Tucannon River Spring Chinook Salmon Captive Broodstock Program

2003 Annual Report

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Acknowledgments

The Tucannon River spring chinook salmon captive broodstock program is the result of efforts by many individuals within the Washington Department of Fish and Wildlife (WDFW) and from other agencies.

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Abstract

This report summarizes the objectives, tasks, and accomplishments of the Tucannon River Spring Chinook Captive Broodstock Program during 2003.

The WDFW initiated a captive broodstock program in 1997. The overall goal of the Tucannon River captive broodstock program is for the short-term, and eventually long-term, rebuilding of the Tucannon River spring chinook salmon run, with the hope that natural production will sustain itself. The project goal is to rear captive salmon selected from the supplementation program to adults, spawn them, rear their progeny, and release approximately 150,000 smolts annually into the Tucannon River between 2003-2007. These smolt releases, in combination with the current hatchery supplementation program (132,000 smolts) and wild production, are expected to produce 600-700 returning adult spring chinook to the Tucannon River each year from 2005-2010.

The captive broodstock program collected fish from five (1997-2001) brood years (BY). As of January 1, 2004, WDFW has approximately 18 BY 1999, 189 BY 2000, 405 BY 2001, and 277 BY 2002 (for extra males) fish on hand at LFH.

The 2003 eggtake from the 1998 brood year (Age 5) was 8,378 eggs from 5 ripe females. Egg survival was 64%. Mean fecundity based on the 3 fully spawned females was 1,794 eggs/female.

The 2003 eggtake from the 1999 brood year (Age 4) was 226,043 eggs from 158 ripe females. Egg survival was 65%. Mean fecundity based on the 157 fully spawned females was 1,433 eggs/female.

The 2003 eggtake from the 2000 brood year (Age 3) was 74,995 eggs from 60 ripe females. Egg survival was 45%. Mean fecundity based on the 59 fully spawned fish was 1,250 eggs/female.

The total 2003 eggtake from the captive brood program was 309,416 eggs. A total of 122,673 dead eggs (40%) were removed with 186,743 live eggs remaining for the program. An additional 21,943 dead eggs/fry (11.8%) were picked at ponding leaving 164,800 fish for rearing. As of May 1, 2004 we had 153,038 BY 2003 captive brood progeny on hand

During April 2004, WDFW volitionally released 44,784 BY 2002 captive broodstock progeny smolts from Curl Lake Acclimation Pond into the Tucannon River. These fish were marked with agency-only wire tags and no fin clips in order to differentiate them from the supplementation fish (CWT/Right Red VIE/No Finclip). A total of 1,029 captive brood progeny smolts were PIT tagged to compare their outmigration with smolts from the supplementation program (1,016 tagged). Monitoring their survival and future releases to adult returns, along with future natural production levels, will determine the success or failure of this captive broodstock program.

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Introduction

Reporting Period

This report summarizes the accomplishments of the Tucannon River spring chinook salmon (*Oncorhynchus tshawytscha*) captive brood program for 2003. This report, while originally intended to cover activities accomplished exclusively under the Fiscal Year (FY) 2003 contract, includes some events during FY2004 activities as well. This was done to provide readers with complete results from the tagging, rearing, and spawning activities that have occurred.

Tucannon River Spring Chinook Program Overview

Prior to 1985, artificial production of spring chinook in the Tucannon River was nearly nonexistent, with only two fry releases in the 1960s (WDFW et al. 1999). In August 1962 and June 1964, 16,000 Klickitat (2.3 g fish or 197 fish/lb) and 10,500 Willamette (2.6 g fish or 175 fish/lb) stock spring chinook, respectively, were released by the Washington Department of Fisheries into the Tucannon River. The out-planting program was discontinued after a major flood destroyed the rearing ponds in 1965. Neither of these releases is believed to have returned any significant number of adults. After completion of the four lower Snake River dams, the Lower Snake River Compensation Plan (LSRCP) program was created to provide hatchery compensation for the loss of spring chinook, fall chinook, and summer steelhead in the Snake River (USACE 1975). In 1985, Washington Department of Fish and Wildlife (WDFW) began the hatchery spring chinook production program in the Tucannon River by trapping wild (unmarked) adults for the hatchery broodstock. Hatchery-origin fish have been returning to the Tucannon River since 1988. The hatchery broodstock since 1989 has consisted of natural and hatchery-origin fish.

