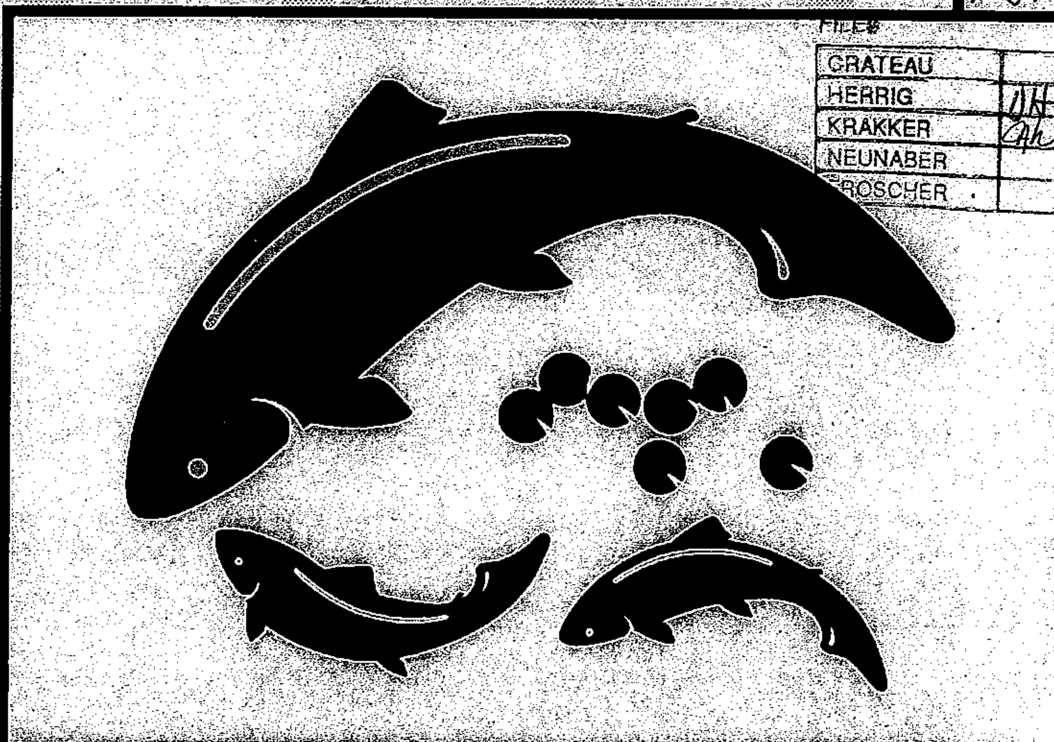
1995 ANNUAL REPORT

November 1996

Lyons Ferry Hatchery Evaluation: Fall Chinook



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Washington Department of
FISH AND WILDLIFE
Hatcheries Program
Assessment and Development Division

Report # H96-09

Acknowledgements

The Lyons Ferry Fall Chinook Salmon Hatchery Evaluation Program is the result of work by many individuals within the Washington Department of Fish and Wildlife (WDFW) Hatcheries Program. We wish to thank all those who contributed to this program. Our tasks would have been much more difficult without their help.

We thank hatchery managers Rob Allan and Jim Dills for cooperation with hatchery sampling and providing us information regarding hatchery operations. Our particular thanks to Ted Parks, Butch Harty and Pat Phillips for their assistance and patience during and after merger/complexing at the hatchery. We also thank all the personnel at the hatchery for their assistance. We appreciate the assistance of Lynn Anderson and her crew at the WDFW Tag Recovery Lab. John Sneva processed scale samples for us.

Jerry Harmon (NMFS) and his crew at Lower Granite Dam trapped marked adult and jack fall chinook salmon for us. They were very cooperative and assisted us a great deal by documenting fish collected, etc. We appreciate all their efforts to make the trapping and transport program succeed.

Gary Thorgaard and Paul Wheeler of Washington State University continued to assist us with our gene banking (cryopreservation) efforts. We appreciate their cooperation and assistance.

We thank Mark Schuck, Joe Bumgarner, Butch Harty, Pat Phillips, Joe Krakker, Geraldine Vander Haegen, and Bob Foster for reviewing a draft of this report and providing valuable comments.

Finally, we thank Ed Crateau and Dan Herrig, U.S.Fish and Wildlife Service, Lower Snake River Compensation Plan Office for providing funding, as well as encouragement for this program.

LYONS FERRY HATCHERY EVALUATION

FALL CHINOOK SALMON
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by

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Cooperative Agreement
14-48-0001-93539

Hatcheries Report Number H96-09

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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 1995 to 1 May 1996. This work was completed with Fiscal Year 1995 funds provided by the U.S. Fish and Wildlife Service (USFWS) under the Lower Snake River Compensation Plan (LSRCP). We describe the fall chinook salmon program at Lyons Ferry Fish Hatchery (FH), and some related natural production in tributaries of the Snake River. We also have incorporated information about salmon trapping at Lower Granite (LGR) Dam.

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 LGR 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 3,609 adults and jacks available as broodstock to Lyons Ferry in 1995. However, during spawning we processed 2,256 adults and jacks that had voluntarily returned to the hatchery and 668 salmon we had transported from trapping operations at LGR Dam (2,924 total). Fish trapped at Lyons Ferry FH and LGR Dam accounted for 42.9% and 13.3%, respectively, of the fall chinook salmon escapement above Ice Harbor Dam.

Recoveries of CWTs from salmon spawned at Lyons Ferry FH indicate a substantial number of fall chinook salmon from outside the basin strayed into the Snake River in 1995, as in past years. Umatilla hatchery strays comprised 29.8% of the hatchery fall chinook salmon that escaped to LGR Dam, and 2.3% of hatchery salmon that voluntarily returned to Lyons Ferry FH. Stray salmon from Klickitat and Trinity River hatcheries comprised 11.8% of the hatchery fish at LGR Dam.

Fall chinook salmon were spawned at Lyons Ferry FH from 25 October to 5 December 1995. Peak of spawning was 14 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" or mixed origin. Total egg take from all fish was 1,403,000. Progeny from stray and unmarked salmon were transferred to Klickitat FH (346,900 "eyed" eggs) for subsequent release there. The egg take from Lyons Ferry origin salmon was 998,200 with 964,200 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. Preliminary results are that mean fertilization rates with cryopreserved semen are generally 60-70%, the highest we have ever obtained. Complete analyses will be included in subsequent reports. These techniques may provide us with management options to maintain population size and maximize genetic contribution for threatened fall chinook salmon.

Lyons Ferry FH released 407,503 yearling (1994 brood) fall chinook salmon directly from the hatchery on 9-12 April 1996. All fish were adipose clipped (marked), coded-wire tagged and tagged with a red elastomer tag in the clear tissue behind the left eye. We transferred yearling salmon to the Nez Perce Tribe at Pittsburg Landing, Idaho where 114,299 fish were released into the Hells Canyon portion of the Snake River. We participated in planning, coordination, and monitoring of this release. Between February and March 31, we had 83,183 fry of the 1995 brood escape a raceway and enter the Snake River.

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, particularly in 1995. Few females return prior to age 4. Subyearling releases return larger adult fish than yearling releases at the same age, but substantially fewer fish. Most of the returning fish collected in 1995 were jacks and small males. Fecundity increased proportionally with age of female. Fecundity decreased during the spawning period.

We monitored fall chinook salmon spawning in the Tucannon and Palouse rivers. We observed 29 redds (2.9 redds/km below RK 9.6) in the lower Tucannon River in 1995. We recovered 12 carcasses, four originated at Umatilla Hatchery) and one originated from Lyons Ferry FH. All other carcasses were unmarked.

We are unable to account for approximately 28.5% (1,485 salmon) of the fall chinook escapement past Ice Harbor Dam in 1995. 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.

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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. One 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 general 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 to help maintain the integrity of Snake River Basin fall chinook salmon stocks (WDF 1994). Specific program objectives were outlined previously (Mendel et al. 1995).

This report summarizes the results and activities performed by the WDFW's LSRCP Fall Chinook Salmon Evaluation Program from 1 April 1995 through juvenile release in April 1996. Additional summarization and analyses of these data 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. Release locations included the hatchery (on-station), downstream of Ice Harbor Dam (barged), or upstream of Lower Granite Dam (direct and acclimated releases). 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.

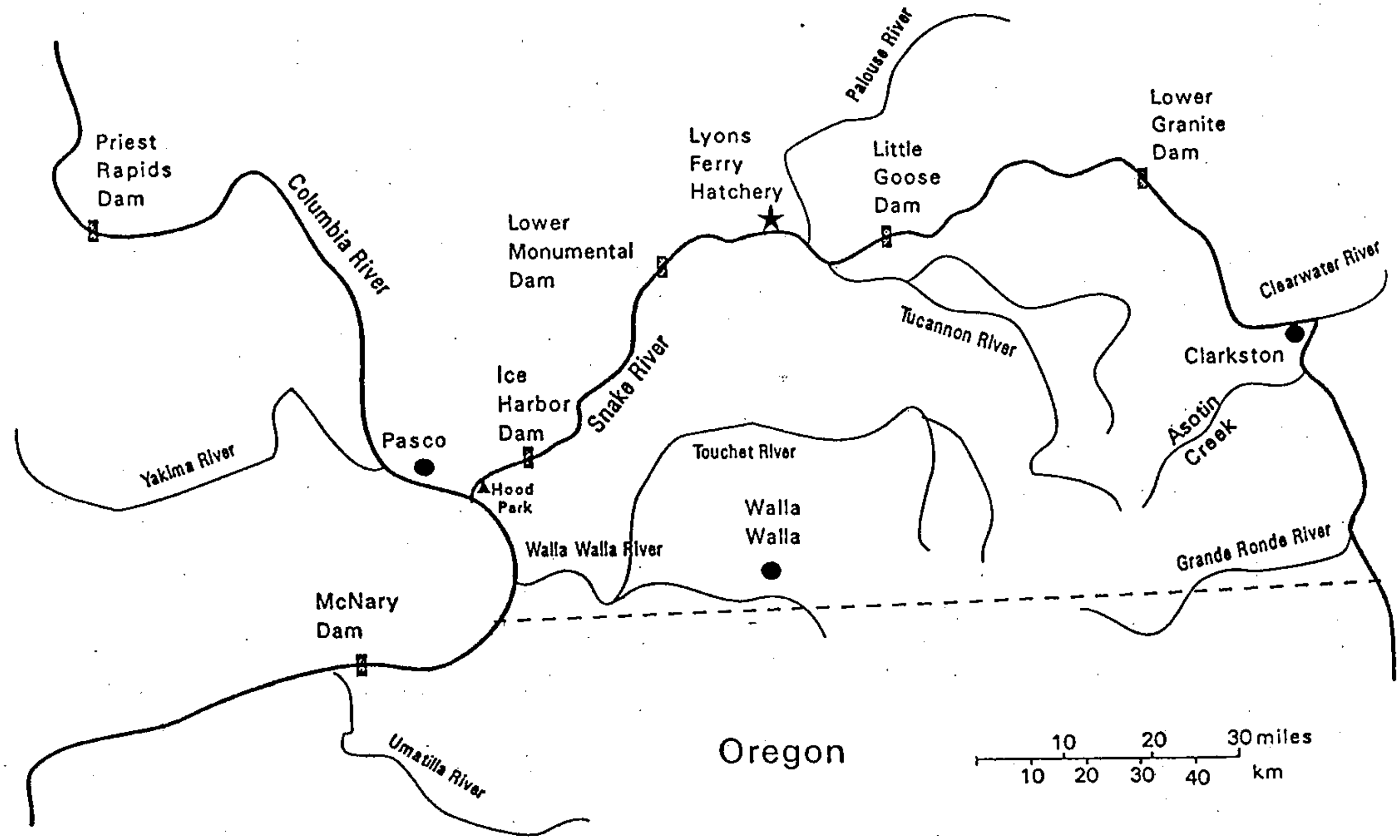

Figure 1. Lower Snake River Basin, showing the location of Lyons Ferry Fish Hatchery and major tributaries in the area.

SECTION 2: BROODSTOCK COLLECTION AND MANAGEMENT

2.1: Broodstock Collection

Lyons Ferry FH has been developing its broodstock since the facility began operating in 1984. Salmon were obtained from two primary sources before 1991: 1) returns to the Lyons Ferry FH ladder, and 2) adults trapped at Ice Harbor (IHR) Dam and transported to Lyons Ferry FH (Bugert and Hopley 1991). Until 1990, Lyons Ferry FH broodstock collection from these two sources averaged 37% of total escapement to the project area; past Ice Harbor Dam (Bugert et al. 1991). From 1984 to 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) has been summarized previously (Bugert and Hopley 1989, Bugert et al. 1991, Bugert et al. 1995). The first year of adult ($\geq$3 years old) returns from Lyons Ferry FH production was 1986.

From 1990 to 1993, salmon broodstock were obtained from voluntary returns to Lyons Ferry FH, trapping at IHR Dam, and trapping at LGR Dam (Table 1). National Marine Fisheries Service (NMFS) and WDFW personnel cooperatively trap, collect and transport adult and jack salmon, or kill hatchery jacks[3] and minijacks at LGR Dam for the following reasons: 1) to obtain information about run composition and stray hatchery salmon, 2) to reduce the number of stray hatchery salmon spawning naturally upstream of LGR Dam, and 3) to collect broodstock for Lyons Ferry FH. The 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 LGR Dam and spawn naturally. However, our request was not approved. Adult salmon have been collected for broodstock and run composition information at LGR since 1990, but jacks have been collected only since 1992.

[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 $\leq$ 56 cm total length in 1995, whereas the criterion at Lyons Ferry FH was < 50 cm fork length. Minijacks were < 30 cm fork length.

Table 1. Fall chinook salmon returns to Lyons Ferry FH estimated at the time of collection 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 location	Number collected adults	Number collected jacks	Dam counts[a] adults	Dam counts[a] jacks
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]	-		
	Ice Harbor Dam	-	-	2,069[c]	1,033[c]
	Lower Granite Dam	328[b]	-	791[c]	255[c]
1995	Lyons Ferry FH	2,231	-		
	Ice Harbor Dam	-	-	2,750	2,452
	Lower Granite Dam	693[e]	-	1,067	308

[a] Classification of adults and jacks is based upon size at collection (minijacks excluded).

[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 or 1995.

