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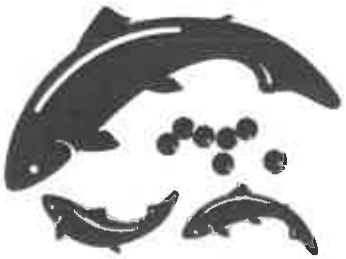
LYONS FERRY FALL CHINOOK SALMON HATCHERY EVALUATION PROGRAM



LOWER SNAKE RIVER
COMPENSATION PLAN
Hatchery Program

Washington Department of Fisheries
1990 Progress Report

AFF 1/LSR-91-15

LOWER SNAKE RIVER COMPENSATION PLAN

LYONS FERRY FALL CHINOOK SALMON HATCHERY PROGRAM

1990 EVALUATION REPORT

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Cooperative Agreement 14-16-0001-90525

ABSTRACT

This report provides a synopsis of activities from 1 April 1990 to 31 March 1991 by the Washington Department Fisheries' Lower Snake River Hatchery Evaluation Program. This work was completed with Fiscal Year 1990 funds provided by the U. S. Fish and Wildlife Service under the Lower Snake River Fish and Wildlife Compensation Plan (LSRCP). In this report we describe the fall chinook salmon program at Lyons Ferry Fish Hatchery (FH), and related natural production in the Snake River. Mandated adult return objective for this hatchery is 18,300 fall chinook salmon, Snake River stock, back to the LSRCP project area (past Ice Harbor Dam).

Fall chinook salmon escapement to Lyons Ferry FH in 1990 was 1,795 adults (age 3+) and 851 jacks. Fish were obtained from three sources, voluntary returns to the FH ladder, and fish trapped at both Ice Harbor and Lower Granite Dams for transport to Lyons Ferry FH. We obtained 1,092 adults from trapping operations at Ice Harbor Dam, 49 adults and 94 jacks from Lower Granite Dam, and 521 adults and 602 jacks through rack returns. This was the first year broodstock were collected adults at Lower Granite Dam; we collected only coded-wire tagged (CWT) salmon, primarily to ascertain stray rates.

Preliminary CWT recovery analysis indicates no consistent difference between the on-station and transported release groups in returns to the LSRCP project area and fisheries' contribution. This pertains to both subyearling and yearling categories. To date, yearling release groups have survived better than the subyearlings, regardless of release location. The 1984 brood had 0.32- 0.35% escapement to the LSRCP project area, and 0.53- 0.61% contributed to high seas and Columbia River fisheries, for a total survival rate of 0.85- 0.96% through age 6. The 1985 brood rate of return to the project area was 0.08- 0.78%, depending upon release type. On-station release groups performed better--both for subyearling and yearling releases. Conversely, transported groups survived better for the 1986 brood; return rates were 0.06- 0.43%. Return rates of age 3 fish were 0.00-0.07%. These survival rates are preliminary and will be updated in future reports.

Analysis of CWT recoveries from salmon spawned at Lyons Ferry FH indicated a significant stray rate of other Upriver Bright fall chinook salmon stocks to Lyons Ferry FH in 1990. Broodstock collected from Ice Harbor Dam had a 32% incidence of strays. Those collected at Lower Granite had a 25% stray rate. Stray fish comprised 16% of voluntary returns to Lyons Ferry FH. In all locations, salmon released from Umatilla River comprised the majority of the strays. We read CWT of all marked fish prior to spawning: only verified Snake River salmon were used for

broodstock. The resultant eggtake was 1,035,000. Progeny from all stray and unmarked salmon were transferred to Klickitat FH (2,039,000 eggs total).

Fall chinook salmon were spawned at Lyons Ferry FH from 20 October to 8 December. Peak of spawning was 6 November. Lyons Ferry FH staff planted 436,353 yearling (1988 brood) fall chinook salmon in April 1990; all were marked (CWT and adipose-clip). In June and July 1990, 3,043,756 subyearling (1989 brood) fall chinook salmon were released; all were marked with either a CWT or blank-wire tag but no adipose clip. The 1989 brood is progeny of parentage with a 43% stray rate; all were marked to allow identification of that group upon return. We differentially marked (CWT) representative groups of the yearling and subyearling groups for release on-station and for transport below Ice Harbor Dam for release. On-station releases were coordinated with spill at Lower Monumental Dam. Travel time of the subyearling on-station release group from Lyons Ferry FH to McNary Dam ranged from 6.1 to 6.5 km/day, slower than the 1986-1989 average of 7.08 km/day.

We provide an analysis of historical and current electrophoretic data on Snake River stock fall chinook salmon, and its relation to other Columbia Basin fall chinook salmon stocks. Changes in several allele frequencies, notably sSOD-1*, sIDHP-1,2*, and PEPA*, are noted from the early stages of the Egg Bank Program (1977) to present returns (which includes stray fish). These changes indicate introgression from mid-Columbia fall chinook salmon. However, allele frequencies of verified 1990 Lyons Ferry FH salmon (with strays removed), were significantly different ($p=0.00002$) from the mid-Columbia collections. This indicated the effects of straying are mitigated by restricting broodstock to known Lyons Ferry salmon.

We monitored natural spawning in all streams upriver of Lower Granite Dam believed to be used by fall chinook salmon adults. Spawning ground counts in the Clearwater, Grande Ronde, Imnaha, and mainstem Snake Rivers in 1990 totaled 5, 1, 3, and 37 redds, respectively. After broodstock collections at Lower Granite Dam, 342 adults passed the dam, providing an adult-to-redd ratio of about 7. We found 61 fall chinook salmon redds in lower Tucannon River, which is the highest on record (6.6 redds/km). We recovered CWT from nine marked carcasses; eight were from six separate releases from Lyons Ferry FH, one was from the Umatilla River.

We provide nine recommendations to improve broodstock management, spawning, rearing, and release strategies at Lyons Ferry FH.

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ACKNOWLEDGEMENTS

Many people within the Washington Department of Fisheries (WDF) Salmon Program and Planning, Research, and Harvest Management Program contributed to this hatchery evaluation. Among those who make this project work are: Andy Appleby, Lee Blankenship, Kent Dimmitt, Rich Eltrich, Bob Foster, Howard Fuss, Mark Kimbel, Bill Koss, Anne Marshall, Larry Peck, John Schandl, and Paul Seidel.

Tom Cooney spent considerable time and effort in analysis of coded-wire tag recoveries within the Snake River Basin, and provided many constructive insights into survival rates. Bill Hopley and Kathy Hopper lead the difficult process of broodstock separation and coded-wire tag reading during spawning at Lyons Ferry FH. Hatchery managers Carl Ross and Ted Parks were receptive and cooperative in all aspects of research at Lyons Ferry.

Fish culturists Jeri Fulbright, Steve Harris, Steve Henry, Wendy Nieman-Campbell, Jason Mings, and Byron Wenning helped in many aspects of operations and research. Tamara Black and Larrie LaVoy of WDF contributed substantially to both operations and research at Lyons Ferry FH. Gary Thorgaard and Paul Wheeler of Washington State University instructed us on gamete crypreservation and evaluation.

Electrophoretic analyses were done by members of the WDF Genetics Unit--Craig Busack, Anne Marshall, Steve Phelps, Jim Shaklee, and Sewell Young. Jim Shaklee is to be particularly thanked for the comparison of historical genetic records presented in Table 21. Electrophoretic data on early collections at Ice Harbor Dam, Hanford Reach, and both Lyons Ferry and Priest Rapids Hatcheries were supplied by David Teel of National Marine Fisheries Service (NMFS). Bill Ingram, Larry LeClair, and Norm Switzler of WDF scored the gels for the 1990 analyses.

Randy McIntosh of WDF and Tammy Froscher of U.S. Fish and Wildlife Service (USFWS) provided help through their administration of the state and federal Conservation Corps programs, respectively. We used these programs extensively.

Jerry Harmon and crew at the NMFS trap at Lower Granite Dam were always responsive to our needs--often with limited notice. Their contribution to this program is significant.

Tamara Black, Bob Foster, Bill Hopley, Kathy Hopper, Larrie LaVoy and Anne Marshall of WDF and Dan Herrig of USFWS provided constructive criticism of the manuscript.

Ed Crateau and Dan Herrig of the U.S. Fish and Wildlife Service (USFWS) once again bent over backwards to provide logistical, technical, and financial support for this program. The success of this program is, in many ways, a result of their effort.

This study was funded by the USFWS through the Lower Snake River Compensation Plan.

LOWER SNAKE RIVER COMPENSATION PLAN
LYONS FERRY FALL CHINOOK SALMON HATCHERY PROGRAM
1990 EVALUATION REPORT

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 and is currently under operation. A partial objective of this hatchery is to compensate for the loss of 18,300 adult fall chinook salmon, Snake River stock (USACE 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 objectives.

The Washington Department of Fisheries (WDF) has identified two broad-based goals in its evaluation program: 1) monitor hatchery practices at Lyons Ferry FH to ensure quality smolt releases, high downstream migrant survival, and sufficient contribution to fisheries with escapement to meet the LSRCP compensation goals, and 2) gather genetic information which will help maintain the integrity of Snake River Basin chinook salmon stocks (WDF 1991). A specific list of the evaluation program's objectives is outlined in Appendix A.

In June 1991, the National Marine Fisheries Service (NMFS) concluded that Snake River fall chinook salmon face a high risk of extinction if factors affecting the population remain unchanged (Waples et al. 1991). Specific factors include, but are not limited to: 1) spatial and temporal abundance in relation to historical records, 2) possible threats to genetic integrity, and 3) natural and anthropogenic factors that affect survival and abundance, both short-term and indefinitely. Their use of a stochastic model predicted a high likelihood of extinction if present conditions continue. This conclusion was prompted by a substantial review of the status of this stock for inclusion as "threatened" or "endangered" under the U.S. Endangered Species Act (ESA) of 1973 as amended (U.S.C. 1531 *et seq.*).

This report summarizes all activities performed by the Washington Department of Fisheries' LSRCP fall chinook salmon evaluation program for the period 1 April 1990 through 31 March 1991. This report also provides some historical information on Snake River fall chinook salmon where germane to the evaluations program or to the potential recovery plan for fall chinook salmon under the ESA. A report on the WDF spring chinook salmon evaluation program during the Fiscal Year (FY) 1990 contract period is published separately (Bugert et al. 1991).

1.2: Description of Facilities

Lyons Ferry FH is located at the confluence of Palouse River with lower Snake River at river kilometer (RK) 90 (Lower Monumental Pool, Figure 1). Design capacity for the fall chinook salmon program is 101,800 pounds (9,162,000 subyearling smolts at 90 fish per pound). Lyons Ferry FH has a single pass wellwater system through the incubators, two adult holding ponds, and 28 raceways. Salmon[1] are hatched and reared at Lyons Ferry FH and either released on-station or barged downstream of Ice Harbor Dam and released. Adult salmon return to the fish ladder at Lyons Ferry FH and, during these initial years of broodstock establishment, are trapped at Ice Harbor and Lower Granite Dams and transported to Lyons Ferry FH to supplement the voluntary returns. The first year of adult (3+ year old) returns to the hatchery was 1986.

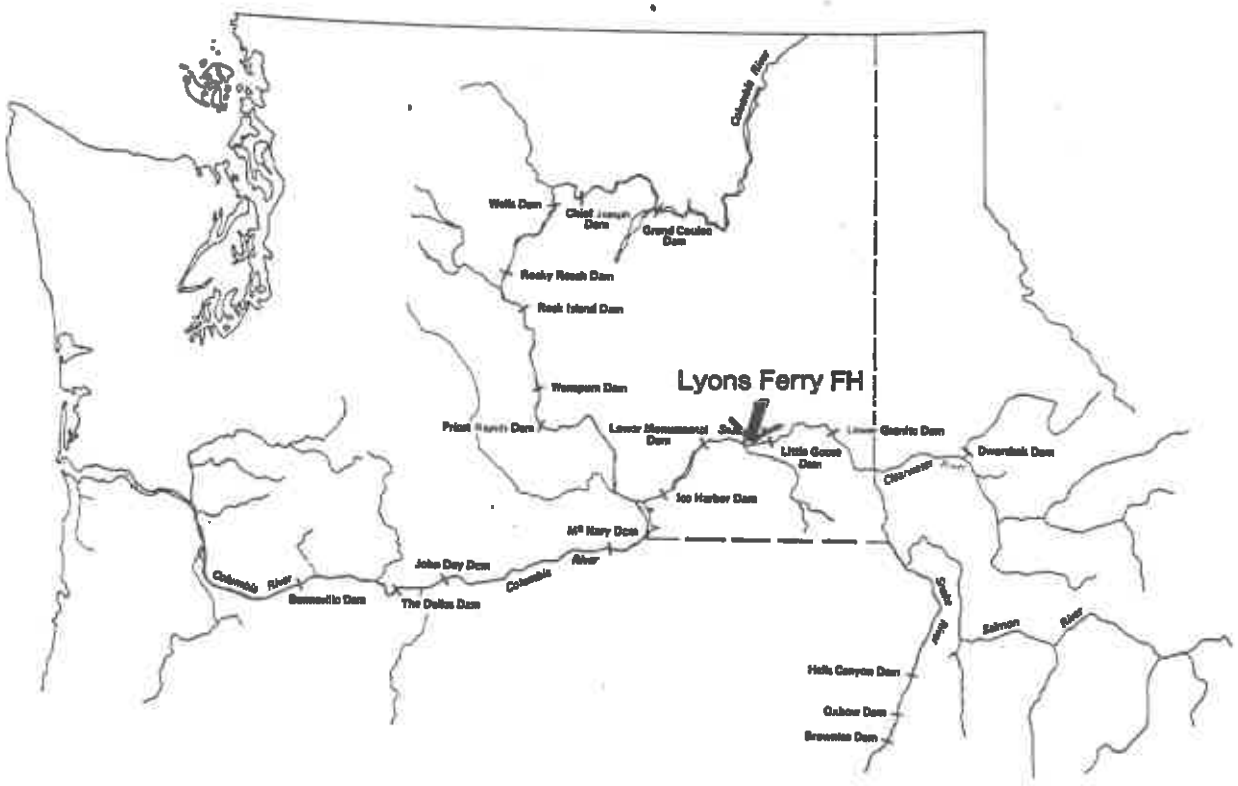

Figure 1. Lower Snake River Basin, showing location of Lyons Ferry Fish Hatchery.

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[1] *To ease reader burden, the term "salmon" refers to Snake River stock fall chinook salmon, unless otherwise noted.*

SECTION 2: BROODSTOCK MANAGEMENT

2.1: Broodstock Collection

Lyons Ferry FH has been building its broodstock since the facility was completed in 1984. Salmon are obtained from two primary sources: 1) returns to the Lyons Ferry FH ladder, and 2) adults trapped at Ice Harbor Dam for transport to Lyons Ferry FH (Bugert and Hopley 1991). Since its inception, Lyons Ferry FH broodstock collection from these two sources has averaged 37% of total escapement to the project area (past Ice Harbor Dam, Figure 2). An ancillary source of broodstock in 1990 was the NMFS upstream migrant trap at Lower Granite Dam (Section 2.1.3).

During the period 1984- 1986, eyed eggs were transported from Kalama Falls FH to Lyons Ferry FH, done as part of the Snake River Egg Bank Program. In these initial years of operation, the eggbank program provided 25% to 62% of production at Lyons Ferry FH (Bugert and Hopley 1989). Hagerman National Fish Hatchery released salmon in the Snake River upstream of Lower Granite Dam from 1979 to 1985; some of these returns were trapped at Ice Harbor Dam for Lyons Ferry FH broodstock. From 1984 to 1990, an average of 91.3% (range: 80- 100%) of adult broodstock were obtained from Ice Harbor Dam; 8.7% were collected as hatchery volunteers (range: 0- 20%).

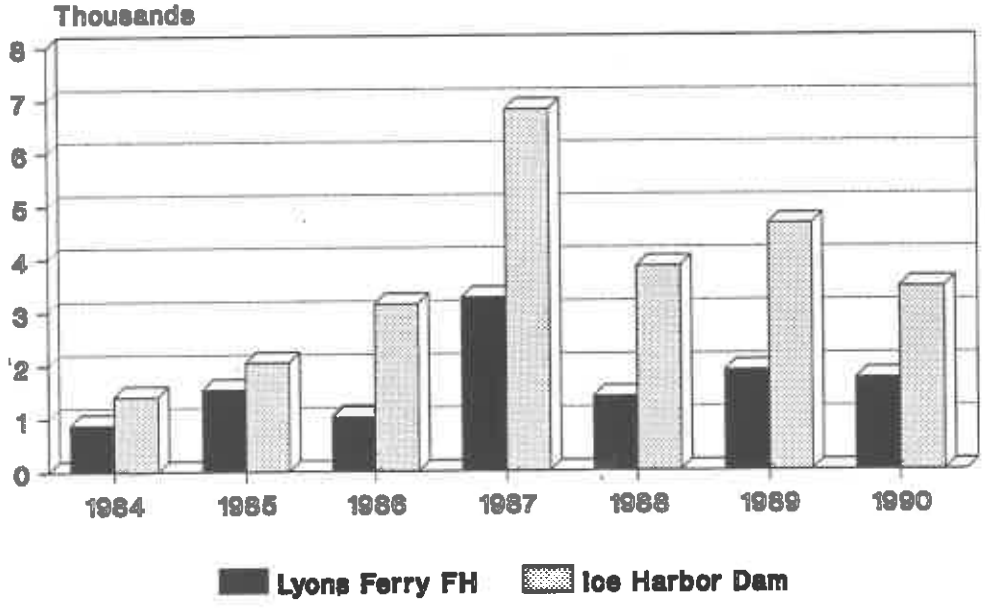

Figure 2. Comparison of fall chinook counts at Ice Harbor Dam with escapement to Lyons Ferry Fish Hatchery, 1984- 1990.

2.1.1: Returns to Lyons Ferry Fish Hatchery

In general, numbers of salmon returning to the Lyons Ferry FH ladder vary yearly with run size at Ice Harbor Dam. A total of 521 adults and 602 jacks[1] returned to Lyons Ferry FH in 1990. Duration of returns was 71 days, compared to the 1986- 1989 average of 84 days; duration has changed little since 1986, yet the peak of returns has varied (Tables 1, 2). The mechanical crowder at the hatchery ladder broke in early November, which prevented us from collecting some volunteers at that time.

Table 1. Voluntary returns of fall chinook salmon to Lyons Ferry Fish Hatchery, duration of returns, and peak day of returns from 1986 through 1990.

	Number of returns		Duration of	Peak return day	
Year	adults	jacks	returns	date	number
1986	245	1,125	5 Sep - 15 Nov	18 Sep	24
1987	1,645	543	18 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

2.1.2: Ice Harbor Dam trapping

Since 1977, returning adult fall chinook salmon have been trapped at Ice Harbor Dam and transported to Dworshak and Tucannon FH in conjunction with the Snake River Fall Chinook Egg Bank Program (Bugert and Hopley 1989). Since its completion in 1984, Lyons Ferry FH has been receiving the transported salmon (Table 3). Over the 14-year period, numbers of fish transported have averaged 638 adults (range: 212- 1,613) and 52 jacks (range: 0- 150). Since inception of Lyons Ferry FH in 1984, an average of 27.3% of adults counted at Ice Harbor Dam have been taken for broodstock. In 1990, 1,092 adults were trapped and hauled to Lyons Ferry FH (Bugert and Hopley 1991), representing 31.7% of the total run of fall chinook salmon adults past Ice Harbor Dam for that year (Table 2). Actual trap efficiency for the period of operation, however, was 41.6%. Fish were collected on only the south shore ladder at the dam, where 84.8% of fall chinook salmon were counted in 1990.

[1] *Throughout this report, jacks collected in trapping operations and returns to the hatchery rack were distinguished by size, and in some cases our estimates were revised when coded-wire tag or scale data became available. The length criterion for jacks collected at Ice Harbor Dam and Lyons Ferry FH was 61 cm, the length criterion at Lower Granite Dam was 55 cm.*

Table 2. Contribution of 1984- 1990 fall chinook salmon returns to Lyons Ferry Fish Hatchery (FH) from Ice Harbor Dam, Kalama Falls FH, to the Lyons Ferry FH ladder, and from Lower Granite Dam. Values are compared to the total count at Ice Harbor Dam.

Year	Collection point	Number collected adults	Number collected jacks	Ice Harbor Dam count adults	Ice Harbor Dam count jacks
1984	Lyons Ferry FH	0	0	1,410	642[a]
	Ice Harbor Dam	663	97		
	Kalama Falls FH	220	10		
1985	Lyons Ferry FH	6	4,070[b]	2,046	7,119
	Ice Harbor Dam	589	90		
	Kalama Falls FH	952	0		
1986	Lyons Ferry FH	245	1,125	3,152	2,665
	Ice Harbor Dam	212	23		
	Kalama Falls FH	576	0[c]		
1987	Lyons Ferry FH	1,654	543	6,812	1,619
	Ice Harbor Dam	1,613	47		
1988	Lyons Ferry FH	327	1,053	3,847	2,035
	Ice Harbor Dam	1,076	6		
1989	Lyons Ferry FH	704	670	4,638	1,352
	Ice Harbor Dam	1,179	0		
1990	Lyons Ferry FH	521	602	3,447	1,839
	Ice Harbor Dam	1,092	0		
	Lower Granite Dam	49	0		

[a] *Classification of adults and jacks is based upon size only.*

[b] *The first release from Lyons Ferry FH was in 1985 (1983 brood); first returns of hatchery-reared stock to Lyons Ferry FH were age 2 jacks in 1985.*

[c] *The last year adults returned to Kalama Falls FH was 1986.*

Table 3. Numbers of fall chinook salmon trapped at Ice Harbor Dam and hauled to Lyons Ferry Fish Hatchery, duration of trapping, and peak day of trapping from 1984 through 1990.

Year	Number trapped adults	Number trapped jacks	Duration of trapping	Peak trapping day date	Peak trapping day number
1984	663	97	1 Sep - 5 Oct	11 Sep	57
1985	589	90	31 Aug - 30 Sep	9 Sep	68
1986	212	23	4 Sep - 3 Oct	18 Sep	24
1987	1,613	47	2 Sep - 11 Oct	26 Sep	97
1988	1,076	6	3 Sep - 11 Oct	15 Sep	67
1989	1,179	0	2 Sep - 11 Oct	26 Sep	78
1990	1,092	0	4 Sep - 6 Oct	12 Sep	100

2.1.3: Lower Granite Dam trapping

Adult collections At our request, NMFS trapped about 50% of coded-wire tagged adults reaching Lower Granite Dam from 5 September to 14 November 1990. Adults were given a numbered jaw tag and immediately transported in a 1,200 L aerated non-refrigerated tank truck to Lyons Ferry FH. From 5 September to 14 November, 49 adults were collected (Bugert and Hopley 1991). This enabled us to: 1) monitor adult composition at the dam, which had not been done in previous years, 2) collect fish for a spawning program designed to remove marked stray salmon, and 3) supplement Lyons Ferry FH eggtake. Coded-wire tags were read during spawning at Lyons Ferry FH (Section 2.2.2).

Analysis We used 1990 coded-wire tag (CWT) recovery data to estimate the historical run composition in the Snake River spawning grounds above Lower Granite Dam. This estimate was based upon the ratio of: 1) Lyons Ferry, Umatilla, and "Other" CWT recoveries from Lower Granite Dam to 2) CWT recoveries from Ice Harbor Dam and Lyons Ferry FH volunteers. This ratio was then used to estimate percentage of fish from the three sources in the run past Lower Granite Dam in earlier years (Table 4). Contribution of Hagerman FH (Egg Bank Program) returns was based on CWT recoveries during that period.

During the period 1983 to 1990, an average of 49.9% (range: 21%- 77%) of the adult salmon run to Lower Granite Dam was comprised of hatchery fish of various origins. On average, 84.8% of the hatchery run was comprised of progeny derived through Snake River stock (either Hagerman or Lyons Ferry FH).

Table 4. Estimates of stock composition of fall chinook salmon at Lower Granite Dam, 1975- 1990, based on 1990 coded-wire tag recoveries. The 1990 dam count is after removal of 49 fish for Lyons Ferry FH broodstock.

Year	Adult dam count	Lyons Ferry	Hagerman	Umatilla	Other	Natural	Percent hatchery
1975	1,000					1,000	0
1976	470					470	0
1977	600					600	0
1978	640					640	0
1979	500					500	0
1980	450					450	0
1981	340					340	0
1982	720					720	0
1983	540		112			428	21
1984	640		310	6		324	49
1985	691		241	12		438	37
1986	784	64	261	5	5	449	43
1987	951	575	69	43	11	253	73
1988	627	192	9	49	9	368	41
1989	706	206		158	47	295	58
1990	336	174		77	6	78	77

Jack collections At our request, NMFS trapped roughly half the marked (CWT) jacks from 30 August to 12 November 1990. Ninety-four marked jacks were collected and processed (Bugert and Hopley 1991). Techniques were similar to that of previous years. Marked jacks have been sampled at Lower Granite Dam since 1985, except 1989. The objective of this operation was to determine composition of stray salmon to the mid-Snake River (Section 2.2).

Analysis For 1985- 1988 we assumed 50% jack sampling and 100% trapping efficiency; for 1990 we assumed 100% sampling with 90.8% trapping efficiency[1]. Stray jacks documented at Lower Granite Dam are less diverse than strays into the broodstock, but the two major stray sources into the broodstock (Umatilla and Bonneville) are predominant among jacks as well (Table 5). The earliest record of Umatilla jack straying is 1986, whereas adult strays first appeared in Lyons Ferry FH broodstock in 1984.

Table 5. Stock composition of jack fall chinook salmon at Lower Granite Dam from 1985 to 1990, estimated by coded-wire tag recoveries. Values are expanded counts (with percent of total). Jacks were not trapped in 1989.

Year	Jack[a] dam count	Stock origin			
		Snake	Umatilla	Other	Natural
1985	2,530	218 (8.6%)	0	0	2,312 (91.4%)
1986	1,307	746 (57.2%)	28 (2.1%)	24[b] (1.8%)	509 (38.9%)
1987	936	260 (27.8%)	0	4[c] (0.4%)	672 (71.8%)
1988	329	49 (14.9%)	0	0	280 (85.1%)
1990	388	94 (24.2%)	4 (1.0%)	58[d] (15.0%)	232 (59.8%)

[a] *Counts include jacks and minijacks (fork length 55 cm or less) counted from 18 August to 15 December.*

[b] *Twenty-two Trinity spring chinook and two Trinity fall chinook salmon.*

[c] *Bonneville fall chinook salmon.*

[d] *Imnaha summer chinook salmon minijacks.*

[1] *Jerry Harmon, National Marine Fisheries Service, Route 3, Box 53, Pomeroy, WA 99347.*

2.2: Stray Fish Management

2.2.1: Stray fish from 1981 to 1989

Procedures A fairly extensive CWT data base is available on fall chinook salmon recovered in Snake River through the Eggbank Program, jack trapping operations at Lower Granite Dam, and routine recoveries at Snake River hatcheries and spawning grounds. Recovery data were not available from some locations; some expansions are adjusted to compensate for these data gaps. Tags from the Eggbank Program were recovered at Dworshak FH, but none were recovered at Tucannon FH. Between 1981 and 1983, tags were recovered only at Hagerman FH.

Coded-wire tags were recovered from fish collected at Ice Harbor Dam, Kalama Falls FH (through 1986), and Lyons Ferry FH volunteers. We analyzed CWT expansions by brood year (determined by scales) and stock for recoveries at Lyons Ferry FH from 1984 to 1989 (Appendixes B, C, D). During that period, fish were not identified by collection source, hence site-specific stray rates cannot be calculated. Site-specific stray rates were calculated in 1990, and are discussed in Section 3.2. Expansions are presented both as fish counts and as the proportion each stock comprises of the total fish present in each brood year. All fish count data are from WDF unpublished reports[1]. Fish not accounted for by exotic tags are considered to be Snake River origin. Expansions were calculated separately for each tag group (with a few exceptions, noted later), assuming 100% sampling and without any calculations for tag loss (Appendix D). National Marine Fisheries Service passage study tags were ignored because the source of fish for these studies was unknown.

Analysis We noted a steady increase in percentage of stray salmon used for broodstock at Lyons Ferry FH since its inception in 1984. Recent analyses of CWT recoveries from the Snake River Eggbank Program show an incidence of strays at an earlier date. Coded-wire tagged salmon began appearing in 1981 in collections at Ice Harbor Dam. In 1984, the first year of Lyons Ferry FH operations, tags with origin other than Snake River began to appear in the broodstock.

Although much attention has lately been focused on strays from the Umatilla program, there have been several other sources of strays into Lyons Ferry FH. The most common of these is Bonneville FH, a low-level source of nearly continuous strays. Strays at low levels have also been common from the Social Security Lake and Rock Creek net pen studies (1985- 1987; Nelson et al. 1987) in John Day pool, the ultimate source being Little White Salmon FH. Little White Salmon FH releases into Yakima River have also been recovered at Lyons Ferry FH. Trinity River (California) FH chinook salmon, both spring and fall, have also

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[1] *Various contributors, Washington Department of Fisheries, Battle Ground, WA 98604.*

appeared at the hatchery, also in fairly low numbers. The appearance of these fish is quite common in Columbia Basin, despite their remote source. Spring chinook salmon from Lookingglass FH appeared one year, as did a putative spring chinook salmon from a transport group.

Two curious recoveries are tags from Washougal FH (one tag in 1985, 1983 brood) and Klickitat FH (one tag in 1986, 1981 brood). Washougal FH is a lower Columbia River hatchery releasing tule[1] falls, and Klickitat FH also released tules from 1980 to 1983. Tules released far downriver would not be expected to stray as far upstream as Snake River. One other incident of tule strays also occurred: Umatilla 1981 brood, recovered in 1984. The Umatilla program now releases only brights[1], but initially released tules.