In 1992, the National Marine Fisheries Service (NMFS) listed Snake River spring/summer chinook as “endangered” (April 22, 1992 Federal Register, Vol. 57, No. 78, p 14653), which included the Tucannon River stock. The listing status was changed to “threatened” in 1995 (April 17, 1995 Federal Register, Vol 60, No 73, p 19342). Between 1993-1998, WDFW operated the supplementation program under Section 10 direct take permit #848 for artificial propagation and research. Since 1998, WDFW has operated both the supplementation and captive broodstock program under Section 10 direct take permits #1126 (artificial propagation), and #1129 (research). The Endangered Species Act (ESA) allows for “the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures pursuant to the Act are no longer necessary” (ESA 1973).

Consistent with that provision, WDFW and the co-managers [The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and the Nez Perce Tribe (NPT)] decided in 1997 to implement the Tucannon River captive broodstock program to sustain and potentially recover this listed population. Both of the hatchery programs (supplementation and captive brood) are being conducted with the recognition that artificial propagation may have potentially deleterious direct and indirect effects on the listed fish (Hard et al. 1992; Cuenco et al. 1993; Busack and Currens 1995; Campton 1995). These effects may include genetic and ecological hazards that cause maladaptive genetic, physiological, or behavioral changes in donor or target populations, with attendant losses in natural productivity (Hard et al. 1992). However, WDFW and the co-managers believed the risk of extinction in the Tucannon River was high enough to warrant intervention beyond the current supplementation program. Further, this program has been defined to last for only one-generation cycle (five brood years), and any potential negative effects should be reduced due to the short-term nature of the program.

Adult returns between 1985-1993 were between 400-750 wild and hatchery fish combined (Figure 1). In 1994, the adult escapement declined severely to less than 150 fish, and the run in 1995 was estimated at 54 fish. In 1995, WDFW started the Captive Broodstock Program on their own but discontinued it based upon the 1996-97 predicted returns. Unfortunately, the 1996 and 1997 returns were not as strong as predicted. In addition, major floods in 1996 and 1997 on the Tucannon River eliminated most natural production. Moreover, an 80% loss of the hatchery egg take occurred in 1997 due to a malfunction of a water chiller that cold shocked the eggs. Because of the lower returns, and losses to both natural and hatchery production, the Tucannon River spring chinook captive broodstock program was re-initiated with the 1997 brood year.