[e] Plus 27 jacks killed at the juvenile bypass for CWT recovery. The total includes one fish with a jaw tag recovered at Lyons Ferry that was not listed as transported at LGR Dam.

2.1.1: Snake River Dam trapping operations

Adult collections: As in 1994, no salmon were trapped or collected from IHR Dam in 1995 because of the high incidence of stray salmon collected there in past years, as well as our concerns about personnel safety and salmon passage delay caused by trapping.

The door of the trap in the south shore fish ladder at LGR Dam was activated by salmon with coded-wire tags (CWT), blank-wire tags (BWT), or other metal objects. Also, fin clipped (right or left ventral; RV or LV) salmon without wire were captured and retained during periods when the trap door was kept open to scale sample a portion of the steelhead passing the dam. Salmon collected and transported live were anesthetized, given numbered metal jaw tags, and hauled to the hatchery in an approximately 1,200 L aerated, unrefrigerated tank truck, with water obtained from wells at Lyons Ferry FH or the adult trap at LGR. Some small fish (jacks and minijacks) that were not needed at the hatchery as broodstock were killed at the upstream trap and frozen for CWT recovery and to prevent their upstream passage at the dam. Salmon to be used as potential broodstock at Lyons Ferry FH were collected at the trap and transported to the hatchery by WDFW personnel.

The 1995 count of fall chinook salmon at LGR Dam (18 August to 5 December) was 1,067 adults, 308 jacks, and an unknown number of mini-jacks (< 30 cm; U.S. Army Corps of Engineers 1996). The adult count was less than in 1993, but higher than all other years since 1979 (Figure 2).

The U.S. vs Oregon process, and obtaining an Endangered Species Act (ESA) permit, delayed trapping at LGR Dam until 26 August. The trap was operated until 13 December, although no fall chinook salmon were collected or passed upstream after 24 November (Figure 3).

We transported slightly more adipose clipped (marked, indicating CWTs) adults and jacks than were estimated to have passed the counting window at LGR (333 adults and 292 jacks collected of 334 marked adults and 202 marked jacks counted). However, separation of adipose clipped and unclipped fish is usually incomplete at the counting window because of problems with several fish passing the window simultaneously, or inadequate time to determine adipose fin status before each fish passes.

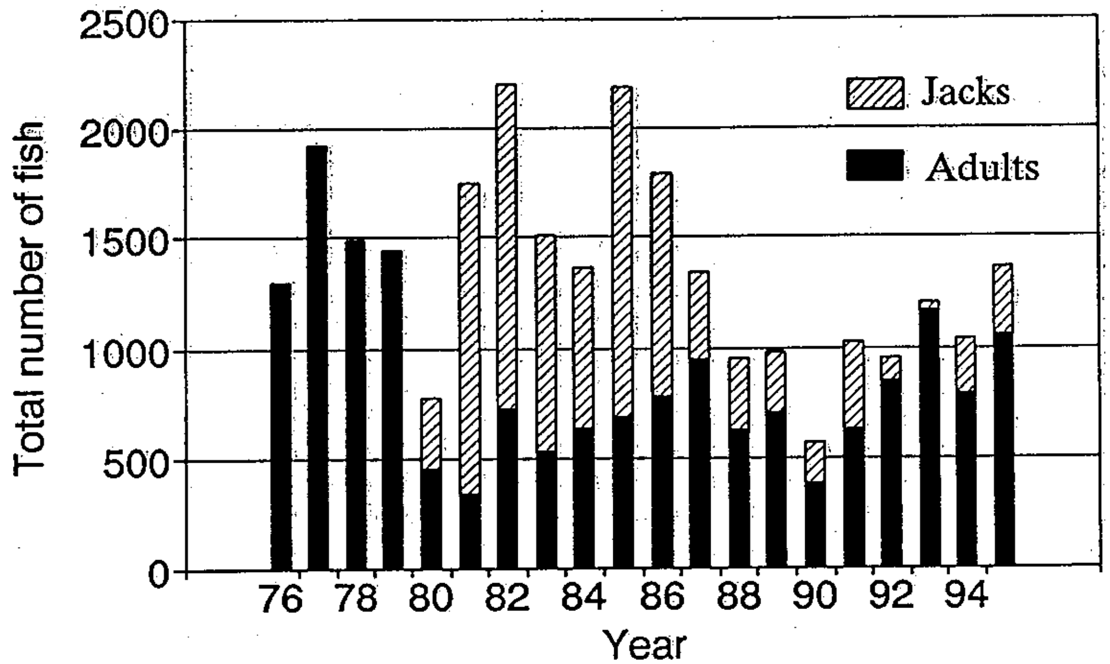

Figure 2. Fall chinook salmon counts at Lower Granite Dam since 1976.

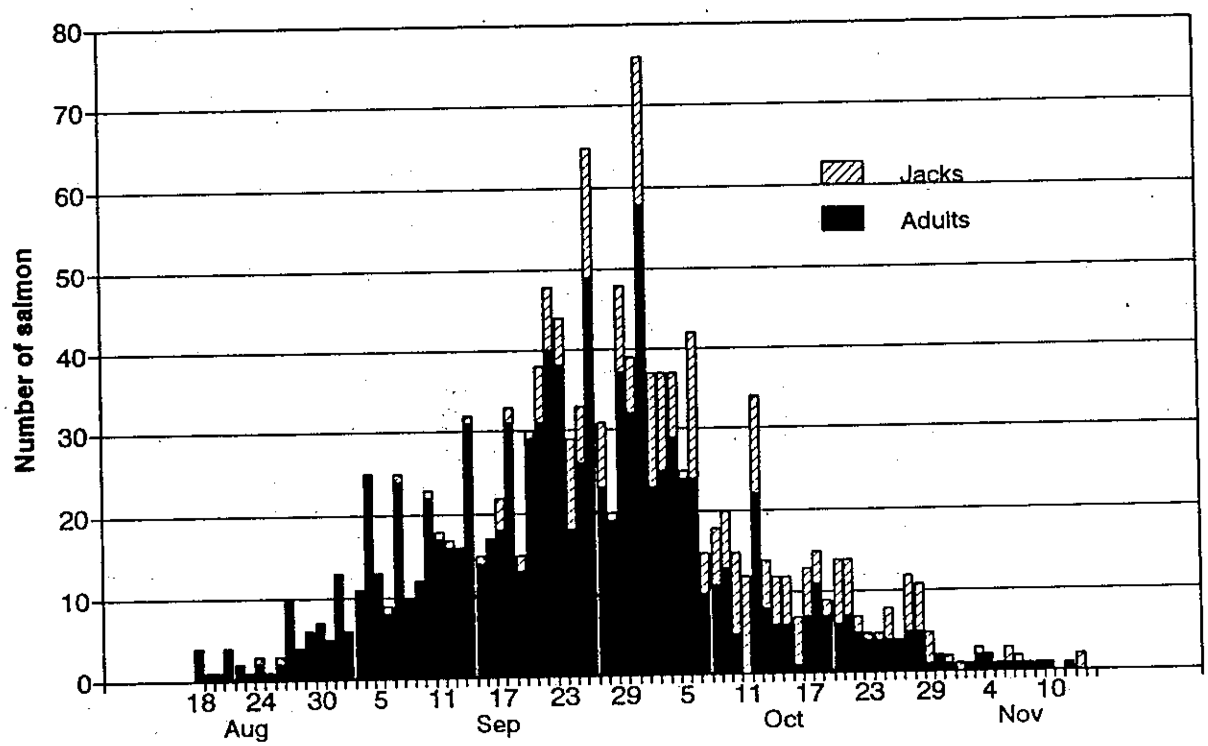

Figure 3. Daily fall chinook salmon counts at Lower Granite Dam from 18 August to December 1995.

A total of 693 fall chinook salmon were collected at the adult trap at LGR Dam. Nine jacks were killed prior to transport to recover CWTs. These nine fish included one salmon from Lyons Ferry, three spring chinook from Dworshak Hatchery in Idaho, one unknown origin salmon, and four summer chinook salmon from the Salmon River, Idaho. Consequently, 684 trapped salmon were transported to Lyons Ferry FH as potential broodstock, but only 668 salmon were accounted for during processing for at the hatchery (Table 2). Two of the recovered salmon with BWTs were from the 1989 Lyons Ferry brood. This brood was uniquely identified with a BWT and no fin clip because they originated from parents composed of an unacceptably high proportion of strays from the Umatilla River. At least 78 of the processed fish had been released as juveniles in the Umatilla River.

Table 2. Summary of salmon collected at the adult trap at LGR Dam in 1995.

Number of fish	Comments
693	Total salmon collected
- 9	sacrificed jacks for CWT recovery

684	live broodstock transported to Lyons Ferry
- 1	fish was not be jaw tagged at LGR
-15	fish with jaw tags not accounted for at Lyons Ferry FH

668	salmon accounted for at the hatchery
590	with readable CWTs (544 from Lyons Ferry)
20	no tags (8) or lost tags (12)
2	BWTs from 1989 brood Lyons Ferry
24	BWTs from Umatilla Hatchery
18	RV or LV fin clips from Umatilla Hatchery
13	unmarked (10 were listed at LGR as BWT from Umatilla Hatchery)
1	CWT from a fish that was not adipose clipped
668	

Another 27 small salmon were killed at the juvenile bypass facility as they descended through LGR Dam. These fish were collected for the following reasons: 1) to prevent them from spawning in the Snake River Basin, 2) because they were not needed as broodstock at the hatchery and, 3) to recover their CWTs (Appendix A). All but one of the fish captured at the juvenile bypass had a CWT from Lyons Ferry FH.

Mark rates: WDFW personnel counted marked and unmarked fall chinook salmon adults (≥ 56 cm total length) and jacks (30-56 cm) (Steve Richards, WDFW, personal communications). Separate counts of marked and unmarked minijacks (<30 cm) were not available for LGR Dam in 1995. Thirty-nine percent (530 of 1,358) of the adult and jack salmon observed at the counting window at LGR Dam from 18 August to 15 December were marked. This is above the rates observed the past few years.

Twenty-six (3.1%) of the 828 unmarked salmon known to have passed the counting window at LGR Dam had BWTs and were subsequently collected at the trap. Another 28 (3.4%) unmarked salmon collected at the trap were from the Umatilla Hatchery (RV or LV clips, or wire in the right shoulder). Three other unmarked fish were collected with CWT or BWTs. One of these fish was from Lyons Ferry FH and the origin of the other two is unknown.

2.1.2: Voluntary returns to Lyons Ferry FH

In 1995, 2,256 adults and jacks voluntarily returned to Lyons Ferry FH. Duration of returns was 87 days in 1995 (Table 3). The peak of returns was 17 October when 42 adults and 201 jacks entered the hatchery.

Table 3. Voluntary returns of fall chinook salmon to Lyons Ferry FH, estimated at the time of collection.

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
1995	627	1,604	8 Sep - 3 Dec	17 Oct	42

[a] Jacks were classified by size (≤ 61 cm fork length) at the time of collection prior to 1994. Jack size was changed to < 50 cm fork length in 1995 (2,256 accounted for in 1995 during processing at Lyons Ferry).
[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 LGR Dam comprised 56.2% of the total estimated escapement (2,924 of 5,202) of adults and jacks past IHR Dam in 1995. Voluntary returns to Lyons Ferry FH (2,231 fish) represent 42.9% of the estimated escapement over IHR Dam. This is higher than the 30.8% in 1994 and is only the second year we have been able to estimate the percentage of fish that passed upstream of IHR and voluntarily entered the hatchery without the confounding effect of salmon collection at that dam. The NMFS upstream migrant trap at LGR Dam collected 13.3% (693 fish) of fish passing over IHR Dam.

During 1995, we estimated that we collected 2,915 salmon for broodstock from voluntary returns to Lyons Ferry (2,231) and trapping at Lower Granite (684, excluding 9 fish killed at the dam). However, 2,256 adults and jacks from voluntary returns and 668 broodstock from LGR Dam were actually processed at Lyons Ferry FH, a total of 2,924. 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, or we may have missed the jaw tags during processing. Sixteen fish collected at LGR Dam could not be identified at Lyons Ferry FH, so they were apparently processed with voluntary returns, or they escaped from the hatchery. These problems have occurred nearly every year, but our procedures are continually revised to improve accounting during spawning.

We collected 22.8% (668 fish identified from LGR) of the salmon processed at Lyons Ferry FH, and approximately 19.0% (555) of the hatchery broodstock of known Lyons Ferry origin, from LGR Dam. The remaining 77.2% of the broodstock processed at the hatchery had voluntarily entered the facility, and they comprised 81.0% of the broodstock of Lyons Ferry origin.

Broodstock were collected and spawned in 1995 according to our 1992 Broodstock Collection and Spawning Protocol (Mendel et al. 1995), with slight modifications (Appendix B).

2.2: Run Composition

In 1995, nearly all the returning fish that voluntarily entered the hatchery had been released as juveniles at Lyons Ferry FH (Table 4). The percentage of Lyons Ferry origin fish that voluntarily returned to the hatchery was higher than in previous years. Salmon from Lyons Ferry and Umatilla hatcheries comprised the majority of hatchery fish recovered at LGR Dam (Table 5), although the percentage of fish of Lyons Ferry origin remained less than 60%, as in 1994 (Mendel et al. 1995). Fall chinook released from Klickitat Hatchery comprised 10% of the estimated escapement of hatchery fish to LGR Dam in 1995. This is the second year Klickitat Hatchery fish were recovered at LGR Dam.

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 on mark rate for CWT and adipose clips, with CWTs lost during processing added based on CWT proportions. Fish with a BWT were added to CWT recoveries. Fish, from which CWTS were lost during processing, that had red or yellow VI tags behind the left eye (Lyons Ferry origin), or were ventral fin clipped (RV or LV = Umatilla R. releases), were added to the number of salmon estimated in the CWT expansions (Tables 4 and 5). Other fish with VI tags or fin clips were excluded because mark rate expansions already included these recoveries. The expansions do not include sample rate. Sample rates can be applied to fish collected at LGR Dam, but we assume a 100% sample rate for voluntary returns to Lyons Ferry FH in 1994 and 1995.

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 fishery managers could identify and potentially prevent these fish from spawning above LGR Dam or contributing to the broodstock at Lyons Ferry FH. 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 LGR 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 LGR 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).

Table 4. Run composition of 2,256 fall chinook salmon processed as **voluntary** returns at Lyons Ferry FH in 1995 (from CWTs, BWTs, elastomer tags, and fin clips).

