilla River	90	51,728	667	1,290,647	25.96	0	78	78
	12	12	7	53	28	Umatilla River	90	48,266	2,048	50,328	2.09	0	25	25
	2	2	7	54	4	Umatilla River	89	53,160	401	77,539	2.47	0	5	5
1		1	7	54	7	Columbia R., R-2	89	46,657	3,286	0	1.07	1	0	1
	5	5	7	54	49	Umatilla River	90	48,481	1,620	49,861	2.06	0	10	10
	9	9	7	54	50	Umatilla River	90	51,814	128	384	1.01	0	9	9
	2	2	7	54	51	Umatilla River	90	52,444	0	262	1.00	0	2	2
	5	5	7	55	60	Umatilla River	90	25,720	0	142	1.01	0	5	5
1	3	4	7	55	62	Umatilla River	90	22,309	986	0	1.04	1	3	4
	2	2	7	55	63	Umatilla River	90	26,173	246	62	1.01	0	2	2
	4	4	7	56	1	Umatilla River	90	24,762	1,697	126	1.07	0	4	4
1	2	3	7	56	2	Umatilla River	90	25,476	1,067	63	1.04	1	2	3
	1	1	7	63	30	Umatilla River	92	28,964	816	263,115	10.11	0	10	10
	1	1	7	63	31	Umatilla River	92	29,537	1,105	251,483	9.55	0	10	10
1		1	23	24	59	Bonneville Bypass	89	29,727	2,289	0	1.08	1	0	1
1		1	23	25	34	Bonneville Bypass	89	29,786	1,020	0	1.03	1	0	1
1		1	63	40	30	Klickitat River	90	75,342	838	2,553,820	34.91	35	0	35
	2	2	63	40	31	Klickitat River	90	75,943	690	176,167	3.33	0	7	7
1		1	63	56	14	Methow River	89	200,670	6,206	28,391	1.17	1	0	1
11	63	74										81	238	319

a The following four salmon were recovered with CWTs, but were not adipose clipped: (1 vol. 7 56 1), (3 LG., 7 54 49, 7 54 50, 7 55 62).

APPENDIX C

Coded-wire tag recoveries at Lyons Ferry FH in 1994 (and expansions according to our data to include all fish relea from Lyons Ferry FH). Vol=voluntary return to the hatchery, LG=hauled from L. Granite Dam.

Table 1. Recoveries of Lyons Ferry origin CWTs at Lyons Ferry Hatchery in 1994 (data matches PSMFC). a

VOL	LG	TOTAL	CWT CODES			RELEASE SOURCE	BROOD YEAR	NUMBER CWT (T)	NUMBER AD-ONLY (A)	NUMBER UNMARKED (U)	EXPANSION RATE ((T+A+U)/T)	EXPANDED RECOVERY VOL	LG	TOTAL
3	1	4	63	2	31	Lyons Ferry	88	58,988	458	18,708	1.32	4	1	5
2		2	63	2	32	Lyons Ferry	88	58,989	458	18,708	1.32	3	0	3
2	3	5	63	2	35	Lyons Ferry	88	55,922	496	83,264	2.50	5	7	12
2	1	3	63	2	37	Lyons Ferry	88	56,597	502	83,264	2.48	5	2	7
4		4	63	37	31	Lyons Ferry	91	9,196	197	0	1.02	4	0	4
3		3	63	40	12	Lyons Ferry	90	23,954	113	0	1.00	3	0	3
4		4	63	40	13	Lyons Ferry	90	21,137	268	0	1.01	4	0	4
34	12	46	63	41	18	Lyons Ferry	90	218,110	1,515	0	1.01	34	12	46
42	3	45	63	41	20	Lyons Ferry	90	202,674	2,566	0	1.01	43	3	46
39	12	51	63	41	43	Lyons Ferry	90	111,784	562	0	1.01	39	12	51
36	9	45	63	41	60	Lyons Ferry	90	110,748	1,345	0	1.01	36	9	45
16	5	21	63	42	9	Lyons Ferry	90	104,820	792	0	1.01	16	5	21
22		22	63	42	10	Lyons Ferry	90	98,374	560	0	1.01	22	0	22
41		41	63	46	18	Lyons Ferry	91	82,796	1,647	0	1.02	42	0	42
13	3	16	63	46	31	Lyons Ferry	91	51,408	415	0	1.01	13	3	16
12	1	13	63	46	55	Lyons Ferry	91	52,093	104	0	1.00	12	1	13
20		20	63	46	56	Lyons Ferry	91	49,656	2,449	0	1.05	21	0	21
20		20	63	46	57	Lyons Ferry	91	53,595	541	0	1.01	20	0	20
17	2	19	63	46	58	Lyons Ferry	91	51,663	312	0	1.01	17	2	19
17	3	20	63	46	59	Lyons Ferry	91	51,371	624	0	1.01	17	3	20
9	4	13	63	46	60	Lyons Ferry	91	51,887	104	0	1.00	9	4	13
20	6	26	63	46	61	Lyons Ferry	91	51,370	206	0	1.00	20	6	26
15	2	17	63	46	62	Lyons Ferry	91	51,410	310	0	1.01	15	2	17
11	1	12	63	46	63	Lyons Ferry	91	50,892	828	0	1.02	11	1	12
14	1	15	63	47	3	Lyons Ferry	91	38,460	139	0	1.00	14	1	15
24	1	25	63	47	5	Lyons Ferry	91	38,170	386	0	1.01	24	1	25
14		14	63	47	6	Lyons Ferry	91	33,994	907	0	1.03	14	0	14
14		14	63	47	9	Lyons Ferry	91	31,901	987	0	1.03	14	0	14
17	3	20	63	47	58	Lyons Ferry	92	51,316	0	206	1.00	17	3	20