Only three Priest Rapids FH tags, which would be clear evidence of mid-Columbia straying (or "dip-in" capture at Ice Harbor Dam) have appeared at Lyons Ferry FH, one in 1988 and two in 1989. Expansion of Priest Rapids tags is problematical. Using straightforward expansion by tag lots, two of these each expand to two fish, and one (1986 brood recovered in 1989) expands to 25. However, Priest Rapids tags can also considered as tags for the entire mixed hatchery and natural production of the Hanford Reach (mid-Columbia area). Expansions can then be done based on the adult marked/unmarked ratio for the entire mid-Columbia River production. Using similar reasoning, a case can also be made for expanding some NMFS passage study tags, since based on production differences between Snake and mid-Columbia Rivers, a randomly captured salmon outmigrant is very likely to have come from the mid-Columbia River. We have not used this approach on NMFS tags, however, because it could also be argued that if a fish trapped below McNary Dam returns to Snake River, it was likely to have come from there. The large untagged production of mid-Columbia River does present a problem in that considerable numbers could have strayed into Lyons Ferry FH (or been trapped as dip-ins) and we would have had no direct evidence of it.

The most common source of strays was Umatilla FH (which uses Bonneville stock). This operation accounted for 5% of the adult (age 3 or older) recoveries in 1984, 10% in 1985 (in both of these years, recoveries apparently were tules), 2% in 1986, 3% in 1987, 15% in 1988, and 34% in 1989. These values are based upon expansions for individual tag groups.

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[1] *The term "tule" refers to a subgroup of fall chinook salmon originating in the lower Columbia River; "bright" refers to that subgroup originating in the mid-Columbia and Snake Rivers.*

Discussion In calculating the possible genetic contribution of these strays, the proportionate use as spawners of fish of different ages needs to be kept in mind, particularly use of jacks (age 2 or less). However, in practice jacks are classified by size, not age. At Lyons Ferry FH in 1990, over 60% of the three-year olds could be classified as jacks. For the period 1984 to 1990, an average of 55.9% (range: 27%- 93%) of the salmon collected at Lyons Ferry FH were age 2 or 3. Washington Department of Fisheries hatchery guidelines (Seidel 1983) call for use of jacks, but not to exceed 2% of total fish of both sexes spawned per day. The general practice is to make little use of small males, but to use small females more extensively.

Another important aspect of considering the impact of strays to Lyons Ferry FH is the genetic relationships among the straying stocks. Both the Bonneville and Little White Salmon production groups were founded from bright fish obviously intending to travel further upstream, probably to the mid-Columbia or Snake Rivers. Production from Bonneville FH, Little White Salmon FH, and Priest Rapids FH would be expected to be closely related, and electrophoretic evidence (Section 5.2) verifies this. Since 1981, there have been many sources of strays, but the overall genetic impact would be to make the Lyons Ferry stock more similar to the mid-Columbia upriver bright fall chinook salmon stocks.

2.2.2: Stray rates in 1990

Procedures In 1990, adults (classified by fork length) were collected at Ice Harbor and Lower Granite Dams; adults and jacks were collected as volunteers to Lyons Ferry FH. Adults collected at Ice Harbor and Lower Granite Dams were placed in a holding pond separate from volunteer adults and jacks. All fish collected at the three sources--Ice Harbor Dam, Lower Granite Dam, and hatchery volunteers--were given unique color-coded tags in the holding ponds on a weekly basis to allow recognition by week of arrival (Hopper 1991). Broodstock collection occurred over a six week period at Ice Harbor Dam, and 12 weeks at Lyons Ferry ladder, providing 18 location/week combinations. Fish collected from Lower Granite Dam were given a numbered jaw tag the day they were trapped.

Coded-wire tags were read as fish were spawned, so fish were spawned in three groups: Lyons Ferry tagged, foreign tagged, and untagged. Progeny of foreign tagged and untagged adults were to be used in the Lyons Ferry program if the stray rate was deemed to be below an acceptable level. We operated under the assumption that stray incidence may be less on a given week than others. This enabled us to keep progeny of unmarked fish that arrived in a given week if the stray rate of marked fish from that same week was tolerable. Stray levels were appreciable, however, and showed little variation among weeks of arrival, so only progeny of Lyons Ferry tagged adults were retained for program use. The remainder were transported as eyed eggs or fry to Klickitat FH.

During spawning, ripe fish were killed and set aside. Marked fish had CWT removed and read; if they were verified as Lyons Ferry, their color tag was recorded, indicating week of arrival. This information was then applied to unmarked fish that arrived that same week. Only known Lyons Ferry stock fish were mated together. Marked fish found to be strays were spawned together, and the color noted to determine week and location collected. Gametes from known Lyons ferry fish were placed in a separate area of the incubation room from those known to be progeny of strays. Fish without CWT were mated together by color of external tags, hence fish of the same week and location of collection were mated together.

Results Adult sampling at Lower Granite Dam occurred only in 1990, although some jack sampling was done in earlier years (Section 2.1.3). The 1990 data offer the only information we have of adult stock composition on the spawning grounds. Lyons Ferry salmon accounted for 49% of adults collected at Ice Harbor Dam, 76% of Lyons Ferry volunteers, and 52% of adults collected at Lower Granite Dam in 1990. Umatilla strays accounted for 21% of adults collected at Ice Harbor Dam, 13% of Lyons Ferry FH volunteers, and 23% of adults collected at Lower Granite Dam. Fish from other sources accounted for 1% at Ice Harbor Dam (Bonneville, and Little White Salmon released in the Yakima), 2% of the volunteers (Bonneville and 1986 brood Dworshak springs), and 2% of the Lower Granite run (Tables 6, 7, 8). Refer to Appendix E for an individual listing of CWT recoveries of stray salmon by collection site in 1990.

Discussion The historical estimates indicate that hatchery fish have comprised from 21% to 77% of the run at Lower Granite since 1983 (Table 4). Therefore, unless 1) hatchery and natural spawners are spatially or temporally separated, or 2) hatchery fish have very poor spawning success compared to wild fish, hatchery operations (Lyons Ferry and Umatilla) have had a genetic impact on the population on the spawning grounds. There are no data on relative reproductive success of Snake River hatchery and natural salmon, and few data available on stock composition on the spawning grounds. From our attempt to collect fish for electrophoresis (Section 6.1.1), we found at least 14 of 18 salmon collected (78%) were hatchery fish (based on tags from Lyons Ferry and Umatilla hatcheries, and yearling scale patterns). This would be expected from our estimated 77% hatchery composition of the run (Table 4). These data cannot be regarded as conclusive evidence of random mixing of hatchery and natural salmon over the entire range of spawning habitat, however, because fish were collected in only one spawning area (on Snake River between confluences of Asotin Creek and Grande Ronde River).

Table 6. Stock composition of fall chinook salmon trapped at Ice Harbor Dam and transported to Lyons Ferry FH in 1990. Data are based upon coded-wire tag recoveries for salmon age 3 to 6.

Origin	Number of tags recovered	Expanded contribution	Percent of expanded total
Lyons Ferry	281	452	67.8
Umatilla	42	200	30.0
Bonneville	10	10	1.5
Yakima	1	4	0.6
McNary	1	1	0.1
Totals	335	667	100.0

Table 7. Stock composition of fall chinook salmon collected as volunteers to Lyons Ferry FH in 1990. Data are based upon coded-wire tag recoveries for salmon age 3 to 6.

Origin	Number of tags recovered	Expanded contribution	Percent of expanded total
Lyons Ferry	266	443	83.7
Umatilla	11	74	14.0
Dworshak	2	12	2.3
McNary	1	- -	- -
Totals	280	529	100.0

Table 8. Stock composition of fall chinook salmon trapped at Lower Granite Dam and transported to Lyons Ferry FH in 1990. Data are based upon coded-wire tag recoveries for salmon age 3 to 6.

Origin	Number of tags recovered	Expanded contribution	Percent of expanded total
Lyons Ferry	45	105	75.0
Umatilla	8	32	22.9
Bonneville	2	3	2.1
Totals	55	140	100.0

SECTION 3: ADULT RETURN RATES

3.1: Experimental Design

Since Lyons Ferry FH began in 1984, our study design for release strategies has been a 2x2 factorial comparison of subyearling versus yearling releases, combined with a comparison of on-station release versus off-station (transported below Ice Harbor Dam). Since the eggtake for the 1984 brood was small, we had only enough marked fish to compare the subyearling versus yearling on-station release strategies. The 1985 brood eggtake was large enough to compare the subyearling versus yearling on-station release, and the subyearling on-station versus transport component of the experimental design. Lyons Ferry FH had sufficient eggtakes in 1985 through 1989 to do all four treatments in the experiment (Table 9). Replicates by treatment group are as follows: 1) Subyearling on-station: 6, 2) Subyearling transport: 5, 3) Yearling on-station: 6, and 4) Yearling transport: 4. Numbers of marked (CWT) salmon released by treatment group is listed in Appendix B.

Table 9. Replicates within treatment cells for fall chinook salmon rearing/release studies at Lyons Ferry Fish Hatchery.

Release year	Subyearling on-station	Subyearling transport	Yearling on-station	Yearling transport
1985	X		X	
1986	X	X	X	
1987	X	X	X	X
1988	X	X	X	X
1989	X	X	X	X
1990	X	X	X	X

3.2: Returns to Lower Snake River

3.2.1: Hatchery returns

Representatives of all release groups from the 1983 through 1986 broods returned to Lyons Ferry FH in 1990 (Table 10 and Appendix C). The 1988 and 1986 year classes comprised a majority of the returns; the numbers returned for those year classes were nearly equal (Figure 3, Table 10). In general, age class composition in Lyons Ferry FH broodstock has stabilized in recent years, primarily because no particular year class is dominating returns, and secondarily because adults from an increasing number of release groups comprise the returns. Average age class breakdown since Lyons Ferry began broodstock collections in 1984 is 26% age 2, 29% age 3, 35% age 4, 9% age 5, and 1% age 6 (Figure 4, Table 11). Actual age distributions of returning fall chinook salmon to Lyons Ferry FH are based on scale impressions and verified with CWT recoveries.

Table 10. Number (and percent) of Lyons Ferry fall chinook salmon coded-wire tag recoveries by treatment (release) group and return year to Lower Snake River Compensation Plan project area.

Brood Year	Release group	Number marked	Tag recoveries	Coded-wire tag recoveries by year 1985	1986	1987	1988	1989	1990	Totals
1983	Yearling on-station	334,442	Actual recoveries	1,970	670	1,422	275	1	1	4,339
			Expanded recoveries	5,310	2,217	5,110	928	4	3	13,571
			Percent recovered	1.59	0.66	1.53	0.28	0.00	0.00	4.06
1984	Subyearling on-station	234,985	Actual recoveries		34	118	59	3	0	214
			Expanded recoveries		113	433	199	11	0	755
			Percent recovered		0.05	0.18	0.08	0.00	0.00	0.32
1984	Yearling on-station	258,355	Actual recoveries		49	91	98	20	4	262
			Expanded recoveries		162	334	331	71	11	909
			Percent recovered		0.06	0.13	0.13	0.03	0.00	0.35
1985	Subyearling on-station	246,625	Actual recoveries			18	20	5	17	60
			Expanded recoveries			66	59	18	49	192
			Percent recovered			0.03	0.02	0.01	0.02	0.08
1985	Subyearling transport	245,561	Actual recoveries			6	11	15	16	48
			Expanded recoveries			22	32	53	46	154
			Percent recovered			0.01	0.01	0.02	0.02	0.06
1985	Yearling on-station	152,479	Actual recoveries			129	116	75	81	401
			Expanded recoveries			473	342	266	233	1,314
			Percent recovered			0.31	0.22	0.17	0.15	0.86
1985	Yearling transport	156,036	Actual recoveries			112	117	75	70	374
			Expanded recoveries			411	345	266	201	1,223
			Percent recovered			0.26	0.22	0.17	0.13	0.78
1986	Subyearling on-station	251,646	Actual recoveries				24	15	60	99
			Expanded recoveries				71	15	60	146
			Percent recovered				0.03	0.01	0.02	0.06
1986	Subyearling transport	255,998	Actual recoveries				129	38	94	261
			Expanded recoveries				380	38	94	512
			Percent recovered				0.15	0.01	0.04	0.20
1986	Yearling on-station	117,705	Actual recoveries				94	29	96	219
			Expanded recoveries				277	29	96	402
			Percent recovered				0.24	0.02	0.08	0.34
1986	Yearling transport	120,804	Actual recoveries				134	31	95	260
			Expanded recoveries				395	31	95	521
			Percent recovered				0.33	0.03	0.08	0.43
1987	Subyearling on-station	248,739	Actual recoveries					2	7	9
			Expanded recoveries					2	7	9
			Percent recovered					0.00	0.00	0.00

Table 10, continued.

Brood Year	Release group	Number marked	Tag recoveries	Coded-wire tag recoveries by year 1985	1986	1987	1988	1989	1990	Totals
1987	Subyearling transport	245,749	Actual recoveries					0	4	4
			Expanded recoveries					0	4	4
			Percent recovered					0.00	0.00	0.00
1987	Yearling on-station	115,350	Actual recoveries					6	19	25
			Expanded recoveries					6	19	25
			Percent recovered					0.01	0.02	0.02
1987	Yearling transport	119,217	Actual recoveries					25	57	82
			Expanded recoveries					25	57	82
			Percent recovered					0.02	0.05	0.07
1988	Subyearling on-station	226,478	Actual recoveries						2	2
			Expanded recoveries						2	2
			Percent recovered						0.00	0.00
1988	Subyearling transport	234,103	Actual recoveries						4	4
			Expanded recoveries						4	4
			Percent recovered						0.00	0.00
1988	Yearling on-station	112,519	Actual recoveries						153	153
			Expanded recoveries						153	153
			Percent recovered						0.14	0.14
1988	Yearling transport	117,977	Actual recoveries						141	141
			Expanded recoveries						141	141
			Percent recovered						0.12	0.12

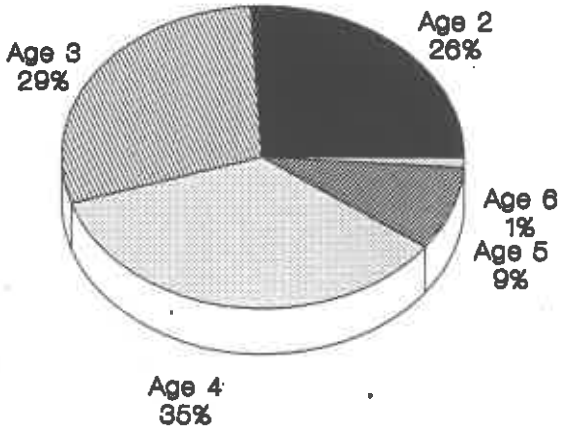

Figure 3. Age composition of fall chinook salmon at Lyons Ferry Fish Hatchery since its inception.

Table 11. Age composition (and percent of total) for fall chinook salmon broodstock since Lyons Ferry Fish Hatchery began operations. Numbers include both voluntary returns to the hatchery and fish trapped at Ice Harbor Dam.

Year	Age 2	Age 3	Age 4	Age 5	Age 6	Total
1984	0	278	401	67	-	746
	(0)	(37)	(54)	(9)		(100)
1985	4,147	71	442	95	-	4,755
	(87)	(2)	(9)	(2)		(100)
1986	157	1,344	63	41	-	1,605
	(10)	(83)	(4)	(3)		(100)
1987	563	453	2,823	18	-	3,857
	(15)	(12)	(72)	(1)		(100)
1988	781	444	647	583	-	2,455
	(32)	(18)	(26)	(24)		(100)
1989	277	982	957	248	18	2,482
	(11)	(39)	(39)	(10)	(1)	(100)
1990	851	336	1,057	398	4	2,646
	(32)	(13)	(40)	(15)	(<1)	(100)

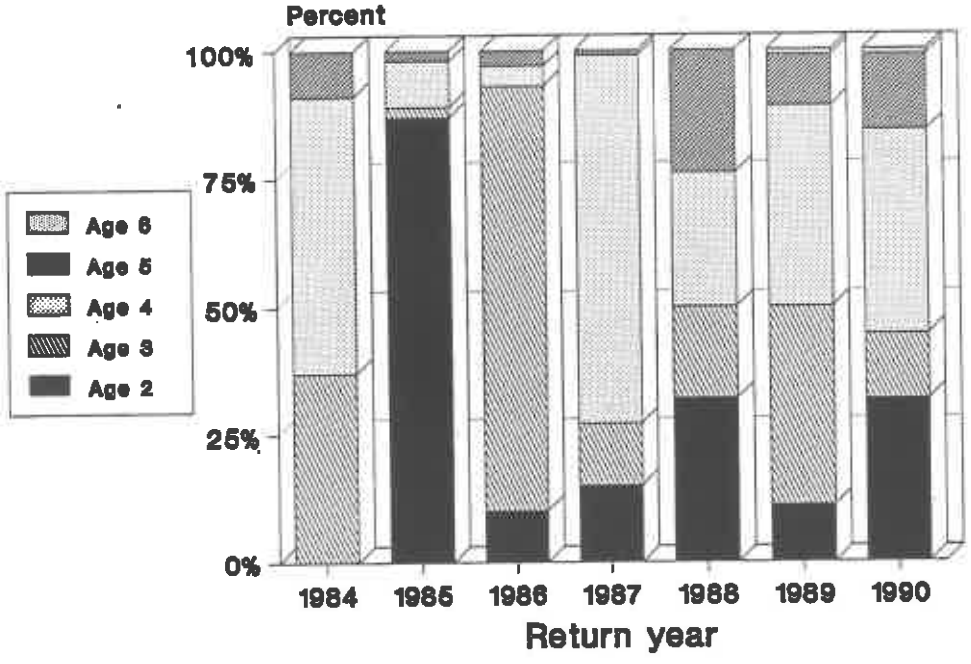

Figure 4. Comparison of fall chinook salmon age class contribution by year, 1984 to 1990, at Lyons Ferry FH.

3.2.2: Snake River sport fishery

In 1987, WDF adopted a fall chinook salmon jack (less than 71 cm) sport fishery in the Snake River from Lower Monumental Dam upstream to the Palouse River confluence (adjacent to Lyons Ferry FH). The fishery regulations were changed in 1989: 1) the length restriction was changed to 61 cm to protect small age 4 females, and 2) the open area was extended downstream to the Snake River mouth, to increase angling opportunities. Based upon a 2.6 expansion of punch card data, 69 jacks were caught in 1987, and 14 jacks were caught in 1988[1]. Based upon a 3.0 expansion of punch card data, 21 jacks were caught in 1989, and 3 jacks were caught in 1990[2]. No creel surveys have been conducted on this fishery since it began in 1987, likewise, no coded-wire tags have been recovered.

3.2.3: Spawning ground surveys

Coded-wire tags were recovered from eight marked salmon on Tucannon River spawning grounds, and three marked salmon on Snake River spawning grounds (Section 6). Tucannon River recoveries included one 1984 brood yearling on-station release, two 1985 brood yearling transport releases, two 1986 brood subyearling on-station releases, two 1986 brood subyearling transport releases, and one 1986 brood yearling transport release. Mainstem Snake River recoveries were one 1985 brood subyearling on-station release and two 1986 brood subyearling transport releases (Table 10).

3.3: Fishery Contribution

To date, 36 of 40 groups released since 1985 contributed to catches in commercial and sport fisheries. These groups were represented in a wide geographic distribution, ranging from California to Alaska (Appendix D). In general, yearling releases have been recovered more in high seas fisheries off the Washington and Oregon coasts; subyearling releases have been recovered more in British Columbia high seas fisheries. All release groups contributed substantially to Columbia River net fisheries (Figure 5). For the 1984 and 1985 brood years, more subyearlings were harvested as 2 and 3 year olds, whereas more yearlings were harvested as 4 and 5 year olds. It appears that no particular release group contributes more to fisheries in general than others. The average proportion of CWT recovered from various fisheries relative to total recoveries for the 1983- 1988 broods release groups were:

1) subyearling on-station $x=0.56$, $s=0.12$, $n=12$;
2) subyearling transport $x=0.56$, $s=0.10$, $n=9$;
3) yearling on-station $x=0.57$, $s=0.12$, $n=8$;
4) yearling transport $x=0.56$, $s=0.08$, $n=5$.

[1] *Lee Hoines, Washington Department of Fisheries, 115 General Administration Building, Olympia, WA 98504.*

[2] *Tony Zincola, Washington Department of Fisheries, 115 General Administration Building, Olympia, WA 98504.*

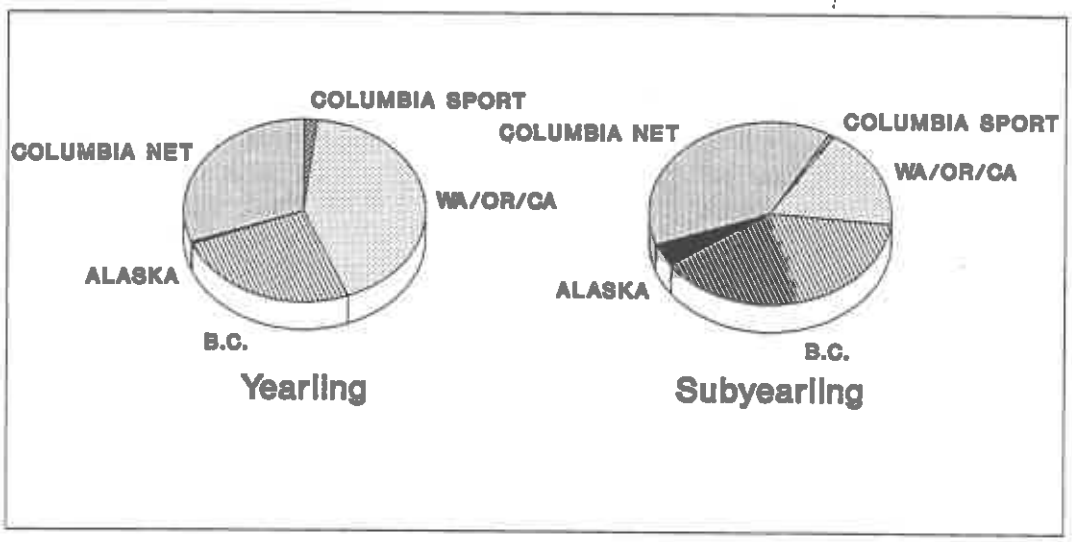

Figure 5. Comparison of harvest contribution by 1983- 1986 broods yearling and subyearling fall chinook salmon released from Lyons Ferry FH.

3.4: Discussion

To date, we see no consistent difference in survival and contribution between the on-station and transported release groups within both the subyearling and yearling categories (Table 12). We have detected a difference in only two comparisons: 1) the 1985 brood subyearling on-station releases, recovered through age 5, survived better than the transported group (paired one-tailed t-test, $p<0.07$), and 2) the 1986 brood releases however, which have been recovered through age 4, appear to have benefitted from transportation ($p<0.05$). In all broods, yearling release groups have survived better than subyearling releases, regardless of release location.

We see a large difference in survival between Snake River release years (Figures 6 and 7). The 1983 brood yearling and 1984 brood subyearling release groups outmigrated in 1985, and survived much better than release groups from the 1986 and 1987 runoff years (it should be noted, however, that all age classes from the latter releases have not returned, and this interpretation is preliminary). We see no obvious differences in flow, spill (both magnitude and duration), or both water temperature and turbidity in the Columbia and Snake Rivers between 1985 and other runoff years that would account for this large difference in survival.

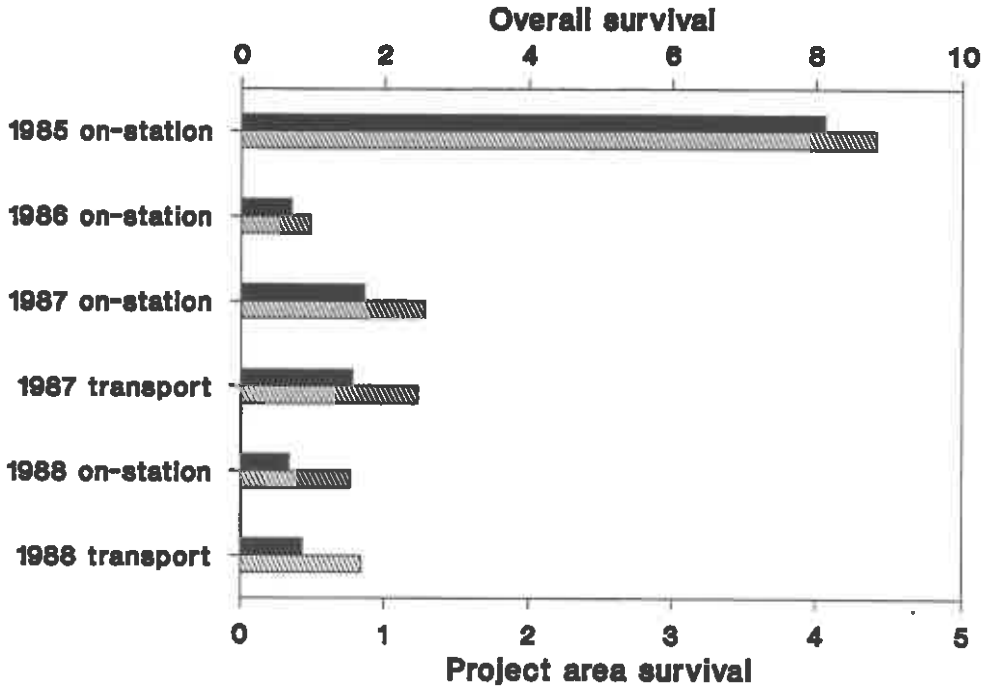

Figure 6. Comparison of yearling fall chinook salmon survival rates with year released from Lyons Ferry Fish Hatchery.

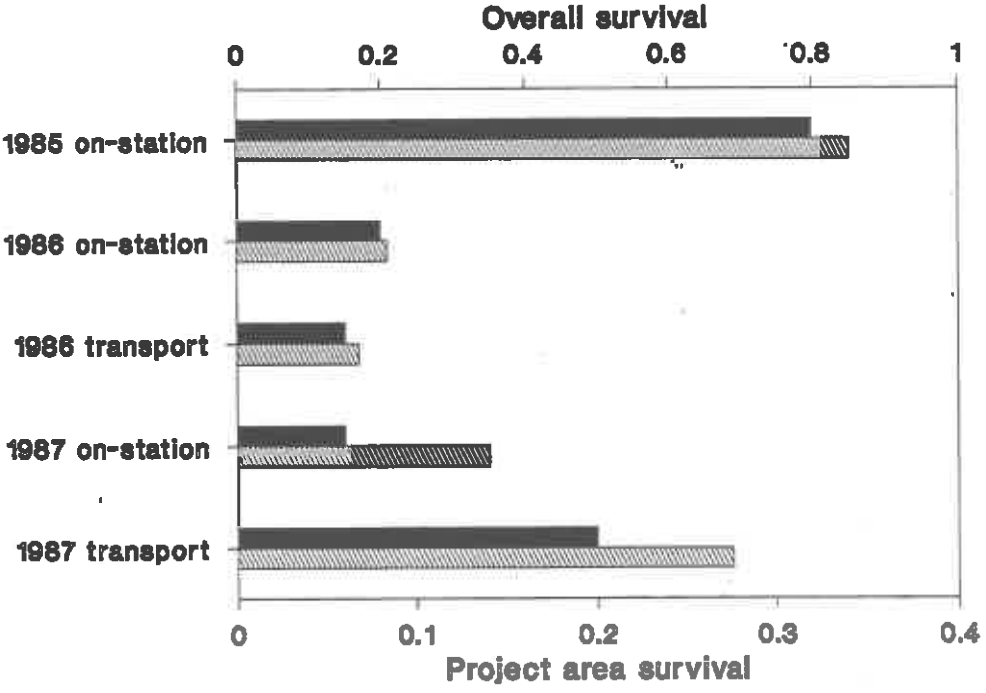

Figure 7. Comparison of subyearling fall chinook salmon survival rates with year released from Lyons Ferry Fish Hatchery.

Table 12. Percent returns to LSRCP project area and overall survival (returns and fisheries contribution) of 1983 to 1988 broods fall chinook salmon released as subyearlings and yearlings at Lyons Ferry FH and transported below Ice Harbor Dam.

Brood year	Subyearling		Yearling	
Survival (%)	On-station	Transport	On-station	Transport
1983				
Project area	- -	- -	4.06[a]	- -
Overall	- -	- -	8.82	- -
1984				
Project area	0.32	- -	0.35	- -
Overall	0.85	- -	0.96	- -
1985				
Project area	0.08	0.06	0.86	0.78
Overall	0.21	0.17	2.55	2.45
1986				
Project area	0.06	0.20	0.34	0.43
Overall	0.35	0.69	1.51	1.68
1987				
Project area	0.00	0.00	0.02	0.07
Overall	0.01	0.01	0.09	0.28
1988				
Project area	0.00	0.00	0.14	0.12
Overall	0.01	0.01	0.16	0.26

[a] *Returns of 1983 and 1984 broods are complete; returns of 1984- 1988 broods are incomplete.*

Table 13. Comparison of expanded contribution and return rates of 1984 through 1986 broods Lyons Ferry fall chinook salmon, based upon coded-wire tag recoveries.

Brood year	Release type	Number recovered	Mark rate	Expansion
1984	Subyearling on-station	1,999	0.4356	4,589
	Yearling on-station	2,482	0.5361	4,630
1985	Subyearling on-station	629	0.1599	3,934
	Subyearling transport	420	0.9926	423
	Yearling on-station	3,892	0.6618	5,881
	Yearling transport	3,826	0.9970	3,838
1986	Subyearling on-station	878	0.7450	1,179
	Subyearling transport	1,767	0.7613	2,321
	Yearling on-station	1,773	0.4107	4,317
	Yearling transport	2,031	0.9965	2,038

The 1986 releases (which include the 1984 yearling and 1985 subyearling broods) have shown relatively poor survival. Compared to other release years, the subyearlings released in 1986 experienced higher flows, higher dissolved gas levels, and higher water turbidity (USACE 1986). Branded fish from this subyearling release group had a later peak passage date, and longer duration of passage at both Lower Monumental and McNary Dams (Fish Passage Center 1988).