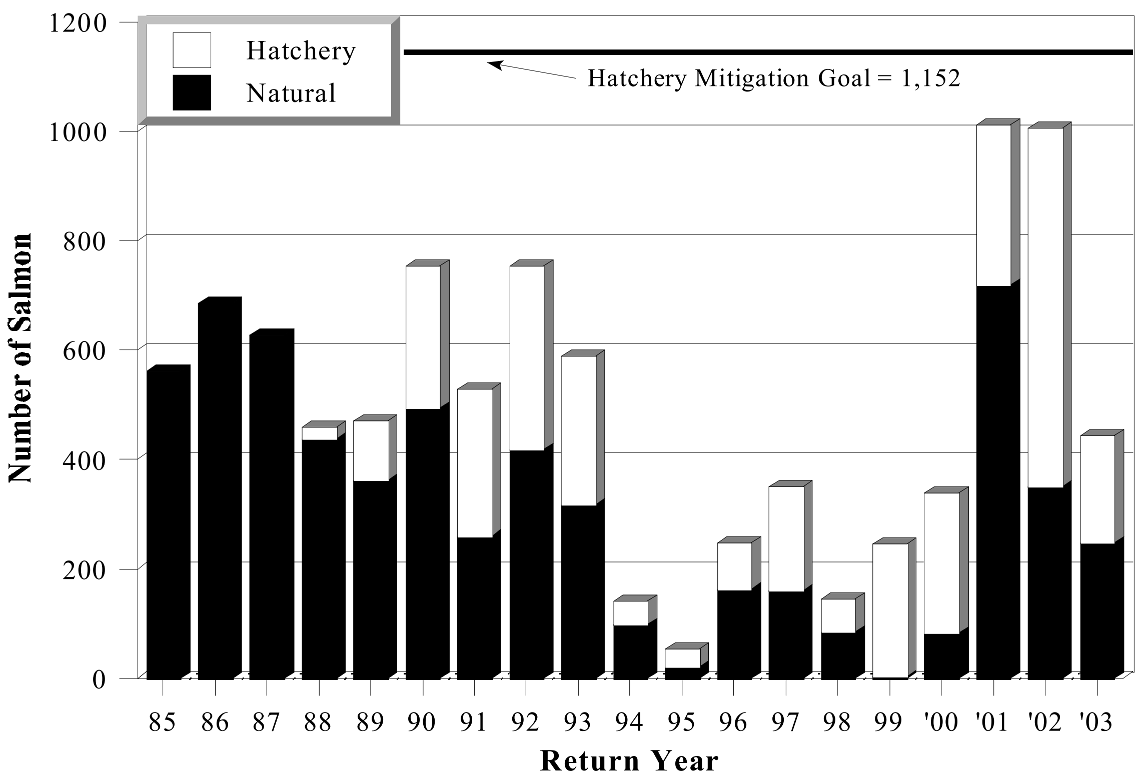

Figure 1. Total estimated escapement of Tucannon River spring chinook salmon from 1985-2003.

Key to the Tucannon River spring chinook restoration effort will be whether or not the natural population can consistently return above the replacement level. Since 1985, WDFW has monitored and estimated the success of the natural population for comparison to the hatchery program as part of the LSRCP program (USFWS 1998). Monitoring efforts to date have shown the natural population below replacement almost every year (Figure 2). In short, unless the natural population returns to a point above replacement the overall goal of the Tucannon River spring chinook restoration program will not be met.