Origin	Number of tags recovered	Expanded contribution [a]	Percent of expanded
Lyons Ferry	2,142[b]	2,159[b]	97.7
Umatilla	40[c]	50[c]	2.3
Lost [d]	9	--	--
Totals	2,191	2,209	100.0

[a] Expansion based on juvenile mark rates, and proportioning lost CWTs.
[b] Includes 1 BWT from the snout of an unclipped fish (1989 brood Lyons Ferry) and 32 elastomer tags (Lyons Ferry).
[c] Includes 3 fish with BWT and 35 fish with right or left ventral fin clips, without wire.
[d] Lost CWTs prior to reading or fish had adipose clips and no CWTs. Three additional fish had CWTs, but were not adipose clipped (two 63/51/62; Lyons Ferry and one lost CWT). Forty additional fish were unmarked and did not have wire. Twenty-two other fish were marked but did not have CWTs.

Table 5. Run composition of 668 fall chinook salmon trapped at **Lower Granite Dam** and transported as broodstock to Lyons Ferry FH in 1995 (from CWTs, BWTs, elastomer tags, and fin clips). Sixteen additional fish trapped at LGR could not be accounted for at Lyons Ferry FH.

Origin	Number of tags recovered	Expanded contribution [a]	Percent of expanded
Lyons Ferry	552[b]	561[b]	58.4
Umatilla	78[c]	286[c]	29.8
Klickitat	7	96	10.0
Trinity River [d]	3	17	1.8
Lost [e]	6	--	---
Totals	646	960	100.0

[a] Expansion based on juvenile mark rates for CWTs and proportioning lost CWTs.
[b] Includes 2 BWTs from snouts (1989 brood Lyons Ferry) and six VI tags.
[c] Includes 24 BWTs (24), and 18 ventral fin clips with no marks or CWTs.
[d] Recovery of two 06/57/34 code and one 06/57/49 code.
[e] Includes lost CWTs. Plus eight fish with adipose clips but no CWTs. Plus one fish with CWT (63/50/12 - Lyons Ferry) was unmarked. Thirteen other fish were unmarked and did not have wire. Plus nine jacks killed at the adult trap.

LaVoy and Mendel (1996) used CWT recovery data reported here to estimate run composition to LGR Dam and to spawning grounds upstream of the dam. Total escapement past LGR Dam was estimated to be 635 adult (1,067 counted - 432 collected) and 29 jack (308 - 279) fall chinook salmon in 1995. An estimated 350 adult and 29 jack salmon that passed LGR Dam were of natural origin. Hatchery fish that passed the dam consisted of 194 adult salmon of Umatilla Hatchery origin, as well as 91 other hatchery adults.

Some differences exist between run composition estimates reported here and those reported by LaVoy and Mendel (1996). The estimates reported here are restricted to composition of the hatchery portion of the run at at the adult trap LGR and Lyons Ferry FH, and they do not include trapping efficiency estimates or recoveries at the juvenile bypass facility at LGR Dam. Estimates of run composition by LaVoy and Mendel (1996) include hatchery and naturally produced salmon as well as include the trapping efficiency at LGR Dam.

SECTION 3: HATCHERY OPERATIONS

3.1: Spawning operations

3.1.1: Spawning and egg take

Salmon collected at LGR Dam were held separately from voluntary returns to Lyons Ferry FH. Fish collected at LGR 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.

Ripe fish were killed and set aside during spawning. 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, identified through examination of CWTs or the presence of elastomer tags behind the left eye, 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. Lyons Ferry origin fish 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 Lyons Ferry fish were incubated separately from those eggs known to be from stray or unmarked fish. Chilled water was used for eggs from the first two egg takes of Lyons Ferry origin fish so that all egg takes would hatch on approximately the same date. Other eggs from Lyons Ferry origin fish could not be chilled because they exceeded chiller capacity.

Fish were spawned from 25 October through 5 December 1995 (Table 6). The peak of spawning was 14 November, when approximately 415,600 eggs were taken. This peak date is consistent with previous years, and coincides with the apparent peak date on the spawning grounds in the Snake and Tucannon rivers. The total egg take at Lyons Ferry FH (corrected after picking) was 1,403,000; initial mortality was 5.88% (Table 7). Lyons Ferry origin salmon produced 998,200 total eggs ("green" or unfertilized eggs), while the total from other fish was 404,800 eggs. Under authority of an interagency and tribal agreement, progeny of stray, unmarked and 1989 brood Lyons Ferry broodstock were transported to Klickitat FH (346,900 "eyed" eggs) for hatching, rearing and release there. Another 10,000 eggs were given to the University of Idaho for research. The remaining 964,200 "eyed" eggs were retained for Lyons Ferry FH production.

3.1.2: Sperm cryopreservation and fertilization experiments

In 1995 we collected, cryopreserved, and archived semen from 12 Lyons Ferry origin fall chinook salmon. We also performed several experiments at Lyons Ferry FH on stray or unmarked fall chinook. Some experiments were duplicates of experiments we performed on spring chinook at Cowlitz FH in 1995. The following experiments were performed with stray salmon at Lyons Ferry FH:

1. Comparison of fertilization rates with fresh (control) and frozen semen from the same males (using two freezing methods). All semen was used or frozen the same day as collected and semen from individual males was added to eggs pooled from several females, with no backup males.
   a) WDFW freezing method vs. U.S. Biological Survey technique vs fresh semen (control).
   b) varied amounts of semen applied to eggs (2.5, 5, and 10 times recommended rates of semen) with both the WDFW freezing method and the Biological Survey method.

2. Comparison of fertilization rates using fresh semen and eggs with unfrozen semen and eggs held in a refrigerator for one day. Waiting one day would make cryopreservation activities much more convenient by having less conflicts with spawning activities (used WDFW freezing method).
   a) fresh (control) vs unfrozen semen held one day (2.5 rates used).
   b) unfrozen semen held one day at different concentrations with eggs (2.5 and 5 times recommended).
   c) fresh frozen semen vs semen frozen after one day holding (both groups of frozen semen at 2.5 and 5 times recommended rate for semen to eggs).

Table 6. Collection and spawning summary for fall chinook salmon broodstock processed at Lyons Ferry FH, 1995.

Week ending	Salmon Arrivals[a]	Mortality M	Mortality F	Spawned M[b]	Spawned F[c]	M[d]	Eggtake[e]
2 Sep	4						
9 Sep	25						
16 Sep	67						
23 Sep	163						
30 Sep	193						
7 Oct	450						
14 Oct	460	3					
21 Oct	509	1	1				
28 Oct	399			29	41	614	146,400
4 Nov	224	10	1	54	66	545	233,900
11 Nov	276	11	3	141	94	448	292,800
18 Nov	112	35		144	128	102	415,600
25 Nov	21	20	3	103	81	115	251,300[f]
2 Dec	8	15	1	47	21	25	57,900
9 Dec	1	8	1	4	2	7	5,100
Totals[g]	2,912	103	10	522[h]	433	1,856	1,403,000

[a] Escapement is estimated during collection. Numbers of adults and jacks were combined in 1995.

[b] Many males were live spawned early in the season and listed as spawned when they were killed.

[c] Includes 14 females that had bad eggs, were not ripe when killed, had spawned in pond, or were crushed during sorting: four fish on 25 October, four on 1 November, two on 7 November, and four on 14 November.

[d] Males killed ("surplused"), but no semen taken (includes jacks of ≤ 50 cm total length).

[e] Corrected total egg take after shocking was 1,403,000 eggs. This includes 404,800 eggs from stray females (includes 10,000 eggs to UI and eggs used in fertilization experiments). Lyons Ferry origin eggtake was 998,200.

[f] Includes approximately 10,000 unfertilized eggs given to the University of Idaho for laboratory research.

[g] The number of salmon broodstock accounted for during processing at Lyons Ferry FH was 2,924 adults and jacks (another 35 fish processed from LGR for CWT recovery).

[h] Includes three males on 1 November, one on 7 November, and two on 14 November that were not ripe when killed.

Table 7. Duration and peak of spawning, egg take, and percent egg mortality at Lyons Ferry FH 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]
1995	25 Oct - 5 Dec	14 Nov	1,403,000	5.88[e]

[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%.

[e] Combined loss from both known Lyons Ferry and stray/other fish; known Lyons Ferry was 3.41%, and stray/other was 12.13% (Plus 10,000 eggs from strays given to University of Idaho). The egg loss from strays was 8.63% excluding eggs used in fertilization experiments.

3. Evaluation of the use of backup males and different delay times between backup males (semen and eggs after one day holding).

   a) effects of backup male on fertilization rates using frozen semen.
      1) frozen semen with no backup semen (extender with no semen added as second straw) vs frozen semen with backup semen 30 and 60 seconds later.

   b) comparison of fertilization rates with different delay times between initial semen and backup semen.
      1) see a1 above.

Preliminary results from these experiments were summarized previously (Appendix D). We will complete the data analyses and include them in subsequent reports.

3.2: Incubation and Rearing

3.2.1: 1994 brood

The progeny of 1994 Lyons Ferry origin broodstock consisted of 525,694 fish at ponding. Yearlings were marked in September and October of 1995 with adipose fin clips, CWTs, and elastomer tags (VI). Red or blue VIs were placed in the clear tissue behind the eye depending on the eventual release site.

Blue VIs were placed behind the right eye of fish that were shipped to the Nez Perce Tribe for acclimation and release into the Hells Canyon portion of the Snake River. These fish were reared in raceways the entire time they were at Lyons Ferry FH. On 5 March, the Nez Perce Tribe received the first group of 7,200 salmon for testing the new acclimation site at Pittsburg Landing, Idaho. Shortly after the test group of salmon arrived some of the 20 ft diameter fiberglass round ponds without fish began failing. The remaining fish in the Pittsburg release group were retained at Lyons Ferry until the tank supports were repaired and strengthened. On 26 and 27 March, 108,300 salmon were transported to the Pittsburg Landing acclimation site. Fish transferred to the Nez Perce Tribe averaged 11.5 fish per pound.

A red VI was placed behind the left eye of fish that were to be released on-station at Lyons Ferry FH. The 1994 brood with red VIs were reared primarily in raceways, until January. On 8-9 January the fish were transferred to Lake 2, an earthen pond previously used for rearing steelhead. This was the first year fall chinook were reared in any of the large lakes at Lyons Ferry FH.

3.2.2: 1995 brood

The final estimate of the 1995 egg take was 998,200 eggs from Lyons Ferry origin broodstock. Approximately 3.4% did not survive to the eyed stage. Thus, 964,200 eyed eggs from Lyons Ferry origin broodstock remained for hatchery production. From eye-up to ponding there was approximately a 6.3% loss, most of which was due to a water line break that smothered 33,000 fry. Total number of fry ponded was 903,100 fish. The salmon for on-station release or outplanting will be marked with clipped adipose fins, CWTs (two different codes), and VI tags in September and October, 1996.

Stray or unmarked fall chinook from the 1995 brood produced 404,800 unfertilized eggs, 10,000 of which were transferred to the University of Idaho for research. Of the remaining 394,800 unfertilized eggs, 47,900 eggs did not survive to the eyed stage (16,814 eggs died in fertilization experiments). Klickitat FH was shipped the balance (346,900) of the eyed eggs (which included 17,752 eyed eggs from cryogenics and fertilization experiments).

3.3: Disease Incidence and Prophylaxis

The 1994 and 1995 broodstocks were given flow through treatments of formalin (1:7,000; 143 mg/L) as prophylaxis for Saprolegnia sp. (fungus). Salmon were injected at capture with Erythromycin 200 (20 mg/kg of fish), and again every 30 days with erythromycin, 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; 100 ppm) and formalin (1:600; 1,667 ppm) was added every other day for 15 minutes to control fungus on the incubating eggs. Females were examined for the incidence of BKD (using ELISA techniques), but only three egg lots had a high titer in the 1995 brood. Results from most egg lots were low, or below low levels, for both brood years.

The 1994 brood were healthy until January. A delayed decision was made not to put the fish into the adult salmon ponds, but instead, to put the fish into one of the large lakes (Lake 2) at the hatchery that had previously been used for steelhead. Lengths, weights, tag retention and general condition were assessed in January for both the on-station and off-station release groups. PIT tags were implanted into 1000 fall chinook to be released on-station before they were transferred into the lake. By the time the 420,103 fish destined for on-station release were moved to Lake 2 on 8 and 9 January, they had been at relatively high densities in the raceways. Some of these fish were further stressed when a loading pipe full of fish was dropped during transfer to the lake. Fish in the lake began dying on 15 February 1996. These fish were diagnosed with cold water disease and erythrocytic inclusion body syndrome (EIBS). Mortality increased from 150 fish/week at the onset of symptoms of disease to the peak of 1,500 fish/week during March. The lake was snorkeled several times per week to recover mortalities. Many of the live diseased fish were observed to have opaque eye lenses. Dead fish were checked for the presence of PIT tags. The fish were treated with oxytetracycline hydrochloride (4% TM 100) fed at 1% of body weight for 10 days from 11-20 March. Total estimated mortality was 10,350 (2.5%) from 15 February through 25 March, although we believe to be an minimum estimate because of our inability to recover all dead fish from the lake. Prior to release mortalities had decreased to less than 100 fish/week and stabilized. A small proportion (2.9%) of the fish at release were blind in one eye as a result of the disease (compared with only 0.1% in January). The proportions of blindness in the left and right eyes were the same. We received comments from some downstream collection facilities at dams that they were noticing higher than normal proportions of fish from

Lyons Ferry FH with blindness in one eye. The majority of the fish appeared healthy just before, and during release.

The 1995 brood has had no fish health problems during the report period and no prophylactic treatments were administered.

3.4: Juvenile Releases and migration

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). Approximately half the fish were to be transported downstream of IHR 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 gave fish 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 LGR Dam in 1996 to replace (in adult equivalents) the adults and jacks collected at LGR 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 salmon for release each year. Half of those fish would be released on-station, and the other half would be released from acclimation sites upstream of LGR Dam. If the egg take was inadequate, the first priority would be the 450,000 yearlings to be released at the hatchery. However, progeny of adults collected at LGR Dam could not be used for releases at Lyons Ferry FH. If additional production was available beyond the full yearling program, subyearlings would be reared for monitoring, research, or production. The subyearlings would be released above LGR Dam, or at Lyons Ferry FH. WDFW's goal, however, is to emphasize yearling releases as a means to increase the run size of adult salmon into the Snake River as quickly as possible. Additionally, we wish to compare and evaluate subyearling releases with yearling releases in an attempt to improve subyearling survival and maintain natural age and sex distribution for returning adults.