In most years, the number of adults produced per pound of production appear to be the same between yearlings and subyearlings. The 1984 brood year, based upon recoveries through age 6, is an example: Lyons Ferry FH was equally effective at returning adults by releasing 539,000 subyearlings at 67- 85 fish per pound (fpp) as by releasing 482,000 yearlings at 8 fpp (Table 13). Lyons Ferry FH is most effective however, by maintaining a large yearling production program. This strategy is valid in years when low escapement to the Snake River, or stray fish culling procedures severely limit eggtake capacity. Since 1984, Lyons Ferry FH has operated at 11% to 54% of effective eggtake capacity (these values do not include commitments to Idaho Power Company). Smolt production follows these values closely, yet poundage production is at or above capacity, because of the yearling program (Figure 8).

The cost required to retain subyearling salmon for yearling production is about $137,000 for full capacity (about 100,000 pounds at release). This estimate is based upon an average feed conversion rate of 1.1, feed cost of $0.40/pound, two Gallimycin treatments, and electrical demands for pumped water.

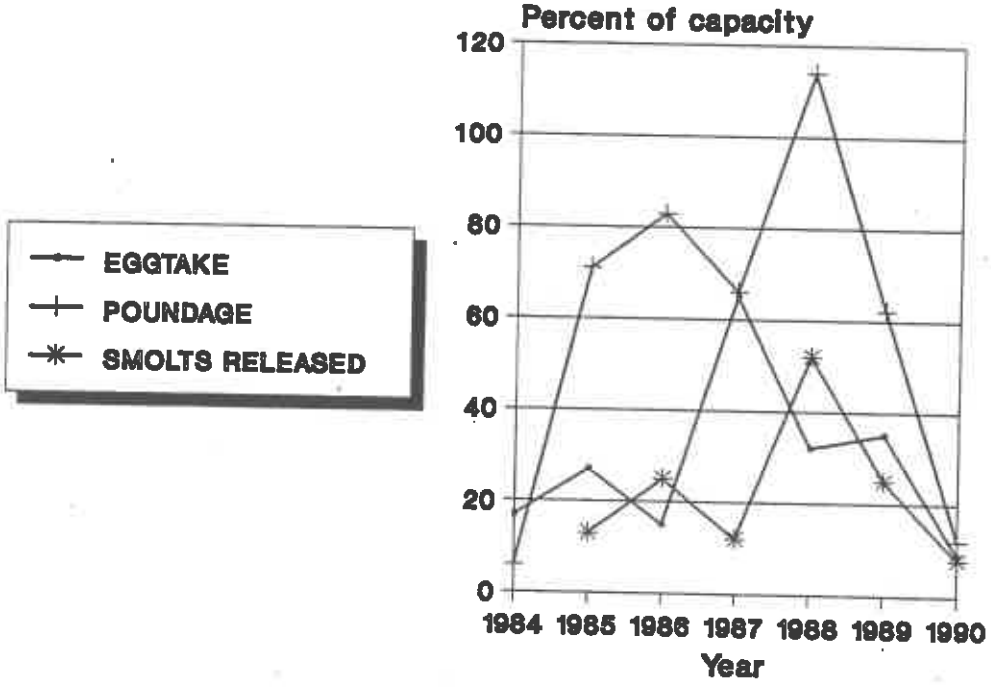

Figure 8. Eggtake, smolt releases, and poundage production at Lyons Ferry Fish Hatchery, 1984 to 1990.

SECTION 4: HATCHERY OPERATIONS

4.1: Spawning and Eggtake

4.1.1: Spawning operations

Duration of 1990 fall chinook salmon spawning was from 20 October through 8 December (Table 14). Peak of spawning was 6 November, when 239 females were spawned. This date is consistent with previous years dates, and apparent peaks on the spawning grounds. The egg take was 3,512,571, with an initial mortality rate of 8.28% (Table 15).

Table 14. Collection and spawning summary for 1990 fall chinook salmon broodstock at Lyons Ferry Fish Hatchery.

Week ending	Arrivals adult	/ jacks	Mortality M	/ F	/ J	Spawned M	/ F	/ J	Estimated egg take
08 Sep	204								
15 Sep	495	4	2	3					
22 Sep	317	12	2	1					
29 Sep	205	37							
06 Oct	171	132		1					
13 Oct	16	178							
20 Oct	28	143	14	35		3[a]	16	285[a]	56,000
27 Oct	63	166	5	13	3	6	41	5	143,500
03 Nov	115	175	19	23	2	14	151	105	572,000
10 Nov	110	145	11	15	14	19	239	171	819,000
17 Nov	1		75	6	30	75	208	89	724,500
24 Nov			121	4	78	102	140	62	486,500
01 Dec			82	7	52	72	51	73	168,000
08 Dec			50	4	10	26	8	1	24,500
Totals	1,725[b]	992	381	112	189	317	854	791	2,994,000[c]

[a] *Most males were live-spawned. Two percent of jacks (age 2) contributed gametes.*

[b] *In-season escapement is estimated, and classification of adults and jacks at time of arrival was based on size only. Coded-wire tag and scale impression data revised escapement to 1,795 adults and 851 jacks (age 2). Jacks sacrificed at Lower Granite Dam are not included in jack tally.*

[c] *Corrected egg take after shocking was 3,512,571.*

4.1.2: Egg transfer

Under authority of an interagency and tribal agreement, Lyons Ferry FH staff transported all progeny of stray and unmarked adults to Klickitat FH (2,039,000 eggs and alevin) for release there. Lyons Ferry FH retained all progeny of known (CWT) Snake River origin salmon (1,035,000).

Table 15. Duration and peak of spawning, eggtake, and percent egg mortality at Lyons Ferry Fish Hatchery since it began operations.

Year	Spawning duration	Peak of spawning	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

4.1.3: Sperm cryopreservation and evaluation

We collected semen from males during the 1990 eggtake to: 1) develop a sperm bank for use in future years, 2) evaluate quality of sperm for cryopreservation, and 3) compare relative efficacy of using the ultra-low freezer at Lyons Ferry FH versus liquid nitrogen tanks for long term storage.

Sperm bank collection Semen was collected from 25 salmon for freezing. Cryoextender (Wheeler and Thorgaard 1991) was mixed with sperm at a ratio of 3:1. The mixture was then pulled into 4 ml straws and both ends of the straws were sealed. Straws were put on dry ice then placed in a liquid nitrogen tank. Unfortunately, all samples were destroyed because of difficulties with the tank. The problem was rectified for the 1991 eggtake.

Evaluation of sperm quality Motility and sperm cell density are two indicators of sperm quality. Motility is estimated by use of a microscope, and measured as a percent. Sperm moving in a forward direction are considered motile. Motility is the easier and more accurate indicator for sperm quality. Washington State University (WSU) genetics staff calculated sperm cell density on semen samples from four males. Sperm cell density was correlated to optical density of a diluted sample of semen. Optical density was measured using a spectrophotometer.

Before using the spectrophotometer to read cell density, a regression line must be derived. Aliquots of a semen sample are diluted to a series of concentrations. We used dilutions of 1/100, 1/200, 1/400, and 1/4000. The cell density in each sample is counted through a microscope using a hemocytometer. Each sample was counted four times each by two people and an average count was used to ensure accuracy. Optical density (percent absorbance at 550*nm*) was then measured for these samples. The linear regression of optical density on sperm cell concentration was calculated ($r^2 = 0.98$). This information will

be used whenever cell densities need to be measured. Wheeler[1] recommended to use motility as the primary indicator for sperm quality. Samples of semen that appear thickest have been proven to be better samples than thin ones. In the field, observations of semen consistency and motility checks are the best indicators for sperm quality.

Evaluation of preservation techniques In a joint venture with WSU, we compared fertility of cryoextended semen frozen in liquid nitrogen (-170°C) and an ultra-low (-80°C) freezer. Semen from five salmon collected at Lyons Ferry FH were used. All samples were frozen 24 hrs, thawed, and used to fertilize eggs. Egg fertility was determined after nine days incubation. Straws stored in liquid nitrogen had an average fertility of 77.3%, while those stored in the ultra-low freezer had 59.5% average fertility relative to that of unfrozen semen (Table 16).

Initial test results indicate that retention of sperm in the ultra-low freezer is not sufficient for long-term cryopreservation. To determine long-term effects of freezing, we retained samples from the same five males used in the preceding experiment in storage at WSU. After a given period, fertilization tests will be run again to determine long-term differences in liquid nitrogen and ultra-low freezer storage.

Table 16. Comparison of fertilization rates between fall chinook salmon sperm preserved in liquid nitrogen (-170°C), ultra-low freezer (-80°C), and control group (unfrozen).

Treatment	Male	Number of eggs		Percent fertilized	
		Fertilized	Unfertilized	Actual	Relative[a]
Liquid nitrogen	1	148	491	23.2	38.4
	2	302	364	45.3	90.4
	3	293	344	46.0	82.3
	4	291	330	46.9	101.7
	5	281	370	43.2	73.6
Ultra-low freezer	1	122	528	18.8	31.0
	2	166	455	26.7	53.3
	3	238	420	36.2	64.8
	4	280	354	44.2	95.9
	5	205	460	30.8	52.5
Unfrozen control	1	393	254	60.7	--
	2	311	310	50.1	--
	3	358	283	55.9	--
	4	285	333	46.1	--
	5	374	263	58.7	--

[a] *Percent fertilization relative to unfrozen samples.*

[1] *Paul Wheeler, Department of Zoology, Washington State University, Pullman, WA 99164.*

4.2: Incubation and Rearing

For the 1989 brood, 94.2% of the eggs hatched. Mortality from egg hatch to ponding was 2.73%. Total weight of fry ponded was 1,282 kg. Overall feed conversion rate from ponding to subyearling release was 1.20 (22,312 kg feed for a weight gain of 18,602 kg).

For the 1990 brood, 91.7% of the eggs hatched. A major part of this loss was from dewatering of an incubation tray by a clogged water supply line. This occurred in January 1991, resulting in a loss of about 27,000 eggs.

Monthly mortality rates for the 1989 and 1990 broods during this study period averaged 1.66% (range: 0.41 - 3.36, n = 12) and 0.21% (range: 0.10 - 0.33, n = 3), respectively. Overall (egg to smolt) mortality rates for the subyearling and yearling release groups have decreased since 1984 (Table 17).

Table 17. Lyons Ferry fall chinook salmon overall (egg to smolt) mortality rates, with monthly ranges, for the 1984 through 1988 brood years. Values are percentages with sample sizes (n).

Brood year	Subyearling (Monthly range, n)	Yearling (Monthly range, n)
1984	13.78 (0.24 - 7.99, 4)	16.49 (0.03 - 7.99, 15)
1985	12.65 (0.55 - 4.81, 4)	13.77 (0.11 - 4.81, 15)
1986	10.95 (0.25 - 4.95, 4)	15.31 (0.23 - 4.95, 15)
1987	9.11 (0.73 - 3.75, 4)	11.41 (0.17 - 3.75, 15)
1988	6.42 (0.10 - 2.73, 4)	11.16 (0.41 - 3.36, 15)
1989	13.68 (0.10 - 1.94, 6)	- - - -

4.3: Disease Incidence and Prophylaxis

The 1990 adult salmon were given flush treatments of formalin (1:7,000) as prophylaxis for *Saprolegnia* sp. Females were injected once with a broad-spectrum antibiotic to treat for *Renibacterium salmoninarum*. The 1990 brood juveniles had no fish health problems during the report period.

Prior to release in April 1990, WDF pathologist Black[1] noted the presence of bacterial kidney disease (BKD) in 11 of 14 mortalities examined in the 1988 brood.

[1] *Tamara Black, Washington Department of Fisheries, 610 North Mission St., Suite B8, Wenatchee, WA 98801.*

The 1989 brood salmon had no obvious fish health problems during the report period. In May 1990, they had minor infestations of *Hexamita*; no treatments were given. They were given one 21-day Gallimycin feeding at 2% of body weight per day in April 1990, prior to their release as subyearlings. Fish size was 240 fpp at feeding.

The 1990 brood salmon were given one 21-day Gallimycin feeding at 2% of body weight per day, in August 1991. A second feeding will be given in March 1992, prior to release.

During the report period, no juveniles showed any clinical evidence of gill hyperplasia or bacterial gill disease. This was the first year since completion of Lyons Ferry FH that gill disease was not observed. Previous studies by Hopper[1] suggested a link between presence of suspended manganese particles and gill disease. It appears that most of the manganese in the water originates from well 4. Lyons Ferry FH staff pumped its water from all wells except number 4 in 1990; presence of manganese in the water decreased considerably--as well as incidence of gill disease.

4.4: Smolt Releases

To ensure identification of all indigenous salmon during future spawns, we marked (CWT with adipose clip) the entire 1990 brood held at Lyons Ferry (1,100,000). Most of this brood were retained for yearling production, since this provides the highest return rates (Section 3.4). We marked the entire 1989 brood held at Lyons Ferry (3,044,000); 490,000 salmon were marked with CWT and adipose clip, and 2,554,000 salmon were marked with blank-wire tag in snout but were not adipose-clipped. The blank-wire tag (BWT) operation went from 29 May to 11 July 1990, just prior to release.

Hatchery staff planted 436,353 yearling (1988 brood) salmon in April 1990 and 3,036,756 subyearling (1989 brood) salmon in June and July 1990 (Table 18). Of the yearling group, 280,045 salmon were released from Lyons Ferry FH, and 156,308 were transported by barge for release below Ice Harbor Dam. The 1988 brood comprised the most fish Lyons Ferry FH retained for yearling production. Hatchery staff released 2,796,208 subyearling salmon on-station and transported 247,548 subyearlings below Ice Harbor Dam. Our experimental design for fall chinook salmon releases is a 2x2 factorial treatment of yearlings and subyearlings released both on-station and transported by barge to be released immediately downstream of Ice Harbor Dam (Section 3.1). In the first three years of operations at Lyons Ferry FH (1984 to 1986), we did not have sufficient eggtakes to meet minimum CWT sample size to perform all treatment groups (Appendix B). Since 1987, we had enough smolts on a yearly basis to perform all 4 treatments. There was no yearling releases of the 1989 brood, however.

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[1] *Kathy Hopper, Washington Department of Fisheries, Olympia WA 98504.*

4.4.1: Yearling releases

On-station group Mean length and coefficient of variation for the yearling (1988 brood) salmon released at Lyons Ferry FH were 164.7 mm and 8.6, respectively (Figure 9). The date of release (16 April) was coordinated with the Corps of Engineers for a controlled spill (70% of instantaneous discharge) at Lower Monumental Dam from 1800 to 0600 hours nightly beginning 18 April. Snake River water temperature at time of release was 11.1° C.

Transport group Fish were loaded into the barge on 17 April and released adjacent to the lower navigation wing wall at Ice Harbor Dam the following day. Water temperature was 11.1° C. during transport. Water was continuously pumped through the barge during transport to aid fish in olfactory acclimation to Snake River. Mean length and coefficient of variation of these fish at time of release were 164.5 mm and 10.0, respectively (Figure 10).

4.4.2: Subyearling releases

On-station group Mean length and coefficient of variation for the subyearling (1989 brood) salmon marked with CWT and released from Lyons Ferry FH were 93.4 mm and 10.1, respectively (Figure 11). The date of release (6 June) was coordinated with the Corps of Engineers for a controlled spill (100% of instantaneous discharge) at Lower Monumental Dam. Snake River water temperature during release was 13.3° C. Fish marked with BWT were released every monday from 6 June to 12 July 1990.

Transport group Fish were loaded into the barge on 8 June and released adjacent to the lower navigation wing wall at Ice Harbor Dam the following day. Water temperature at Ice Harbor Dam at time of release was 13.3° C. Water was continuously pumped through the barge during transport to aid fish in olfactory acclimation to Snake River. Mean length and coefficient of variation of fish at release were 88.9 mm and 10.1, respectively (Figure 12).

Table 18. Summary of 1988 and 1989 broods fall chinook salmon releases from Lyons Ferry Fish Hatchery in 1990. Data are summarized by release site and date, number and weight of fish planted, presence of coded-wire tag (CWT), blank-wire tag (BWT) placed in snout, freeze brand, or adipose clip, number of fish per pound (FPP), mean length (mm), coefficient of variation (CV), and condition factor (Kfactor) at time of release.

Age Brood year	Release site	Date	Number planted	Pounds planted	Marks and tag code	FPP	Length	CV	Kfactor
Subyearlings									
1989 brood	On-station	6/06/90	39,813	517	Brand RA-U-1[a], BWT	77	93.4	10.0	0.99
	On-station	6/06/90	39,863	518	Brand RA-U-3[a], BWT	77	93.4	10.0	0.99
	On-station	6/06/90	123,640	2,248	Ad & CWT 6355/44 R6[b]	55	93.4	10.1	0.99
	On-station	6/06/90	126,233	2,241	Ad & CWT 6355/47 R6[b]	55	93.4	10.1	0.99
	On-station	6/06/90	7,263	132	Ad only	55	93.4	10.1	0.99
	On-station	6/06/90	303,255	4,332	BWT[c]	70	93.4	10.1	0.99
	On-station	6/18/90	793,349	10,868	BWT	73	88.5	9.8	0.90
	On-station	6/25/90	604,205	8,757	BWT	69	83.7	13.8	1.28
	On-station	7/02/90	768,312	10,821	BWT	71	83.1	12.9	1.10
	On-station	7/12/90	227,413	2,707	BWT	84	83.1	12.9	1.10
subtotal			2,796,208	39,844					
	Ice Harbor	6/08/90	118,104	1,905	Ad + CWT 6355/49 R6	62	88.9	10.1	1.03
	Ice Harbor	6/08/90	119,941	1,935	Ad + CWT 6355/50 R6	62	88.9	10.1	1.03
	Ice Harbor	6/08/91	9,503	153	Ad only	62	88.9	10.1	1.03
subtotal			247,548	3,993					
Total 1989 brood			3,043,756	43,837					
Yearlings									
1988 brood	On-station	4/16/90	55,922	6,214	Ad & CWT 6302/35 R6	9	164.7	8.6	1.07
	On-station	4/16/90	56,597	6,289	Ad & CWT 6302/37 R6	9	164.7	8.6	1.07
	On-station	4/16/90	998	111	Ad only	9	164.7	8.6	1.07
	On-station	4/16/90	166,528	18,503	Unmarked	9	164.7	8.6	1.07
subtotal			280,045	31,117					
	Ice Harbor	4/17/90	58,988	5,363	Ad & CWT 6302/31 R6	11	164.5	10.0	1.11
	Ice Harbor	4/17/90	58,988	5,363	Ad & CWT 6302/32 R6	11	164.5	10.0	1.11
	Ice Harbor	4/17/90	916	83	Ad only	11	164.5	10.0	1.11
	Ice Harbor	4/17/90	37,416	3,401	Unmarked	11	164.5	10.0	1.11
subtotal			156,308	14,210					
Total 1988 brood			436,353	45,327					

[a] *Freeze branded fish were released on-station in conjunction with the Fish Passage Center to assess travel time through lower Snake and Columbia Rivers' sampling stations.*

[b] *Six unique codes were given within this tag code to provide statistical replication.*

[c] *Blank-wire tagged fish were released every monday after they were tagged.*

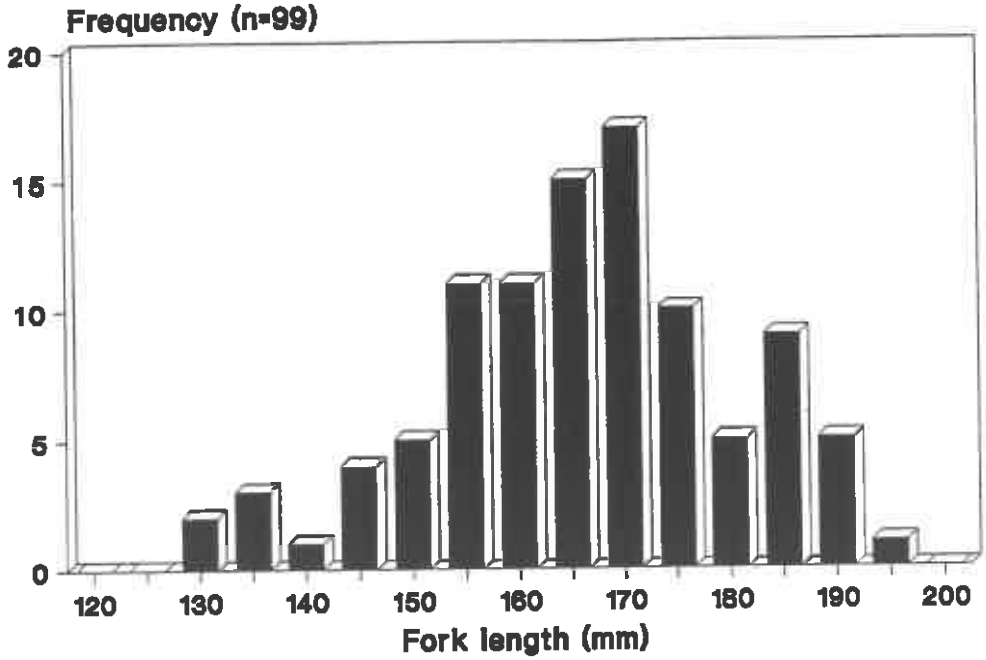

Figure 9. Length frequency distribution of yearling fall chinook salmon released from Lyons Ferry Fish Hatchery in April 1990.

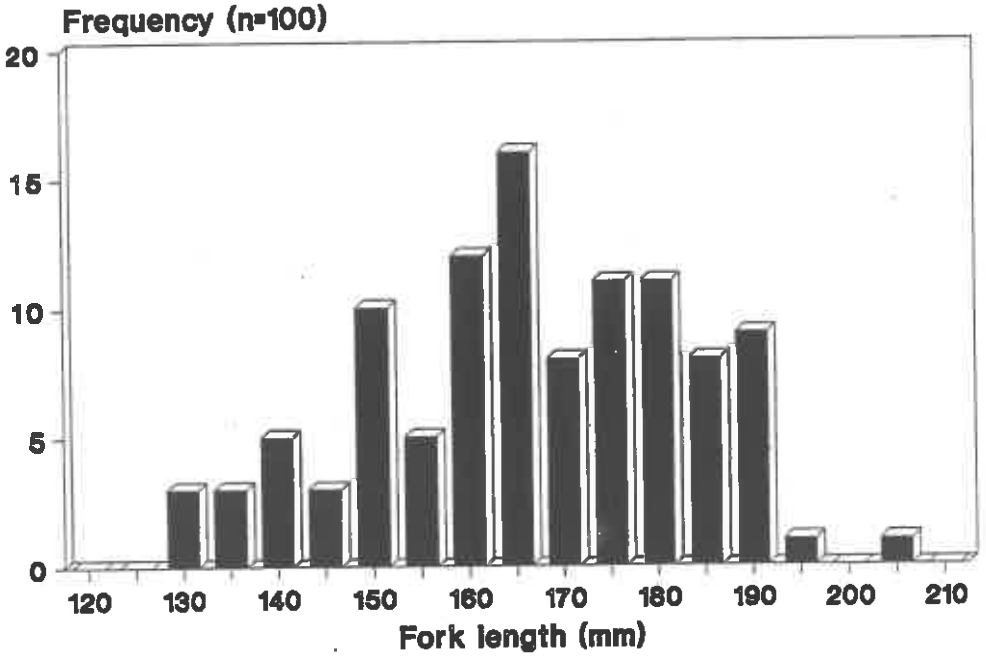

Figure 10. Length frequency distribution of yearling fall chinook salmon transported below Ice Harbor Dam in April 1990.

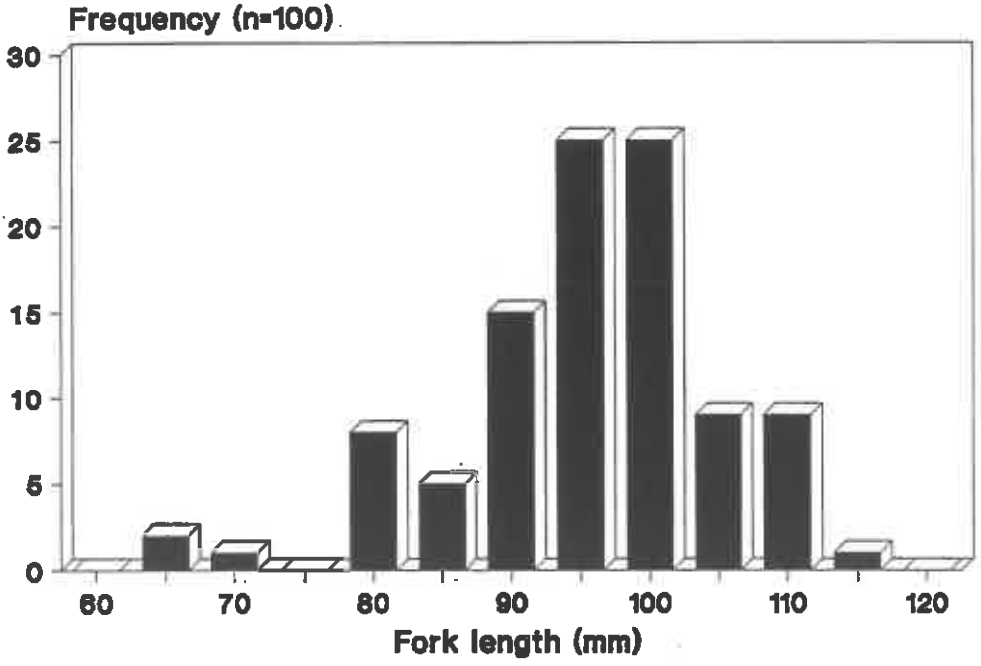

Figure 11. Length frequency distribution of subyearling fall chinook salmon released from Lyons Ferry Fish Hatchery in June 1990.

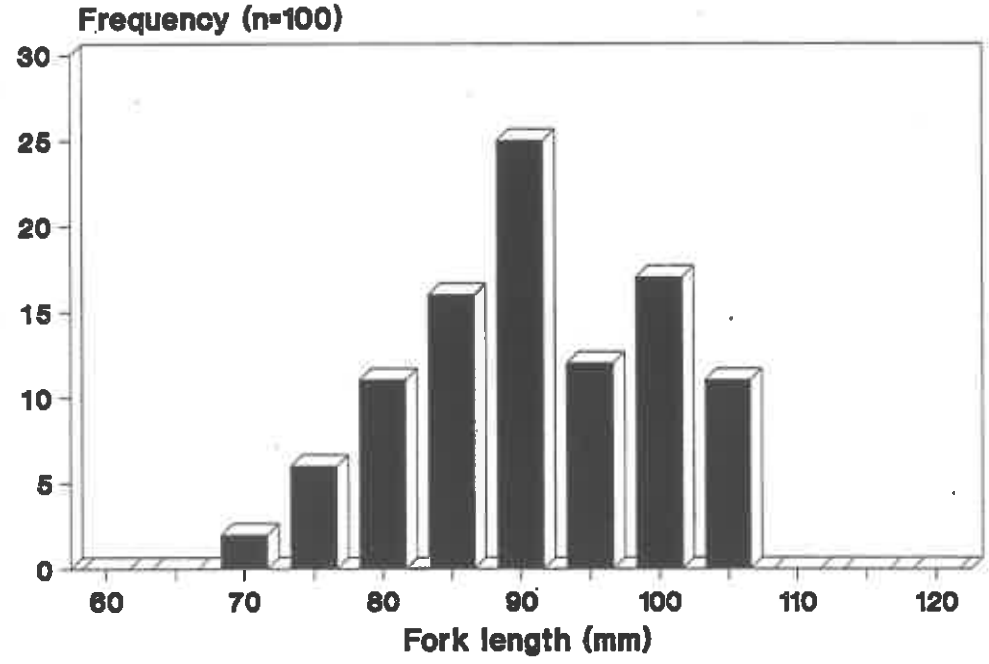

Figure 12. Length frequency distribution of subyearling fall chinook salmon transported below Ice Harbor Dam in June 1990.

4.4.3: Fish passage

Yearling salmon Yearling fall chinook released from Lyons Ferry FH on 16 April began arriving at Lower Monumental Dam on 19 April. Controlled spill at Lower Monumental Dam was 70% of instantaneous discharge (range: 29%- 100%) 12 hours/day (1800 hrs to 0600 hrs) from 19 April to 31 May (44 days). Controlled spill at Ice Harbor Dam was 25% of instantaneous discharge for 12 hours/day from 22 April to 31 May (43 days). Daily changes in spill schedules were made to accommodate predator research activities at the base of the dams[1]. No branded yearling groups were released in 1990.

Subyearling salmon Branded subyearling fall chinook released from Lyons Ferry FH on 6 June began arriving at Lower Monumental Dam on 8 June. Controlled spill at Lower Monumental Dam was 70% of instantaneous discharge for 12 hours/day from 11 June through 1 July, and then 100% through 22 July. Spill at Ice Harbor Dam occurred from 13 June through 22 July at 25% of instantaneous discharge for 12 hours/day. Spill for both the yearling and subyearling groups terminated at the projected 90th percentile of spring and summer outmigrants, respectively.

The last day of releases from Lyons Ferry FH was 12 July (Table 18). Based upon travel time estimates of branded subyearling salmon, it seems likely that the last release group arrived at Ice Harbor Dam prior to spill termination.

Travel time of branded subyearling fall chinook from Lyons Ferry FH to McNary Dam ranged from 6.1 to 6.5 km/day, slower than the 1989 travel time of 7.4 to 7.8 km/day and 1986-1989 average of 7.08 km/day (Figure 13). Average Snake River flow during this period in 1990 was less than 1989, but more than the 1986- 1989 mean (67.9 kcfs versus 81.6 kcfs and 49.68 kcfs).

Duration of the middle 80% passage at McNary Dam was 23 days (10% passage; 17 June, 90% passage; 9 July). Peak day of passage was 26 June. These values are roughly the same as in previous years. The 80% passage period for branded subyearling salmon from Lyons Ferry FH was within the 80% window for all subyearling chinook salmon sampled at McNary Dam (14 June to 20 July; Fish Passage Center 1991). The middle 80% passage dates for branded subyearling fall chinook salmon from Lyons Ferry FH at John Day Dam was 26 June to 5 August.