Appendix C: Table 1. continued.

VOL	LG	TOTAL	CWT CODES			RELEASE SOURCE	BROOD YEAR	NUMBER CWT (T)	NUMBER AD-ONLY (A)	NUMBER UNMARKED (U)	EXPANSION RATE ((T+A+U)/T)	EXPANDED RECOVERY VOL	LG	TOTAL
19	2	21	63	47	60	Lyons Ferry	92	51,160	726	0	1.01	19	2	21
15	4	19	63	47	63	Lyons Ferry	92	50,481	1,831	104	1.04	16	4	20
25	5	30	63	49	12	Lyons Ferry	92	51,168	273	0	1.01	25	5	30
10	1	11	63	49	15	Lyons Ferry	92	51,258	273	0	1.01	10	1	11
10	2	12	63	49	17	Lyons Ferry	92	51,702	312	0	1.01	10	2	12
16	6	22	63	49	18	Lyons Ferry	92	51,702	312	0	1.01	16	6	22
13	1	14	63	49	20	Lyons Ferry	92	49,248	49	155	1.00	13	1	14
52	83	135	63	50	12	Lyons Ferry	92	203,177	3,598	0	1.02	53	84	137
34	3	37	63	52	24	Lyons Ferry	92	53,276	53	168	1.00	34	3	37
12	6	18	63	52	27	Lyons Ferry	92	51,260	413	104	1.01	12	6	18
16	6	22	63	52	29	Lyons Ferry	92	51,091	1,149	0	1.02	16	6	22
15		15	63	52	63	Lyons Ferry	92	50,481	1,831	104	1.04	16	0	16
1		1	63	55	44	Lyons Ferry	89	123,640	3,662	0	1.03	1	0	1
1	1	2	63	55	47	Lyons Ferry	89	123,233	3,601	0	1.03	1	1	2
5		5	63	55	49	Lyons Ferry	89	118,104	4,716	0	1.04	5	0	5
2		2	63	55	50	Lyons Ferry	89	119,941	4,787	0	1.04	2	0	2
733	193	926										747	199	946

a Plus one CWT (63 55 47) was recovered from a fish that was not adipose clipped, voluntary return.

Appendix D. continued.