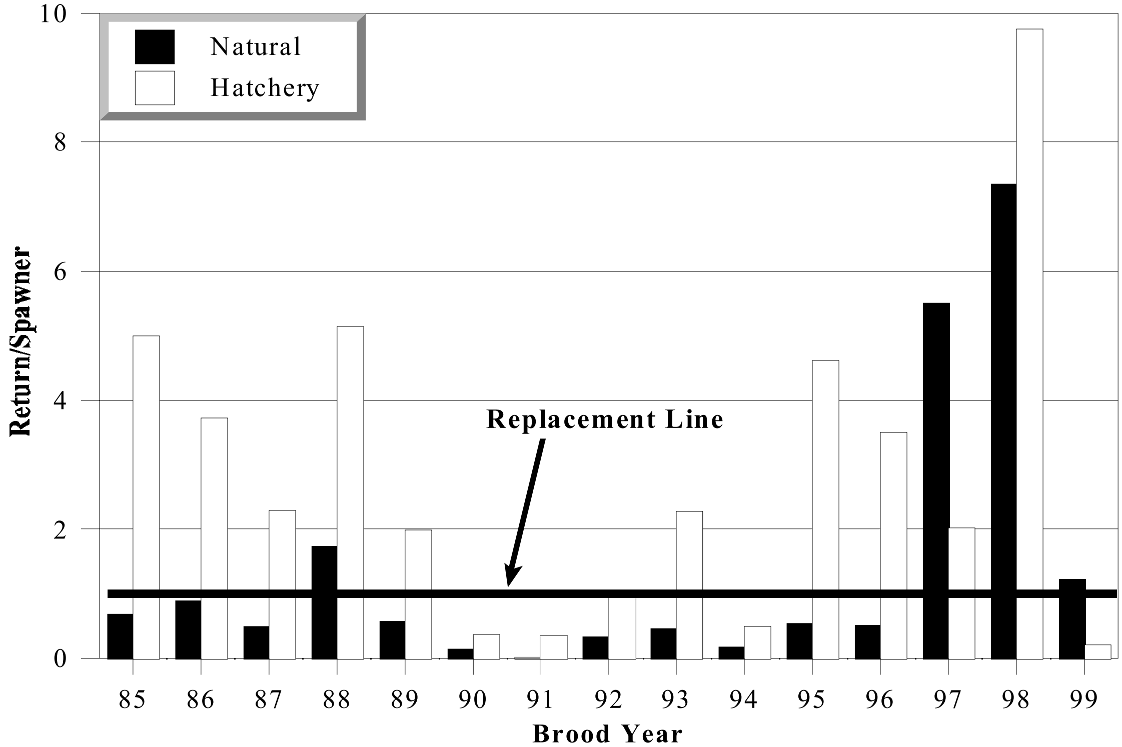

Figure 2. Return per spawner ratio (with replacement line) for Tucannon River spring chinook salmon for the 1985-1999 brood years.

Tucannon River Watershed Characteristics

The Tucannon River empties into the Snake River between Little Goose and Lower Monumental dams approximately 622 river kilometers (rkm) from the mouth of the Columbia River (Figure 3). Stream elevation rises from 150 m at the mouth to 1,640 m at the headwater (Bugert et al. 1990). Total watershed area is about 1,295 km^2. Mean discharge is 4.9-m^3/sec with a mean low of 1.7-m^3/sec (August) and a mean high flow of 8.8-m^3/sec (April/May). Local habitat problems related to logging, road building, recreation, and agriculture/livestock grazing has limited the production potential of spring chinook in the Tucannon River. Spring chinook typically spawn and rear above rkm 40. WDFW and the co-managers believe smolt releases in the upper watershed have the best chance for high survival, and recovery effects from the captive brood and supplementation programs will be maximized by producing smolts.