Samplers at Lower Monumental Dam collected yearling salmon (size range: 180- 195 mm) in late March 1990; these were verified as holdovers from subyearling releases from Lyons Ferry FH in 1989. This phenomenon also occurred in 1987.

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[1] *Various contributors, Fish Passage Center, 2501 S.W. First Avenue, Suite 230, Portland, OR 97201.*

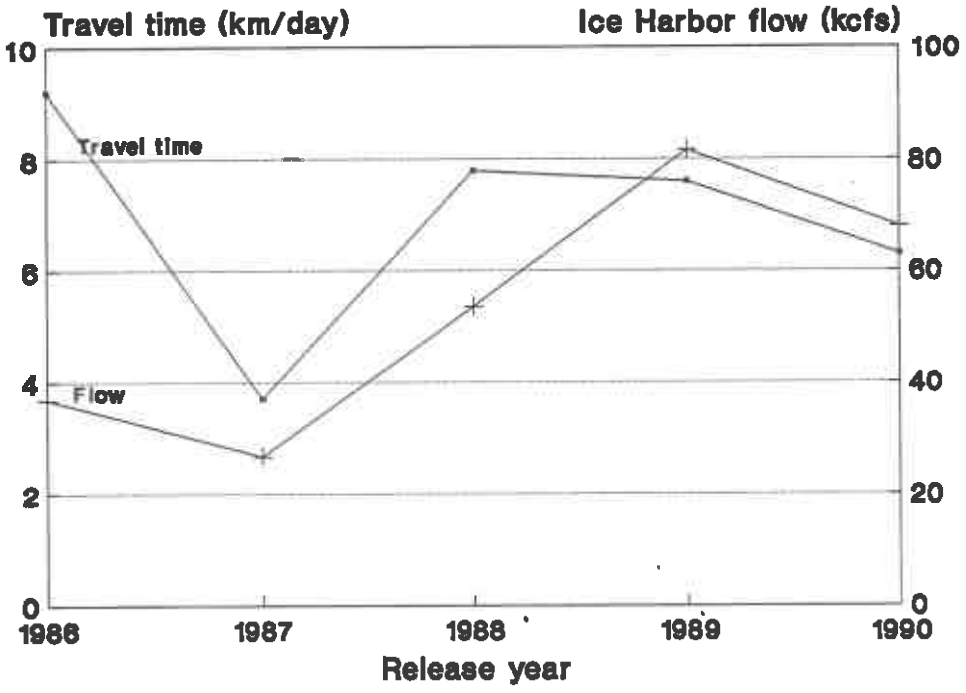


Figure 13. Travel time of branded subyearling fall chinook salmon from Lyons Ferry Fish Hatchery to McNary Dam, compared to flow at Ice Harbor Dam during the travel period, 1986 to 1990.

SECTION 5: STOCK PROFILE EVALUATION

5.1: Population Structure

5.1.1: Age and sex structure

From 4 September through 14 November 1990, 1,795 fall chinook salmon adults and 851 jacks (age 2) were collected at Lyons Ferry FH. Duration of collections was terminated about two weeks earlier than previous years. Fish were spawned, and scales were sampled from 20 October to 8 December, with a total of 813 scale samples taken (31%; Figure 14). Dominant age classes in 1990 were 2 and 4 year olds (Table 19); dominant ages vary yearly depending upon year class strength (Figure 3).

The ratio of females to males for all age classes in 1990 (including unmarked fish) was 0.58:1.00 (966:1,680). Of the known Snake River origin fall chinook salmon, sex ratios of the those trapped at Ice Harbor Dam were 1.43 female:1.00 male (187:131), hatchery volunteers were 0.27 female:1.00 male (123:451), and Lower Granite Dam were 0.66 female:1.00 male (31:47), for a total sex ratio of 0.54 female:1.00 male (341:629). The 1989 ratio was 0.57:1.00 (900:1,582), the 1988 ratio was 0.44:1.00 (749:1,706). The 1988 and 1989 values include stray fish, since they were not culled in those years. The average female:male ratio since 1977 is 1.00:1.00. Sex ratios vary yearly depending upon jack returns. Composition of age 2 and 3 returns to Lyons Ferry FH from 1984 to 1990 has averaged 55.9% of total broodstock (range: 27%- 93%, Figure 15).

Table 19. Age composition by sex of randomly collected adult fall chinook salmon sampled at Lyons Ferry Fish Hatchery, 1990.

Sex	Age 2	3	4	5	6	7	Totals
Male	851	276	389	161	3	0	1,680
Female	0	60	668	237	1	1	967
Totals	851	336	1,057	398	4	1	2,647[a]

[a] *This information was extrapolated from a sample of 813 fish.*

Average fork length of known 1990 Snake River salmon spawned at Lyons Ferry FH was 63.2 cm (Figure 14). Most of these fish were age 4_2 (Tables 20, 21). Average length by location of collections were: Ice Harbor Dam, 82.8 cm; Lyons Ferry FH volunteers, 52.5 cm; Lower Granite Dam, 63.6 cm. Average length of females was 79.5 cm, average length of males was 53.9 cm.

[1] *Ron Roler, Washington Department of Fisheries, P.O. Box 999, Battle Ground, WA 98604.*

Table 20. Age composition by sex of known Snake River origin fall chinook salmon spawned at Lyons Ferry Fish Hatchery, 1990.

Sex	Age 2	3	4	5	6	7	Total
Male	1	2	69	42	2	0	116
Female	1	7	196	48	1	0	253
Total	2	9	265	90	3	0	369

Table 21. Sex, mean fork length (cm), and age (based upon coded-wire tags) of known 1990 Lyons Ferry fall chinook salmon sampled at the hatchery.

Sex	Mean length (n, s) at given age 2	3	4	5	6
Male	33 (1, 0)	61.0 (2, 4.2)	80.5 (69, 12.4)	91.6 (42, 9.4)	106.0 (2, 4.2)
Female	37 (1, 0)	63.9 (7, 8.5)	77.8 (196, 7.4)	83.7 (108, 7.4)	84.0 (1, 0)

5.1.2: Fecundity and egg size

Average fecundity and egg size for 1990 adult (marked and unmarked) fall chinook salmon was 4,118 eggs/female and 1,558 eggs/pound (0.291 grams/egg), respectively. We do not have an estimate of fecundity for known 1990 Snake River origin females. Fecundity values were determined by dividing the total number of eggs taken by the number of females spawned. Average fecundity of Snake River stock fall chinook salmon since inception of the Egg Bank Program in 1977 is 4,302.

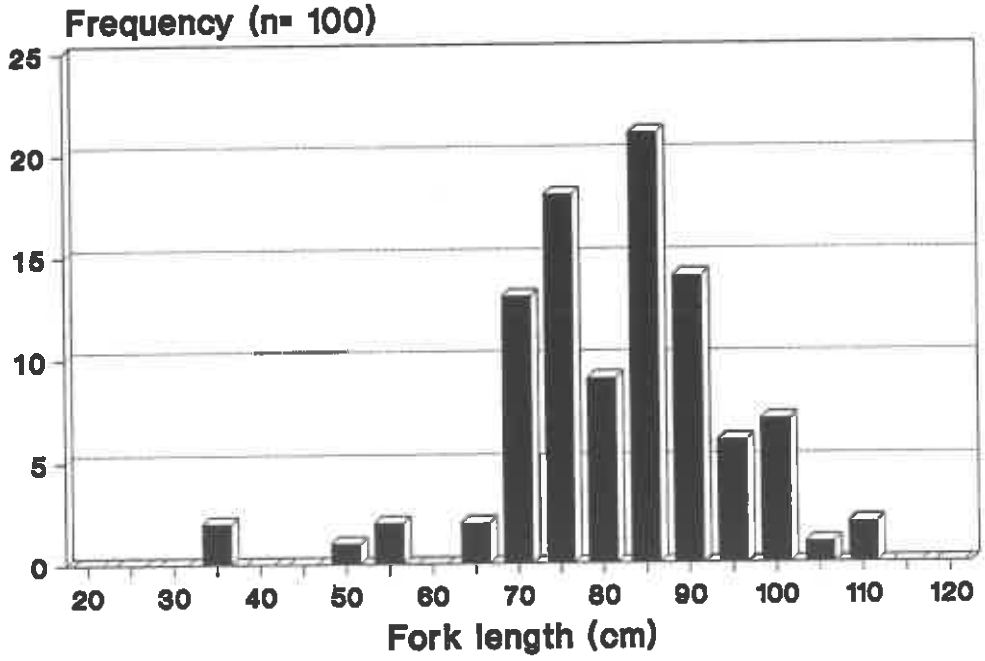


Figure 14. Length frequency distribution of known Lyons Ferry fall chinook salmon sampled at the hatchery in 1990.

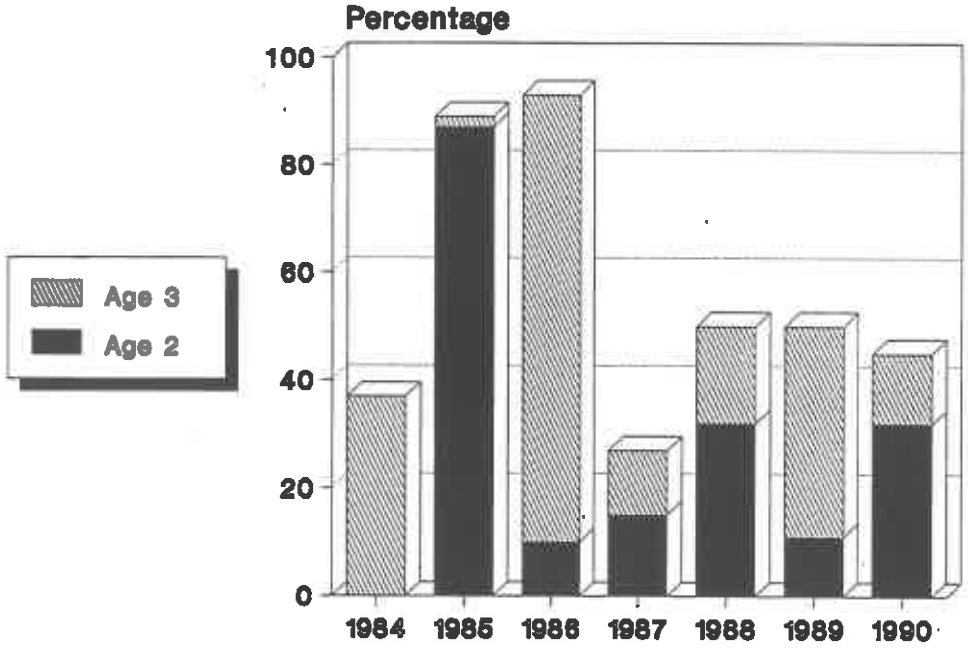


Figure 15. Percentage of age 2 and 3 fall chinook salmon in Lyons Ferry Fish Hatchery broodstock since its inception.

5.2: Electrophoretic Analysis

The genetic status of Lyons Ferry stock is of critical importance for protection of Snake River fall chinook salmon under the Endangered Species Act for two reasons. First, the stock was created by trapping and spawning wild Snake River salmon. As wild salmon have not been genetically sampled since the early 1980's, and has never been sampled on the spawning grounds, electrophoretic data from Lyons Ferry FH gives us our best estimate of the genetic relationship of Snake River stock to other Columbia River fall chinook salmon stocks. Second, while Lyons Ferry stock is derived from wild Snake River salmon, a substantial proportion of the present naturally spawning salmon in Snake River is derived from Lyons Ferry stock. Thus, the genetic composition of the two groups are interrelated. Straying of exotic stocks into the hatchery can impact the genetic composition of the natural spawners as much as straying of exotic stocks onto Snake River spawning grounds.

The purpose of this section is to present and discuss the available data relating to genetic issues associated with the Lyons Ferry salmon program and naturally spawning Snake River fall chinook salmon.

5.2.1: Historical analysis

A large body of electrophoretic data dating back to 1977 exists for salmon collected at Ice Harbor Dam, Lyons Ferry FH broodstock, and related upriver bright fall chinook salmon stocks. These data were collected for a variety of purposes, including: 1) earlier ESA considerations (Utter et al. 1982), 2) concerns about straying, and 3) established baseline stocks for analysis of mixed fisheries (Marshall et al. 1991).

Adults collected at Ice Harbor Dam were sampled annually by NMFS from 1977 to 1982 (collection codes beginning with S or C). Lyons Ferry FH was sampled by NMFS in 1985, and annually since then by WDF (collection codes beginning with W). Priest Rapids FH and the Hanford Reach (mid-Columbia) natural spawners have also been frequently sampled since 1977. Sample sizes in general have been large, usually 100 or more.

Table 22 shows allele frequency data for the common allele in chronological order for selected loci sampled in these stocks. In most cases, only two alleles occur, so little information is lost by exclusion of frequencies for other alleles (complete allele frequency data for several of these collections is presented in Appendix G). Locus nomenclature here and elsewhere in this document follows the system of Shaklee et al. (1990). The loci chosen are those which best discriminate between Snake River and mid-Columbia River salmon. In general, the loci are those used by Utter et al. (1982) to establish the genetic distinctness of the two stock groups, but we have added two potentially informative loci, PGK-2* and PEP-LT*, and excluded some used by Utter et al. (1982).

Table 22. Historical overview of genetic characteristics of Lyons Ferry and associated chinook salmon stocks.

Collection, year, and code	N	Frequency of the common (=*100) allele										
		sAH	PEPA	sIDHP-1,2[a]	LDH-B2	LDH-C	sMDH-B1,2	MPI	PGK-2	PEP-LT	sSOD-1	PEPB-1[b]
Ice Harbor Dam, 1977, S0091	65	---	0.98	---	1.00	1.00	0.99	0.74	- -	- -	0.71	- -
Ice Harbor Dam, 1978, S0092[d]	100	---	1.00	1.00	1.00	0.99	0.98	0.79	- -	- -	0.66	0.92
Ice Harbor Dam, 1979J, S0094[e]	185	---	0.98	1.00	1.00	1.00	0.97	0.83	- -	- -	0.71	0.84
Ice Harbor Dam, 1980, S0095[e]	300	0.91	0.98	0.97	1.00	0.99	0.97	0.79	- -	- -	0.64	0.90
Ice Harbor Dam, 1981, S0096[f]	200	0.874	0.968	0.977	1.000	0.997	0.985	0.793	0.549	0.922[c]	0.705	0.918
Ice Harbor/Kalama FH, 1986, W86PP	100	0.925	0.985	0.928	1.000	0.984	0.972	0.790	0.520	0.924	0.610	0.840
Lyons Ferry FH, 1985J, S0150[c]	100	0.894	0.980	0.964	1.000	0.995	0.973	0.763	0.541	0.904	0.652	0.890
Lyons Ferry FH, 1986, W86OO	100	0.895	0.970	0.960	1.000	0.995	0.978	0.700	0.585	0.875	0.565	0.895
Lyons Ferry FH, 1987, W87BR	99	0.854	0.975	0.957	1.000	0.995	0.982	0.737	0.500	0.904	0.566	0.904
Lyons Ferry FH, 1988, W88AI	100	0.900	0.975	0.935	1.000	1.000	0.970	0.725	0.595	0.825	0.581	0.820
Lyons Ferry FH, 1989, W89CE	100	0.810	0.995	0.924	1.000	0.995	0.962	0.740	0.631	0.825	0.550	0.825
Lyons Ferry FH, 1990CWT, W90DI	100	0.919	0.995	0.959	1.000	0.977	0.970	0.775	0.575	0.830	0.655	0.870
Lyons Ferry FH, 1990(random), W90DT	100	0.815	0.975	0.948	1.000	0.994	0.960	0.680	0.600	0.840	0.571	0.835
Priest Rapids FH, 1977JH, S0194	120	---	1.00	0.89	1.00	0.99	0.98	0.67	---	---	0.49	---
Priest Rapids FH, 1978JW, S0196[d]	45	---	0.98	0.94	1.00	0.99	0.96	0.75	---	---	0.57	0.81
Priest Rapids FH, 1978JH, S0198[d]	98	---	0.99	0.93	1.00	1.00	0.94	0.68	---	---	0.50	0.80
Priest Rapids FH, 1980, S0197[c]	150	0.81	0.99	0.91	1.00	0.97	0.97	0.72	---	---	0.51	0.76
Priest Rapids FH, 1981J, S0195[f]	100	0.825	0.995	0.908	1.000	0.984	0.955	0.705	0.643	0.785[c]	0.550	0.793
Priest Rapids FH, 1986, W86NN	100	0.860	0.970	0.925	1.000	0.980	0.970	0.695	0.565	0.789	0.550	0.770
Priest Rapids FH, 1987, W87BS	100	0.805	0.985	0.905	1.000	0.975	0.980	0.695	0.610	0.758	0.500	0.735
Priest Rapids FH, 1990, W90DN	100	0.815	0.955	0.897	0.995	0.980	0.960	0.660	0.631	0.800	0.540	0.763
Hanford Reach, 1982, C0003[c]	159	0.825	0.974	0.920	1.000	0.980	0.972	0.684	0.599	0.816	0.503	0.785
Hanford Reach, 1990, W90DH	99	0.808	0.990	0.937	1.000	0.984	0.978	0.653	0.591	0.801	0.535	0.762
Little White Salmon FH, 1990, W90DC	100	0.820	0.935	0.948	1.000	1.000	0.965	0.705	0.565	0.830	0.505	0.850
Little White Salmon FH, 1990J, W90AC	100	0.842	0.990	0.945	1.000	0.985	0.975	0.715	0.620	0.840	0.510	0.720
Bonneville, 1990J, W90AE	100	0.790	0.990	0.945	1.000	0.985	0.972	0.692	0.570	0.805	0.545	0.805

[a] Frequency includes the *94 allele
[b] Frequency includes the *-350 allele
[c] David Teel, National Marine Fisheries Service, Northwest Fisheries Science Center, P.O. Box 130, Manchester, WA 98353.
[d] Adapted from Milner et al. 1980.
[e] Adapted from Utter et al. 1982.
[f] Adapted from Utter et al. 1989.

To visualize temporal trends, allele frequency changes at seven genetic systems are represented graphically in Figure 16. Two series of points are plotted, one for Ice Harbor/Lyons Ferry and one for Priest Rapids/Hanford Reach. In years in which data for multiple collections are available, composite allele frequencies were calculated as the unweighted mean of the individual frequencies, with one exception: in 1990 two collections of samples were taken at Lyons Ferry FH, one of known Lyons Ferry salmon (collection W90DI), determined through CWT analysis, and one of untagged fish randomly sampled during spawning (collection W90DT). Data from untagged fish are plotted separately, to evaluate effects of using only tagged fish at the hatchery (Section 2.2.2).

Frequencies at sAH* and PGK-2* are too erratic to indicate trends, although it is clear that the untagged 1990 Lyons Ferry fish are more similar to mid-Columbia fish than the tagged fish. The two series are nearly parallel for MPI* frequencies, but with a large difference between the two 1990 Lyons Ferry collections in the expected directions. The two series of PEPB-1* frequencies appear approximately parallel, and both appear to be headed downward. Ice Harbor/Lyons Ferry frequencies at sSOD-1*, sIDHP-1,2*, and PEPA* exhibit unequivocal trends in the direction of the mid-Columbia series, which in each case remains stable. Except for PEPA*, the common pattern holds of the untagged 1990 Lyons Ferry collection being more like the mid-Columbia fish than the tagged.

Two time periods are of interest in examining these trends, pre-Umatilla straying (before 1984), and after. In all three cases where a strong trend toward mid-Columbia frequencies was observed, the trend was apparent before 1984. This suggests introgression from mid-Columbia fall chinook. The possibility that mid-Columbia dip-ins have been trapped at Ice Harbor Dam is thus compatible with the genetic data.

Although a genetic impact from mid-Columbia fish through straying and possible dip-in capture is evident, the genetic distinction between Snake River and mid-Columbia River salmon remains. A comparison of allele frequencies between 1990 tagged Lyons Ferry and 1990 Priest Rapids collections by chi-square heterogeneity test is highly significant ($p=0.00002$). A similar comparison of 1990 tagged Lyons Ferry collection and 1986 Lyons Ferry collection was insignificant ($p=0.7096$), indicating effects of heavy Umatilla straying in recent years is reduced by restricting broodstock to known Lyons Ferry fish.

Genetic data bearing on another issue, the effect of the Eggbank Program, is shown in Table 22. In 1986 a collection of Snake River stock returns to Kalama Falls (collection code W86PP) was compared by chi-square heterogeneity test to Lyons Ferry FH broodstock. Significant differences were found at two loci, mAH-4* ($p=0.03$, not in Table 22) and MPI* ($p=0.03$), but overall the test was nonsignificant ($p=0.32$; FY 1987 report). This indicates a general maintenance of Snake River stock characteristics through the Eggbank Program.

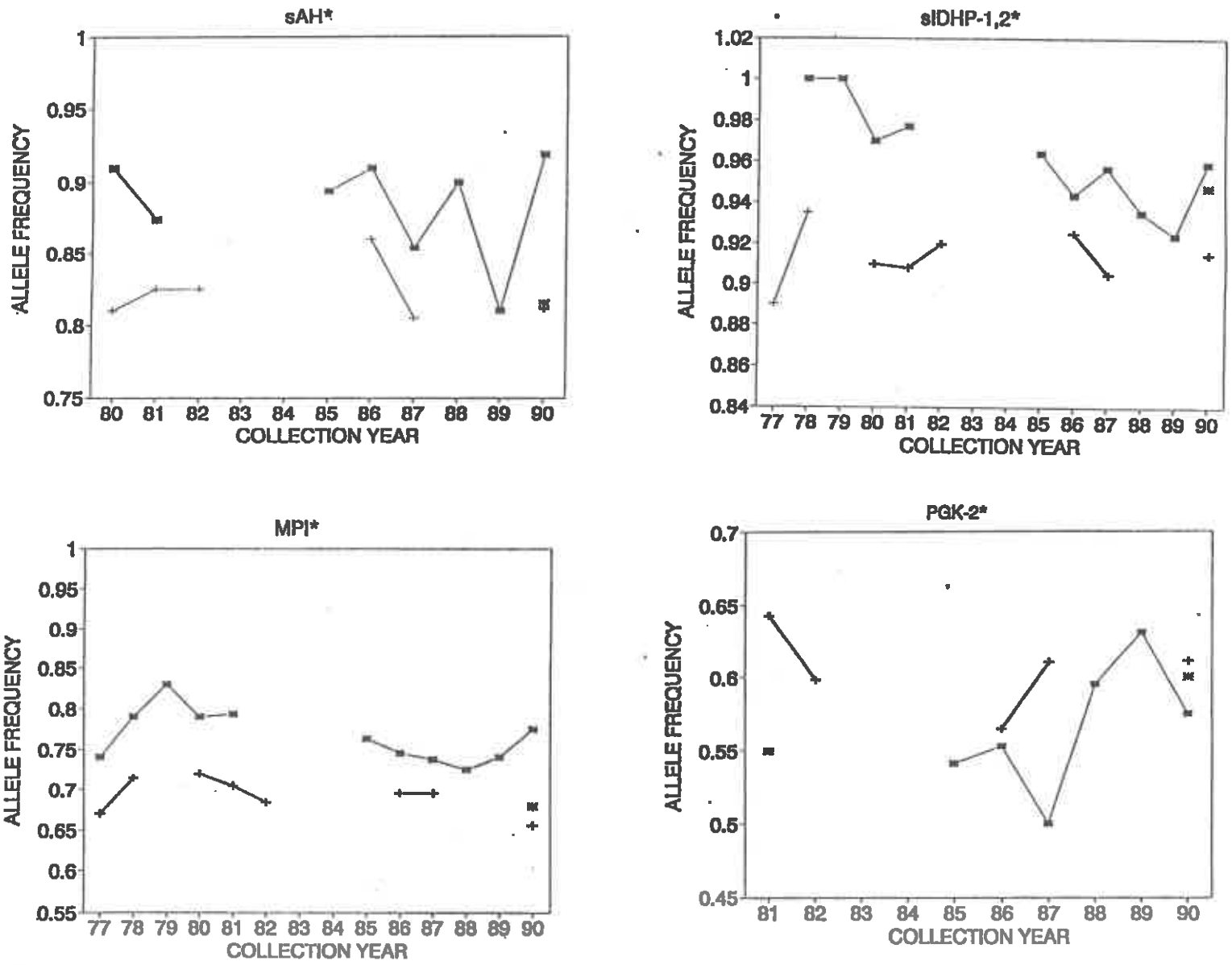
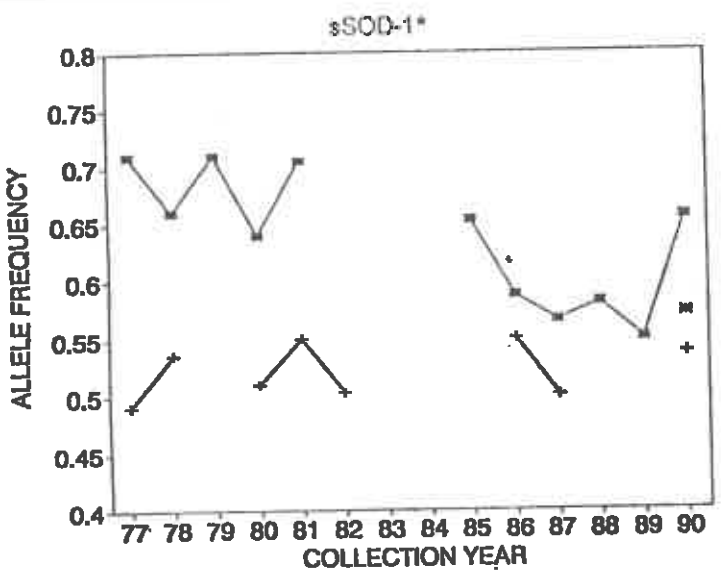
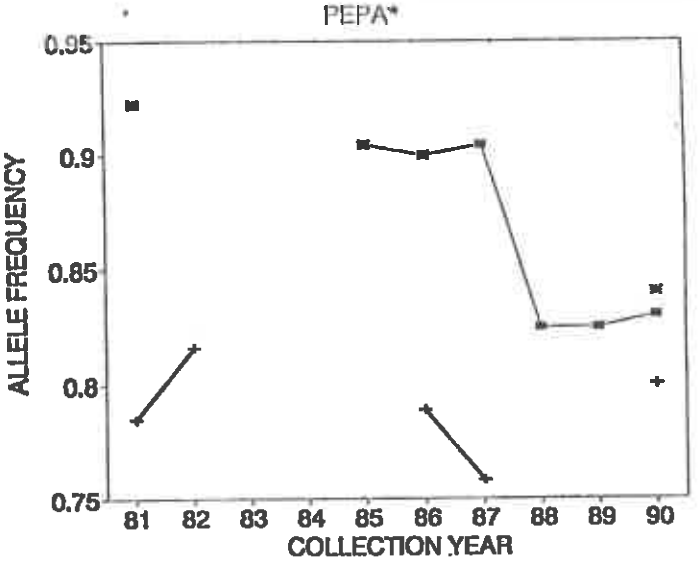


Figure 16. Temporal allele frequency changes at eight loci (including one isolocus) in Ice Harbor Dam/Lyons Ferry FH fall chinook salmon collection (solid squares) and Priest Rapids FH/Hanford Reach fall chinook salmon collection (crosses). The 1990 Lyons Ferry FH value is for the known (tagged) collection (W90DI); the asterisks represent frequencies from the random (untagged) collection (W90DT).





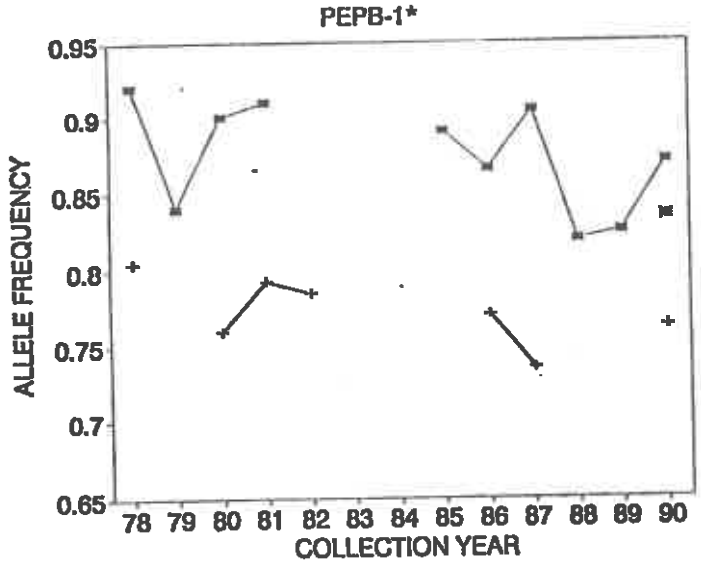


Figure 16, continued.

5.2.2: Genetic relationships of upriver bright fall chinook salmon

Procedures To evaluate genetic relationships among Columbia Basin fall chinook salmon, Nei's (1978) unbiased genetic distance statistic was first calculated for each pairwise comparison of 17 WDF salmon collections, including three from lower Columbia River. We analyzed 31 loci (including four isoloci systems). All loci used are accepted by the coastwide GSI consortium (described by Shaklee and Phelps 1990), and allele pooling was to coastwide standards (e.g. Marshall et al. 1991). To maximize locus coverage, only recent collections (1986 and later) are included. Complete allele frequency information is presented in Appendix G. Collections were clustered by genetic distance using the unweighted pair group (UPGMA) method to generate a dendrogram of genetic relationships (Figure 17).

Results Overall, genetic distances among these stocks are small, with the largest differences seen between upriver and downriver (Spring Creek, Cowlitz, Kalama) stocks. The three downriver stocks are substantially more genetically heterogeneous than upriver ones; within the upriver collections, genetic distances as low as 0.000 are common. Three clusters of upriver stocks are apparent, one consisting of two Priest Rapids collections, one of three Lyons Ferry collections and Marion Drain (Yakima River), and one of all remaining collections.