3.4.1: 1993 brood smolt migration

The 1993 brood yearlings (349,024 fish) were released directly into the Snake River from Lyons Ferry Hatchery on 17 April 1995. Mean length of fish at release was 171.7 mm. Prior to release all fish were marked with a red VI tag in the clear adipose tissue behind the left eye. Elastomer tag retention at release was estimated at >90%. In addition, we tagged 398 fish with Passive Integrated Transponder (PIT) tags on 23 February. PIT tag retention was estimated at 100% at time of release. Juvenile bypass collection facilities and PIT tag interrogation units at downstream Snake and Columbia River dams provided passage data for each tag type.

Left red VI tags were first observed on 6 and 13 April at Lower Monumental and McNary dams, respectively, even though the release at Lyons Ferry was on 17 April. Left red VI tags were also released in a small group (14,632) of spring chinook salmon from the Tucannon River. Based on release numbers, we believe that only 5% of the left red VI tagged fish sampled at each dam were spring chinook salmon from the Tucannon River. Peak passage dates of VI tagged fish and travel time information obtained from PIT tagged fish would suggest that five or six days were required to travel the distance between Lower Monumental and McNary Dams (≈109 km). Therefore, left red VI fish sampled before 18 April at Lower Monumental Dam, or 23-24 April at McNary Dam were likely to be spring chinook from the Tucannon River.

Lower Monumental Dam: Left red VI tagged fish (3,924) were sampled at the juvenile bypass collection facility in 1995. Mean length of sampled fish was 181 mm. Peak passage date (based on passage index) was 6 May (range: 6 April-4 July; Figure 4). The passage index is calculated by assuming 100% collection efficiency at the turbine intake diversion screens, and adjusted by the proportion of river flow that is spilled at that dam. The 10% and 90% passage dates were 22 April and 9 May, respectively. The estimated number (based on sample rate) of left red VI tagged fish collected at the dam was 102,973, or 32.7% of the fish released. This percentage accounts for VI tag loss and the percentage of Tucannon spring chinook in the sample.

PIT tag interrogation units detected 117 (29.4%) PIT tagged fish released from Lyons Ferry in 1995. Mean travel time of PIT tagged fish to Lower Monumental Dam was 15.5 days. Peak passage date (based on daily detections) was 5 May (range: 18 April-14 May; Figure 4). The 10% and 90% passage dates were 21 April and 9 May, respectively.

McNary Dam: Left red VI tagged fish (471) were sampled at the juvenile bypass collection facility in 1995. Peak passage date (based on passage index) was 11 May (range: 13 April-13 June; Figure 5). The 10% and 90% passage dates were 4 May and 20

May, respectively. About 12.1% (38,015) of the fish released with left red VI tags were collected at the dam, based on sample rate.

PIT tag interrogation units detected 51 (12.8%) PIT tagged fish released from Lyons Ferry in 1995. Mean travel time of PIT tagged fish to McNary Dam was 21.9 days. Peak passage date (based on daily detections) was 10 May (range: 29 April-22 May; Figure 5). The 10% and 90% passage dates were 2 May and 19 May, respectively.

Mean length of left red VI tagged fish sampled at McNary Dam was 177.2 mm. Eight PIT tagged fish released from Lyons Ferry were also measured at McNary Dam in 1995. Their mean length was 179.8 mm.

John Day and Bonneville Dams: PIT tag interrogation units detected three (0.75%) and one (0.25%) PIT tagged fish released from Lyons Ferry at John Day Dam and Bonneville Dam, respectively, in 1995. Mean travel time of PIT tagged fish detected at John Day Dam was 28.5 days (range: 22.7-31.7 days). Travel time of the one fish detected at Bonneville Dam was 33.4 days.

A more detailed analysis of the VI and PIT tag data from Lyons Ferry FH releases may be included in future reports.

3.4.2: 1994 brood yearling releases

We evaluated tag retention for yearling fish with a red VI tag behind the left eye three days before release. Tag retention was 89.8%. Fish to be released at Pittsburg Landing were inadvertently not sampled just before release, but about one month before release (8 March) they had a VI retention rate of 85.1%.

On 8 April, NMFS took 3,233 fish (1994 BY) to test the new Ice Harbor juvenile fish passage facilities before most of the other juvenile migrants in the Snake River reached there. These fish had been adipose clipped and had CWTs and left red VI tags for the on-station release at Lyons Ferry. The fish were released either into the bypass collection system at the dam, or just downstream.

The majority of the 1994 brood yearlings were released at two locations. From 9-15 April, 404,270 yearlings were volitionally released from Lake 2 at Lyons Ferry FH. While PIT tagging on 9 April, we measured and weighed 536 of these fish that had exited Lake 2 and were holding in a downstream raceway before leaving the hatchery facilities. Samples were collected for smoltification index (organosomatic index and ATPase levels) and cortisol levels (stress index). Mean fork length and standard deviation (SD) was 161.4 mm (SD=11.3) and mean weight was 43.1 gm (SD=8.4). These fish were 10.5 fish per pound (fpp) with a coefficient of variation (CV) for length of 7.1 mm. Condition factor (K) was 1.03. Fish from Lake 2 were also sampled on 15 April for lengths, weights as they exited the lake. The mean length on 15 April was 160.4 mm (SD=11.1, n=408) with a mean weight of 41.3 g (SD=8.1, 11.0 fpp). The CV of length was 7.3 and condition factor was 1.0. The data from the two groups were combined to represent the release group (mean length= 161.0 mm, SD=11.6, n=2,009, CV of length=7.2, mean wt. 42.3 g, SD=8.3, n=943, fpp=10.7, and K=1.0). Data for smoltification and stress levels will be included in subsequent reports.

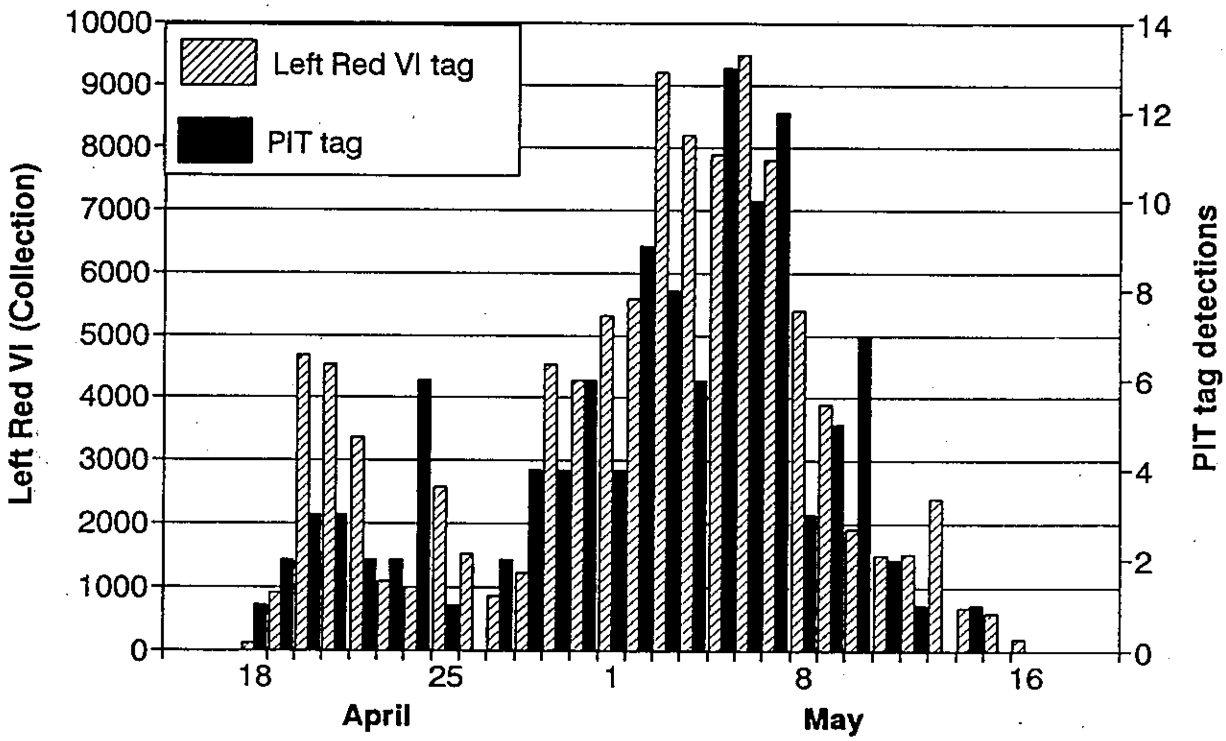

Figure 4. Estimated passage index of left red elastomer tagged salmon, and PIT tag detections at Lower Monumental Dam of fish released from Lyons Ferry in 1995.

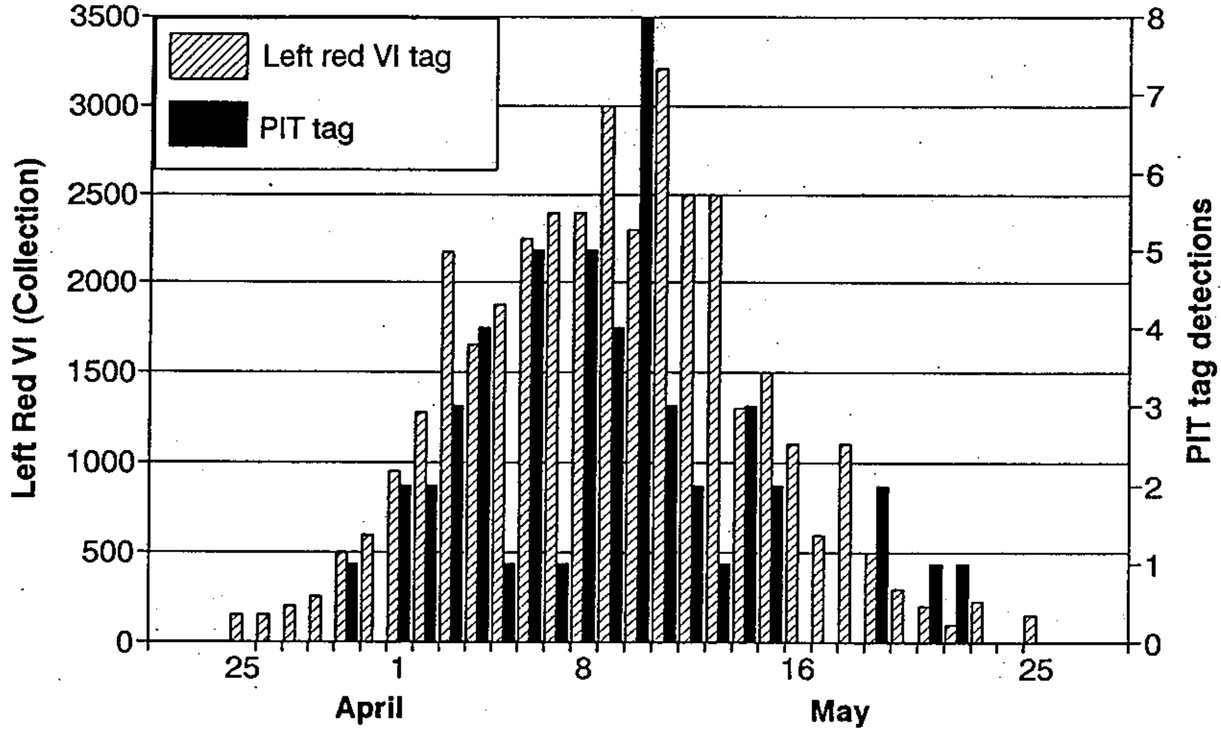

Figure 5. Estimated passage index of left red elastomer tagged salmon, and PIT tag detections at McNary Dam of fish released from Lyons Ferry in 1995.

Salmon at Pittsburg Landing were sampled by personnel from the USFWS and the Nez Perce Tribe during PIT tagging on 2-5 April. Mean length was 159.7 mm (SD=15.2, CV=9.5, n=1,127), mean weight was 44.1 g (SD=11.1, 10.3 fpp), and the condition factor was 1.1. The 114,299 yearlings (1994 brood) were released from the acclimation site at Pittsburg Landing from 12-14 April, 1996. Samples were also taken prior to transport to Pittsburg Landing and post release (at LGR, Little Goose, Lower Monumental and McNary dams). The samples included lengths, weights, and ATPase levels. Cortisol levels were taken just prior to release as an indicator of stress levels. This sampling information will likely be included in a cooperative monitoring and evaluation report for Pittsburg Landing.

PIT tagging, migration timing, detection rates, and post-release lengths, weights, and ATPase samples collected at juvenile sampling sites at dams will be summarized and presented in subsequent reports.

3.4.3: 1995 brood releases

In March of 1996, hatchery personnel estimated that 83,183 fry accidentally escaped because of an improperly placed screen in the raceway. All fish were unmarked and were recorded as an average size of 500 fpp. These fish were recorded as an unintentional fry plant to the Snake River.

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 1990-1995 broods (Table 8) to estimate survival rates within the hatchery environment (Table 9). Mean egg-to-release survival rates are 86.7% (SD=4.7) for yearlings and 87.8% (SD=3.1) 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 FH are several times higher for yearling releases than for subyearling releases (Bugert et al. 1996 draft report).

Table 8. Estimated salmon progeny from known Lyons Ferry origin adults, 1990-1995 brood years.

Brood Year	Total eggs	Eyed eggs	Fry ponded	Subyearlings 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[i]	583,871	553,189	542,461	25,858[j]	536,867	521,822[k]
1995[l]	998,200	964,200	903,100	28,855[m]	- -	- -

[a] Marking (CWT and adipose clip) 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] 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.
[i] During marking 16,767 more fish were counted than expected, this amount was added to each of the population estimates at earlier life stages.
[j] Progeny of 1989 brood Lyons Ferry fish shipped to Klickitat FH and marked as strays. In May 30,300 fish were shipped back to Lyons Ferry to be released by NMFS/USFWS for the subyearling survival study.
[k] Includes the 3,233 yearling fall chinook released by NMFS to test juvenile facilities at Ice Harbor Dam and 114,299 released by the Nez Perce Tribe at Pittsburg Landing.
[l] Partitioned loss of fish among subyearlings, yearlings, and fry that escaped (83,183) until fry were split into subyearling group and yearlings on 21 May. Back calculated to estimate 33,459 eggs for subyearlings and 92,107 eggs for escaped fry (resulting in 789,618 ponded for yearling release).
[m] Progeny of known Lyons Ferry origin broodstock, released by NMFS for subyearling survival study.