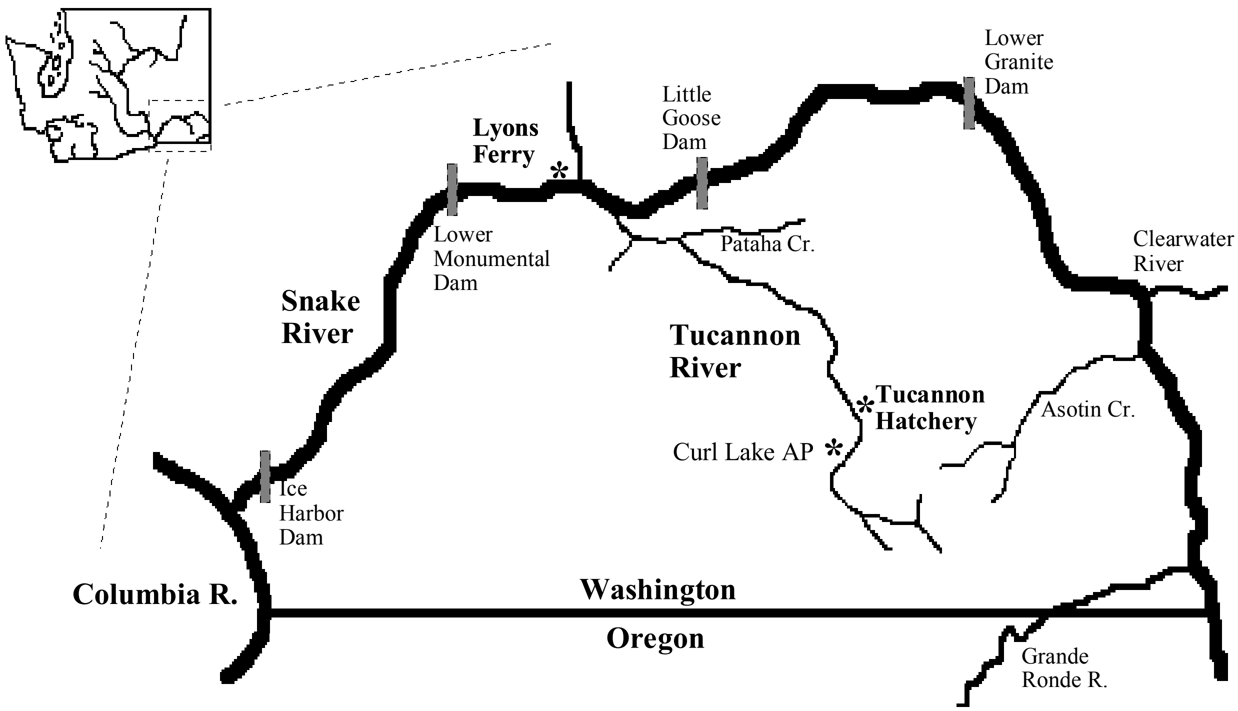

Figure 3. Location of the Tucannon River within the Snake River Basin, and locations of Lyons Ferry Hatchery, Tucannon Hatchery, and Curl Lake Acclimation Pond within the Tucannon River Basin.

It is hoped that recent initiatives for habitat improvement within the Tucannon Basin (BPA funded Tucannon River Model Watershed Program, and the State of Washington Governor's Salmon Recovery Plan) that are aimed at increasing in-river survival, along with changing and improved ocean conditions, and continued adult and juvenile passage improvements at Federal Columbia River Power System (FCRPS) dams, will be enough to return the natural population productivity to above the replacement level. For example, broad based goals of the Tucannon Model Watershed Program are to: 1) restore and maintain natural stream stability, 2) reduce water temperatures, 3) reduce upland erosion and sediment delivery rates, and 4) improve and re-establish riparian vegetation. Managers hope that these habitat recovery efforts will ultimately increase survival of naturally reared spring chinook in the river. While this will only provide an increase to population numbers (parr or smolts), greater numbers of juveniles will return more adult fish to the Tucannon River even if passage problems and ocean conditions remain unchanged. The captive brood program should provide a quick increase in the number of adults that will produce progeny to take advantage of these habitat improvements.

Facility Descriptions

The spring chinook supplementation program currently utilizes three different WDFW facilities: Lyons Ferry Hatchery (LFH), Tucannon Fish Hatchery (TFH), and Curl Lake Acclimation Pond (AP). Each of these facilities will also be used in some manner for the captive broodstock program for rearing, release and subsequent adult capture upon return. Lyons Ferry Hatchery is located on the Snake River (rkm 90) at its confluence with the Palouse River (Figure 3). Lyons Ferry was constructed with funds provided by the Army Corps of Engineers, and has subsequently been funded through the LSRCP program of the U.S. Fish and Wildlife Service. Ultimately, the FCRPS through BPA bears the cost of the LSRCP program. Lyons Ferry is used for adult broodstock holding and spawning, and incubation and early life rearing until production marking. Fifteen 1.2-m diameter circular starter tanks were purchased when the captive broodstock program was started in 1995. In 1999, LSRCP purchased and supplied the funding for installation of eight 6.1-m diameter circular rearing tanks for the adults, and for relocation of the small circular tanks. The tanks were installed during August and September of 1999 in the captive broodstock rearing area at LFH. During 2000, BPA supplied funding for security fencing around the broodstock rearing area. A diagram of the captive broodstock facility is shown in Appendix A.

Tucannon Hatchery, located at rkm 59 on the Tucannon River (Figure 3), has an adult collection trap on-site. Following marking at LFH, juveniles are transferred to TFH to rear through winter. In mid-February, the fish are transferred to Curl Lake AP for a minimum of three weeks acclimation. Curl Lake AP is a 0.85 ha natural bottom lake with a mean depth of 2.8 meters (pond volume estimated at 22,203 m^3). During the middle of March, the pond exit is opened and the fish are allowed to volitionally emigrate from the lake until the third week of April when they are forced out.