The clustering of Lyons Ferry 1986, Lyons Ferry 1987, and the 1990 tagged Lyons Ferry collections apart from other upriver collections is to be expected, but the fact that two Priest Rapids collections also cluster apart raises the possibility that the clustering is spurious, based on sampling error. To investigate this possibility, we constructed another dendrogram (not presented) based on only the 10 loci which were polymorphic at the 0.90 level (i.e., those loci in which the frequency of the most common allele was less than 0.90 in at least one collection). The Priest Rapids cluster was still present, but clustered with the large upriver cluster at a smaller distance than did the Lyons Ferry cluster. The clustering, although based on very small distances, does not appear to be a sampling artifact. The clustering is also according to expectation. The heavily "strayed-affected" Lyons Ferry collections cluster with mid-Columbia collections, and the earlier Lyons Ferry collections cluster with the 1990 tagged Lyons Ferry collection. The latter observation is not surprising, since the 1990 fish are the progeny of the 1986 and 1987 fish.

Although overall there is not much electrophoretically detectable genetic variation in upriver salmon, a major portion of the diversity present is represented by the relatively unimpacted Lyons Ferry collections. This indicates the stock's importance in maintaining genetic diversity in upriver Columbia fall chinook salmon.

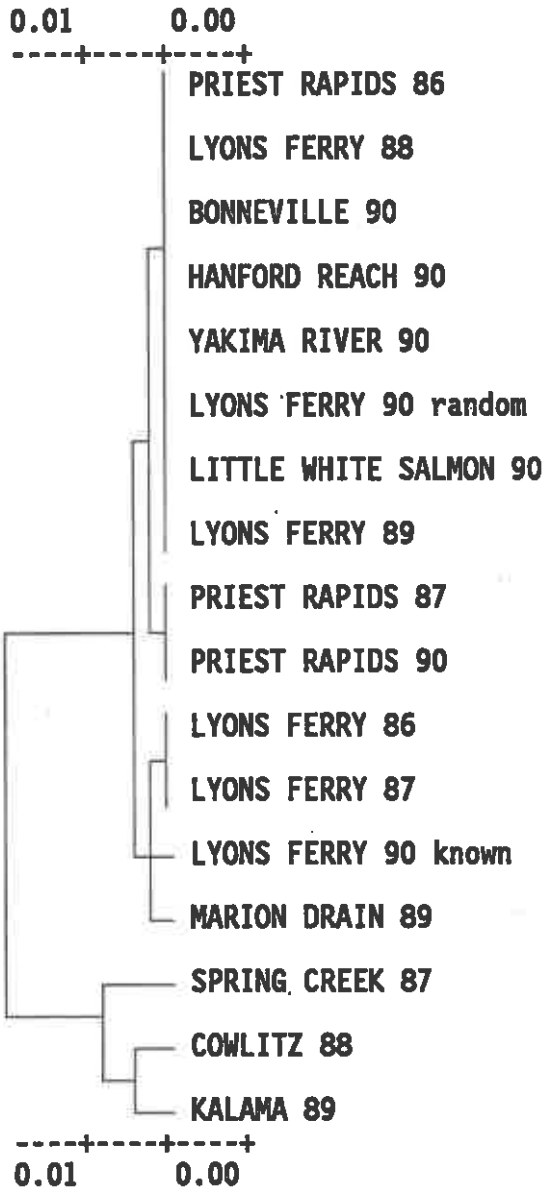


Figure 17. Unweighted pair group (UPGMA) dendrogram of 17 Columbia River fall chinook salmon collections, based upon Nei's (1978) unbiased genetic distance calculated over 31 loci.

The inclusion of the Marion Drain collection within the Lyons Ferry cluster is of interest. Marion Drain is an irrigation drain in lower Yakima River. The Marion Drain collection differs substantially from mainstem Yakima River collection, which clusters with most the upriver collections (Figure 17). The mainstem Yakima River has been heavily planted with hatchery fish in recent years (some of which have strayed to Lyons Ferry FH), so our working hypothesis at this point is that Marion Drain may represent the original Yakima fall chinook salmon stock. Waples[1] constructed dendrograms in which Deschutes River fall chinook salmon also cluster with Lyons Ferry and Marion Drain. This suggests the possibility of Lyons Ferry stock and Snake River wild spawners being part of a larger evolutionarily significant unit (ESU). Unfortunately however, the position natural Snake River spawners would occupy on this dendrogram is unknown. These genetic relationships, suggesting two major groups of Columbia Basin upriver salmon, should be explored further. The WDF Genetics Unit is now in the process of sampling the Deschutes fall chinook salmon.

5.2.3: Discussion and conclusions

A number of genetic issues have been raised concerning the Lyons Ferry program and its relationship to naturally spawning fish above Lower Granite Dam. Probably the oldest is the concern over genetic contamination of the stock during the Egg Bank Program. As mentioned earlier, available electrophoretic data suggests minimal, if any contamination. Spawning procedures were designed to ensure that fish other than Snake River stock were eliminated from the program. All Kalama Falls FH releases were ventral fin-clipped so they could be identified. On one occasion there was confusion over fish identification, but in this case the fish of concern were removed from the program to avoid genetic contamination.

Another long-standing issue has been the wisdom of collecting broodstock at Ice Harbor Dam. Electrophoretic data indicate that Lyons Ferry allele frequencies have become more like mid-Columbia frequencies over time, and started to do so before Umatilla straying began, so our data support the hypothesis of mid-Columbia dip-ins being trapped at Ice Harbor Dam. This trapping would have also exacerbated Umatilla "straying" if Umatilla fish also dip into Snake River.

The hypothesis that Umatilla straying is largely an artifact of Ice Harbor Dam broodstock collection, however, is not supported by CWT data (Section 2.2.2). The percentage of Umatilla fish at Lower Granite Dam in 1990 was virtually the same as the percentage taken at Ice Harbor Dam.

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[1] *Robin Waples, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, WA 98112.*

The impact of straying on the fitness of Snake River salmon, both hatchery and natural, is unknown, and will be very difficult to answer by research. Straying at some level is a natural phenomenon; what level was normal in this part of the basin is unknown. The stocks that stray into Lyons Ferry FH are for the most part not very different genetically from the hatchery stock, so perhaps outbreeding depression is not a large concern. Moreover, many of the hatchery upriver stocks, since they originated from mainstem Columbia River interceptions, may have Snake River ancestry.

A final issue is the genetic relationship between Lyons Ferry FH salmon and natural spawners above Lower Granite Dam. This is unanswerable at present. Research is planned by WDF for 1991 to determine if hatchery and natural fish are segregated on the spawning grounds. If they are segregated, natural fish may be better representatives of the original Snake River fall chinook salmon than the hatchery stock. If there is no segregation, it is probable that the natural spawners are genetically very similar to the Lyons Ferry stock. An average of 31% of the run at Ice Harbor Dam has been trapped for broodstock every year since 1977 (Section 2.1.2), so immigration of wild fish into the hatchery has been substantial. Similarly, the percentage of hatchery fish in the run over Lower Granite Dam has been substantial, so gene flow from the hatchery to the spawning grounds must be high. The question of which has been more heavily impacted by strays, Lyons Ferry FH or the natural spawners, is also not answerable at this point. Certainly in 1990 the hatchery stock and wild spawners were equally strayed into by the Umatilla stock, but we don't know how typical a year 1990 was. We also don't know if other exotic stocks display the same behavior.

The natural spawners and Lyons Ferry stock, if they are not segregated on the spawning grounds, may differ genetically in one important respect, the extent to which effects of straying can be controlled. The 1989 hatchery brood, which was a product of 34% Umatilla straying, was 100% marked at release (Section 4.4). Current plans are to eliminate them from the broodstock, and to stop as many as possible at Lower Granite Dam. In contrast, the 1989 natural brood, if it was similarly impacted by strays, has to sustain the impact. In 1990, Umatilla fish were kept out of the Lyons Ferry FH broodstock by exclusive use of Lyons Ferry tagged fish, whereas natural spawners had to sustain another 23% straying event (Table 8). Although measures are being taken to reduce straying from Umatilla, straying onto the spawning grounds will continue for years, until 100% marked Umatilla fish can be removed from the run at Lower Granite Dam.

It is likely that Lyons Ferry stock may now be genetically more similar to the original Snake River stock than the fish spawning naturally above Lower Granite Dam. Moreover, the naturally spawning group may deviate even further from its ancestral genetic composition before the straying problem can be controlled.

SECTION 6: NATURAL PRODUCTION

In November and December 1990, the Nez Perce Tribe, Idaho Power Company, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and WDF cooperatively surveyed the Snake River from Asotin to Hells Canyon Dam and all its tributaries believed to be used by fall chinook salmon adults. All streams were surveyed with a Hiller 12E helicopter unless noted otherwise.

6.1: Streams Above Lower Granite Dam

6.1.1: Redd deposition

The mainstem Snake River was surveyed for salmon redds on 12 and 26 November, and 11 December 1990, the first year we had three independent surveys. The final tally for all counts was 37 redds 18 adults (Table 23), less than the totals for the period 1987 to 1989 (Table 24). We saw 15 redds on the first flight, 17 new redds on the second, and 5 new redds on the third; peak of spawning was probably 15- 20 November.

Table 23. Date, location, and number of fall chinook salmon redds and adults observed on the Snake River in 1990, and survey when redds were first seen.

River km	Proximal landmark	Number of redds	Number of adults	Survey number
239.8	Tenmile range	1	2	1
246.4	Tenmile Canyon	16	14	1,2,3
254.4	Couse Rapids	1		2
262.1	Captain John Creek	2	1	2
264.1	Captain John Rapids	2		1
266.2	Lower Billy Creek Rapids	1		3
284.4	*Washington/Oregon border*			
308.5	Eureka Creek	2		1
312.7	Divide Creek Rapids	2		2
313.2	Big Canyon Creek	3		2
313.8	Zigzag Creek	2	1	2
320.9	Robinson Gulch	2		1
345.2	Pleasant Valley Creek	1		2
395.3	Brush Creek	2		2
Totals		37	18	

Conditions were good to excellent on all three flights. Secchi disk readings were 8 feet for both the first and second surveys, and 11 feet for the third. Discharge from Hells Canyon Dam for the day of the first flight was maintained at 9,026 cfs, discharge for the second survey was 9,374 cfs, mean discharge for the third survey was 10,844 cfs (range: 10,010- 14,660).

Table 24. Numbers of fall chinook salmon redds and adults seen in mainstem Snake River from 1986 to 1990, with a comparison of visibility and discharge during the surveys.

Year	Number of surveys	Redds	Adults	Visibility (feet)	Discharge (kcfs)
1986	1	7[a]	0	- -	- -
1987	2	66	13	9 -10[b]	13.8 -15.8
1988	2	57	19	9 -10	11.6 -15.6
1989	2	58	27	- -	9.1 -11.7
1990	3	37	18	8 -11	9.0 -10.8

[a] *Flows from Hells Canyon Dam were not lowered for the 1986 survey, which hindered visibility.*

[b] *Visibility readings (measured with a Secchi disk) are taken downstream of the Grande Ronde River; data were not taken in 1986 and 1989.*

The Grande Ronde River was surveyed from the mouth to the Wenaha River confluence (61 km) on 11 December 1990; one redd and no adults were seen. Visibility was poor in the stream because of turbidity. No salmon redds were seen in the Grande Ronde in 1986, seven in 1987, one in 1988, and none in 1989.

The Imnaha River was surveyed from the mouth to the Cow Creek confluence (10 km) on 11 December 1990. Three redds and no adults were seen; all redds were within 500 m of the mouth. Visibility was good. No redds were seen in this reach in 1987, while one redd was observed in this reach both in 1988 and 1989.

The Clearwater River was surveyed from its mouth to the North Fork Clearwater confluence (58 km) on 16 November and 3 December 1990; one redd was seen on the first flight, and 4 on the second (5 total). In this same reach, 21 salmon redds were counted in 1988 and ten in 1989. Conditions were poor on the first count (Secchi disk reading of 6 ft), and very good on the second count (14 ft).

Asotin Creek was surveyed by foot from the mouth to Headgate Dam (11 km) on 8 and 26 November 1990; no redds or adults were seen. We saw no spawning activity in this reach in 1988 or 1989 either. Alpowa Creek was surveyed from the mouth to Banner Ranch (1.5 km) on 6 December 1990; no redds or fish were seen.

The final 1990 fall chinook salmon count at Lower Granite Dam (18 August to 15 December) was 391 adults and 185 jacks (30 to 56 cm fork length). The adult count was down 49% from the 1987 to 1989 average of 761 (1987; 951, 1988; 627, 1989; 706). National Marine Fisheries Service personnel trapped 49 marked (CWT) adults and 94 marked jacks at Lower Granite Dam for WDF broodstock and research needs (Section 2.2.3), adjusting escapement to spawning grounds above the dam to 342 adults and 91 jacks. The total redd count above Lower Granite Dam in 1990 was 46, resulting in a ratio of about 7 adults per sighted redd, compared to 10 in 1989 and 8 in 1988.

6.1.2: Carcass recoveries

With the exception of six-year olds, all adipose-clipped fall chinook salmon observed at Lower Granite Dam originated from downstream hatcheries or collection points, since the last release of marked salmon above the dam was 1984 brood (54,925 subyearlings from Hagerman National Fish Hatchery).

Blankenship[1] recovered 17 fall chinook carcasses off the mainstem Snake River spawning grounds in November 1990. Most were recovered at river kilometer (RK) 246. Four were marked; two were 1986 brood subyearling releases from Lyons Ferry FH, one was a 1985 brood subyearling Lyons Ferry release, and one was a 1985 brood yearling release from Minthorn (Umatilla River). Scale pattern analysis of nine recovered fish indicated they were yearling hatchery releases, and therefore strays. The Nez Perce Tribe recovered two carcasses, one unmarked fish at RK 307, and one marked fish at RK 246, which was a 1986 brood yearling release from Bonifer (Umatilla River)[2]. The U.S. Fish and Wildlife Service recovered a marked fall chinook at Dworshak FH, which was a 1986 brood subyearling release from the lower Umatilla River[3].

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[1] *Lee Blankenship, Washington Department of Fisheries, Olympia, WA, 98504.*

[2] *Michael Banach, Nez Perce Tribe, P.O. Box 365, Lapwai, ID 83540.*

[3] *Ralph Roseburg, U.S. Fish and Wildlife Service, P.O. Box 18, Ahsahka, ID, 83520.*

Washington Department of Wildlife staff confiscated three marked fall chinook salmon during steelhead creel surveys on the mainstem Snake River[1]. Two were collected in Lower Monumental Pool; one was a 1985 brood yearling release from Umatilla River, the other was 1985 brood yearling release from Lyons Ferry FH. The third salmon was recovered near Clarkston (above Lower Granite Dam); it was a 1986 brood subyearling release from Umatilla River.

6.2: Streams Below Lower Granite Dam

6.2.1: Redd deposition

The Tucannon River was surveyed weekly by foot from 5 November to 5 December 1990. Most surveys were from the mouth to the irrigation diversion dam (9.2 km); the 19 November survey extended to Highway 12 (23 km). A total of 61 redds were observed, all below the diversion dam, which appears to be an impediment. Spawning ground density was 6.6 redds/km, compared to 5.2 in 1989, 2.8 in 1988, and 1.7 in 1987.

We found 39 carcasses (31 female, 8 male) in the lower Tucannon River, of which 11 were marked with an adipose clip. Nine coded-wire tags were recovered; eight were from six separate releases from Lyons Ferry FH (Section 3.2.3), and one was a 1986 subyearling release from Umatilla River.

We surveyed the Palouse River from the falls downstream to its confluence with the Snake River on 7 and 26 November 1990. One redd and three adults were seen, compared to two redds and four adults in 1989, the first year this stream was surveyed.

The final 1990 fall chinook salmon count at Ice Harbor Dam (12 August to 31 October) was 3,477 adults and 1,839 jacks (30 to 56 cm fork length). The adult count was down 32% from the 1987 to 1989 average of 5,099. In 1990, 1,092 adults were trapped at Ice Harbor Dam and trucked to Lyons Ferry FH for broodstock (Section 2.1.2). An additional 521 adult and 602 jack fall chinook volunteered to Lyons Ferry FH in 1990 (Section 2.1.1).

In 1990, 1,431 fall chinook salmon adults and 1,052 jacks cannot be accounted for. These values are the difference between the Ice Harbor Dam counts and the sum of the Lower Granite Dam counts, Lyons Ferry FH escapement, and estimated escapement to the Tucannon and Palouse Rivers. Possible

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[1] *Mark Schuck, Washington Department of Wildlife, 411 South First St., Dayton, WA, 99328.*

disposition of these fish include: 1) fall back at Ice Harbor Dam, 2) mortality, or 3) spawning in tailraces of the lower Snake River dams.

Mark rates of fall chinook salmon (all ages) at Ice Harbor Dam in 1990 was 50.6%, compared to 37.6% at Lower Granite Dam (Kleist[1]). Overall mark rate for Lyons Ferry release groups returning in 1990 was about 27%.

[1] *Todd Kleist, Washington Department of Wildlife, P.O. Box 754, Waitsburg, WA, 99361.*

SECTION 7: RECOMMENDATIONS

Current broodstock collection plans for 1991 involve collection at Ice Harbor Dam, Lyons Ferry FH, and Lower Granite Dam. Only tagged fish will be collected at Ice Harbor and Lower Granite Dams. Again, only Lyons Ferry tagged adults will be used as program broodstock. Beginning with the 1990 brood, all fish released from Lyons Ferry will be tagged, greatly increasing the number of tagged adults available for future broodstock. Broodstock collection plans will undoubtedly continue to evolve in response to ESA listing decisions and the role the hatchery program will play in any recovery plan.

The following recommendations are to be considered as supplements to those provided in the FY 1989 report:

1) Two changes to the physical plant are required to improve the capability for rearing salmon to yearlings:

a) We need to investigate the feasibility of constructing large ponds. A large pond is necessary for the additional rearing of yearling fall chinook salmon, as outlined in preliminary plans for future brood years. This pond could also serve as a holding area for Tucannon spring chinook salmon adults. Furthermore, this pond may become useful if a captive brood plan is implemented.

b) There should be exploration for additional well sites. We know, by circumstantial evidence, that at least one well is heavily loaded with manganese. By not using this well during months when salmon are susceptible to bacterial gill disease, we have avoided higher losses and costly treatments. We should consider a replacement for that well, and additional water for rearing yearlings.

2) There should be a direct line from the raceways to the Snake River. This would be beneficial for two reasons; a) a less stressful release in normal situations, and b) provide an emergency release pipe in case of water supply problems.

3) We need the capability for introducing Snake River water to at least some of the ponds. This would have two uses--as a backup water supply, and a potential acclimation water source.

4) Beginning with the 1991 adult returns, ELISA (enzyme linked immunosorbant assay) analyses will be used as a management tool for prevention and control of BKD. Levels of *Renibacterium salmoninarum* antigen in adults should determine incubation and ponding of progeny. At a minimum, progeny of adults with high antigen levels should be segregated from progeny of adults with low or undetectable levels of antigen.

Screening with ELISA could be used to make better-informed decisions in any management strategy for BKD. For example, juveniles could be tested to help determine most effective times to treat with Gallimycin.

5) The yearling on-station release groups need either brands or passive integrated transponder (PIT) tags to guide our decisions for releases and resultant travel time to downstream dams. We hope that PIT tag detection capabilities are to be installed at Lower Monumental Dam, because we time our releases primarily towards effective passage through this dam.

6) Continued funding is required for the fall chinook salmon radio telemetry research. This work, funded by LSRCP for 1991, needs funds for work through 1993. We have solicited funding commitments from Bonneville Power Administration through the Columbia Basin Fish and Wildlife Authority. Information gained through this study include: a) stray salmon behavior and effects upon indigenous natural spawners, b) incidental capture of "dip-ins" at Ice Harbor Dam (i.e., salmon that were bound for mid-Columbia River), c) spawning behavior in the mainstem Snake River, both in the free-flowing and impounded reaches, and d) disposition of salmon in the Snake River that are not accounted for by dam counts and hatchery escapement.

7) Modifications to the upstream migrant trap on the south shore ladder of Ice Harbor Dam is necessary to minimize handling of salmon and steelhead. We recommend a study be done to determine the feasibility of broodstock collection at Lower Monumental or Little Goose Dams in lieu of Ice Harbor Dam.

8) Routine baseline electrophoretic data should be collected annually on all Columbia River fall chinook salmon stocks, to further clarify the relationships among distinct groups. This may ultimately enable geneticists to refine their classification of evolutionarily significant units, and to identifiy which units require the most protection.

9) Yearling production at Lyons Ferry FH is becoming an increasingly important part of the fall chinook salmon program. The proportion of yearlings released has increased from 18% in the 1985 brood to a projected 74% in the 1990 brood. The composition of age 2 jacks in the broodstock will correspondingly increase. A well-established plan for use of gametes from this age group will be needed.

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APPENDIX A

Washington Department of Fisheries' objectives for the LSRCP Hatchery Evaluation Program. These objectives are interrelated in scope, and are not set in priority.

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

2) Maintain records of adult returns to the Snake River Basin for each rearing program, categorized by stock and brood year. Data are collected at hatchery racks and spawning grounds by program staff, and compared with escapement to other hatcheries and streams throughout the Columbia River Basin.

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

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

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

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

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

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

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

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

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

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

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

APPENDIX B

Lyons Ferry fall chinook salmon releases and proportion marked (coded-wire tag) compared by release year and group.

Brood year release group	Number marked	Number unmarked	Mark rate	Total released
1983				
yearling on-station	334,442	315,858	0.5143	650,300
1984				
subyearling on-station	234,985	304,407	0.4356	539,392
yearling on-station	258,355	223,595	0.5361	481,950
1985				
subyearling on-station	246,625	1,295,543	0.1599	1,542,168
subyearling transport	245,561	1,831	0.9926	247,392
yearling on-station	152,479	77,934	0.6618	230,413
yearling transport	156,036	470	0.9970	156,506
1986				
subyearling on-station	251,646	86,139	0.7450	337,785
subyearling transport	255,998	80,264	0.7613	336,262
yearling on-station	117,705	168,906	0.4107	286,611
yearling transport	120,804	425	0.9965	121,229
1987				
subyearling on-station	248,739	1,760,409	0.1238	2,009,148
subyearling transport	245,749	2,318,550	0.0958	2,564,299
yearling on-station	115,350	177,852	0.3934	293,202
yearling transport	119,217	598	0.9950	119,815
1988				
subyearling on-station	226,478	869,124	0.2067	1,095,602
subyearling transport	234,103	435,728	0.3495	669,831
yearling on-station	112,519	167,526	0.4018	280,045
yearling transport	117,977	38,332	0.7548	156,309
1989				
subyearling on-station	246,873	2,556,060[a]	0.0881	2,802,933
subyearling transport	238,045	9,503	0.9616	247,548

[a] All 1989 brood subyearlings released on-station were marked; those listed as unmarked had a blank-wire tag and no adipose clip.

APPENDIX C

Percent survival of fall chinook salmon released from Lyons Ferry Fish Hatchery since its inception. Survival rates are based upon coded-wire tag recoveries, which are listed by age of release (subyearling or yearling) either released on-station or transported below Ice Harbor Dam. Recoveries include all fisheries, hatchery returns, jack collections at Lower Granite Dam, and spawning ground recoveries.

Brood year	Release type	Tagcode	Number marked	Recovery year	Fishery contribution observed	Fishery contribution expanded	Hatchery returns observed	Hatchery returns expanded	Lower Granite observed	Lower Granite expanded	Spawning grounds	Total	Percent survival
1983	Yearling on-station	63/32/18	83,611	1985	14	36	504	1,358	16	32	0	1,426	
				1986	188	690	158	523	12	24	0	1,237	
				1987	1,022	3,795	376	1,351	0	0	1	5,147	
				1988	169	635	91	307	0	0	0	942	
				1989	7	24	0	0	0	0	0	24	
				1990	0	0	1	3	0	0	0	3	
				totals	1,400	5,180	1,130	3,542	28	56	1	8,779	10.50
1983	Yearling on-station	63/21/52	250,831	1985	55	156	1,425	3,841	35	70	0	4,067	
				1986	584	2,343	512	1,694	28	56	0	4,093	
				1987	2,706	10,437	1,069	3,841	1	2	1	14,281	
				1988	440	1,683	187	631	0	0	0	2,314	
				1989	9	38	1	4	0	0	0	42	
				totals	3,739	14,501	1,769	6,170	29	58	1	20,730	8.26
1984	Yearling on-station	63/28/41	258,355	1986	2	6	49	162	4	8	0	176	
				1987	47	188	91	327	3	6	0	521	
				1988	267	941	99	334	0	0	3	1,278	
				1989	106	385	20	71	0	0	0	456	
				1990	12	38	4	11	0	0	1	50	
				totals	434	1,558	263	906	7	14	4	2,482	0.96
1984	Subyearling on-station	63/32/26	78,417	1986	12	36	13	43	24	49	0	128	
				1987	51	195	37	133	0	0	0	328	
				1988	41	146	19	64	0	0	0	210	
				1989	5	21	0	0	0	0	0	21	
				1990	0	0	0	0	0	0	0	0	
				totals	109	398	69	240	24	49	0	687	0.88

Appendix C, continued.

Brood year	Release type	Tagcode	Number marked	Recovery year	Fishery contribution observed	Fishery contribution expanded	Hatchery returns observed	Hatchery returns expanded	Lower Granite observed	Lower Granite expanded	Spawning grounds	Total	Percent survival
1984	Subyearling on-station	63/32/27	78,064	1986	7	27	12	40	13	26	0	93	
				1987	38	142	36	129	0	0	0	271	
				1988	56	216	19	64	0	0	0	280	
				1989	4	17	1	4	0	0	0	21	
				1990	1	3	0	0	0	0	0	3	
				totals	106	405	68	237	13	26	0	668	0.86
1984	Subyearling on-station	63/32/28	78,504	1986	8	29	9	30	19	38	0	97	
				1987	39	134	45	162	1	2	0	298	
				1988	40	149	21	71	0	0	1	221	
				1989	8	22	2	7	0	0	0	29	
				totals	95	334	77	221	20	40	1	644	0.82
1985	Subyearling transport	63/36/33	49,112	1987	0	0	1	4	0	0	0	4	
				1988	3	13	0	0	0	0	0	13	
				1989	12	49	2	7	0	0	0	56	
				1990	7	15	3	9	0	0	0	24	
				totals	22	77	6	19	0	0	0	96	0.20
1985	Subyearling transport	63/36/34	49,112	1987	0	0	1	4	0	0	0	4	
				1988	5	18	3	10	0	0	0	28	
				1989	8	34	3	11	0	0	0	45	
				1990	0	0	5	14	0	0	0	14	
				totals	13	52	12	39	0	0	0	91	0.18
1985	Subyearling transport	63/36/35	49,112	1988	4	15	2	7	0	0	0	22	
				1989	6	20	3	11	0	0	0	31	
				1990	0	0	3	9	0	0	0	9	
				totals	10	35	8	26	0	0	0	61	0.12

Appendix C, continued.

Brood year	Release type	Tagcode	Number marked	Recovery year	Fishery contribution observed	Fishery contribution expanded	Hatchery returns observed	Hatchery returns expanded	Lower Granite observed	Lower Granite expanded	Spawning grounds	Total	Percent survival
1985	Subyearling transport	63/36/36	49,113	1987	0	0	1	4	0	0	0	4	
				1988	4	14	2	7	0	0	0	21	
				1989	5	19	3	11	0	0	0	30	
				1990	0	0	3	9	0	0	0	9	
				totals	9	33	9	30	0	0	0	63	0.13
1985	Subyearling transport	63/36/37	49,112	1987	1	4	4	14	3	6	0	24	
				1988	3	10	2	7	0	0	0	17	
				1989	9	31	3	11	0	0	0	42	
				1990	5	20	2	6	0	0	0	26	
				totals	18	65	11	38	3	6	0	109	0.22
1985	Subyearling on-station	63/36/38	98,650	1987	1	5	4	14	3	6	0	25	
				1988	3	11	2	7	0	0	0	18	
				1989	13	85	3	11	0	0	0	96	
				1990	5	14	5	14	0	0	0	28	
				totals	22	115	14	46	3	6	0	167	0.17
1985	Subyearling on-station	63/36/39	49,325	1987	1	5	1	4	5	10	0	19	
				1988	3	13	7	24	0	0	0	37	
				1989	15	47	2	7	0	0	0	54	
				1990	3	10	6	17	0	0	0	27	
				totals	22	75	16	52	5	10	0	137	0.28
1985	Subyearling on-station	63/36/40	49,325	1987	0	0	3	11	4	8	0	19	
				1988	3	15	2	7	0	0	1	23	
				1989	9	37	2	7	0	0	0	44	
				1990	3	10	3	9	0	0	1	20	
				totals	15	62	10	33	4	8	2	105	0.21

Appendix C, continued.

Brood year	Release type	Tagcode	Number marked	Recovery year	Fishery contribution observed	Fishery contribution expanded	Hatchery returns observed	Hatchery returns expanded	Lower Granite observed	Lower Granite expanded	Spawning grounds	Total	Percent survival
1985	Subyearling on-station	63/36/41	49,325	1987	0	0	7	25	1	2	0	27	
				1988	2	5	3	10	0	0	1	16	
				1989	12	41	0	0	0	0	0	41	
				1990	5	17	2	6	0	0	0	23	
				totals	19	63	12	41	1	2	1	107	0.22
1985	Subyearling on-station	63/36/42	49,325	1987	1	4	3	11	3	6	0	21	
				1988	5	14	6	20	0	0	0	34	
				1989	11	39	0	0	0	0	0	39	
				1990	4	17	1	3	0	0	0	20	
				totals	21	74	10	34	3	6	0	114	0.23
1985	Yearling on-station	63/41/56	152,479	1987	6	28	130	467	15	31	0	526	
				1988	79	234	122	412	8	16	0	662	
				1989	448	1,708	71	252	0	0	0	1,960	
				1990	143	512	81	233	0	0	0	745	
				totals	676	2,482	404	1,363	23	47	0	3,892	2.55
1985	Yearling transport	63/41/59	156,036	1987	8	32	113	406	2	4	0	442	
				1988	92	286	121	408	2	4	1	699	
				1989	442	1,663	75	266	0	0	0	1,929	
				1990	157	553	70	201	0	0	2	756	
				totals	699	2,534	379	1,281	4	8	3	3,826	2.45
1986	Subyearling on-station	63/42/61	125,570	1988	1	4	17	57	0	0	0	61	
				1989	25	105	3	11	0	0	0	116	
				1990	51	176	26	75	0	0	1	252	
				totals	77	285	46	143	0	0	1	429	0.34

Appendix C, continued.