Release year Age (brood yr)	Release type[a]	Date[b]	Number CWT	CWT code[c]	Adipose only marked	Number unmarked	lbs	fish/ lb
1991								
subyearling (90)	barge	6/2	111,784	41/43	562		2,293	49
			110,748	41/60	1,345		2,288	49
			222,532		1,907		4,581	
1992								
yearling (90)	direct	4/15	104,820[o]	42/09	792[o]		13,201	8
						5,125[p]	641	8
						5,207[ql]	651	8
			4,386[q]	43/20			548	8
			218,110[r]	41/18	1,515[r]		27,453	8
			23,954[s]	40/12	113[s]		3,008	8
			351,270		2,420	10,332	45,502	
yearling (90)	barge	4/17	98,374[t]	42/10	560[t]		10,993	9
			202,674[u]	41/20	2,566[u]		22,804	9
			21,137[u]	40/13	268[u]		2,378	9
			322,185		3,394		36,175	
1993								
yearling (91)	direct	4/12	51,663[v]	46/58	312[v]		4,725	11
			51,371	46/59	624		4,727	11
			51,370[w]	46/61	206[w]		4,689	11
			51,887	46/60	104		4,726	11
			51,408	46/31	415		4,711	11
			52,093[x]	46/55	104[x]		4,745	11
			50,892	46/63	828		4,702	11
			51,410[x2]	46/62	310[x2]		4,702	11
			412,094		2,903		37,727	
yearling (91)	barge	4/19	9,196[y]	37/31	197[y]		1,044	9
			82,796	46/18	1,647		4,691	18
			31,901	47/09	987		3,289	10
			33,994[z]	47/06	907[z]		3,490	10
			49,656[z1]	46/56	2,449[z1]		5,211	10
			53,595	46/57	541		4,921	11
			38,460[z2]	47/03	139[z2]		3,509	11
			38,170	47/05	386		3,505	11
			337,768		7,253		29,660	
subyearling (92)	direct	6/24	203,177	50/12	3,598		3,390	61
1994								
yearling (92)	direct	4/18	53,276[A]	52/24	53	168	4,863	11
			49,248[A]	49/20	49	155	4,496	11
			51,488[B]	49/18	311		4,709	11
			51,487[B]	49/17	311		4,709	11
			51,258[C]	49/15	273		4,685	11
			51,168[C]	49/12	273		4,676	11
			307,925		1,270	323	28,138	
		4/19	50,481[D]	47/63	1,831	104	4,765	11
			51,160[E]	47/60	726		4,717	11
			50,915[F]	52/29	1,145		4,733	11
			51,260[G]	52/27	413	104	4,707	11
			51,316[G]	47/58		206	4,684	11
			33,736[H]	52/63	135		3,074	11
			288,868		4,250	414	26,680	

Appendix D. continued.

Release year Age (brood yr)	Release type[a]	Date[b]	Number CWT	CWT code[c]	Adipose only marked	Number unmarked	lbs	fish/ lb
1995								
yearling (93)	direct	4/17	73,986[I]	56/40	484	346	9,237	8
			101,165[J]	51/63	300		13,529	7.5
			82,624[K]	56/39	39	195	10,761	8
			89,800[L]	51/62	85		11,378	8
			347,575		908	541	44,905	

[a] Barged fish were released immediately downstream of Ice Harbor Dam.
[b] Release date (month/day).
[c] All tag codes start with agency code 63.
[d] Mean length of marked (67 fpp) and unmarked fish (85 fpp) differed.
[e] Freeze branded (RA-7k-1 in April 1986) and branded RA-T-3 in June.
[f] Freeze branded LA 7N-1.
[g] PIT tagged (Passive Integrated Transponder) by NMFS for migration timing.
[h] Freeze branded LA S-1.
[i] Freeze branded RA 7S-1 for April release and RD R-1 for June.
[j] Freeze branded LD 7U-1 (13,033), LA 7U-1 (13,017) and LA 7U-3 (12,994).
[k] The average of six groups of different sized fish.
[l] Freeze branded LAU-1 (39,991) and branded LAU-3 (40,025).
[m] Freeze branded RA U-1 (39,813) and RA U-3 (39,863) and all BWT in the snout.
[n] All with blank wire tags (BWT) in the snout.
[o] 50.4% have red filament tags behind left eye and 49.6% have BWT in left cheek.
[o1] BWT in left cheek.
[p] All with red filament tags behind left eye (VT).
[q] 49.4% have VT behind left eye and 50.6% have BWT in left cheek.
[r] 49.7% have VT behind left eye and 50.3% have BWT in left cheek.
[s] 49.6% have VT behind left eye and 50.4% have BWT in left cheek.
[t] 51.7% have VT behind left eye and 48.3% have BWT in left cheek.
[u] 49.8% have VT behind left eye and 50.2% have BWT in left cheek.
[v] 90.4% retained red elastomer tag behind left eye.
[w] 91% retained red elastomer behind left eye.
[x] 88.4% retained red elastomer behind left eye.
[x2] 96% retained red elastomer behind left eye.
[y] high density ELISA (BKD) group.
[z] 94.2% retained red elastomer behind left eye.
[z1] 95% retained red elastomer behind left eye.
[z2] 90.3% retained red elastomer behind left eye.
[A] 97.5% retained red elastomer behind left eye.
[B] 96.0% retained red elastomer behind left eye.
[C] 96.8% retained red elastomer behind left eye.
[D] 93.0% retained yellow elastomer behind left eye.
[E] 96.2% retained yellow elastomer behind left eye.
[F] 95.2% retained yellow elastomer behind left eye.
[G] 94.4% retained yellow elastomer behind left eye.
[H] 96.1% retained yellow elastomer behind left eye.
[I] 91.9% retained red elastomer behind left eye.
[J] 95.9% retained red elastomer behind left eye.
[K] 95.5% retained red elastomer behind left eye.
[L] 92.8% retained red elastomer behind left eye.