Monitoring and Evaluation

As previously mentioned, the LSRCP Tucannon River spring chinook supplementation program has ongoing evaluations. Some of the monitoring and evaluation activities include: smolt release sampling, smolt trapping, spawning ground surveys, genetic monitoring, snorkel surveys for juvenile population estimates, spawning, fecundity monitoring, and experimental release strategies for smolts. Through these and other activities, survival rates of the natural and hatchery fish have been documented for the span of the supplementation program. These same and other activities will continue to play a major role in evaluating the success of the captive broodstock program in the future (for both parents and progeny).

As part of the monitoring plan, survival and rate of maturation are being documented by family groups within each brood year. Fecundity and egg size in relation to spawning success will be documented for all spawned captive broodstock females. Maturation timing will be monitored as well as overall growth rates for each brood year. Smolt migration will be monitored through the use of Passive Integrated Transponder (PIT) tags, and adult return rates will be monitored through adult trapping and carcass recoveries during spawning ground surveys.

Captive Broodstock Program

The overall goal of the Tucannon River spring chinook salmon captive broodstock program is for the short-term, and eventually long-term, rebuilding of the natural run, with the intent that the natural population will sustain itself. The current hatchery mitigation goal under the LSRCP is to return 1,152 adult spring chinook of Tucannon River stock to the river annually. Attempts to reach the LSRCP mitigation goal through an annual release of 132,000 smolts have failed largely because of poor smolt-to-adult survival rates. Currently, there is not an escapement goal for naturally produced spring chinook in the Tucannon River. It is hoped that through re-negotiation of the Columbia River Fish Management Plan (CRFMP), and as part of the development of a Snake River chinook recovery plan, an agreed upon goal will be established.

The captive broodstock program is not intended to replace the hatchery supplementation program. Rather, it is to provide a quick "boost" to the population in the short term because of poor runs initially predicted through 2000. A quick "boost" would not be possible under the existing supplementation program, as it would require about 200 adults for hatchery broodstock each year. This was not believed possible by WDFW, as returns from 1998-2000 were expected to be less than 200 total fish annually. Further, such an increase would require taking more fish from the river, nearly eliminating natural production potential. WDFW believed that the low runs between 1997-2000 would limit both natural and hatchery production, possibly to a point where the run would not be able to recover. Based on this conclusion, the captive broodstock program was initiated.

The specific objectives of the program are to rear spring chinook salmon from eggs to adults, spawn them, rear their progeny, and release the progeny as smolts into the Tucannon River. The program is scheduled to terminate with the final release of smolts in 2008. Successes and failures during and after the program ends will be evaluated by WDFW concurrently with the LSRCP hatchery evaluation program.

Eggs/fry to be incorporated into the captive broodstock program were collected from the 1997-2001 BYs that are part of the supplementation program. The captive broodstock goal is to collect 290,000 eggs/year from captive brood females when three complete age classes (Age 3-Age 5) are spawned concurrently. Under the original program design, these eggs are expected to produce about 150,000 smolts for release from the Curl Lake AP. Depending on smolts produced each year this should provide a return of about 300 adult fish of captive broodstock origin per year between 2005-2010. These fish combined with fish from the hatchery supplementation program and natural production from the river should return 600-700 fish annually between 2005-2010. While this return is still well below the LSRCP mitigation goal, it increases the in-river population level to a pre-1994 run size.

Captive brood program production (adults, eggs, or juveniles) in excess of the smolt goal may be released by other methods as discussed in the Master Plan (WDFW et al. 1999). Options include adult outplants, remote site egg incubation, fry outplants, or smolt releases into other systems deemed suitable for Tucannon River spring chinook introductions.