Brood year	Release type	Tagcode	Number marked	Recovery year	Fishery contribution observed	Fishery contribution expanded	Hatchery returns observed	Hatchery returns expanded	Lower Granite observed	Lower Granite expanded	Spawning grounds	Total	Percent survival
1986	Subyearling on-station	63/42/59	126,076	1988	2	6	7	24	0	0	0	30	
				1989	19	93	12	43	0	0	0	136	
				1990	57	185	34	98	0	0	1	284	
				totals	78	284	53	164	0	0	1	449	0.36
1986	Subyearling transport	63/42/62	127,715	1988	6	23	64	216	4	8	0	247	
				1989	51	197	17	60	0	0	0	257	
				1990	67	219	40	115	0	0	2	336	
				totals	124	439	121	391	4	8	2	840	0.66
1986	Subyearling transport	63/44/01	128,283	1988	10	31	68	229	3	6	0	266	
				1989	42	139	21	74	0	0	0	213	
				1990	77	290	54	155	1	2	2	449	
				totals	129	460	143	459	4	8	2	929	0.72
1986	Yearling transport	63/44/07	60,523	1988	0	0	63	213	1	2	0	215	
				1989	26	121	9	32	0	0	0	153	
				1990	143	520	51	147	0	0	1	668	
				totals	169	641	123	391	1	2	1	1,035	1.71
1986	Yearling transport	63/44/08	60,281	1988	0	0	73	246	0	0	0	246	
				1989	24	73	22	78	0	0	0	151	
				1990	128	472	44	126	0	0	0	598	
				totals	152	545	139	451	0	0	0	996	1.65
1986	Yearling on-station	63/44/11	58,735	1988	0	0	44	148	2	4	0	152	
				1989	20	75	19	67	0	0	0	142	
				1990	125	453	44	126	0	0	0	579	
				totals	145	528	107	342	2	4	0	874	1.49

Appendix C, continued.

Brood year	Release type	Tagcode	Number marked	Recovery year	Fishery contribution observed	Fishery contribution expanded	Hatchery returns observed	Hatchery returns expanded	Lower Granite observed	Lower Granite expanded	Spawning grounds	Total	Percent survival
1986	Yearling on-station	63/44/13	58,970	1988	1	3	51	172	1	2	0	177	
				1989	28	95	10	35	0	0	0	130	
				1990	114	442	52	149	0	0	0	591	
				totals	143	540	113	357	1	2	0	899	1.52
1987	Yearling transport	63/47/50	59,608	1989	0	0	0	0	0	0	0	0	
				1990	39	86	28	80	1	2	0	168	
				totals	39	86	28	80	1	2	0	168	0.28
1987	Yearling on-station	63/47/52	57,756	1989	0	0	0	0	0	0	0	0	
				1990	10	18	9	26	3	6	0	50	
				totals	10	18	9	26	3	6	0	50	0.09
1987	Yearling transport	63/47/55	59,609	1989	0	0	0	0	0	0	0	0	
				1990	29	79	29	83	2	4	0	166	
				totals	29	79	29	83	2	4	0	166	0.28
1987	Yearling on-station	63/47/56	57,594	1989	0	0	0	0	0	0	0	0	
				1990	8	23	10	29	2	4	0	56	
				totals	8	23	10	29	2	4	0	56	0.10
1987	Subyearling transport	63/52/11	122,850	1989	0	0	0	0	0	0	0	0	
				1990	2	3	1	3	0	0	0	6	
				totals	2	3	1	3	0	0	0	6	0.00
1987	Subyearling transport	63/52/13	122,899	1989	1	2	0	0	0	0	0	2	
				1990	1	7	3	9	0	0	0	16	
				totals	2	9	3	9	0	0	0	18	0.01

Appendix C, continued.

Brood year	Release type	Tagcode	Number marked	Recovery year	Fishery contribution observed	Fishery contribution expanded	Hatchery returns observed	Hatchery returns expanded	Lower Granite observed	Lower Granite expanded	Spawning grounds	Total	Percent survival
1987	Subyearling	63/52/14	124,345	1989	1	4	0	0	0	0	0	4	
	on-station			1990	1	3	3	9	2	4	0	16	
				totals	2	7	3	9	2	4	0	20	0.02
1987	Subyearling	63/52/16	134,394	1989	0	0	0	0	0	0	0	0	
	on-station			1990	2	5	4	11	1	2	0	18	
				totals	2	5	4	11	1	2	0	18	0.01
1988	Subyearling	63/52/04	116,935	1990	0	0	3	9	1	2	0	11	
	transport			totals	0	0	3	20	1	2	0	11	0.01
1988	Subyearling	63/52/07	117,168	1990	1	2	1	3	0	0	0	5	
	transport			totals	1	2	1	23	0	0	0	5	0.00
1988	Subyearling	63/02/26	113,193	1990	2	3	1	3	2	4	0	10	
	on-station			totals	2	3	1	26	2	4	0	10	0.01
1988	Subyearling	63/02/28	113,285	1990	0	0	1	3	5	10	0	13	
	on-station			totals	0	0	1	29	5	10	0	13	0.01
1988	Yearling	63/02/32	78,155	1990	0	0	76	218	1	2	0	220	
	transport			totals	0	0	76	247	1	2	0	220	0.28
1988	Yearling	63/32/31	78,154	1990	0	0	65	187	2	4	0	191	
	transport			totals	0	0	65	434	2	4	0	191	0.24
1988	Yearling	63/02/35	139,520	1990	0	0	80	230	2	4	0	234	
	on-station			totals	0	0	80	664	2	4	0	234	0.17
1988	Yearling	63/02/37	140,363	1990	0	0	73	210	6	12	0	222	
	on-station			totals	0	0	73	874	6	12	0	222	0.16

APPENDIX D

Contribution of 1984, 1985, 1986, 1987, and 1988 broods Lyons Ferry fall chinook salmon to commercial, Indian, and sport fisheries, escapement to the hatchery rack and Lower Granite Dam. Data are based on CWT tag recoveries from 1986 through 1990.

Table 1. Recoveries of 1984 brood fall chinook salmon subyearlings released on-station in June 1985. Tagcode was 633226. Mark rate was 43.55 percent (78,417 out of 180,053). Size of fish at release was 67.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1986			
Mixed Net and Seine - CDFO	8	22	430
Columbia River Gillnet - ODFW	3	11	453
Sport (Private) - WDF	1	3	470
Lyons Ferry hatchery rack	13	13	464
Lower Granite Dam trap	24	49	462
1986 totals:	49	98	458
1987			
Ocean Troll (Non-treaty) - CDFO	12	65	688
Ocean Sport - CDFO	3	12	
Columbia River Gillnet - ODFW	14	58	666
Ocean Sport - ODFW	2	5	640
Ocean Troll (Non-treaty) - ODFW	10	23	683
Estuary Sport - ODFW	1	3	640
Ocean Troll (Non-treaty) - ADFG	1	2	740
Ocean Gillnet (non-treaty) - ADFG	1	1	590
Treaty Troll - WDF	1	6	490
Ocean Troll (Non-treaty) - WDF	1	2	670
Sport (Charter) - WDF	3	7	670
Sport (Private) - WDF	2	8	735
Lyons Ferry hatchery rack	37	37	670
1987 totals:	88	229	671
1988			
Ocean Troll (Non-treaty) - CDFO	17	62	804
Ocean Troll (Non-treaty) - ODFW	2	7	827
Test Fishery Net - ODFW	1	1	980
Columbia River Gillnet - ODFW	17	66	826
Ocean Troll (Non-treaty) - WDF	2	8	715
Treaty Troll - WDF	1	2	500
Lyons Ferry Hatchery rack	19	19	
1988 totals:	59	165	807

Appendix D, Table 1, continued.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Columbia River Gillnet - ODFW	4	20	910
Ocean Troll (Non-treaty) - ADFG	1	1	
1989 totals:	5	21	910
1990 No recoveries.			
Totals for tagcode 633226:	201	513	649

Table 2. Recoveries of 1984 brood fall chinook salmon subyearlings released on-station in June 1985. Tagcode was 633227. Mark rate was 43.56 percent (78,064 out of 179,199). Size of fish at release was 67.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1986			
Mixed Net and Seine - CDFO	4	13	445
Columbia River Gillnet - ODFW	3	14	480
Lyons Ferry hatchery rack	12	12	458
Lower Granite Dam trap	13	27	454
1986 totals:	32	66	457
1987			
Ocean Troll (Non-treaty) - CDFO	10	36	664
Mixed Net and Seine - CDFO	1	4	564
Ocean Sport - CDFO	1	4	
Columbia River Gillnet - ODFW	1	49	670
Ocean Sport - ODFW	2	4	725
Ocean Troll (Non-treaty) - ODFW	7	25	669
Estuary Sport - ODFW	1	3	752
Ocean Troll (Non-treaty) - ADFG	1	2	630
Sport (Private) - WDF	1	3	710
Sport (Charter) - WDF	1	2	710
Ocean Troll (Non-treaty) - WDF	1	3	700
Lyons Ferry hatchery rack	36	36	659
1987 totals:	73	171	666

Appendix D, Table 2, continued.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Ocean Troll (Non-treaty) - CDFO	15	61	793
Ocean Troll (Non-treaty) - CDFO	1	13	855
Columbia River Gillnet - ODFW	24	91	821
Ocean Troll (Non-treaty) - ODFW	3	7	846
Ocean Troll (Non-treaty) - ADFG	4	9	820
Treaty Troll - WDF	1	1	610
Ocean Troll (Non-treaty) - WDF	6	21	788
Sport (Private) - WDF	2	11	785
Lyons Ferry hatchery rack	19	19	
1988 totals:	75	233	807
1989			
Ocean Troll (Non-treaty) - CDFO	1	4	1,022
Columbia River Gillnet - ODFW	3	13	877
Lyons Ferry hatchery rack	1	1	
1989 totals:	5	18	914
1990			
Ocean Troll (Non-treaty) - CDFO	1	3	
Totals for tagcode 633227:	186	490	681

Appendix D, continued.

Table 3. Recoveries of 1984 brood fall chinook salmon subyearlings released on-station in June 1985. Tagcode was 633228. Mark rate was 43.58 percent (78,504 out of 180,140). Size of fish at release was 67.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1986			
Mixed Net and Seine - CDFO	5	19	419
Columbia River Gillnet - ODFW	3	10	516
Lyons Ferry hatchery rack	9	9	432
Lower Granite Dam trap	19	39	456
1986 totals:	36	77	451
1987			
Ocean Troll (Non-treaty) - CDFO	12	57	687
Ocean Sport - CDFO	1	4	
Columbia River Gillnet - ODFW	6	26	698
Ocean Troll (Non-treaty) - ODFW	11	22	685
Ocean Troll (Non-treaty) - ADFG	3	5	698
Ocean Sport - ADFG	1	1	527
Ocean Troll (Non-treaty) - WDF	4	16	678
Sport (Private) - WDF	1	2	720
Lyons Ferry hatchery rack	45	45	656
Lower Granite Dam trap	1	2	530
1987 totals:	85	182	667
1988			
Ocean Troll (Non-treaty) - CDFO	12	52	754
Columbia River Sport - ODFW	1	8	800
Estuary Sport - ODFW	2	7	773
Columbia River Gillnet - ODFW	16	57	812
Ocean Troll (Non-treaty) - ODFW	1	2	690
Ocean Troll (Non-treaty) - ADFG	3	6	740
Treaty Troll - WDF	3	10	663
Ocean Troll (Non-treaty) - WDF	2	5	695
Lyons Ferry hatchery rack	21	21	
1988 totals:	61	168	767
1989			
Ocean Troll (Non-treaty) - CDFO	3	10	873
Columbia River Gillnet - ODFW	3	9	840
Ocean Troll (Non-treaty) - ADFG	1	2	950
Ocean Sport - ADFG	1	1	838
Lyons Ferry hatchery rack	2	2	
1989 totals:	10	24	866
Totals for tagcode 633228:	171	451	656

Appendix D, continued.
Table 4. Recoveries of 1984 brood fall chinook salmon yearlings released on station in April 1986. Tagcode was 632841. Mark rate was 58.49 percent (258,355 out of 441,676). Size of fish at release was 8.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1986			
Mixed Net and Seine - CDFO	1	2	
Columbia River Gillnet - ODFW	1	4	378
Lyons Ferry hatchery rack	49	49	362
Lower Granite Dam trap	4	8	333
1986 totals:	55	63	360
1987			
Ocean Troll (Non-treaty) - CDFO	5	40	507
Mixed Net and Seine - CDFO	12	37	486
Ocean Sport - CDFO	7	28	
Columbia River Gillnet - ODFW	9	43	546
Ocean Sport - ODFW	3	8	546
Ocean Troll (Non-treaty) - ODFW	1	3	530
Treaty Troll - WDF	1	5	530
Sport (Private) - WDF	4	12	563
Estuary Sport - WDF	3	12	
Mixed Net and Seine - WDF	1	5	550
Sport (Charter) - WDF	1	2	530
Lyons Ferry hatchery rack	90	91	537
Lower Granite Dam trap	3	6	507
1987 totals:	140	292	525
1988			
Ocean Troll (Non-treaty) - CDFO	94	378	704
Mixed Net and Seine - CDFO	1	2	744
Ocean Sport - CDFO	2	8	
Ocean Troll (Non-treaty) - CDFG	1	4	740
Ocean Troll (Non-treaty) - ODFW	58	194	703
Columbia River Gillnet - ODFW	41	156	727
Ocean Sport - ODFW	3	6	740
Ocean Troll (Non-treaty) - ADFG	2	2	718
Treaty Troll - WDF	18	51	595
Coastal Gillnet - WDF	1	2	910
Ocean Troll (Non-treaty) - WDF	28	83	689
Sport (Private) - WDF	7	27	683
Sport (Charter) - WDF	9	18	679
Estuary Sport - WDF	1	5	
Lyons Ferry hatchery rack	98	98	
1988 totals:	364	1,034	696

Appendix D, Table 4, continued.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Ocean Troll (Non-treaty) - CDFO	25	105	811
Ocean Sport - CDFG	2	14	854
Ocean Troll (Non-treaty) - CDFG	1	3	850
Estuary Sport - ODFW	1	3	980
Columbia River Gillnet - ODFW	45	165	835
Ocean Troll (Non-treaty) - ODFW	8	35	787
Ocean Troll (Non-treaty) - ADFG	1	2	888
Treaty Troll - WDF	5	9	676
Ocean Troll (Non-treaty) - WDF	11	26	760
Sport (Private) - WDF	5	19	790
Sport (Charter) - WDF	2	4	
Lyons Ferry hatchery rack	20	20	
1989 totals:	126	405	810
1990			
Col. River Gillnet - ODFW	8	31	795
Ocean Troll (Non-treaty) - ODFW	1	3	790
Ocean Troll (Non-treaty) - WDF	1	2	730
Ocean Troll (Non-treaty) - ADFG	1		
Mixed Net and Seine - CDFO	1	1	796
1990 Totals:	12	37	788
Totals for tagcode 632841:	745	1870	673

Appendix D, continued.

Table 5. Recoveries of 1985 brood fall chinook salmon subyearlings transported below Ice Harbor Dam in June 1986. Tagcode was 633633. Mark rate was 99.26 percent (49,112 out of 49,478). Size of fish at release was 55.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Lyons Ferry hatchery rack	1	1	500
1987 total:	1	1	500
1988			
Ocean Troll (Non-treaty) - CDFO	2	9	682
Columbia River Gillnet - ODFW	1	4	675
1988 totals:	3	13	679
1989			
Ocean Troll (Non-treaty) - CDFO	6	30	786
Columbia River Gillnet - ODFW	4	12	848
Ocean Troll (Non-treaty) - ADFG	2	7	833
Lyons Ferry hatchery rack	2	2	
1989 totals:	14	51	817
1990			
Col. River Gillnet - ODFW	4	11	904
Estuary Sport - WDF	1		
Multiple Gear - ADFG	1		
Mixed Net and Seine - CDFO	1	2	935
1990 Totals:	7	13	910
Totals for tagcode 633633:	32	81	804

Appendix D, continued.

Table 6. Recoveries of 1985 brood fall chinook salmon subyearlings transported below Ice Harbor Dam in June 1986. Tagcode was 633634. Mark rate was 99.26 percent (49,112 out of 49,478). Size of fish at release was 55.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Lyons Ferry hatchery rack	1	1	440
1987 totals:	1	1	440
1988			
Ocean Troll (Non-treaty) - CDFO	1	3	
Ocean Troll (Non-treaty) - ODFW	1	4	620
Columbia River Gillnet - ODFW	2	8	654
Mixed Net and Seine - WDF	1	3	640
Lyons Ferry hatchery rack	3	3	
1988 totals:	8	21	642
1989			
Ocean Troll (Non-treaty) - CDFO	3	16	787
Columbia River Gillnet - ODFW	3	13	856
Ocean Troll (Non-treaty) - ADFG	1	3	931
Ocean Troll (Non-treaty) - WDF	1	2	850
Lyons Ferry hatchery rack	3	3	
1989 totals:	11	37	839
1990			
Col. River Gillnet - ODFW	3	7	992
Ocean Troll (Non-treaty) - ADFG	2		920
Ocean Troll (Non-treaty) - CDFO	1		980
1990 Totals:	6	7	975
Totals for tagcode 633634:	31	72	797

Appendix D, continued.

Table 7. Recoveries of 1985 brood fall chinook salmon subyearlings transported below Ice Harbor Dam in June 1986. Tagcode was 633635. Mark rate was 99.26 percent (49,112 out of 49,478). Size of fish at release was 55.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Ocean Troll (Non-treaty) - CDFO	2	9	663
Columbia River Gillnet - ODFW	1	4	662
Treaty Troll - WDF	1	2	510
Lyons Ferry hatchery rack	2	2	
1988 totals:	6	17	624
1989			
Ocean Troll (Non-treaty) - CDFO	2	7	869
Columbia River Gillnet - ODFW	3	11	812
Ocean Troll (Non-treaty) - ADFG	1	3	785
Lyons Ferry hatchery rack	3	3	
1989 totals:	9	24	826
1990			
Ocean Troll (Non-treaty) - ODFW	1	4	850
Col. River Gillnet - ODFW	1	2	965
1990 Totals:	2	6	908
Totals for tagcode 633635:	23	53	778

Appendix D, continued.

Table 8. Recoveries of 1985 brood fall chinook salmon subyearlings transported below Ice Harbor Dam in June 1986. Tagcode was 633636. Mark rate was 99.26 percent (49,113 out of 49,480). Size of fish at release was 55.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Lyons Ferry hatchery rack	1	1	460
1987 totals:	1	1	460
1988			
Ocean Troll (Non-treaty) - CDFO	1	5	720
Columbia River Gillnet - ODFW	1	5	651
Treaty Troll - WDF	1	1	570
Sport (Charter) - WDF	1	2	620
Lyons Ferry hatchery rack	1	1	
1988 totals:	5	15	640
1989			
Columbia River Gillnet - ODFW	3	12	865
Ocean Troll (Non-treaty) - ODFW	1	4	790
Ocean Troll (Non-treaty) - ADFG	1	3	875
Lyons Ferry hatchery rack	4	4	
1989 totals:	9	23	852
1990			
Col. River Gillnet - ODFW	3	10	883
Ocean Troll (Non-treaty) - ADFG	1	5	878
Ocean Troll (Non-treaty) - CDFO	2	6	876
1990 Totals:	6	21	880
Totals for tagcode 633636:	25	64	798

Appendix D, continued.

Table 9. Recoveries of 1985 brood fall chinook salmon subyearlings transported below Ice Harbor Dam in June 1986. Tagcode was 633637. Mark rate was 99.26 percent (49,112 out of 49,478). Size of fish at release was 55.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Mixed Net and Seine - CDFO	1	4	
Lyons Ferry hatchery rack	3	3	460
1987 totals:	4	7	460
1988			
Ocean Troll (Non-treaty) - CDFO	1	5	663
Columbia River Gillnet - ODFW	1	3	623
Treaty Troll - WDF	1	2	510
Lyons Ferry hatchery rack	5	5	
1988 totals:	8	15	599
1989			
Ocean Troll (Non-treaty) - CDFO	2	10	781
Columbia River Gillnet - ODFW	3	13	820
Ocean Troll (Non-treaty) - ADFG	4	8	815
Lyons Ferry hatchery rack	3	3	
1989 totals:	12	34	813
1990			
Col. River Gillnet - ODFW	2	6	997
Ocean Troll (Non-treaty) - ADFG	1	5	850
Ocean Troll (Non-treaty) - CDFO	2	9	955
1990 Totals:	5	20	951
Totals for tagcode 633637:	32	79	753

Appendix D, continued.

Table 10. Recoveries of 1985 brood fall chinook salmon subyearlings released on-station in June 1986. Tagcode was 633638. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Mixed Net and Seine - CDFO	1	5	401
Lower Granite Dam trap	3	6	403
Lyons Ferry hatchery rack	4	4	423
1987 totals:	8	15	413
1988			
Mixed Net and Seine - CDFO	1	2	524
Ocean Troll (Non-treaty) - ODFW	1	6	685
Sport (Charter) - WDF	1	2	560
Lyons Ferry hatchery rack	2	2	
1988 totals:	5	12	590
1989			
Ocean Troll (Non-treaty) - CDFO	6	32	770
Columbia River Gillnet - ODFW	5	20	760
Ocean Troll (Non-treaty) - ODFW	1	30	860
Ocean Troll (Non-treaty) - ADFG	1	3	780
Lyons Ferry hatchery rack	3	3	
1989 totals:	16	88	774
1990			
Col. River Gillnet - ODFW	3	7	1007
Ocean Troll (Non-treaty) - ADFG	1	3	800
Ocean Troll (Non-treaty) - CDFO	1	5	843
1990 Totals:	5	15	933
Totals for tagcode 633638:	38	129	692

Appendix D, continued.

Table 11. Recoveries of 1985 brood fall chinook salmon subyearlings released on-station in June 1986. Tagcode was 633639. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Mixed Net and Seine - CDFO	1	5	345
Lower Granite Dam trap	5	10	428
Lyons Ferry hatchery rack	1	1	430
1987 totals:	7	16	416
1988			
Ocean Troll (Non-treaty) - CDFO	1	2	617
Mixed Net and Seine - CDFO	1	3	621
Columbia River Gillnet - ODFW	1	4	663
Lyons Ferry hatchery rack	7	7	
1988 totals:	10	16	634
1989			
Ocean Troll (Non-treaty) - CDFO	4	16	827
Columbia River Gillnet - ODFW	6	19	800
Ocean Troll (Non-treaty) - ODFW	1	1	820
Ocean Troll (Non-treaty) - ADFG	3	9	807
Sport (Charter) - WDF	1	2	850
Lyons Ferry hatchery rack	2	2	
1989 totals:	17	49	814
1990			
Col. River Gillnet - ODFW	3	10	912
1990 Totals:	3	10	912
Totals for tagcode 633639:	42	97	708

Appendix D, continued.

Table 12. Recoveries of 1985 brood fall chinook salmon subyearlings released on-station in June 1986. Tagcode was 633640. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Lower Granite Dam trap	4	8	455
Lyons Ferry hatchery rack	3	3	437
1987 totals:	7	11	447
1988			
Ocean Troll (Non-treaty) - CDFO	1	6	595
Columbia River Gillnet - ODFW	2	7	833
Sport (Charter) - WDF	1	1	600
Lyons Ferry hatchery rack	2	2	
1988 totals:	6	17	715
1989			
Ocean Troll (Non-treaty) - CDFO	2	7	882
Ocean Sport - ODFW	1	1	830
Columbia River Gillnet - ODFW	6	28	792
1989 totals:	9	36	816
1990			
Col. River Gillnet - ODFW	3	9	859
Ocean Troll (Non-treaty) - ADFG	1	5	884
1990 Totals:	4	14	866
Totals for tagcode 633640:	32	77	667

Appendix D, continued.

Table 13. Recoveries of 1985 brood fall chinook salmon subyearlings released on-station in June 1986. Tagcode was 633641. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Lyons Ferry hatchery rack	7	7	449
Lower Granite Dam trap	1	2	460
1987 totals:	8	9	450
1988			
Ocean Troll (Non-treaty) - CDFO	1	3	826
Treaty Troll - WDF	1	2	500
Lyons Ferry hatchery rack	3	3	
1988 totals:	5	8	663
1989			
Ocean Troll (Non-treaty) - CDFO	2	10	780
Columbia River Gillnet - ODFW	8	26	814
Ocean Troll (Non-treaty) - ADFG	1	3	805
Ocean Troll (Non-treaty) - WDF	1	2	790
1989 totals:	12	41	805
1990			
Col. River Gillnet - ODFW	2	8	854
Ocean Troll (Non-treaty) - ADFG	1		853
Ocean Troll (Non-treaty) - CDFO	2	9	978
1990 Totals:	5	17	903
Totals for tagcode 633641:	35	78	663

Appendix D, continued.

Table 14. Recoveries of 1985 brood fall chinook salmon subyearlings released on-station in June 1986. Tagcode was 633642. Mark rate was 99.06 percent (49,325 out of 49,793). Size of fish at release was 58.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Columbia River Gillnet - ODFW	1	4	655
Lyons Ferry hatchery rack	3	3	437
Lower Granite Dam trap	3	6	440
1987 totals:	7	13	469
1988			
Mixed Net and Seine - CDFO	1	2	610
Columbia River Gillnet - ODFW	1	4	514
Ocean Troll (Non-treaty) - ODFW	2	6	666
Sport (Charter) - WDF	1	2	650
Lyons Ferry hatchery rack	6	6	
1988 totals:	11	20	621
1989			
Ocean Troll (Non-treaty) - CDFO	3	12	769
Columbia River Gillnet - ODFW	5	19	786
Ocean Troll (Non-treaty) - ADFG	1	2	720
Sport (Private) - WDF	1	4	830
Ocean Troll (Non-treaty) - WDF	1	2	740
1989 totals:	11	39	775
1990			
Col. River Gillnet - ODFW	1	2	1024
Estuary Sport - WDF	1		
Ocean Troll (Non-treaty) - ADFG	1	10	850
Ocean Troll (Non-treaty) - CDFO	1	4	906
1990 Totals:	4	16	927
Totals for tagcode 633642:	40	89	682

Appendix D, continued.

Table 15. Recoveries of 1985 brood fall chinook salmon yearlings released on-station in April 1987. Tagcode was 634156. Mark rate was 99.30 percent (152,479 out of 153,554). Size of fish at release was 6.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Mixed Net and Seine - CDFO	3	16	297
Columbia River Gillnet - ODFW	2	10	343
Ocean Sport - ODFW	1	2	380
Lyons Ferry hatchery rack	129	129	366
Lower Granite Dam trap	15	28	353
1987 totals:	150	185	363
1988			
Ocean Troll (Non-treaty) - CDFO	2	8	521
Mixed Net and Seine - CDFO	27	53	495
Ocean Sport - CDFO	1	4	
Estuary Sport - ODFW	7	23	585
Ocean Troll (Non-treaty) - ODFW	4	17	630
Ocean Sport - ODFW	2	4	586
Columbia River Gillnet - ODFW	15	63	531
Commercial Seine - ADFG	2	2	518
Ocean Sport - ADFG	1	1	430
Mixed Net and Seine - WDF	3	6	570
Sport (Private) - WDF	6	23	573
Sport (Charter) - WDF	3	6	577
Treaty Troll - WDF	1	7	640
Lyons Ferry hatchery rack	116	116	
1988 totals:	190	333	537
1989			
Ocean Troll (Non-treaty) - CDFO	98	454	717
Mixed Net and Seine - CDFO	2	8	600
Ocean Sport - CDFO	6	27	
Ocean Sport - CDFG	1	4	720
Ocean Troll (Non-treaty) - CDFG	2	7	742
Estuary Sport - ODFW	2	6	790
Ocean Troll (Non-treaty) - ODFW	79	388	710
Columbia River Gillnet - ODFW	91	363	756
Ocean Sport - ODFW	12	27	752
Freshwater Sport - ODFW	1		
Ocean Troll (Non-treaty) - ADFG	6	9	720
Ocean Sport - ADFG	1		760
Estuary Sport - WDF	2	7	720
Sport (Private) - WDF	15	58	743

Appendix D, Table 15, continued.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Treaty Troll - WDF	24	97	648
Ocean Troll (Non-treaty) - WDF	68	170	694
Sport (Charter) - WDF	38	81	719
Lyons Ferry hatchery rack	71	71	
1989 totals:	519	1,779	719
1990			
Estuary Sport - ODFW	1	3	850
Col. River Gillnet - ODFW	59	182	853
Ocean Sport - ODFW	3	6	832
Ocean Troll (Non-treaty) - ODFW	5	14	805
Sport (Private) - WDF	3	12	815
Treaty Troll - WDF	10	43	749
Sport (Charter) - WDF	5	11	812
Ocean Troll (Non-treaty) - WDF	10	52	743
Ocean Troll (Non-treaty) - ADFG	11	27	824
Multiple Gear - ADFG	1		
Ocean Troll (Non-treaty) - CDFO	32	154	803
Mixed Net and Seine - CDFO	1		712
1990 Totals:	141	505	819
Totals for tagcode 634156:	1187	2974	653

Appendix D, continued.