APPENDIX E

Mean fork length, standard deviation, sample size and range for returning Lyons Ferry origin fall chinook salmon that had been released as subyearlings and yearlings.

Table 1. **Mean (cm) fork length** (standard deviation, sample size) and range for Lyons Ferry fall chinook salmon released as subyearlings.

Recovery year	sex	Brood year 1992	1991	1990	1989	1988	1987	1986	1985
1991	male				46.3 (3.91, 36[a]) 40-53	67.0 (14.36, 10) 49-95	78.5 (7.51, 4) 72-88	99.9 (7.80, 16) 84-108	-- (--, 1) 98
	female					70.3 (2.52, 3) 68-73	79.0 (6.86, 11) 68-84	89.9 (5.87, 28) 68-73	-- (--, 1) 92
1992	male			46.6 (3.46, 24) 40-54	66.4 (6.84, 59[a]) 52-78	77.7 (6.81, 3) 70-83			
	female				70.7 (5.57, 21[a]) 68-80	76.8 (7.86, 14) 73-87		-- (--, 1) 99	-- (--, 1) 85
1993[b]	male			68.8 (5.89, 42[c]) 58-85	80.7 (10.31, 105) 44-104				
	female			70.5 (5.16, 20) 62-79	80.7 (5.55, 176) 64-94	76.5 (14.89, 2) 66-87			
1994[b]	male	44.7 (3.92, 134) 36-54		87.0 (7.16, 27[c]) 69-101	86.0 (12.13, 16) 61-105				
	female			81.0 (4.41, 67) 71-90	85.6 (4.08, 44) 71-92				

[a] Plus BWTs; 221 in 1991, 149 males in 1992, and 39 females in 1992.
[b] Includes BWTs.
[c] Plus one fish with no length measurement.

APPENDIX E continued.

Table 2. **Mean (cm) fork length** (standard deviation, sample size) and range for Lyons Ferry fall chinook salmon released as yearlings.

Recovery year	sex	Brood year 1992	1991	1990	1989	1988	1987	1986	1985
1991	male					52.2 (5.22, 191) 36-65	72.1 (11.13, 71) 45-87	89.6 (11.39, 44[a]) 61-109	90.6 (14.29 11) 52-107
	female					65.5 (12.02, 2) 68-73	72.8 (4.90, 123) 60-82	81.2 (6.60, 89) 65-94	89.1 (8.55, 12) 79-103
1992	male			34.4 (2.16, 129) 31-39		73.1 (9.95, 161) 46-96	86.2 (9.99, 22) 60-102		
	female					73.4 (5.82, 241) 56-90	80.1 (5.39, 34) 68-94	-- (--, 1) 85	-- (--, 1) 79
1993[b]	male		33.4 (2.56, 102) 28-35	51.9 (6.09, 58) 40-66		82.3 (11.41, 61) 45-99	-- (--, 1) 77		
	female			64.0 (15.56, 2) 53-75		79.6 (6.12, 102) 67-94			
1994[b]	male	35.0 (2.89, 241[a]) 29-51	53.2 (5.10, 283[c]) 42-82	73.3 (9.91, 55) 35-91		84.7 (10.75, 4) 76-98			
	female		59.0 (2.71, 4) 57-63	72.9 (5.29, 86[a]) 58-86		80.5 (7.96, 10) 67-92			

[a] Plus one fish with no length measurement.
[b] Includes BWTs.
[c] Plus two fish with no length measurement.

APPENDIX F

Length/weight for Lyons Ferry returning origin male and female salmon processed at the hatchery during spawning, 1992-1994.