Table 9. Estimated survivals (%) between various life stages at Lyons Ferry FH for fall chinook salmon of Lyons Ferry origin.

Brood year	Stage	Egg-to-Fry [a]	Fry-to-release	Egg-to-release
1990	yearling	86.8[b]	94.5	82.1
	subyearling	86.8[b]	98.0	85.1
1991	yearling	89.1[b]	94.7	83.8
1992	yearling	92.7	96.6	89.5
	subyearling	92.7	98.4	91.2
1993	yearling	88.0[b]	99.0	87.1
1994	yearling	92.7	99.3	92.1
1995	yearling	90.5	- -	- -
	subyearling	90.5	95.4[c]	86.2[c]
Means				
yearlings		90.0	95.5	86.2
SD		2.5	1.0	3.8
subyearlings		90.0	97.7	87.4
SD		2.5	1.6	2.6

[a] Total egg take (unfertilized "green" eggs).
[b] Based on back calculation to estimate green eggs taken.
[c] Estimated after partitioning loss in that raceway for subyearlings (33,459 eggs), yearlings, and escaped fry (83,183).

SECTION 4: STOCK PROFILE EVALUATION

4.1: Population Structure

4.1.1: Age and sex structure

Females continue to dominate the older age classes of returning Lyons Ferry origin salmon because few females return at age 3 or younger (Table 10). Few males are recovered at age 5 and older. Males tend to be smaller at the same age as females, at least in the younger age categories. Returning adults from subyearling releases tend to be larger than returning adults from yearling releases (Appendix E). Small, two year old males dominated the Lyons Ferry origin salmon processed at the hatchery in 1995 (Fig. 6). The large number of small males that returned in 1995 may be a result of the large size at release (8 fpp) for the 1993 brood year. Stray hatchery fish were generally larger than 65 cm (Fig. 7).

4.1.2 Fecundity and egg size

We conducted both total counts of eggs, or a weight sample with three separate 100 egg weights and total egg weight, for estimating the number of eggs for some of the Lyons Ferry origin females. Mean fecundity for females increased by age, excluding the one age 2 female (Table 11). Mean fecundity was correlated with mean length of fish in 1994 (Mendel et al. 1995) and 1995 (Fig. 8). We also found that fecundity decreased within an age group during the spawning season (Fig. 9). However, we believe this decrease is related to a decrease in fish size during the spawning season (Mendel et al. 1995).

4.2: Stock Profile Sampling

We did not collect electrophoretic samples from adult or juvenile fall chinook salmon of Lyons Ferry origin in 1995. We will resume sampling for genetics trend analyses, probably beginning again in 1998. We did not collect morphometric or meristic data from any fall chinook during this contract year. At release we collected organosomatic data from the 1993 and 1994 brood years. Results from these collections are on file and may be reported later.

Table 10. Age and sex of known (with CWT or BWT) Lyons Ferry origin salmon processed at Lyons Ferry FH (1991-1995).

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
1995 [b]							
male	1,759[c]	410[d]	26	130	1	0	2,326
female	1	93	53	194	3[e]	1	345
percent	66.1	18.8	2.9	12.0	0.1	0.0	2,671
Total fish	2,649	1,308	1,224	790	41	2	6,014
Means							
% male	33.5	19.6	10.7	5.1	0.3	0.0	69.3
(SD)	20.3	6.2	7.3	3.1	0.4	0.0	
% female	0.0	3.0	18.1	9.0	0.5	0.0	30.7
(SD)	0.0	2.8	11.3	5.3	0.5	0.0	
% total	33.5	22.6	28.8	14.2	0.8	0.1	100.0

[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.

[c] Two fish were not adipose clipped, plus 26 fish were killed at the juvenile bypass and one at the adult trap for CWT recovery.

[d] One fish was not adipose clipped.

[e] Three fish had BWTs.

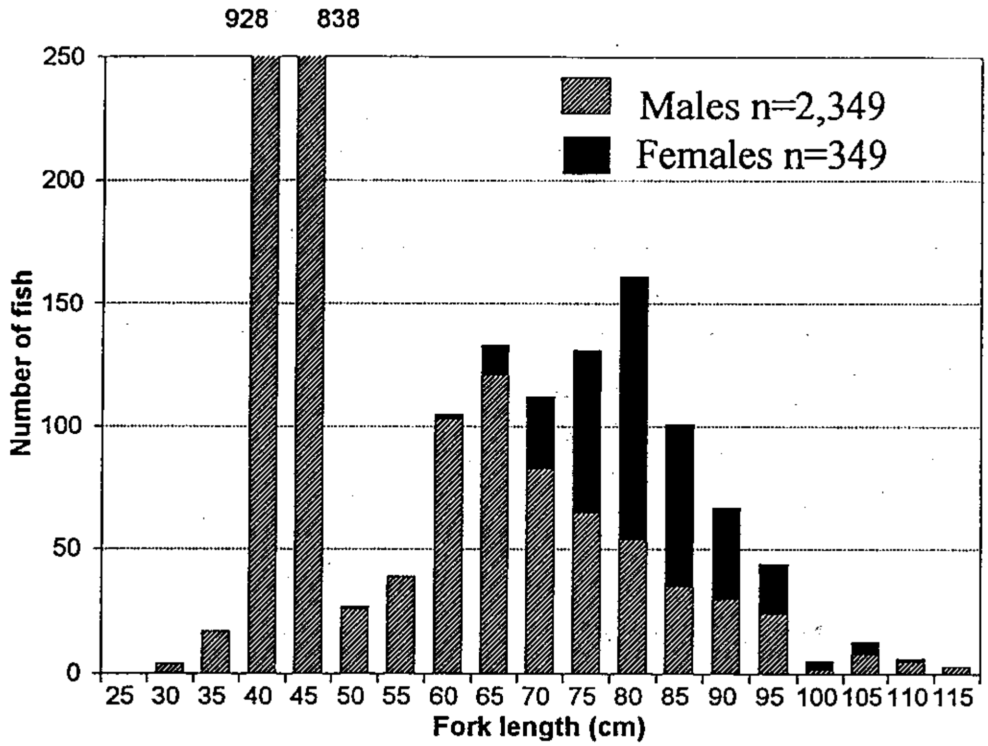

Figure 6. Length-frequency of Lyons Ferry origin salmon processed at Lyons Ferry FH in 1995.

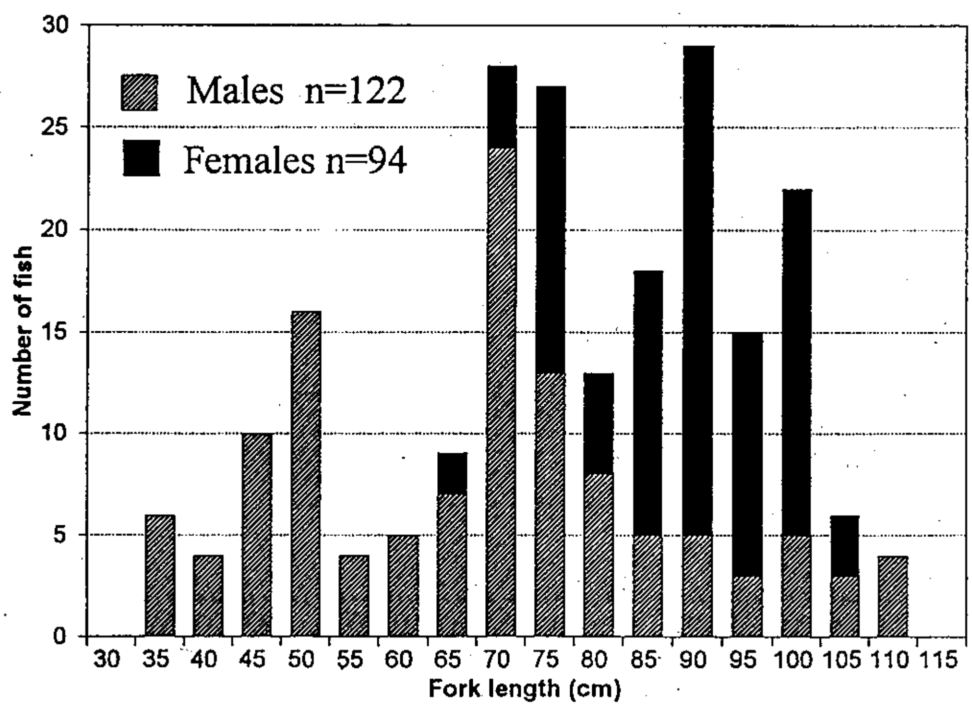

Figure 7. Length-frequency of stray hatchery salmon processed at Lyons Ferry FH in 1995.

Table 11. Mean number and standard deviation (SD) of eggs per Lyons Ferry origin female during spawning at Lyons Ferry FH, as determined by weight samples and actual counts, 1995.

Age	Actual count	Standard Dev. (sample size)	Weight sample	Standard Dev. (sample size)	Mean weight/ 100 eggs (g)
2	3,383	- - (1)	3,576	- - (1)	30.8
3	2,885	877 (10)	3,155[a]	914 (21)	23.0
4	3,133	1,065 (8)	3,207[b]	840 (17)	29.6
5	3,251	1,043 (11)	3,596[c]	935 (22)	30.2

[a] Mean number of eggs per female by weight sample was 3,044 (SD=933) for the same 10 females as the for the total counts.
[b] Mean number of eggs per female by weight sample was 3,248 (SD=1,017.8) for the same 8 females as for the total egg counts.
[c] Mean number of eggs per female by weight sample was 3,479 (SD=1,203.3) for the same 11 females as for the total egg counts.

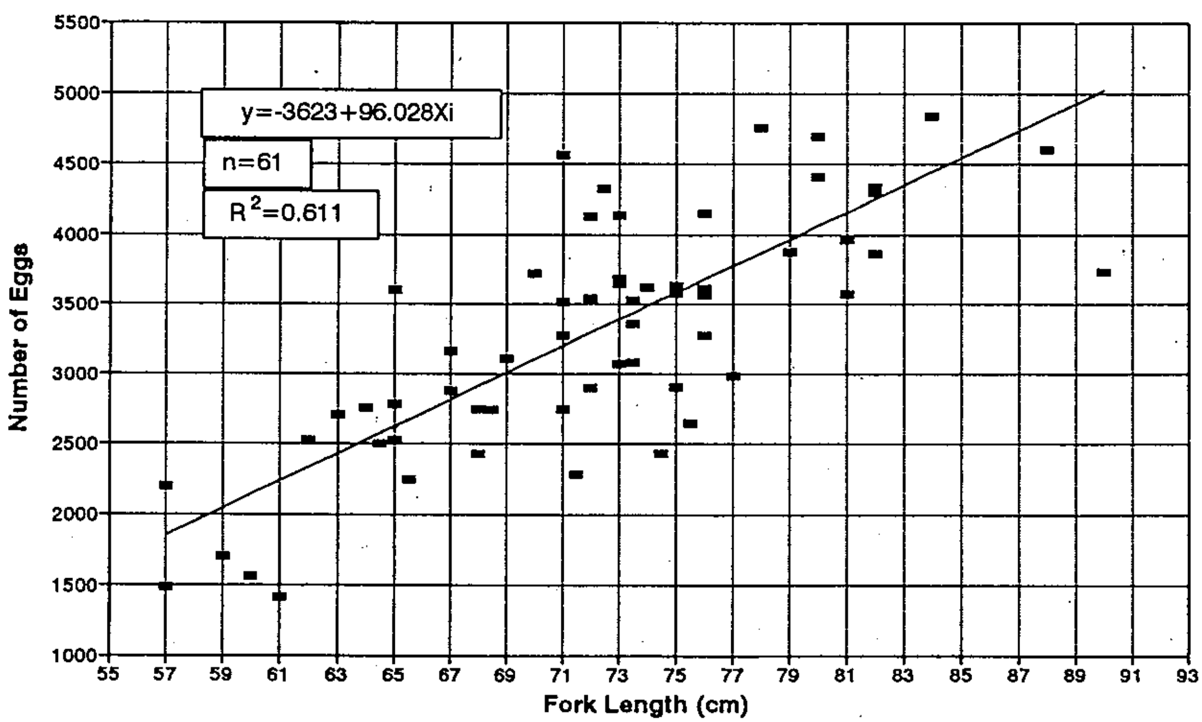

Figure 8. Relation between of female length and number of eggs (estimated by weight samples) for Lyons Ferry origin fall chinook salmon spawned in 1995 (all ages combined).