Table 16. Recoveries of 1985 brood fall chinook salmon yearlings transported below Ice Harbor Dam in April 1987. Tagcode was 634159. Mark rate was 99.70 percent (156,036 out of 156,506). Size of fish at release was 6.9 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1987			
Mixed Net and Seine - CDFO	2	8	310
Columbia River Gillnet - ODFW	1	4	396
Ocean Sport - ODFW	1	2	380
Ocean Sport - ADFG	1	1	368
Mixed Net and Seine - WDF	2	13	430
Estuary Sport - WDF	1	4	55
Lyons Ferry hatchery rack	112	112	358
Lower Granite Dam trap	2	4	330
1987 totals:	122	148	356
1988			
Ocean Troll (Non-treaty) - CDFO	2	5	475
Mixed Net and Seine - CDFO	26	64	476
Ocean Sport - CDFO	2	9	
Ocean Troll (Non-treaty) - ODFW	2	6	725
Ocean Sport - ODFW	5	13	577
Estuary Sport - ODFW	8	25	591
Columbia River Gillnet - ODFW	22	90	544
Estuary Sport - WDF	9	40	236
Mixed Net and Seine - WDF	4	17	540
Sport (Private) - WDF	3	8	557
Sport (Charter) - WDF	6	13	563
Treaty Troll - WDF	2	10	525
Sport (Jetty) - WDF	1	4	580
Lyons Ferry hatchery rack	117	117	
1988 totals:	209	421	504
1989			
Ocean Troll (Non-treaty) - CDFO	93	423	729
Mixed Net and Seine - CDFO	3	9	696
Ocean Sport - CDFO	1	4	
Ocean Troll (Non-treaty) - CDFG	5	36	747
Ocean Sport - CDFG	1	5	713
Estuary Sport - ODFW	3	10	747
Ocean Troll (Non-treaty) - ODFW	67	324	708
Columbia River Gillnet - ODFW	126	466	763
Ocean Sport - ODFW	5	14	731
Freshwater Sport - ODFW	1		870
Ocean Troll (Non-treaty) - ADFG	20	39	718
Ocean Gillnet (non-treaty) - ADFG	1	4	735

Appendix D, Table 16, continued.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Sport (Private) - WDF	16	58	721
Treaty Troll - WDF	14	41	631
Estuary Sport - WDF	2	10	
Ocean Troll (Non-treaty) - WDF	48	115	693
Sport (Charter) - WDF	33	71	720
Lyons Ferry hatchery rack	75	75	
1989 totals:	514	1,705	727
1990			
Col. River Gillnet - ODFW	65	201	835
Test Fishery Net - ODFW	1	1	770
Ocean Sport - ODFW	2	4	827
Ocean Troll (Non-treaty) - ODFW	6	21	792
Sport (Private) - WDF	7	27	866
Sport (Charter) - WDF	9	20	794
Ocean Troll (Non-treaty) - WDF	9	36	744
Treaty Troll - WDF	3	36	797
Ocean Troll (Non-treaty) - ADFG	15	39	806
Multiple Gear - ADFG	1		
Ocean Troll (Non-treaty) - CDFO	36	160	789
Mixed Net and Seine - CDFO	2	4	814
Ocean Sport - CDFO	1	4	
1990 Totals:	157	553	812
Totals for tagcode 634159:	1123	3056	664

Appendix D, continued.

Table 17. Recoveries of 1986 brood fall chinook salmon subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 634262. Mark rate was 99.20 percent (127,715 out of 128,745). Size of fish at release was 71.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Mixed Net and Seine - CDFO	2	5	429
Columbia River Gillnet - ODFW	3	9	448
Commercial Seine - ADFG	1	9	447
Lyons Ferry hatchery rack	63	63	
1988 totals:	69	86	442
1989			
Ocean Troll (Non-treaty) - CDFO	17	74	694
Ocean Sport - CDFO	2	11	
Columbia River Gillnet - ODFW	14	52	712
Ocean Troll (Non-treaty) - ODFW	6	29	688
Ocean Sport - ADFG	1	1	
Estuary Sport - WDF	1	5	
Sport (Private) - WDF	2	8	705
Ocean Troll (Non-treaty) - WDF	2	5	710
Sport (Charter) - WDF	6	13	690
Lyons Ferry hatchery rack	17	17	
1989 totals:	68	215	699
1990			
Col. River Gillnet - ODFW	38	117	839
Ocean Troll (Non-treaty) - ODFW	4	13	829
Sport (Private) - WDF	3	13	827
Ocean Troll (Non-treaty) - WDF	2	4	780
Treaty Troll - WDF	1	3	700
Estuary Sport - WDF	1		
Ocean Troll (Non-treaty) - ADFG	8	25	841
Ocean Troll (Non-treaty) - CDFO	8	38	783
Mixed Net and Seine - CDFO	2	5	798
1990 Totals:	67	219	827
Totals for tagcode 634262:	255	557	654

Appendix D, continued.

Table 18. Recoveries of 1986 brood fall chinook salmon subyearlings transported below Ice Harbor Dam in June 1987. Tagcode was 634401. Mark rate was 99.42 percent (128,283 out of 128,745). Size of fish at release was 71.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Mixed Net and Seine - CDFO	3	7	369
Columbia River Gillnet - ODFW	6	24	469
Commercial Seine - ADFG	1	1	380
Lyons Ferry hatchery rack	66	66	
1988 totals:	76	98	430
1989			
Ocean Troll (Non-treaty) - CDFO	12	44	679
Ocean Sport - CDFO	1	4	
Columbia River Gillnet - ODFW	14	57	709
Ocean Troll (Non-treaty) - ODFW	4	13	721
Ocean Sport - ODFW	1	2	675
Ocean Troll (Non-treaty) - ADFG	3	2	685
Treaty Troll - WDF	3	7	530
Sport (Private) - WDF	1	5	760
Sport (Charter) - WDF	3	5	623
Lyons Ferry hatchery rack	21	21	
1989 totals:	63	160	681
1990			
Col. River Gillnet - ODFW	35	109	855
Ocean Troll (Non-treaty) - ODFW	1	2	740
Ocean Troll (Non-treaty) - WDF	5	15	772
Treaty Troll - WDF	2	7	535
Sport (Charter) - WDF	1	2	750
Sport (Private) - WDF	1	3	710
Ocean Troll (Non-treaty) - ADFG	8	25	805
Multiple Gear - ADFG	1		
Ocean Troll (Non-treaty) - CDFO	20	91	816
Mixed Net and Seine - CDFO	1	2	886
1990 Totals:	75	257	821
Totals for tagcode 634401:	253	547	636

Appendix D, continued.

Table 19. Recoveries of 1986 brood fall chinook salmon yearlings transported below Ice Harbor Dam in April 1988. Tagcode was 634407. Mark rate was 99.60 percent (60,523 out of 60,766). Size of fish at release was 8.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Lyons Ferry hatchery rack	62	62	
1988 totals:	62	62	
1989			
Ocean Troll (Non-treaty) - CDFO	1	4	505
Mixed Net and Seine - CDFO	6	16	508
Ocean Sport - CDFO	1	4	
Estuary Sport - ODFW	2	7	565
Columbia River Gillnet - ODFW	3	9	562
Ocean Troll (Non-treaty) - ODFW	3	16	568
Commercial Seine - ADFG	1	1	480
Mixed Net and Seine - WDF	2	5	555
Estuary Sport - WDF	3	14	550
Treaty Troll - WDF	2	41	525
Sport (Private) - WDF	1	3	530
Sport (Charter) - WDF	1	2	550
Lyons Ferry hatchery rack	9	9	
1989 totals:	35	131	539
1990			
Col. River Gillnet - ODFW	32	108	769
Ocean Troll (Non-treaty) - ODFW	38	139	719
Ocean Sport - ODFW	1	1	720
Sport (Charter) - WDF	9	21	710
Sport (Private) - WDF	6	16	696
Ocean Troll (Non-treaty) - WDF	7	16	705
Treaty Troll - WDF	13	39	671
Ocean Troll (Non-treaty) - ADFG	4	10	726
Ocean Troll (Non-treaty) - CDFO	29	144	705
1990 Totals:	139	495	722
Totals for tagcode 634407:	278	729	584

Appendix D, continued.

Table 20. Recoveries of 1986 brood fall chinook salmon yearlings transported below Ice Harbor Dam in April 1988. Tagcode was 634408. Mark rate was 99.60 percent (60,281 out of 60,523). Size of fish at release was 8.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Lyons Ferry hatchery rack	72	72	
1988 totals:	72	72	
1989			
Mixed Net and Seine - CDFO	4	9	516
Ocean Sport - CDFO	3	12	
Estuary Sport - ODFW	1	3	580
Columbia River Gillnet - ODFW	5	17	598
Ocean Troll (Non-treaty) - ODFW	1	6	570
Ocean Sport - ODFW	2	5	545
Commercial Seine - ADFG	1	1	487
Treaty Troll - WDF	1	1	540
Estuary Sport - WDF	3	10	610
Sport (Private) - WDF	1	4	580
Sport (Charter) - WDF	2	4	555
Lyons Ferry hatchery rack	22	22	
1989 totals:	46	94	559
1990			
Estuary Sport - ODFW	1	3	760
Col. River Gillnet - ODFW	25	82	746
Ocean Sport - ODFW	2	5	710
Ocean Troll (Non-treaty) - ODFW	26	88	731
Sport (Charter) - WDF	10	22	693
Sport (Private) - WDF	6	20	742
Ocean Troll (Non-treaty) - WDF	11	38	701
Treaty Troll - WDF	9	30	703
Estuary Sport - WDF	1		
Ocean Troll (Non-treaty) - ADFG	1		735
Ocean Troll (Non-treaty) - CDFO	33	175	719
Ocean Sport - CDFO	1	4	
1990 Totals:	126	467	723
Totals for tagcode 634408:	288	684	572

Appendix D, continued.

Table 21. Recoveries of 1986 brood fall chinook salmon yearlings released on-station in April 1988. Tagcode was 634411. Mark rate was 47.72 percent (58,735 out of 123,083). Size of fish at release was 8.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Lyons Ferry hatchery rack	44	44	
1988 totals:	44	44	
1989			
Mixed Net and Seine - CDFO	7	27	506
Ocean Sport - CDFO	2	8	
Columbia River Gillnet - ODFW	6	18	578
Ocean Troll (Non-treaty) - ODFW	1	10	615
Mixed Net and Seine - WDF	1	2	530
Sport (Private) - WDF	2	8	530
Sport (Charter) - WDF	1	2	590
Lyons Ferry hatchery rack	19	19	
1989 totals:	39	94	545
1990			
Estuary Sport - ODFW	2	6	785
Col. River Gillnet - ODFW	25	90	776
Ocean Troll (Non-treaty) - ODFW	16	47	735
Ocean Sport - ODFW	1	1	748
Sport (Private) - WDF	7	27	764
Ocean Troll (Non-treaty) - WDF	17	45	709
Treaty Troll - WDF	16	55	679
Sport (Charter) - WDF	4	9	655
Estuary Sport - WDF	1		770
Ocean Troll (Non-treaty) - ADFG	3	6	728
Ocean Troll (Non-treaty) - CDFO	24	125	717
Mixed Net and Seine - CDFO	4	6	611
1990 Totals:	120	419	725
Totals for tagcode 634411:	259	617	596

Appendix D, continued.

Table 22. Recoveries of 1986 brood fall chinook salmon yearlings released on-station in April 1988. Tagcode was 634413. Mark rate was 47.72 percent (58,970 out of 123,576). Size of fish at release was 8.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Mixed Net and Seine - CDFO	1	3	318
Lyons Ferry hatchery rack	50	50	
1988 Totals:	51	53	318
1989			
Mixed Net and Seine - CDFO	5	20	500
Ocean Sport - CDFO	2	8	
Estuary Sport - ODFW	2	3	590
Columbia River Gillnet - ODFW	11	37	547
Ocean Sport - ODFW	2	4	588
Mixed Net and Seine - WDF	1	4	510
Treaty Troll - WDF	2	14	585
Sport (Charter) - WDF	2	4	570
Sport (Private) - WDF	1	2	640
Lyons Ferry hatchery rack	10	10	
1989 Totals:	38	106	553
1990			
Estuary Sport - ODFW	1	3	730
Col. River Gillnet - ODFW	22	64	788
Ocean Troll (Non-treaty) - ODFW	17	55	719
Sport (Charter) - WDF	10	22	720
Ocean Troll (Non-treaty) - WDF	17	58	697
Treaty Troll - WDF	13	67	668
Sport (Private) - WDF	6	24	762
Ocean Troll (Non-treaty) - ADFG	1		
Ocean Troll (Non-treaty) - CDFO	24	123	715
Ocean Sport - CDFO	1	4	
1990 Totals:	112	421	725
Totals for tagcode 634413:	252	636	584

Appendix D, continued.

Table 23. Recoveries of 1986 brood fall chinook salmon subyearlings released on-station in June 1987. Tagcode was 634259. Mark rate was 97.80 percent (126,076 out of 128,912). Size of fish at release was 48.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Mixed Net and Seine - CDFO	1	3	446
Columbia River Gillnet - ODFW	1	3	435
Lyons Ferry hatchery rack	7	7	
1988 totals:	9	13	441
1989			
Ocean Troll (Non-treaty) - CDFO	7	36	680
Mixed Net and Seine - CDFO	2	6	589
Ocean Sport - CDFO	1	4	
Estuary Sport - ODFW	1	3	720
Columbia River Gillnet - ODFW	3	11	575
Ocean Troll (Non-treaty) - ODFW	2	8	710
Ocean Troll (Non-treaty) - ADFG	1	1	660
Treaty Troll - WDF	1	21	600
Sport (Charter) - WDF	1	2	640
Lyons Ferry hatchery rack	12	12	
1989 totals:	31	104	650
Totals for tagcode 634259:	40	117	629

Appendix D, continued.

Table 24. Recoveries of 1986 brood fall chinook salmon subyearlings released on-station in June 1987. Tagcode was 634261. Mark rate was 97.80 percent (125,570 out of 128,395). Size of fish at release was 48.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1988			
Columbia River Gillnet - ODFW	1	4	577
Lyons Ferry hatchery rack	17	17	
1988 totals:	18	21	577
1989			
Ocean Troll (Non-treaty) - CDFO	7	31	683
Mixed Net and Seine - CDFO	2	6	584
Ocean Sport - CDFG	2	17	675
Ocean Troll (Non-treaty) - ODFW	5	21	692
Columbia River Gillnet - ODFW	5	19	733
Treaty Troll - WDF	1	3	540
Ocean Troll (Non-treaty) - WDF	1	2	700
Sport (Charter) - WDF	2	4	620
Lyons Ferry hatchery rack	3	3	
1989 totals:	28	106	676
1990			
Col. River Gillnet - ODFW	23	68	817
Ocean Sport - ODFW	2	5	815
Ocean Troll (Non-treaty) - ODFW	2	6	718
Sport (Private) - WDF	2	7	840
Ocean Troll (Non-treaty) - WDF	2	17	690
Treaty Troll - WDF	4	11	690
Ocean Troll (Non-treaty) - ADFG	5	10	760
Ocean Troll (Non-treaty) - CDFO	11	51	784
1990 Totals:	51	176	786
Totals for tagcode 634261:	115	324	672

Appendix D, continued.

Table 25. Recoveries of 1987 brood fall chinook salmon yearlings released below Ice Harbor Dam in April 1989. Tagcode was 634750. Mark rate was 99.95 percent (59,608 out of 59,638). Size of fish at release was 10.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Lyons Ferry rack - WDF	33	33	351
1989 Totals:	33	33	351
1990			
Col. River Gillnet - ODFW	7	28	570
Ocean Troll (Non-treaty) - ODFW	1	2	650
Sport (Charter) - WDF	7	15	570
Estuary Sport - WDF	8		528
Treaty Troll - WDF	3	14	613
Mixed Net and Seine - WDF	2	6	535
Sport (Private) - WDF	3	10	567
Mixed Net and Seine - CDFO	8	11	480
1990 Totals:	39	85	552
Totals for tagcode 634750:	72	118	452

Appendix D, continued.

Table 26. Recoveries of 1987 brood fall chinook salmon yearlings released below Ice Harbor Dam in April 1989. Tagcode was 634755. Mark rate was 99.95 percent (59,608 out of 59,638). Size of fish at release was 10.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Lyons Ferry rack - WDF	26	26	353
1989 Totals:	26	26	353
1990			
Col. River Gillnet - ODFW	7	26	551
Ocean Troll (Non-treaty) - ODFW	1	1	620
Ocean Sport - ODFW	1	2	590
Sport (Charter) - WDF	6	13	565
Sport (Private) - WDF	2	7	575
Treaty Troll - WDF	6	22	570
Mixed Net and Seine - WDF	2	4	515
Estuary Sport - WDF	2		500
Mixed Net and Seine - CDFO	2	2	479
1990 Totals:	29	77	554
Totals for tagcode 634755:	55	103	457

Appendix D, continued.

Table 27. Recoveries of 1987 brood fall chinook salmon yearlings released on-station in April 1989. Tagcode was 634752. Mark rate was 99.99 percent (57,756 out of 57,762). Size of fish at release was 10.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Lyons Ferry rack - WDF	7	7	349
1989 Totals:	7	7	349
1990			
Col. River Gillnet - ODFW	3	9	565
Sport (Charter) - WDF	1	2	550
Estuary Sport - WDF	2		500
Mixed Net and Seine - WDF	1	2	550
Mixed Net and Seine - CDFO	3	4	439
1990 Totals:	10	17	522
Totals for tagcode 634752:	17	24	441

Appendix D, continued.

Table 28. Recoveries of 1987 brood fall chinook salmon yearlings released on-station in April 1989. Tagcode was 634756. Mark rate was 99.99 percent (57,594 out of 57,600). Size of fish at release was 10.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Lyons Ferry rack - WDF	16	16	340
1989 Totals:	16	16	340
1990			
Col. River Gillnet - ODFW	4	15	556
Mixed Net and Seine - WDF	1	3	530
Estuary Sport - WDF	1		
Mixed Net and Seine - CDFO	2	4	614
1990 Totals:	8	22	569
Totals for tagcode 634756:	24	38	410

Appendix D, continued.

Table 29. Recoveries of 1987 brood fall chinook salmon subyearlings released below Ice Harbor Dam in June 1988. Tagcode was 635211. Mark rate was 99.97 percent (122,850 out of 122,890). Size of fish at release was 53.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1990			
Ocean Troll (Non-treaty) - ODFW	1	2	635
Treaty Troll - WDF	1	2	540
1990 Totals:	2	3	588
Totals for tagcode 635211:	2	3	588

Table 30. Recoveries of 1987 brood fall chinook salmon subyearlings released below Ice Harbor Dam in June 1988. Tagcode was 635213. Mark rate was 99.97 percent (122,899 out of 122,939). Size of fish at release was 53.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Mixed Net and Seine - CDFO	1	2	495
1989 Totals:	1	2	495
1990			
Ocean Troll (Non-treaty) - ODFW	1	7	660
1990 Totals:	1	7	660
Totals for tagcode 635213:	2	9	578

Appendix D, continued.

Table 31. Recoveries of 1987 brood fall chinook salmon subyearlings released on-station in June 1988. Tagcode was 635214. Mark rate was 99.99 percent (124,394 out of 124,401). Size of fish at release was 53.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Estuary Sport - ODFW	1	4	470
1989 Totals:	1	4	470
1990			
Col. River Gillnet - ODFW	1	3	670
1990 Totals:	1	3	670
Totals for tagcode 635214:	2	7	570

Table 32. Recoveries of 1987 brood fall chinook salmon subyearlings released on-station in June 1988. Tagcode was 635216. Mark rate was 99.99 percent (124,345 out of 124,352). Size of fish at release was 53.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1989			
Lyons Ferry rack - WDF	6	6	447
1989 Totals:	6	6	447
1990			
Col. River Gillnet - ODFW	1	3	579
Sport (Charter) - WDF	1	2	550
1990 Totals:	2	5	565
Totals for tagcode 635216:	8	11	476

Appendix D, continued.

Table 33. Recoveries of 1988 brood fall chinook salmon subyearlings released below Ice Harbor Dam in June 1989. Tagcode was 635207. Mark rate was 99.96 percent (116,935 out of 116,977). Size of fish at release was 75.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1990			
Ocean Sport - ODFW	1	2	500
1990 Totals:	1	2	500
Totals for tagcode 635207:	1	2	500

Table 34. Recoveries of 1988 brood fall chinook salmon subyearlings released on-station in June 1989. Tagcode was 630226. Mark rate was 99.98 percent (113,285 out of 113,308). Size of fish at release was 90.0 fpp.

Year Recovery location and agency	Observed recoveries	Estimated recoveries	Average length (mm)
1990			
Col. River Gillnet - ODFW	1	2	445
Mixed Net and Seine - CDFO	1	1	362
1990 Totals:	2	3	404
Totals for tagcode 630226:	2	3	404

APPENDIX E

Table 1. Origin of coded-wire tags recovered at Ice Harbor Dam and transported to Lyons Ferry Fish Hatchery in 1990 that were not Snake River stock.

Tag code	Collection date	Fork length (cm)	Sex	Agency, tag origin
05/19/17	13 Nov	83	F	USFWS, Hanford
07/39/14	17 Oct	92	F	ODFW, Umatilla
07/39/14	24 Oct	94	M	ODFW, Umatilla
07/39/14	30 Oct	92	F	ODFW, Umatilla
07/39/12	06 Nov	84	F	ODFW, Umatilla
07/38/31	06 Nov	89	F	ODFW, Umatilla
07/39/12	06 Nov	88	F	ODFW, Umatilla
07/38/40	06 Nov	95	F	ODFW, Umatilla
07/39/12	06 Nov	90	F	ODFW, Umatilla
07/39/13	06 Nov	88	F	ODFW, Umatilla
07/40/36	13 Nov	70	F	ODFW, Umatilla
07/38/33	13 Nov	86	F	ODFW, Umatilla
07/39/14	13 Nov	74	F	ODFW, Umatilla
07/40/38	13 Nov	85	F	ODFW, Umatilla
07/38/39	13 Nov	92	F	ODFW, Umatilla
07/40/36	13 Nov	77	F	ODFW, Umatilla
07/39/14	13 Nov	93	F	ODFW, Umatilla
07/40/37	13 Nov	77	F	ODFW, Umatilla
07/38/29	20 Nov	98	F	ODFW, Umatilla
07/38/29	20 Nov	93	F	ODFW, Umatilla
07/40/39	20 Nov	81	F	ODFW, Umatilla
07/38/31	20 Nov	91	F	ODFW, Umatilla
07/40/39	20 Nov	84	F	ODFW, Umatilla
07/38/24	20 Nov	99	F	ODFW, Umatilla
07/40/37	20 Nov	86	M	ODFW, Umatilla
07/40/36	23 Nov	77	M	ODFW, Umatilla
07/40/38	26 Nov	88	M	ODFW, Umatilla
07/38/29	27 Nov	97	F	ODFW, Umatilla
07/38/31	27 Nov	83	F	ODFW, Umatilla
07/38/31	27 Nov	94	F	ODFW, Umatilla
07/40/37	27 Nov	80	F	ODFW, Umatilla
07/38/25	27 Nov	80	M	ODFW, Umatilla
07/38/29	27 Nov	84	F	ODFW, Umatilla
07/38/31	27 Nov	96	F	ODFW, Umatilla
07/45/36	27 Nov	68	M	ODFW, Umatilla
07/38/32	27 Nov	96	F	ODFW, Umatilla
07/38/30	27 Nov	95	M	ODFW, Umatilla
07/38/30	27 Nov	88	F	ODFW, Umatilla
07/40/38	27 Nov	74	F	ODFW, Umatilla
07/38/40	02 Dec	90	F	ODFW, Umatilla
07/38/30	02 Dec	99	M	ODFW, Umatilla

Appendix E, Table 1, continued.

Tag code	Collection date	Fork length (cm)	Sex	Agency, tag origin
07/39/14	02 Dec	91	M	ODFW, Umatilla
07/40/39	03 Dec	82	M	ODFW, Umatilla
07/40/38	03 Dec	80	M	ODFW, Umatilla
07/38/32	04 Dec	87	M	ODFW, Umatilla
07/38/31	04 Dec	100	F	ODFW, Umatilla
07/38/28	04 Dec	90	F	ODFW, Umatilla
07/38/31	04 Dec	90	F	ODFW, Umatilla
07/40/38	04 Dec	67	M	ODFW, Umatilla
07/38/28	04 Dec	92	F	ODFW, Umatilla
07/40/39	04 Dec	75	M	ODFW, Umatilla
07/45/36	04 Dec	64	M	ODFW, Umatilla
23/21/16	23 Oct	- -	F	NMFS, Bonneville
23/22/06	30 Oct	90	M	NMFS, Bonneville
23/21/59	06 Nov	83	F	NMFS, Bonneville
23/21/48	06 Nov	78	F	NMFS, Bonneville
23/21/62	13 Nov	89	F	NMFS, Bonneville
23/22/31	13 Nov	78	F	NMFS, Columbia
23/21/51	20 Nov	87	F	NMFS, Bonneville
23/21/22	20 Nov	85	M	NMFS, Bonneville
23/25/38	20 Nov	65	M	NMFS, Bonneville
23/21/16	23 Nov	84	M	NMFS, Bonneville
23/21/22	23 Nov	80	M	NMFS, Bonneville
23/26/16	23 Nov	62	M	NMFS, Bonneville
23/22/10	24 Nov	74	M	NMFS, Bonneville
23/22/05	27 Nov	92	M	NMFS, Bonneville
23/22/07	02 Dec	92	M	NMFS, Bonneville
23/21/48	02 Dec	83	M	NMFS, Bonneville

Appendix E, continued.

Table 2. Origin of coded-wire tags recovered as volunteers to Lyons Ferry Fish Hatchery in 1990 that were not Snake River stock.

Tag code	Collection date	Fork length (cm)	Sex	Tag origin
07/46/48	16 Oct	52	J	ODFW, Umatilla
07/39/13	16 Oct	92	F	ODFW, Umatilla
07/40/36	23 Oct	80	F	ODFW, Umatilla
07/39/13	30 Oct	82	F	ODFW, Umatilla
07/39/13	06 Nov	96	M	ODFW, Umatilla
07/39/14	13 Nov	77	F	ODFW, Umatilla
07/38/35	13 Nov	95	F	ODFW, Umatilla
07/38/37	13 Nov	98	J	ODFW, Umatilla
07/40/37	13 Nov	76	M	ODFW, Umatilla
07/38/40	20 Nov	84	M	ODFW, Umatilla
07/40/37	27 Nov	77	M	ODFW, Umatilla
07/45/36	27 Nov	54	J	ODFW, Umatilla
10/40/55	23 Oct	74	M	USFWS, Dworshak
10/40/57	30 Oct	73	M	USFWS, Dworshak
23/22/17	06 Nov	89	F	NMFS, Bonneville
23/19/30	13 Nov	89	F	NMFS, McNary

Table 3. Origin of coded-wire tags recovered at Lower Granite Dam and transported to Lyons Ferry Fish Hatchery in 1990 that were not Snake River stock.

Tag code	Collection date	Fork length (cm)	Sex	Tag origin
07/45/36	23 Sep	28	J	ODFW, Umatilla
07/45/37	28 Sep	53	J	ODFW, Umatilla
07/45/36	10 Oct	30	J	ODFW, Umatilla
07/46/48	30 Oct	79	F	ODFW, Umatilla
07/39/12	30 Oct	90	F	ODFW, Umatilla
07/39/13	13 Nov	92	F	ODFW, Umatilla
07/33/18	13 Nov	63	M	ODFW, Bonneville
07/45/38	20 Nov	90	F	ODFW, Umatilla
07/38/30	20 Nov	75	M	ODFW, Umatilla
07/40/38	27 Nov	79	F	ODFW, Umatilla
07/38/29	06 Nov	87	F	ODFW, Umatilla
23/21/32	- -	46	J	NMFS, Bonneville

APPENDIX F

Coded-wire tag recoveries at Lyons Ferry Fish Hatchery and Lower Granite Dam from 1984 to 1989.

Year, Location Tag code	Number	Source	Brood year	Number tagged	Number untagged	Expansion rate	Expanded recovery
1984, Lyons Ferry FH							
05 5 27	1	HAGERMAN	79	58100	119692	3.06	3
03 17 33	3	NMFS-MCNARY	80	42924	0	1.00	3
10 22 10	24	HAGERMAN/BONN	80	55400	4826	1.09	26
10 22 11	8	HAGERMAN	80	55700	64757	2.16	17
05 10 22	52	HAGERMAN	81	78300	537945	7.87	409
05 10 23	68	HAGERMAN	81	80425	2482	1.03	70
07 26 63	1	UMATILLA	81	102386	2726449	27.63	28
23 16 14	1	NMFS-MCNARY	81	15525	0	1.00	1
1985, Lyons Ferry FH							
07 25 6	1	BONNEVILLE	80	99632	2450	1.02	1
05 10 22	31	HAGERMAN	81	78300	537945	7.87	244
05 10 23	28	HAGERMAN	81	80425	2482	1.03	29
07 26 63	2	UMATILLA	81	102386	2726449	27.63	55
07 27 41	2	BONNEVILLE	81	99570	994	1.01	2
05 13 54	31	HAGERMAN	83	59300	40226	1.68	52
07 31 24	4	UMATILLA&BONNE	83	210441	755809	4.59	18
07 31 25	3	BONNEVILLE	83	102184	4376	1.04	3
07 31 27	12	UMATILLA	83	88306	109856	2.24	27
63 21 52	1418	LF-YR	83	250831	236894	1.94	2757
63 31 16	1	WASHOUGAL	83	101594	5294668	53.12	53
63 32 18	501	LF-YR	83	83611	78964	1.94	974
1985, Lower Granite Dam							
05 13 54	5	HAGERMAN	83	59300	40226	1.68	8
63 21 52	36	LF-YR	83	250831	236894	1.94	70
63 32 18	16	LF-YR	83	83611	78964	1.94	31

Appendix F, continued.