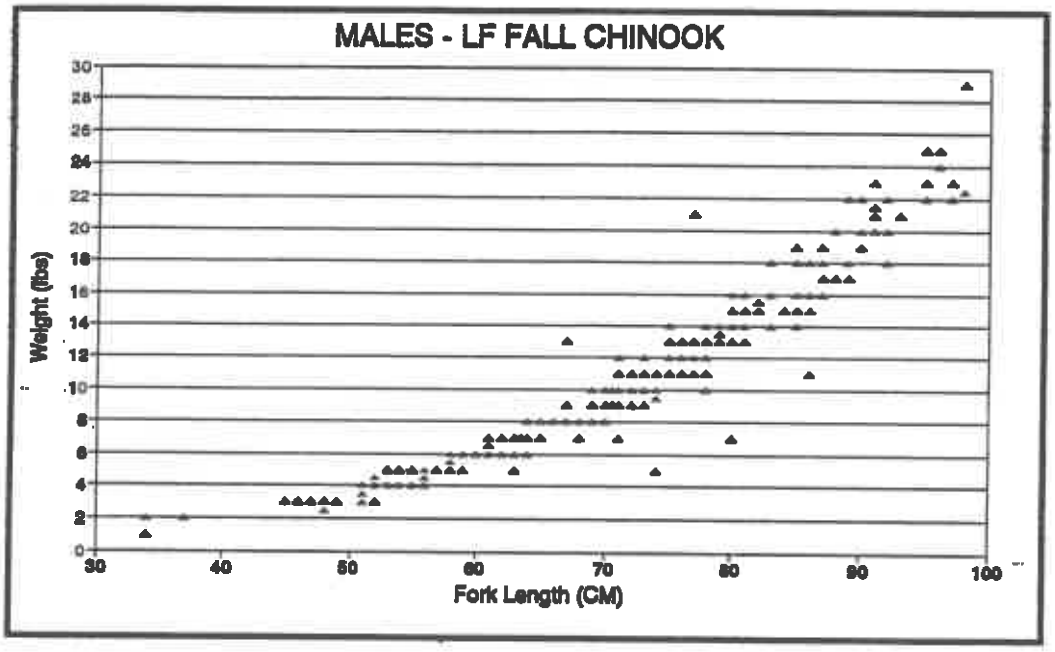

Figure 1. Length/weight for Lyons Ferry origin male salmon processed at the hatchery in 1992-1994.

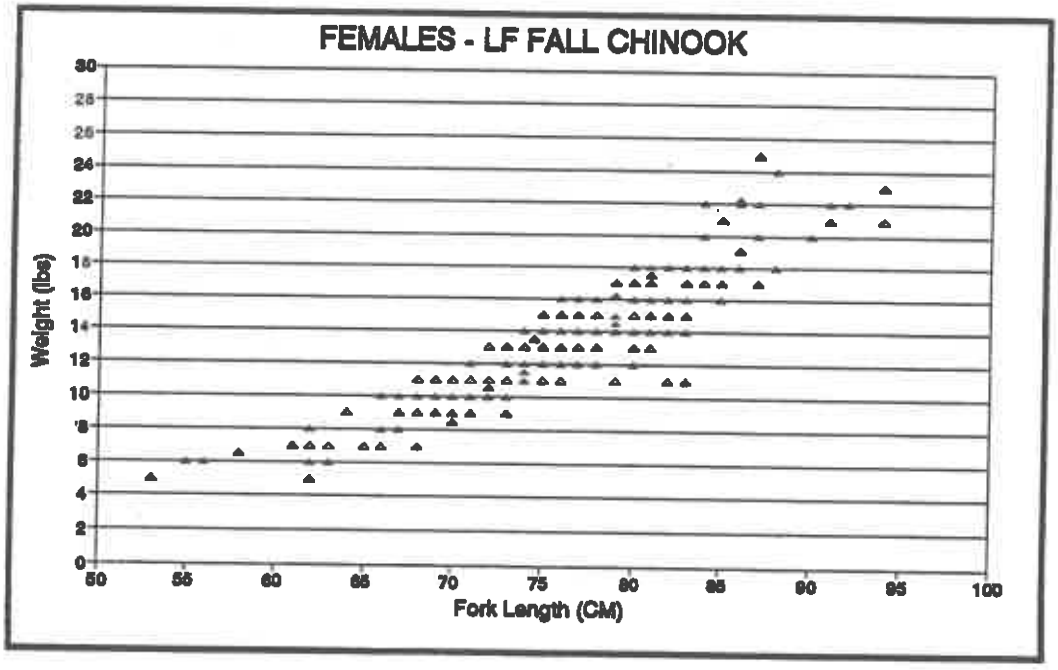

Figure 2. Length/weight for Lyons Ferry origin female salmon processed at the hatchery in 1992-1994.