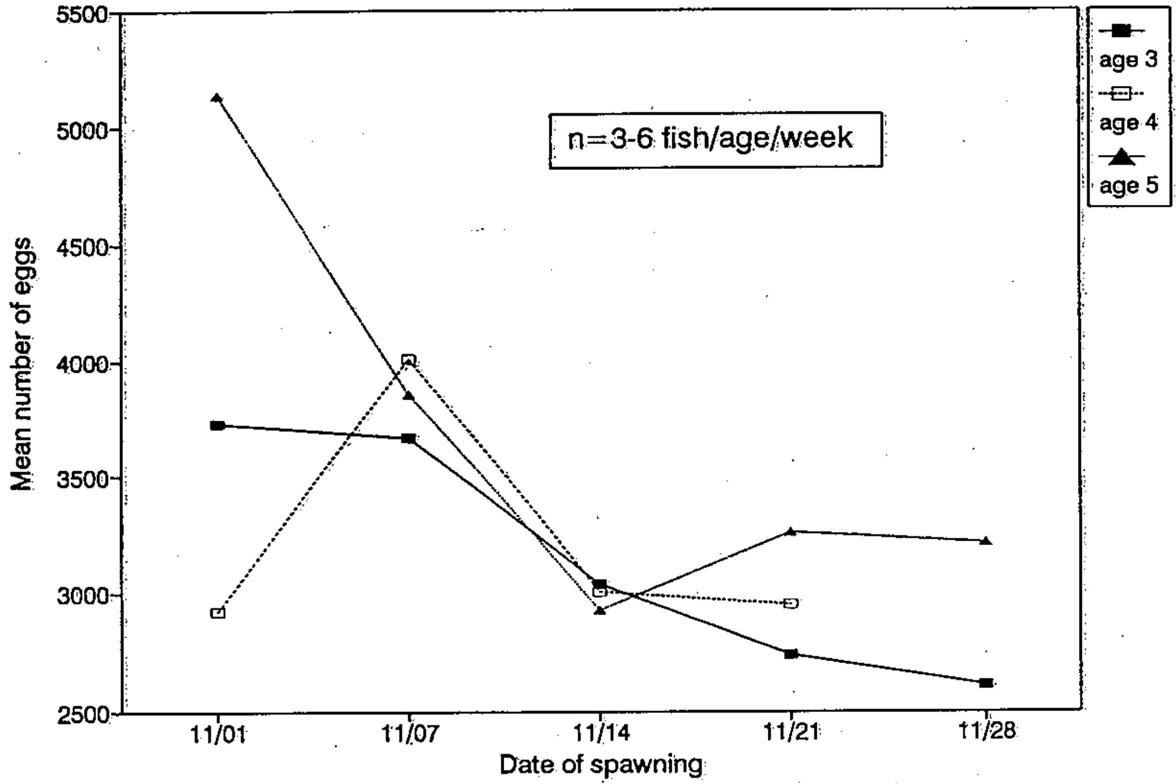

Figure 9. Mean fecundity by age and spawn date for Lyons Ferry fall chinook salmon during the 1995 spawning season.

SECTION 5: NATURAL PRODUCTION

We no longer conduct cooperative spawning surveys upstream of LGR Dam. Personnel from Idaho Power and the 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 22 November 1995. High, turbid water prevented us from conducting surveys after 22 November, although several carcasses were collected on 27 November during a spot check. Therefore, the surveys should be considered incomplete for 1995. Surveys generally encompassed the river from its mouth (above slackwater) upstream at least to Fletcher's Dam (Rk 9.6). Surveys on 16 and 22 November included the river from Enrich Bridge (RK 28.0), above Highway 12, downstream to Pataha Creek (Rk 18.0). Survey conditions were fair to good during survey dates, except after 20 November below Pataha Creek when conditions were poor due to high water and turbidity.

Twenty-nine redds, 45 live salmon and 12 carcasses were observed in the Tucannon River during spawning surveys in 1995 (Table 12). No salmon carcasses were found upstream of Fletcher's Dam (RK 9.6) in 1995, although one redd and a live fish were observed upstream of the dam. A concentration of 32 salmon and 23 redds was found within 2.5 kilometers downstream of Fletcher's Dam. We suspect that passage may have been restricted at this dam in 1995. This dam was identified as a passage barrier prior to modification in 1992 (Mendel et al. 1994). Fall chinook passage and spawning upstream of the dam has remained limited since the dam was modified to improve fish passage. Spawning density was 4.7 redds/mile (2.9 redds/km) downstream of Fletcher's Dam in 1995. Redd densities peaked in 1990 and have remained relatively constant since then (Table 13).

We recovered 12 carcasses (six hatchery and six wild salmon) from the Tucannon River. Three carcasses originated from Umatilla Hatchery (three right ventral (RV) fin clipped and one 7-55-61 CWT). One other fish originated from Lyons Ferry FH (red VI). Another hatchery fish did not contain any wire, but it appeared to be partially adipose clipped.

We were unable to survey the Palouse River in 1995 because of high, turbid flows during most of the spawning season. 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 1995.

Survey date	River kilometer [a]	Redds	Live fish	Carcasses [b] Females	Males
10-19	9.6 - 0.0	No redds or fish seen (live or dead).			
10-26	9.6 - 7.1		1		
	7.1 - 3.5		2		
	3.5 - 0.0				
11-02	17.7 - 12.7	1			
	12.7 - 9.6				
	9.6 - 7.1				
	7.1 - 3.5		1		
	3.5 - 0.0		1	1	
11-16	28.0 - 22.2		1		
	22.2 - 18.0				
11-20	18.0 - 12.7	1	1		
	12.7 - 9.6				
	9.6 - 7.1	23	32	2	
	7.1 - 3.5	4	6	2	3
	3.5 - 0.0			1	
11-22	28.0 - 18.0	No redds or fish seen (live or dead).			
11-27	9.6 - 7.1			3	
Totals		29	44	7	5

[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), Pataha Creek (Rk 18.0), Kessel's Bridge (Rk 17.7), Smith Hollow Bridge (Rk 12.7), Fletcher's Dam (Rk 9.6), Starbuck Bridge (Rk 7.1), Power's Bridge (Rk 3.7) Highway 261 Bridge (Rk 3.5), Tucannon River mouth (Rk 0.0).

[b] Three hatchery fish were found on 11/20. Another three hatchery fish were found on 11/27. All these carcasses were found 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
1995	29	28 [c]	2.9	4.7

[a] Redds/km below Fletcher's Dam. 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 slackwater from the reservoir 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.

[c] We were unable to survey after the peak of spawning because of high water and turbidity. This should be considered an incomplete estimate.

SECTION 6: LOSSES UPSTREAM OF ICE HARBOR DAM

In 1995, 28.5% of fall chinook salmon escapement upstream of Ice Harbor Dam was not accounted for with our standard summation methods (Table 14). This estimated loss is within the 27-56% loss obtained with this method in 1992-1994. Salmon not accounted for consists of the difference between the counts at IHR Dam, and counts or estimates at various locations up to LGR Dam. Possible disposition of missing fish includes fall back at IHR Dam, mortality, or spawning in tributaries or tailraces of the lower Snake River dams. Spawning was probably underestimated in the Tucannon River in 1995 because of poor survey conditions. Also, limited spawning may have occurred below LGR and Little Goose dams as in 1993 and 1994 (Dauble et al. 1994, Dauble personal communications). Other missing fish could have fallen back at IHR Dam as we have documented with radio telemetry in previous years (Mendel et al. 1993).

Table 14. Fall chinook salmon (adults and jacks) accounted for upstream of Ice Harbor Dam, 1995.

	Number of adult and jack salmon
Counted at Ice Harbor Dam	5,202
Collected at Ice Harbor Dam	- 0
Voluntary returns to Lyons Ferry FH	-2,256
Spawning escapement to Tucannon and Palouse rivers[a]	- 87
Counted at Lower Granite Dam	-1,374
Total not accounted for	1,485 (28.5%)

[a] Twenty-five redds with an estimated 3 adults per redd; no adults or redds in the Palouse River. Spawning escapement is probably underestimated because of poor survey conditions after 20 November.

SECTION 7: CLOSING COMMENTS

Studies using Lyons Ferry fall chinook salmon have been confounded because of poor decision processes. The yearling salmon removed in 1996 for testing the juvenile facilities at Ice Harbor Dam have the same CWTs and VI tags as those fish released a few days later at Lyons Ferry FH. Additionally, the group of fish from which they were removed had previously been PIT tagged. We do not know if any of the PIT tagged fish were used in testing at IHR Dam. Therefore, interpretation of the data from our juvenile migration study will be difficult. We will not be able to differentiate the impacts of the Ice Harbor study from our adult returns and associated smolt-to-adult survival estimates. Also, late decisions the past two years for other agencies to use progeny of Lyons Ferry strays (1989 brood), or known Lyons Ferry broodstock, has somewhat compromised those studies. The hatchery program has not been able to provide fish from several egg takes, or to have much flexibility to achieve desired size goals for the fish at the time of release. The WDFW should ensure that decisions are made earlier in the year (January-February) about the use of Lyons Ferry fall chinook subyearlings in outside agency research. Also, once fish are tagged for monitoring and evaluation studies uses that complicate or confound those studies should be avoided.

Errors in the estimates of egg take from Lyons Ferry origin broodstock have caused problems with planning by interagency and tribal groups in 1996, and likely caused our underestimate in the number of fish at the hatchery until they were counted during marking in 1995. These errors also complicate our estimates of survivals between various life stages at the hatchery. We will begin experiments with spring chinook to determine the comparability of several different egg counting or estimating methods. Then a method that will be selected for use with the 1996 brood of fall chinook to improve our estimate of total egg take and ensure that it is available earlier than 1 January.

The 1996 broodstock consisted of many small males (jacks or mini jacks). The high proportion of males will likely affect the size, sex and age structure for the 1994 brood year. This large return of jacks is likely associated with the size of juvenile fish at release. We need more careful monitoring and control of fish size at release to ensure they meet desired release sizes to minimize the number of jacks that return. Additionally, we intend to conduct size and time of release studies of yearling and subyearling fall chinook in 1998 at Lyons Ferry FH, and at an upper Snake River outplant site, to assess the effects of size at release on the survival, sex ratio, age and size of returning salmon. This study is dependant on the availability of a larger chiller at Lyons Ferry FH to reduce fish size at release.

The use of Lake 2 at Lyons Ferry Hatchery may improve juvenile fish condition and smolt-to-adult survival, although it complicates monitoring and evaluation. An unknown portion of fish mortalities may not be counted because they are removed by predators, or they sink into the lake and are never recovered. Therefore, the number of fish released would be over estimated. It is also difficult to obtain representative samples of fish for length/weight estimates for release size, or for PIT tagging to monitor migration timing, etc. Also, runoff from sampling at the north raceways or the tagging trailer may expose these fish to increased disease risk. We will work with hatchery personnel to address these concerns in 1996-1997. We would like the opportunity in 1998 to compare juvenile fish condition, timing and survival to adult returns from the lake and raceways at Lyons Ferry FH.

The designation of "jacks" has been a complicating factor in the Snake River fall chinook program at Lyons Ferry for several years. We are unable to compare with fish counted at the Snake River dams because of conflicting definitions of "jacks". The definition of jacks has also changed several times in the past few years within the WDFW Hatcheries Program so data are not comparable among years. A consistent definition of jacks, or elimination of the term, is needed soon to increase accounting efficiency, and to enable appropriate fish management comparisons and decisions.

We documented mean fertilization rates of 60-70% for cryopreservation experiments at Lyons Ferry FH. We have identified the variability of fertilization rates obtained from different males as a major concern with the use of delayed fertilization techniques. In 1996, we will begin trying to identify a relatively quick and simple method that quantifies the quality of sperm from each male and to correlate that with fertilization rates. If we are successful we will be able to remove much of the uncertainty involved with using cryopreserved semen from different males and improve our management decisions of when to use cryopreserved semen.

We will plan for expanded (up to 450,000 yearling) outplants of fall chinook salmon upstream of LGR Dam in 1997 and 1998. Fish will be marked with adipose clips and CWTs, as well as uniquely identified externally with elastomer tags of different colors and locations. This will enable us to monitor and evaluate the outplant program and pass fish at LGR Dam, or externally identify fish for spawning at the hatchery. Elastomer tag retention has improved, but retention is still lower than the desired level of >90% for returning adults and jacks (Appendix F). In 1996, we will increase our identification of Lyons Ferry origin salmon based on the presence of elastomers to expedite spawning at the hatchery. We will continue to work with the Corps of Engineers, the Tribes, the Production Advisory Committee (PAC), and the USFWS to locate suitable acclimation sites for additional releases of Lyons Ferry fall chinook in 1997 and 1998 (up to 450,000 yearlings, and/or an unknown number of subyearlings in the future). We intend to assist with monitoring and evaluating releases from Pittsburg Landing and other outplant sites upstream of LGR Dam. We will compare their success with fish released from Lyons Ferry using our current activities and marking plans. Also, we have submitted a joint proposal with the USFWS and the Nez Perce Tribe for expanded monitoring and evaluation of releases from, and adult returns to all of these outplant sites.

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APPENDIX A

Coded-wire tag recoveries at Lyons Ferry FH in 1995 (and expansions according to our data to include all fish released 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 1995.

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	EXPANDED RECOVERY LG	EXPANDED RECOVERY TOTAL
	1	1	63	2	31	Lyons Ferry	88	58,988	458	18,708	1.32	0	1	1
5	1	6	63	37	31	Lyons Ferry	91	9,196	89	108	1.02	5	1	6
1		1	63	40	12	Lyons Ferry	90	23,954	113	0	1.00	1	0	1
1	1	2	63	40	13	Lyons Ferry	90	21,137	268	0	1.01	1	1	2
7	6	13	63	41	18	Lyons Ferry	90	218,110	1,515	0	1.01	7	6	13
16	4	20	63	41	20	Lyons Ferry	90	202,674	2,566	0	1.01	16	4	20
10	4	14	63	41	43	Lyons Ferry	90	111,784	562	0	1.01	10	4	14
11	2	13	63	41	60	Lyons Ferry	90	110,748	1,345	0	1.01	11	2	13
9	4	13	63	42	9	Lyons Ferry	90	104,820	792	0	1.01	9	4	13
4		4	63	42	10	Lyons Ferry	90	98,374	560	0	1.01	4	0	4
1		1	63	43	20	Lyons Ferry	90	4,386	0	0	1.00	1	0	1
22		22	63	46	18	Lyons Ferry	91	82,796	1,351	296	1.02	22	0	22
31	8	39	63	46	31	Lyons Ferry	91	51,408	415	0	1.01	31	8	39
20	6	26	63	46	55	Lyons Ferry	91	52,093	104	0	1.00	20	6	26
23	3	26	63	46	56	Lyons Ferry	91	49,656	1,094	1,355	1.05	24	3	27
24	2	26	63	46	57	Lyons Ferry	91	53,595	216	325	1.01	24	2	26
18	10	28	63	46	58	Lyons Ferry	91	51,663	208	104	1.01	18	10	28
18	7	25	63	46	59	Lyons Ferry	91	51,371	624	0	1.01	18	7	25
4	7	11	63	46	60	Lyons Ferry	91	51,887	104	0	1.00	4	7	11
10	6	16	63	46	61	Lyons Ferry	91	51,370	206	0	1.00	10	6	16
25	5	30	63	46	62	Lyons Ferry	91	51,410	310	0	1.01	25	5	30
10	10	20	63	46	63	Lyons Ferry	91	50,892	828	0	1.02	10	10	20
13	4	17	63	47	3	Lyons Ferry	91	38,460	0	139	1.00	13	4	17
13		13	63	47	5	Lyons Ferry	91	38,170	155	231	1.01	13	0	13
12		12	63	47	6	Lyons Ferry	91	33,994	244	663	1.03	12	0	12
4	1	5	63	47	9	Lyons Ferry	91	31,901	494	493	1.03	4	1	5
17	4	21	63	47	58	Lyons Ferry	92	51,316	0	206	1.00	17	4	21