Year, Location Tag code	Number	Source	Brood year	Number tagged	Number untagged	Expansion rate	Expanded recovery
1986, Lyons Ferry FH							
05 10 23	2	HAGERMAN	81	80425	2482	1.03	2
63 21 57	1	KLICKITAT	81	204064	3475556	18.03	18
07 28 28	1	BONNEVILLE	82	99001	5336	1.05	1
07 28 29	1	BONNEVILLE	82	96448	131964	2.37	2
05 13 54	5	HAGERMAN	83	59300	40226	1.68	8
07 31 24	5	UMATILLA&BONNE	83	210441	755809	4.59	23
63 21 52	512	LF-YR	83	250831	236894	1.94	996
63 32 18	157	LF-YR	83	83611	78964	1.94	305
H5 06 06	1	SSRC/SPR CK	83	72027	13668	1.19	1
05 13 53	1	HAGERMAN	84	54925	73304	2.33	2
06 56 20	1	TRINITY F	84	30459	791	1.03	1
63 28 41	48	LF-YR	84	258355	183321	1.71	82
63 32 26	13	LF-0	84	78417	101636	2.30	30
63 32 27	12	LF-0	84	78064	101135	2.30	28
63 32 28	9	LF-0	84	78504	101636	2.29	21
1986, Lower Granite Dam							
63 21 52	28	LF-YR	83	250831	236894	1.94	54
63 32 18	12	LF-YR	83	83611	78964	1.94	23
05 13 53	3	HAGERMAN	84	54925	73304	2.33	7
06 56 21	1	TRINITY F	84	24541	959	1.04	1
06 61 43	2	TRINITY S	84	98568	465402	5.72	11
07 33 27	6	UMATILLA-YR	84	88396	119419	2.35	14
63 28 41	4	LF-YR	84	258355	183321	1.71	7
63 32 26	24	LF-0	84	78417	101636	2.30	55
63 32 27	13	LF-0	84	78064	101135	2.30	30
63 32 28	19	LF-0	84	78504	101636	2.29	44

Appendix F, continued.

Year, Location Tag code	Number	Source	Brood year	Number tagged	Number untagged	Expansion rate	Expanded recovery
1987, Lyons Ferry FH							
07 28 29	2	BONNEVILLE-YR	82	96448	131964	2.37	5
23 16 25	1	NMFS-MCNARY	82	15096	0	1.00	1
05 13 54	4	HAGERMAN	83	59300	40226	1.68	7
05 15 26	2	YAKIMA/SPR CK	83	103822	1102	1.01	2
05 15 31	1	YAKIMA/SPR CK	83	99522	105116	2.06	2
07 30 07	1	BONNEVILLE-YR	83	51960	52976	2.02	2
07 31 24	13	UMATILLA&BONNE	83	210441	755809	4.59	60
07 31 25	1	BONNEVILLE-0	83	102184	4376	1.04	1
07 31 26	1	BONNEVILLE-0	83	101431	1322	1.01	1
07 31 27	17	UMATILLA-YR	83	88306	109856	2.24	38
63 21 52	1068	LF-YR	83	250831	236894	1.94	2077
63 32 18	375	LF-YR	83	83611	78964	1.94	729
H5 06 06	1	SSL/SPR CK	83	72027	13668	1.19	1
H5 06 07	1	RC/SPR CK	83	79610	6923	1.09	1
05 12 51	1	LWS	84	23100	3760	1.16	1
05 13 53	6	HAGERMAN	84	54925	73304	2.33	14
06 61 43	1	TRINITY S	84	98568	465402	5.72	6
07 33 27	8	UMATILLA-YR	84	88396	118419	2.34	19
63 28 41	90	LF-YR	84	258355	183321	1.71	154
63 32 26	37	LF-0	84	78417	101636	2.30	85
63 32 27	36	LF-0	84	78064	101135	2.30	83
63 32 28	45	LF-0	84	78504	101636	2.29	103
H5 07 01	1	RC/SPR CK	84	96145	2185	1.02	1
H5 07 02	2	SSL/SPR CK	84	99169	2411	1.02	2
H5 07 03	1	SSL/SPR CK	84	105406	1932	1.02	1
07 33 18	1	BONNEVILLE-YR	85	47943	66922	2.40	2
07 38 39	1	UMATILLA-0	85	21659	187299	9.65	10
07 38 40	1	UMATILLA-0	85	20269	187281	10.24	10
63 36 33	1	LF-0	85	49112	366	1.01	1
63 36 34	1	LF-0	85	49112	366	1.01	1
63 36 36	1	LF-0	85	49113	367	1.01	1
63 36 37	3	LF-0	85	49112	366	1.01	3
63 36 38	4	LF-0	85	98650	468	1.00	4
63 36 39	1	LF-0	85	49325	468	1.01	1
63 36 40	3	LF-0	85	49325	468	1.01	3
63 36 41	7	LF-0	85	49325	468	1.01	7
63 36 42	3	LF-0	85	49325	468	1.01	3
63 41 56	130	LF-YR	85	152479	1075	1.01	131
63 41 59	113	LF-YR	85	156036	470	1.00	113

Appendix F, continued.

Year, Location Tag code	Number	Source	Brood year	Number tagged	Number untagged	Expansion rate	Expanded recovery
1987, Lower Granite Dam							
63 21 52	1	LF-YR	83	250831	236894	1.94	2
05 13 53	2	HAGERMAN	84	54925	73304	2.33	5
63 28 41	3	LF-YR	84	258355	183321	1.71	5
63 32 28	1	LF-0	84	78504	101636	2.29	2
07 33 18	1	BONNEVILLE-YR	85	47943	66922	2.40	2
63 36 38	3	LF-0	85	98650	468	1.00	3
63 36 39	5	LF-0	85	49325	468	1.01	5
63 36 40	4	LF-0	85	49325	468	1.01	4
63 36 41	1	LF-0	85	49325	468	1.01	1
63 36 42	3	LF-0	85	49325	468	1.01	3
63 41 56	15	LF-YR	85	152479	1075	1.01	15
63 41 59	2	LF-YR	85	156036	470	1.00	2
1988, Lyons Ferry FH							
07 31 24	6	UMATILLA&BONNE	83	210441	755809	4.59	28
07 31 25	5	BONNEVILLE-0	83	102184	4376	1.04	5
07 31 27	7	UMATILLA-YR	83	88306	109856	2.24	16
63 21 52	187	LF-YR	83	250831	236894	1.94	364
63 32 18	91	LF-YR	83	83611	78964	1.94	177
H5 06 07	1	RC/SPR CK	83	79610	6923	1.09	1
05 13 53	3	HAGERMAN	84	54925	73304	2.33	7
07 31 62	3	UMATILLA-0	84	30838	20162	1.65	5
07 33 26	4	UMATILLA-0	84	206756	3016416	15.59	62
07 33 27	17	UMATILLA-YR	84	88396	118419	2.34	40
07 33 63	1	LOOKINGGLASS S	84	50687	40348	1.80	2
63 23 30	1	PRIEST RAPIDS	84	107461	88539	1.82	2
63 28 41	99	LF-YR	84	258355	183321	1.71	169
63 32 26	19	LF-0	84	78417	101636	2.30	44
63 32 27	19	LF-0	84	78064	101135	2.30	44
63 32 28	21	LF-0	84	78504	101636	2.29	48
H5 07 03	1	SSL/SPR CK	84	105406	1932	1.02	1
07 38 23	1	UMATILLA-YR	85	10103	12113	2.20	2
07 38 34	1	UM-0	85	21335	176818	9.29	9
07 38 35	4	UM-0	85	20960	176798	9.44	38
07 38 37	1	UM-0	85	20982	176806	9.43	9
07 38 38	1	UM-0	85	20815	187288	10.00	10
07 38 40	2	UMATILLA-0	85	20269	187281	10.24	20
07 38 41	2	UM-0	85	20895	187289	9.96	20
63 36 34	3	LF-0	85	49112	366	1.01	3
63 36 35	2	LF-0	85	49112	366	1.01	2
63 36 36	1	LF-0	85	49113	367	1.01	1
63 36 37	5	LF-0	85	49112	366	1.01	5

Appendix F, continued.

Year, Location Tag code	Number	Source	Brood year	Number tagged	Number untagged	Expansion rate	Expanded recovery
1988, Lower Granite Dam							
63 36 38	2	LF-0	85	98650	468	1.00	2
63 36 39	7	LF-0	85	49325	468	1.01	7
63 36 40	2	LF-0	85	49325	468	1.01	2
63 36 41	3	LF-0	85	49325	468	1.01	3
63 36 42	6	LF-0	85	49325	468	1.01	6
63 41 56	122	LF-YR	85	152479	1075	1.01	123
63 41 59	121	LF-YR	85	156036	470	1.00	121
B5 03 15	1	SSL/COL	85	52946	2348	1.04	1
07 39 12	1	UM-0	86	40793	456779	12.20	12
07 39 13	1	UM-0	86	41096	460170	12.20	12
07 39 14	1	UM-0	86	39187	438805	12.20	12
07 40 39	2	UM-YR	86	38978	9496	1.24	2
23 20 52	1	NMFS-BONNE	86	9891	1160	1.12	1
23 22 28	1	NMFS-TRBMCNRY	S86	7502	1	1.00	1
63 42 59	7	LF--0	86	126076	2836	1.02	7
63 42 61	17	LF-0	86	125570	2824	1.02	17
63 42 62	63	LF-0	86	127715	1030	1.01	64
63 44 01	68	LF-0	86	128823	1034	1.01	69
63 44 07	62	LF-YR	86	60523	243	1.00	62
63 44 08	72	LF-YR	86	60281	242	1.00	72
63 44 11	44	LF-YR	86	58735	64348	2.10	92
63 44 13	50	LF-YR	86	58970	64606	2.10	105
1989, Lyons Ferry FH							
07 31 24	1	UMATILLA&BONNE	83	210441	755809	4.59	5
63 21 52	6	LF-YR	83	250831	236894	1.94	12
63 32 18	1	LF-YR	83	83611	78964	1.94	2
05 12 55	1	LWS	84	25505	980	1.04	1
07 31 62	7	UMATILLA-0	84	30838	20162	1.65	12
07 33 26	4	UMATILLA-0	84	206756	3016416	15.59	62
07 33 27	19	UMATILLA-YR	84	88396	118419	2.34	44
63 23 30	1	PRIEST RAPIDS	84	107461	88539	1.82	2
63 28 41	59	LF-YR	84	258355	183321	1.71	101
63 32 26	5	LF-0	84	78417	101636	2.30	11
63 32 27	2	LF-0	84	78064	101135	2.30	5
63 32 28	3	LF-0	84	78504	101636	2.29	7
H5 07 01	1	RC/SPR CK	84	96145	2185	1.02	1
H5 07 02	1	SSL/SPR CK	84	99169	2411	1.02	1
H5 07 03	2	SSL/SPR CK	84	105406	1932	1.02	2
06 61 44	1	TRINITY S	85	101091	391769	4.88	5
07 33 18	2	BONNEVILLE	85	47943	66922	2.40	5
07 38 23	1	UMATILLA-YR	85	10103	12113	2.20	2
07 38 24	1	UM-YR	85	10243	12280	2.20	2

Appendix F, continued.

Year, Location Tag code	Number	Source	Brood year	Number tagged	Number untagged	Expansion rate	Expanded recovery
1989, Lyons Ferry FH							
07 38 25	1	UM-YR	85	9917	11890	2.20	2
07 38 26	1	UM-YR	85	9496	11385	2.20	2
07 38 27	1	UM-YR	85	9876	11840	2.20	2
07 38 29	2	UM-YR	85	9970	10242	2.03	4
07 38 30	4	UM-YR	85	10135	10411	2.03	8
07 38 31	5	UM-YR	85	10053	10328	2.03	10
07 38 32	1	UM-YR	85	10081	10357	2.03	2
07 38 33	2	UM-0	85	20636	176796	9.57	19
07 38 35	3	UM-0	85	20960	176798	9.44	28
07 38 36	4	UM-0	85	20170	176782	9.76	39
07 38 37	1	UM-0	85	20982	176806	9.43	9
07 38 38	2	UM-0	85	20815	187288	10.00	20
07 38 39	1	UM-0	85	21659	187299	9.65	10
07 38 40	4	UMATILLA-0	85	20269	187281	10.24	41
07 38 41	3	UM-0	85	20895	187289	9.96	30
07 38 42	4	UM-0	85	21694	187300	9.63	39
23 19 27	1	NMFS-MCNARY	85	10745	0	1.00	1
23 19 28	3	NMFS-MCNARY	85	10745	0	1.00	3
63 36 33	8	LF-0	85	49112	366	1.01	8
63 36 34	8	LF-0	85	49112	366	1.01	8
63 36 35	9	LF-0	85	49112	366	1.01	9
63 36 36	8	LF-0	85	49113	367	1.01	8
63 36 37	6	LF-0	85	49112	366	1.01	6
63 36 38	7	LF-0	85	98650	468	1.00	7
63 36 39	6	LF-0	85	49325	468	1.01	6
63 36 40	5	LF-0	85	49325	468	1.01	5
63 36 41	4	LF-0	85	49325	468	1.01	4
63 36 42	6	LF-0	85	49325	468	1.01	6
63 41 56	233	LF-YR	85	152479	1075	1.01	235
63 41 59	173	LF-YR	85	156036	470	1.00	174
B5 02 15	1	RC	85	52631	2141	1.04	1
B5 03 09	1	RC	85	50817	2726	1.05	1
05 19 16	1	LWS-YAKIMA	86	49769	151703	4.05	4
05 19 18	1	LWS-YAKIMA	86	48796	148692	4.05	4
05 19 21	1	LWS-YAKIMA*	86	49511	150000	4.03	4
07 39 12	11	UM-0	86	40793	456779	12.20	134
07 39 13	7	UM-0	86	41096	460170	12.20	85
07 39 14	11	UM-0	86	39187	438805	12.20	134
07 40 35	1	UM-0	86	632	26	1.04	1
07 40 37	1	UM/MEA-YR	86	38405	10665	1.28	1
07 40 39	1	UM/MEA-YR	86	38978	9496	1.24	1
23 19 60	1	NMFS-MCNARY	86	91146	0	1.00	1
23 20 63	1	NMFS-BONNE	86	16820	1285	1.08	1
23 21 10	1	NMFS-BONNE	86	16499	1261	1.08	1

Appendix F, continued.

Year, Location Tag code	Number	Source	Brood year	Number tagged	Number untagged	Expansion rate	Expanded recovery
1989, Lyons Ferry FH							
23 21 11	1	NMFS-BONNE	86	17880	1618	1.09	1
23 21 12	1	NMFS-BONNE	86	18032	1633	1.09	1
23 21 17	1	NMFS-BONNE	86	16964	1296	1.08	1
23 21 20	1	NMFS-BONNE	86	17389	1329	1.08	1
23 21 38	1	NMFS-BONNE	86	18071	1875	1.10	1
23 21 39	1	NMFS-BONNE	86	17803	2089	1.12	1
23 21 40	1	NMFS-BONNE	86	18462	1411	1.08	1
23 21 44	1	NMFS-BONNE	86	18434	2163	1.12	1
23 21 51	1	NMFS-BONNE	86	18751	1697	1.09	1
23 21 52	1	NMFS-BONNE	86	18653	1688	1.09	1
23 22 09	3	NMFS-BONNE	86	18711	1693	1.09	3
23 22 22	1	NMFS-BONNE	86	18298	1398	1.08	1
63 41 28	1	PRIEST RAPIDS	86	201779	4744221	24.51	25
63 42 59	22	LF--0	86	126076	2836	1.02	22
63 42 61	18	LF-0	86	125570	2824	1.02	18
63 42 62	61	LF-0	86	127715	1030	1.01	61
63 44 01	55	LF-0	86	128823	1034	1.01	55
63 44 07	47	LF-YR	86	60523	243	1.00	47
63 44 08	61	LF-YR	86	60281	242	1.00	61
63 44 11	65	LF-YR	86	58735	64348	2.10	136
63 44 13	58	LF-YR	86	58970	64606	2.10	122
07 50 07	4	UM-0	87	198285	1688472	9.52	38
23 25 02	1	NMFS-BONNE	87	29001	744	1.03	1
23 25 47	1	NMFS-BONNE	87	29739	731	1.02	1
63 47 50	33	LF-0	87	59608	299	1.01	33
63 47 52	7	LF-0	87	57756	69501	2.20	15
63 47 55	26	LF-0	87	59609	299	1.01	26
63 47 56	16	LF-0	87	57594	69307	2.20	35
63 52 16	6	LF-0	87	124394	840392	7.76	47

APPENDIX G

Allele frequencies at 31 loci in 17 recent WDF Columbia Basin fall chinook collections. Key to collection location and date follows frequencies.

Locus	Collection 1	2	3	4	5	6	7	8	9
sAAT-1,2									
(N)	100	100	104	99	100	99	100	101	100
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
sAAT-3									
(N)	100	100	103	99	100	99	95	100	100
1	1.000	1.000	0.995	0.995	1.000	1.000	1.000	1.000	1.000
2	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000	0.000
sAAT-4									
(N)	98	100	102	99	100	99	70	101	100
1	0.995	0.990	0.995	0.995	0.995	1.000	1.000	0.990	0.995
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.005	0.010	0.005	0.005	0.005	0.000	0.000	0.010	0.005
ADA-1									
(N)	100	100	102	99	100	99	100	101	99
1	0.995	0.990	1.000	1.000	0.995	0.990	0.995	0.990	0.995
2	0.005	0.010	0.000	0.000	0.005	0.010	0.005	0.010	0.005
ADA-2									
(N)	100	100	102	99	100	99	100	101	100
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
sAH									
(N)	100	100	102	99	100	99	100	101	100
1	0.860	0.895	0.986	0.854	0.805	0.833	0.850	0.901	0.790
2	0.140	0.105	0.014	0.131	0.190	0.157	0.135	0.084	0.210
3	0.000	0.000	0.000	0.015	0.005	0.010	0.015	0.015	0.000
mAH-4									
(N)	100	100	103	99	100	99	100	100	99
1	0.860	0.880	0.859	0.838	0.875	0.919	0.865	0.835	0.919
2	0.140	0.120	0.141	0.141	0.125	0.076	0.135	0.165	0.081
3	0.000	0.000	0.000	0.020	0.000	0.005	0.000	0.000	0.000
PEPA									
(N)	100	100	102	99	100	99	100	101	100
1	0.970	0.970	0.976	0.975	0.985	0.919	0.925	0.936	0.990
2	0.030	0.030	0.024	0.025	0.015	0.081	0.075	0.064	0.010

Appendix G, continued.

Locus	Collection 1	2	3	4	5	6	7	8	9
GPI-A									
(N)	100	100	102	99	100	99	100	101	100
1	0.990	0.995	1.000	0.995	1.000	1.000	1.000	1.000	0.985
2	0.010	0.005	0.000	0.005	0.000	0.000	0.000	0.000	0.015
GR									
(N)	100	100	102	99	100	99	100	101	100
1	0.980	0.985	0.635	0.990	0.970	0.722	0.800	0.995	0.965
2	0.020	0.015	0.365	0.010	0.030	0.278	0.200	0.005	0.035
HAGH									
(N)	100	100	102	99	100	99	100	101	100
1	1.000	0.995	0.899	0.980	1.000	0.985	0.950	1.000	0.995
2	0.000	0.005	0.101	0.020	0.000	0.015	0.050	0.000	0.005
mIDHP-2									
(N)	100	100	102	99	100	99	100	101	100
1	0.985	1.000	1.000	0.985	0.995	1.000	1.000	0.995	0.995
2	0.015	0.000	0.000	0.015	0.005	0.000	0.000	0.005	0.005
sIDHP-1,2									
(N)	100	100	104	99	100	99	100	101	100
1	0.925	0.960	0.993	0.957	0.905	0.944	0.982	0.943	0.945
2	0.075	0.040	0.007	0.038	0.092	0.033	0.007	0.054	0.055
3	0.000	0.000	0.000	0.003	0.002	0.021	0.010	0.003	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
LDH-B2									
(N)	100	100	102	99	100	99	100	101	100
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LDH-C									
(N)	98	99	103	99	100	99	192	99	100
1	0.980	0.995	1.000	0.995	0.975	1.000	1.000	1.000	0.985
2	0.020	0.005	0.000	0.005	0.025	0.000	0.000	0.000	0.015
sMDH-A1,2									
(N)	100	100	104	99	100	99	100	101	100
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix G, continued.

Locus	Collection 1	2	3	4	5	6	7	8	9
sMDH-B1,2									
(N)	100	100	104	99	100	99	100	101	100
1	0.970	0.977	0.932	0.982	0.980	0.982	0.972	0.955	0.972
2	0.015	0.007	0.067	0.008	0.012	0.017	0.025	0.005	0.025
3	0.015	0.015	0.000	0.010	0.008	0.000	0.002	0.040	0.003
mMDH-2									
(N)	100	100	102	99	100	99	100	101	99
1	0.980	0.990	0.923	0.985	0.975	0.949	0.960	0.990	0.995
2	0.020	0.010	0.077	0.015	0.025	0.051	0.040	0.010	0.005
sMEP-1									
(N)	100	100	102	99	100	99	100	100	148
1	0.755	0.780	0.928	0.722	0.850	0.783	0.810	0.810	0.750
2	0.245	0.220	0.072	0.278	0.150	0.217	0.190	0.190	0.250
MPI									
(N)	100	100	102	99	100	99	100	101	99
1	0.695	0.700	0.548	0.737	0.695	0.439	0.550	0.856	0.692
2	0.290	0.300	0.404	0.258	0.295	0.500	0.435	0.139	0.303
3	0.015	0.000	0.048	0.005	0.010	0.061	0.015	0.005	0.005
PEPD									
(N)	100	100	102	99	100	99	100	101	100
1	1.000	0.995	1.000	0.995	0.980	1.000	1.000	1.000	0.995
2	0.000	0.005	0.000	0.005	0.020	0.000	0.000	0.000	0.005
PEP-LT									
(N)	99	100	102	99	99	99	100	101	100
1	0.789	0.875	1.000	0.904	0.758	0.949	0.995	0.896	0.805
2	0.211	0.125	0.000	0.096	0.242	0.051	0.005	0.104	0.195
PGDH									
(N)	100	100	102	99	100	99	100	101	100
1	0.995	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PGK-2									
(N)	100	100	102	99	100	99	100	101	100
1	0.565	0.585	0.889	0.500	0.610	0.753	0.865	0.579	0.570
2	0.435	0.415	0.111	0.500	0.390	0.247	0.135	0.421	0.430

Appendix G, continued.

Locus	Collection 1	2	3	4	5	6	7	8	9
sSOD-1									
(N)	100	100	102	99	100	99	100	101	100
1	0.550	0.565	0.543	0.566	0.500	0.596	0.560	0.634	0.545
2	0.445	0.435	0.457	0.434	0.500	0.394	0.440	0.361	0.450
3	0.005	0.000	0.000	0.000	0.000	0.010	0.000	0.005	0.005
PEPB-1									
(N)	100	100	102	99	100	99	100	100	100
1	0.770	0.895	0.774	0.904	0.735	0.904	0.820	0.960	0.805
2	0.230	0.105	0.226	0.096	0.265	0.096	0.180	0.040	0.195
TPI-4									
(N)	100	100	102	99	100	99	100	100	100
1	0.995	0.995	0.942	1.000	0.985	0.965	0.970	0.990	1.000
2	0.005	0.005	0.058	0.000	0.015	0.035	0.030	0.010	0.000

Appendix G, continued.

Locus	Collection 10	11	12	13	14	15	16	17
sAAT-1,2								
(N)	99	100	109	100	100	100	100	100
1	0.997	0.997	1.000	1.000	1.000	1.000	1.000	1.000
2	0.003	0.002	0.000	0.000	0.000	0.000	0.000	0.000
sAAT-3								
(N)	94	97	109	99	100	84	100	81
1	1.000	1.000	1.000	1.000	1.000	1.000	0.995	0.994
2	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.006
sAAT-4								
(N)	97	95	105	96	89	97	88	98
1	0.979	1.000	0.981	0.995	0.983	0.995	0.989	0.995
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.021	0.000	0.019	0.005	0.017	0.005	0.011	0.005
ADA-1								
(N)	99	100	109	99	100	100	100	100
1	0.990	0.995	0.991	0.985	1.000	0.990	0.990	1.000
2	0.010	0.005	0.009	0.015	0.000	0.010	0.010	0.000
ADA-2								
(N)	99	100	109	100	100	99	100	99
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
sAH								
(N)	99	100	109	100	100	99	100	100
1	0.808	0.820	0.784	0.810	0.900	0.919	0.815	0.815
2	0.192	0.180	0.206	0.190	0.100	0.081	0.185	0.185
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix G, continued.

Locus	Collection 10	11	12	13	14	15	16	17
mAH-4								
(N)	99	100	109	100	100	100	100	100
1	0.919	0.905	0.904	0.915	0.885	0.880	0.895	0.905
2	0.081	0.095	0.096	0.085	0.105	0.110	0.105	0.085
3	0.000	0.000	0.000	0.000	0.010	0.010	0.000	0.010
PEPA								
(N)	98	100	109	100	100	100	100	100
1	0.990	0.935	0.963	0.995	0.975	0.995	0.955	0.975
2	0.010	0.065	0.037	0.005	0.025	0.005	0.045	0.025
GPI-A								
(N)	98	100	109	100	100	100	100	100
1	0.995	0.995	1.000	0.985	0.990	0.985	0.995	0.995
2	0.005	0.005	0.000	0.015	0.010	0.015	0.005	0.005
GR								
(N)	99	100	109	100	100	99	100	100
1	0.975	0.970	0.986	0.940	0.980	0.980	0.975	0.990
2	0.025	0.030	0.014	0.060	0.020	0.020	0.025	0.010
HAGH								
(N)	99	100	109	100	100	100	100	100
1	1.000	0.985	0.991	0.980	0.985	0.975	0.995	1.000
2	0.000	0.015	0.009	0.020	0.015	0.025	0.005	0.000
mIDHP-2								
(N)	99	100	109	100	100	100	100	100
1	1.000	0.995	1.000	0.995	1.000	1.000	1.000	1.000
2	0.000	0.005	0.000	0.005	0.000	0.000	0.000	0.000
sIDHP-1,2								
(N)	99	100	109	99	100	98	99	100
1	0.934	0.947	0.933	0.924	0.935	0.959	0.897	0.948
2	0.063	0.052	0.067	0.073	0.063	0.035	0.101	0.053
3	0.003	0.000	0.000	0.003	0.003	0.005	0.003	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LDH-B2								
(N)	99	100	109	100	100	100	100	100
1	1.000	1.000	0.991	1.000	1.000	1.000	0.995	1.000
2	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.005	0.000	0.000	0.000	0.005	0.000

Appendix G, continued.

Locus	Collection 10	11	12	13	14	15	16	17
LDH-C								
(N)	96	98	109	99	100	88	100	87
1	0.984	1.000	0.991	0.995	1.000	0.977	0.980	0.994
2	0.016	0.000	0.009	0.005	0.000	0.023	0.020	0.006
sMDH-A1,2								
(N)	99	100	109	100	100	100	100	100
1	0.995	1.000	1.000	1.000	1.000	0.997	1.000	1.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.005	0.000	0.000	0.000	0.000	0.003	0.000	0.000
sMDH-B1,2								
(N)	99	100	109	100	100	100	100	100
1	0.977	0.965	0.975	0.962	0.970	0.970	0.960	0.960
2	0.017	0.015	0.018	0.012	0.010	0.015	0.022	0.017
3	0.005	0.020	0.007	0.025	0.020	0.015	0.017	0.022
mMDH-2								
(N)	98	100	109	100	100	100	100	100
1	0.990	0.995	0.982	0.985	0.990	0.975	0.980	0.980
2	0.010	0.005	0.018	0.015	0.010	0.025	0.020	0.020
sMEP-1								
(N)	99	99	109	100	100	99	100	100
1	0.758	0.732	0.784	0.750	0.750	0.768	0.800	0.815
2	0.242	0.268	0.216	0.250	0.250	0.232	0.200	0.185
MPI								
(N)	98	100	109	100	100	100	100	100
1	0.653	0.705	0.670	0.740	0.725	0.775	0.660	0.680
2	0.347	0.290	0.330	0.255	0.275	0.220	0.335	0.320
3	0.000	0.005	0.000	0.005	0.000	0.005	0.005	0.000
PEPD								
(N)	97	100	109	100	100	100	100	100
1	0.985	0.990	0.982	0.995	0.985	1.000	0.990	0.995
2	0.015	0.010	0.018	0.005	0.015	0.000	0.010	0.005
PEP-LT								
(N)	98	100	109	100	100	100	100	100
1	0.801	0.835	0.752	0.825	0.825	0.830	0.800	0.840
2	0.199	0.165	0.248	0.175	0.175	0.170	0.200	0.160

Appendix G, continued.

Locus	Collection 10	11	12	13	14	15	16	17
PGDH								
(N)	99	100	109	100	100	100	100	100
1	1.000	1.000	1.000	0.995	1.000	1.000	0.995	1.000
2	0.000	0.000	0.000	0.005	0.000	0.000	0.005	0.000
PGK-2								
(N)	99	100	109	99	100	100	99	100
1	0.591	0.565	0.528	0.631	0.595	0.575	0.631	0.600
2	0.409	0.435	0.472	0.369	0.405	0.425	0.369	0.400
sSOD-1								
(N)	99	100	109	100	99	100	100	99
1	0.535	0.505	0.560	0.550	0.581	0.655	0.540	0.571
2	0.465	0.480	0.436	0.450	0.419	0.345	0.460	0.429
3	0.000	0.015	0.004	0.000	0.000	0.000	0.000	0.000
PEPB-1								
(N)	99	100	109	100	100	100	99	100
1	0.762	0.850	0.793	0.825	0.820	0.870	0.763	0.835
2	0.237	0.150	0.206	0.175	0.180	0.130	0.237	0.165
TPI-4								
(N)	99	100	109	100	100	100	100	100
1	0.985	0.985	0.982	0.990	0.990	1.000	0.985	0.990
2	0.015	0.015	0.018	0.010	0.010	0.000	0.015	0.010

Appendix G, continued.

Key to collections.

Number	Location and year
1	PRIEST RAPIDS H 86
2	LYONS FERRY H 86
3	SPRING CREEK NFH 87
4	LYONS FERRY H 87
5	PRIEST RAPIDS H 87
6	COWLITZ H 88
7	KALAMA H 89
8	MARION DRAIN 89
9	BONNEVILLE H 90
10	HANFORD REACH 90
11	LITTLE WHITE SALMON NFH 90
12	YAKIMA R 90
13	LYONS FERRY H 89
14	LYONS FERRY H 88
15	LYONS FERRY H 90 KNOWN (CWT)
16	PRIEST RAPIDS H 90
17	LYONS FERRY H 90 RANDOM COLLECTION