Appendix A, 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	EXPANDED RECOVERY LG	EXPANDED RECOVERY TOTAL
8	9	17	63	47	60	Lyons Ferry	92	51,160	726	0	1.01	8	9	17
21	9	30	63	47	63	Lyons Ferry	92	50,481	1,831	104	1.04	22	9	31
24	5	29	63	49	12	Lyons Ferry	92	51,168	273	0	1.01	24	5	29
19	4	23	63	49	15	Lyons Ferry	92	51,258	273	0	1.01	19	4	23
10	1	11	63	49	17	Lyons Ferry	92	51,702	312	0	1.01	10	1	11
16		16	63	49	18	Lyons Ferry	92	51,702	312	0	1.01	16	0	16
13	3	16	63	49	20	Lyons Ferry	92	49,248	49	155	1.00	13	3	16
56	202	258	63	50	12	Lyons Ferry	92	203,177	3,598	0	1.02	57	206	263
507	56	563	63	51	62	Lyons Ferry	93	89,800	85	0	1.00	507	56	563
401	51	452	63	51	63	Lyons Ferry	93	101,165	300	0	1.00	402	51	453
19	8	27	63	52	24	Lyons Ferry	92	53,276	53	168	1.00	19	8	27
15	5	20	63	52	27	Lyons Ferry	92	51,260	413	104	1.01	15	5	20
18	4	22	63	52	29	Lyons Ferry	92	51,091	1,149	0	1.02	18	4	22
5	7	12	63	52	63	Lyons Ferry	92	33,736	135	0	1.00	5	7	12
	1	1	63	55	44	Lyons Ferry	89	123,640	3,662	0	1.03	0	1	1
397	51	448	63	56	39	Lyons Ferry	93	82,624	39	195	1.00	398	51	449
263	32	295	63	56	40	Lyons Ferry	93	73,986	484	346	1.01	266	32	298
2121	544	2665										2,129	548	2,677

APPENDIX A, continued

Coded-wire tag recoveries (and expansions according to data reported to Pacific States Marine Fisheries Commission) at Lyons Ferry FH in 1995. Vol = voluntary return to the hatchery, LG = hauled from Lower Granite Dam.

Table 2. CWT recoveries from stray hatchery fish at Lyons Ferry Hatchery in 1995.

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	EXPANDED RECOVERY LG	EXPANDED RECOVERY TOTAL
	2	2	6	57	34	Trinity River	92	53,675	852	373,687	7.98	0	16	16
	1	1	6	57	49	Trinity River	92	54,308	710	0	1.01	0	1	1
	3	3	7	0	16	Umatilla River	90	48,301	1,431	49,493	2.05	0	6	6
	1	1	7	1	25	Umatilla River	92	29,360	1,129	242,007	9.28	0	9	9
	1	1	7	7	19	Umatilla River	93	31,658	216	295,826	10.35	0	10	10
1		1	7	7	22	Umatilla River	93	30,950	586	272,307	9.82	10	0	10
	1	1	7	7	23	Umatilla River	93	30,447	965	294,996	10.72	0	11	11
	2	2	7	52	25	Umatilla River	90	52,252	269	1,290,790	25.71	0	51	51
	4	4	7	52	26	Umatilla River	90	51,728	667	1,290,647	25.96	0	104	104
1	2	3	7	53	28	Umatilla River	90	48,266	2,048	50,328	2.09	2	4	6
	1	1	7	54	4	Umatilla River	89	53,160	401	77,539	2.47	0	2	2
	3	3	7	54	49	Umatilla River	90	48,481	1,620	49,861	2.06	0	6	6
	3	3	7	54	50	Umatilla River	90	51,814	128	384	1.01	0	3	3
	3	3	7	54	51	Umatilla River	90	52,444	0	262	1.00	0	3	3
	1	1	7	55	60	Umatilla River	90	25,720	0	142	1.01	0	1	1
	2	2	7	55	61	Umatilla River	90	25,425	283	0	1.01	0	2	2
	2	2	7	55	63	Umatilla River	90	26,173	246	62	1.01	0	2	2
	1	1	7	56	1	Umatilla River	90	24,762	1,697	126	1.07	0	1	1
	3	3	7	56	2	Umatilla River	90	25,476	1,067	63	1.04	0	3	3
	1	1	7	63	29	Umatilla River	92	30,706	102	172,923	6.63	0	7	7
	1	1	7	63	32	Umatilla River	92	29,451	593	247,887	9.44	0	9	9
	1	1	7	63	33	Umatilla River	92	29,718	500	243,444	9.21	0	9	9
	1	1	63	40	30	Klickitat River	90	75,342	838	2,553,820	34.91	0	35	35
	3	3	63	40	31	Klickitat River	90	75,943	690	176,167	3.33	0	10	10
	1	1	63	40	32	Klickitat River	90	76,067	862	1,355,071	18.83	0	19	19
	1	1	63	45	31	Klickitat River	91	75,399	364	719,537	10.55	0	11	11
	1	1	63	47	36	Klickitat River	92	76,341	269	1,503,390	20.70	0	21	21
2	46	48										12	356	368

Appendix A: continued.

Table 3. Other fish processed at Lyons Ferry FH in 1995.

VOL	LG	TOTAL	CWT CODES	RELEASE LOCATION	BROOD YEAR
Not adipose clipped fish (4 total).					
2		2	63 51 62	Lyons Ferry	93
	1	1	63 50 12	Lyons Ferry	92
1		1	Lost CWT		
Jacks (27 fish) sacrificed at LGR juvenile bypass facility					
	9	9	63 51 62	Lyons Ferry	93
	7	7	63 51 63	Lyons Ferry	93
	7	7	63 56 39	Lyons Ferry	93
	3	3	63 56 40	Lyons Ferry	93
	1	1	No CWT (not adipose clipped)		
Minijacks (<30cm FL) fish sacrificed at the adult trap at LGR					
	2	2	05 32 9	Dworshak Hat. Spr ch	93
	1	1	05 35 35	Dworshak Hat. Spr ch	93
	2	2	10 30 39	Salmon R. Summ ch	93
	1	1	10 49 18	Salmon R. Summ ch	93
	1	1	10 49 19	Salmon R. Summ ch	93
	1	1	63 56 39	Lyons Ferry	93
Fish (40 total) with "lost" CWTs.					
	12	12	(6 with elastomers from Lyons Ferry).		
28		28	(19 with elastomers from Lyons Ferry)		
Fish (30 total) without CWTs recovered, but adipose clipped.					
	8	8	(2 with elastomers from Lyons Ferry)		
22		22	(12 with elastomer tags from Lyons Ferry)		
Fish with unreadable CWT (1 total).					
1		1	(elastomer from Lyons Ferry)		
Fish with BWTs (30 total).					
4		4	(1 was 1989 BY Lyons Ferry)		
	26	26	(2 were 1989 BY Lyons Ferry)		
Fish (106 total) that were not adipose clipped or CWT/BWT.					
	31	31	(18 fish were left or right ventral fin clipped)		
75		75	(35 fish were left or right ventral fin clipped)		
134	112	246			
	703		total of all fish from Lower Granite Dam		
2,256			Total of all fish that voluntarily returned to LFH		
		2,959	Grand total of fish processed		

APPENDIX B

LYONS FERRY FALL CHINOOK SALMON BROODSTOCK COLLECTION AND SPAWNING PROTOCOL 1995

Background

The designed production goal for fall chinook salmon at Lyons Ferry Fish Hatchery (FH) was 9,162,000 subyearling smolts released at 90 fish per pound (fpp). Production capabilities at Lyons Ferry FH are limited, however, because of low escapement of fall chinook salmon to the Snake River and the need to cull stray salmon from broodstock. The current production plan for Lyons Ferry FH is to release up to 900,000 yearlings at 10 fpp. This strategy provides the best survival potential, as subyearling releases have very low survival. Releases of yearling salmon at the hatchery and upstream of Lower Granite Dam would equal 450,000 each. Additional production of Snake River stock would be released as subyearlings at 80-120 fpp. Since inception of Lyons Ferry FH in 1984, average fall chinook salmon returns to the Snake River (measured by Ice Harbor Dam counts) is 5,677 salmon (adults and jacks).

Ice Harbor Trap Operations

Since the hatchery's inception, Washington Department of Fish and Wildlife (WDFW) personnel trapped fall chinook salmon at Ice Harbor Dam for broodstock. The University of Idaho operated the Ice Harbor trap in previous years, primarily under directive of the Snake River Fall Chinook Eggbank Program. The primary objective of the trapping program from 1984 to 1993 was collection of adults for direct contribution to Lyons Ferry broodstock. From 1990 to 1993 a related objective of the trap was to cull marked (adipose clipped) stray salmon from Snake River escapement, and to collect the 1989 brood salmon produced at Lyons Ferry Fh. The trap was not used for broodstock collection in 1994, nor will it be used in 1995, because contribution to broodstock has diminished substantially, and stray salmon are not effectively removed at the trap.

Lower Granite Trap Operations

The fall chinook salmon passage period at Lower Granite Dam is 18 August to 15 December. National Marine Fisheries Service (NMFS) operates an adult trap at the dam. To the extent possible, all wire-tagged or externally marked hatchery chinook salmon (adults, jacks, and minijacks) entering the trap from 15 August to 30 November will be collected for transport to Lyons Ferry FH. Trapping may continue after 30 November if marked salmon continue to arrive at the dam. Tagged salmon will be collected by NMFS, transported and subsequently processed by

WDFW. Salmon will be trapped, anesthetized, given numbered jaw tags, and transported in a 1,200 L aerated non-refrigerated tank truck, with water obtained from wells at Lyons Ferry FH. Some, or all, of the minijacks ($\leq$ 30 cm) may be killed when trapped, and frozen for later processing at Lyons Ferry FH.

Lyons Ferry FH Trapping

Salmon that volunteer to Lyons Ferry FH will be transferred to the holding pond at least three times a week, to reduce stress to fish. Volunteers will be held separately from salmon trapped at Lower Granite Dam. The hatchery will trap salmon from September until early or mid December.

Spawning Groups

All salmon at Lyons Ferry FH will be checked for the presence of wire tags. All salmon will receive unique numbers early in processing for identification and accounting. Salmon will be mated and accounted for in three distinct groups:

1) Marked and unmarked salmon that can not be confirmed as Lyons Ferry origin will be spawned together as "strays". Unless a fish has a wire tag in the snout (coded-wire tag - CWT or blank wire tag - BWT, or an elastomer tag behind the left eye, we will assume it is a stray). Salmon identified by CWT as not of Lyons Ferry origin will be included in this group. Fertilized eggs or fry from strays will be transferred to Klickitat FH or elsewhere for subsequent release outside the Snake River Basin.

2) Salmon with adipose clips and wire tags in the snout will have the CWT extracted and read prior to mixing of the gametes. However, salmon that are elastomer/filament tagged behind the left eye may be assumed to be of Lyons Ferry origin and their gametes used in matings prior to reading the CWT. CWTs would be read later to verify their origins. Salmon known to be of Lyons Ferry origin (excluding 1989 brood) will be spawned together and kept separate from other groups. Progeny from these matings will be retained at Lyons Ferry for subsequent Snake River releases.

3) Salmon with wire tags in the snout, but not adipose clipped, will have the wire tag (CWT or BWT) checked to verify they are from the 1989 brood (Lyons Ferry origin) prior to egg fertilization. Any fish with CWT and an adipose clip that are identified as being from the Lyons Ferry 1989 brood will be included with this group. Progeny from these fish may be used in supplementation or survival experiments upstream of Lower Granite Dam in 1996, or they may be shipped to Klickitat FH as strays.

Spawning Operations

Small males will be used in the spawning population to take advantage of genetic diversity and increase genetic contribution across all age classes. However, these fish will contribute to matings at a lower proportion than they exist in the hatchery population in 1995 because selectivity of downstream harvest (almost exclusively adults) and adult mortalities at downstream dams artificially inflates the proportion of jacks in Snake River returns. Also, under natural conditions jacks would usually not be expected to contribute to a high proportion of salmon matings.

Semen from both jack (males ≤50 cm) and adult males (>50 cm fork length) will be used for fertilizing eggs. We intend to take semen from a portion of the jacks and minijacks (≤50 cm) each week throughout the spawning season. Our primary interest in the use of jacks is for matings of known Lyons Ferry origin salmon. However, we will ensure jacks are used to some extent in other matings groups as well. The number of Lyons Ferry origin jacks from which semen will be taken during any week will based on the expected portion of the total females that spawn that week, as well as our goal of having jacks contribute to 10-25% of the known Lyons Ferry origin matings. This jack contribution goal would be reduced if the population in the hatchery consisted of few jacks. Conversely, the jack contribution rate would be increased substantially if few adult males were available. Semen will be collected from jacks without regard to fish size, and collected semen from jacks will be used randomly for matings each week. The jack contribution goal may be difficult to achieve logistically because small males continue to enter the population at the hatchery throughout the spawning season and the number of females of Lyons Ferry origin that are available may not be known until after some matings are complete each week.

We will use single pair matings, with a back up male whenever possible, for all salmon spawned. Our goal is to ensure that semen from as many different males (including jacks) is used for matings of known Lyons Ferry origin salmon. No male should be used more than once as the primary male. Fertilized eggs from each female confirmed to be of Lyons Ferry origin (1990-1992 broods) will be incubated in individual trays with chilled water. Eggs from other females may be pooled (eggs from several females in one incubation tray) within their respective matings groups. Eggs from the 1989 brood will be incubated on chilled water if possible, but chiller capacity is limited.

APPENDIX C

Lyons Ferry fall chinook salmon releases with number marked (adipose clipped), tagged (CWT), and unmarked by release year and type.

Release year Age (brood yr)	Release type[a]	Release 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.

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 C. continued (Revised 1991 release by barge and 1993 release years).

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[ol]	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	89[y]	108	1,044	9
			82,796	46/18	1,351	296	4,691	18
			31,901	47/09	494	493	3,289	10
			33,994[z]	47/06	244[z]	663	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	[z2]	139	3,509	11
			38,170	47/05	155	231	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
			51,702[B]	49/18	312		4,709	11
			51,702[B]	49/17	312		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
			51,091[F]	52/29	1,149		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 C. 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	
1996								
fry (95)	direct	3/1-31				83,183	186	500
yearling (94)	direct	4/9-12	196,820[M]	58/44	177		18,762	10.5
			207,087[M]	58/45	186		19,740	10.5
	Ice Harbor	4/8	3,230[M]	58/44 & 58/45	3		308	10.5
			407,137		366	83,183		
	Pittsburg	4/12-15	113,976[N]	57/12	65	258	11,108	10.3

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.

Appendix C. continued.

[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.
[M] 89.8% retained red elastomer behind left eye.
[N] 82.1% retained blue elastomer behind right eye.

APPENDIX D: PRELIMINARY RESULTS OF FERTILIZATION EXPERIMENTS

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
HATCHERIES PROGRAM
Snake River Lab
401 S. Cottonwood St.
Dayton, WA 99328
(509) 382-1005, FAX (509) 382-2427

January 4, 1996

TO: Butch Harty/John Kerwin

FROM: Glen Mendel

SUBJECT: PRELIMINARY RESULTS OF FERTILIZATION TESTS AT LFH IN 1995

I wanted to get a preliminary summary to you of the fertilization tests we conducted at lyons Ferry Hatchery in 1995. We pooled the eggs from 6 stray females and used semen from each of the same eight males for all tests conducted on Nov 14 &15. We repeated the experiments again on Nov 21 &22 with eggs from 5 females.

Please see the attached pages for the tests conducted and the results for Week One.

We have not run the statistical tests yet but our preliminary conclusion probably won't change much. We obtained the highest mean fertilization rates in 1995 for any frozen semen tests we have conducted at LFH. Fertilization rates with frozen semen just a few years ago averaged about 10-30%. This year the means were in the 50-72% range. We found little difference between the techniques, although the NBS technique produced slightly higher fertilization rates. There is a general trend for higher mean fertilization rates with more semen used. Fertilization rates declined slightly after one day of holding for fresh semen, but declined to about half or less for semen frozen after one day of holding. We also found fertilization improved with backup males and seemed to increase with a 60 second delay between males instead of a 30 second delay.

We repeated these experiments on November 21 and 22. Those results generally confirmed the experiments from the first week. However, we did notice that fertilization rates were generally lower the second week (because it was late in the spawning season?), and fertilization rates after one day of holding were about 40-50% those of the previous week after one day of holding.

We will complete the analysis this next year and distribute the results and conclusions. We appreciate your cooperation in allowing us to conduct these tests. We learned a great deal. Thank you.

gm:gm

cc: Schuck

/CRYO95.MEM

We conducted the following experiments to answer these questions at Lyons Ferry Hatchery in 1995:

1) **Is there a difference between mean fertilization rates using fresh semen and semen that had been frozen (cryopreserved) with our standard technique?**

Hypothesis: Ho: control = frozen

We used 2.5 times the recommended rate of semen (WSU recommendation for experimental fertilization) for the control and treatments, with no backup males use. This rate was kept constant for questions (experiments) 1-3 and it is still at, or below, standard hatchery practices at Lyons Ferry.

Results:	control	our treatment
Mean fertilization	96.6	64.8
Standard deviation	1.70	16.87
range	94.6-98.9	33.3-89.05

General conclusion: frozen semen has a lower fertilization rate

2) **Is there a difference between fertilization rates using fresh semen and semen that had been frozen with the National Biological Service technique?**

Hypothesis: Ho: control = frozen (NBS)

Results:	control	NBS treatment
Mean fertilization	96.6	66.0
Standard deviation	1.70	20.90
range	94.6-98.9	16.0-84.1

General conclusion: frozen semen has a lower fertilization rate

3) **Is there a difference among fertilization rates using two different methods of freezing semen (our technique and the National Biological Service technique)?**

Hypothesis: Ho: our method = NBS method

Results:	our method	NBS method
Mean fertilization	64.8	66.0
Standard deviation	16.87	20.90
range	33.3-89.5	16.0-84.1

General conclusion: little or no difference in fertilization rates between methods

4) **Is there a difference between fertilization rates obtained from using higher quantities of frozen semen with (our technique)?**

Hypothesis: Ho: our method 2.5 x rate = 5 times = 10 times

Results:	2.5 times	5 times	10 times
Mean fertilization	64.8	67.9	67.8
Standard deviation	16.87	19.23	16.59
range	33.3-89.5	31.5-91.5	31.2-82.3

General conclusion: general trend is better fertilization rates with more frozen semen, but not a lot of difference

5) **Is there a difference between fertilization rates obtained from using higher quantities of frozen semen with (NBS technique)?**

Hypothesis: Ho: NBS method 2.5 x rate = 5 times = 10 times

Results:	2.5 times	10 times
Mean fertilization	66.0	71.6
Standard deviation	20.9	19.14
range	16.0-84.1	27.5-88.3

6) **Is there a difference between fertilization rates obtained from using higher quantities of frozen semen with (NBS technique) or our technique ?**

Hypothesis: Ho: NBS method at various rates = our method at various rates

Results: See summaries in test 4 and 5 above.

General conclusion: general trend is better fertilization rates with more frozen semen, but not a lot of difference. NBS gives slightly better mean fertilization rates but it also has lower minimum rates.

The next set of tests basically repeat some of the first six experiments listed above, except they were done one day after the semen and eggs had been collected (conducted on Nov. 15). We did this because in the past we have found only minor differences in fertilization rates between fresh semen used the day of collection and one day later (if held with oxygen in a refrigerator). We are usually very busy on spawning days and it would be much more convenient to do our cryopreservation or fertilization experiments one day after spawning day.

7) **Is there a difference between mean fertilization rates using fresh semen and semen that was held for 1 day (not frozen)?**
Hypothesis: Ho: control fresh = control held 1 day

We used 2.5 times the recommended rate of semen (WSU recommendation for experimental fertilization) for the control and treatments, with no backup males used.

Results:	control	control held
Mean fertilization	96.6	88.9
Standard deviation	1.70	6.83
range	94.6-98.9	77.3-94.75

General conclusion: fresh semen held one day produces lower fertilization rates, but still at very acceptable level after one day.

8) **Is there a difference between mean fertilization rates using fresh semen (held 1 day) at 2.5 times the recommended rate and 5 times the rate?**
Hypothesis: Ho: control (2.5 times) = control (5 times)

We used 2.5 times the recommended rate of semen (WSU recommendation for experimental fertilization) for the control and treatments, with no backup males used.

Results:	control (2.5)	control (5 times)
Mean fertilization	88.9	85.1
Standard deviation	6.83	7.19
range	77.3-94.7	73.5-93.0

General conclusion: slight or no difference

9) **Is there a difference between mean fertilization rates using frozen semen (our technique at 2.5 and 5 time recommended rates) and semen that was held 1 day before being frozen (our technique at 2.5 and 5 times the rate)?**

Hypothesis: Ho: frozen day 0, 2.5 = frozen day 1 at 2.5 times rate
Hypothesis: Ho: frozen day 0, 5 = frozen day 1, at 5 times rate
Hypothesis: Ho: frozen 2.5 times = frozen 5 times rate

Results:

	Day 0		Day 1	
	2.5 rate	5 rate	2.5 rate	5 rate
Mean fertilization	64.8	67.9	32.9	35.7
Standard deviation	16.87	19.23	16.29	10.93
range	33.3-89.0	31.5-91.5	6.1-58.9	20.7-50.5

General conclusion: fertilization rates after one day hold before freezing are about half of those frozen the day of collection. Also, fertilization rates are slightly higher at the 5 times rates.

We also wanted to test if a backup male really makes a difference in fertilization rates, and we wanted to evaluate the 30 and 60 second delays for adding semen from the second male as used in WDFW spawning protocols. We used 2.5 times the recommended semen rate for all tests, and all semen and eggs had been held 1 day prior to freezing with our method.

10) **Is there a difference between fertilization rates using frozen semen with no backup male vs with a backup, and between 30 and 60 second delay between addition of the semen from a backup male?**

Hypothesis: Ho: w backup male = w/o backup
Hypothesis: Ho: 30 sec delay = 60 sec delay

Results:

	30 sec delay		60 sec delay	
	backup	no backup	backup	no backup
Mean fertilization	35.0	20.1	39.1	25.1
Standard deviation	13.70	13.83	12.44	9.78
range	14.7-57.8	6.5-48.8	21.8-62.2	11.9-37.7

General conclusion: with backup is higher than without, 60 second delay produces slightly higher fertilization rates.

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 (1987-1993 broods).

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 1993	1992	1991	1990	1989	1988	1987
1993[a]	male				**68.8** (5.89) 42[b] 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[a]	male		**44.7** (3.92) 134 36-54		**87.0** (7.16) 27[b] 69-101	**86.0** (12.13) 16 61-105		
	female				**81.0** (4.41) 67 71-90	**85.6** (4.08) 44 71-92		
1995	male		**64.4** (8.03) 180 46-87		**101.6** (6.69) 8 87.5-107	- (-) 1 104.0		
	female		**67.8** (4.44) 79 54-78		**101.6** (5.51) 19 82-102	**104.0** (2.08) 3[c] 84-88		

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

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 1993	1992	1991	1990	1989	1988	1987
1993[a]	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[a]	male		35.0 (2.89) 241[b] 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[b] 58-86		80.5 (7.96) 10 67-92	
1995[d]	male	35.4 (2.40) 1782 22-47[e]	55.4 (4.97) 230 41-71.5	75.8 (8.62) 26 51-90	76.8 (10.60) 122 57-105			
	female	-- (-) 1 75.0	61.4 (3.82) 14 56-68	75.0 (5.75) 53 60-90	75.1 (5.93) 175 54.5-95		-- (-) 1 80.0	

[a] Includes BWTs.
[b] Plus one fish with no length measurement.
[c] Plus two fish with no length measurement.
[d] Plus 37 males and 3 females of Lyons Ferry origin with elastomers, but without CWTs or BWTs (includes 27 fish killed at LGR).
[e] Plus 4 fish with no length measurements. One fish of the 1,782 was recorded as 72 cm.

APPENDIX F

Table 1. Detection of visual tags (VT - red filament, or red or yellow elastomer tags) in the clear tissue behind the left eye of returning adult or jack fall chinook salmon at Lyons Ferry Hatchery, 1994.

Tag type CWT code	% released with VT	# CWTs recovered	# VTs detected	number without VT	% with VT
Red Filament (1990 brood)					
63-42-09	50.4	21	2	19	9.5
63-43-20	49.4	0	0	0	0.0
63-41-18	49.7	46	14	32	30.43
63-40-12	49.6	3	1	2	33.33
63-42-10	51.7	22	11	11	50.0
63-41-20	49.8	45	10	35	22.2
63-40-13	49.8	4	0	4	0.0
Red Elastomer (1991 brood)					
63-46-58	90.4	19	18	1	94.74
63-46-61	91.0	26	21	5	80.77
63-46-55	88.4	13	10	3	76.92
63-46-62	96.0	17	14	3	82.35
63-47-06	94.2	14	13	1	92.86
63-46-56	95.0	20	18	2	90.0
63-47-03	90.3	15	13	2	86.87
Red Elastomer (1992 brood)					
63-52-24	97.5	37	26[a]	11	70.27
63-49-20	97.5	14	13[b]	1	92.86
63-49-18	96.0	22	17	5	77.27
63-49-17	96.0	12	8[c]	4	66.67
63-49-15	96.8	11	9[d]	2	81.82
63-49-12	96.8	30	20	10	66.67
Yellow Elastomer (1992 brood)					
63-47-63	93.0	19	5	14	26.32
63-47-60	96.2	21	13[e]	8	61.90
63-52-29	95.2	22	10[f]	12	45.45
63-52-27	94.4	18	8	10	44.44
63-47-58	94.4	20	11	9	55.00
63-52-63	96.1	15	8	7	53.33
63-50-12	0.0	135	8[g]	127	5.9
63-46-60	0.0	1	1[h]	0	

Plus 7 left red and 2 left yellow from fish with lost CWTs or no CWTs recovered.

[a] Includes one fish recorded as left yellow.
[b] Includes two fish recorded as left yellow.
[c] Includes three fish recorded as left yellow.
[d] Includes one fish recorded as left yellow.
[e] Includes two fish recorded as left red.
[f] Includes one fish recorded as left red.
[g] Includes one left red and seven left yellow. This tag code was not to be visual tagged.
[h] Includes one left yellow. This tag code was not to be visual tagged.

Appendix F, continued.

Table 2. Detection of visual tags (VT - red filament, or red or yellow elastomer tags) in the clear tissue behind the left eye of returning adult or jack fall chinook salmon at Lyons Ferry Hatchery, 1995.

Elastomers CWT CODE	Number of CWTs recovered	Number with VT	% retention at release	% retention at recovery	Comments
42/09	13	5	50.4	38.46	filaments
43/20	1	0	49.4	0.00	filaments
41/18	13	5	49.7	38.46	filaments
40/12	1	1	49.6	100.00	filaments
42/10	4	2	51.7	50.00	filaments
41/20	20	7	49.8	35.00	filaments
40/13	2	1	49.8	50.00	filaments
46/58	28	23	90.4	82.14	
46/61	16	14	91	87.50	
46/55	26	22	88.4	84.62	
46/62	30	26	96	86.67	
47/06	12	9	94.2	75.00	1 unk
46/56	26	21	95	80.77	
47/03	17	16	90.3	94.12	
52/24	27	20	97.5	74.07	2 LY
49/20	16	15	97.5	93.75	
49/18	16	13	96	81.25	2 LY
49/17	11	7	96	63.64	1 LY
49/15	23	17	96.8	73.91	
49/12	29	20	96.8	68.97	
47/63	30	20	93	66.67	5 LR YELLOW
47/60	17	12	96.2	70.59	3 LR YELLOW
52/29	22	14	95.2	63.64	5 LR YELLOW
52/27	20	12	94.4	60.00	2 LR YELLOW
47/58	21	18	94.4	85.71	3 LR YELLOW
52/63	12	10	96.1	83.33	1 LR YELLOW
56/40	298	269	91.9	90.27	
51/63	459	423	95.9	92.16	
56/39	456	423	95.5	92.76	1 LY, 1?
51/62	572	531	92.8	92.83	2 ?