The spring chinook captive broodstock program in the short term will help ensure that the Tucannon River spring chinook population is preserved until habitat-related factors and Columbia/Snake River passage problems affecting the productivity and survival of wild fish can be remedied. The captive brood program, in conjunction with the supplementation program, is intended to facilitate recovery of the natural population, while minimizing the risk of further decline. Monitoring and evaluation programs are in place to assess the effects of the captive broodstock program and adjust it as needed (Bumgarner and Schuck 1999, Bumgarner et al. 2000). Measures have been taken to minimize and mitigate potential genetic and/or ecological hazards of this program to the listed population (WDFW et al. 1999).

Source of Captive Population

As described in the Tucannon Master Plan (WDFW et al. 1999), the captive population originated from the hatchery supplementation program during the 1997-2001 BYs. Supplementation broodstock consist of both natural and hatchery returns (generally 1:1 ratio). Returning hatchery fish used in the supplementation broodstock are verified to have come from the Tucannon River stock through Coded-Wire Tag (CWT) verification. Collection of eggs/fry from the supplementation program was done to lessen the effects of removing more fish from the natural population. Also, disease history and origin of parents would be known, and the overall effect to the supplementation program would be minimal.

During the spawning process in the supplementation program, the eggs of two females are split in half with each lot fertilized by a different primary male (each male also acts as a secondary male). Due to the relatively small population size, this 2 x 2 mating (Figure 4) strategy has been incorporated into the supplementation program to increase genetic variation. Milt from a secondary male is added as a backup after 30 seconds. Actual fertilization takes place in a few seconds, so the backup male may not contribute equally to each individual egg lot unless semen from the primary male is non-viable.

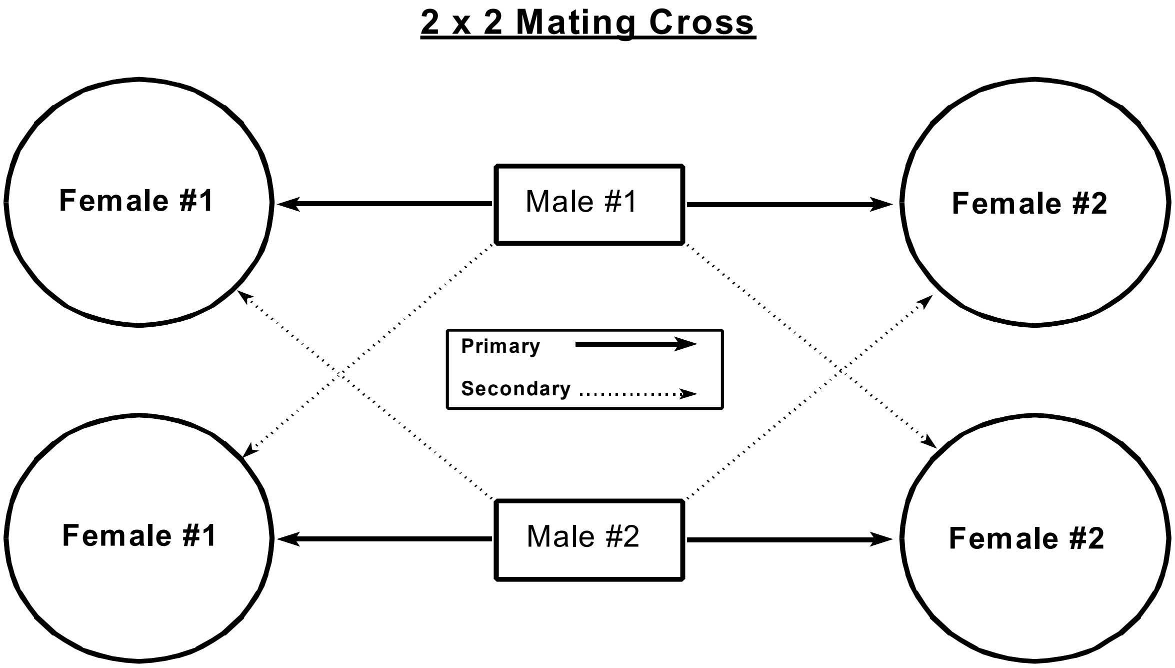

Figure 4. Diagram of the 2 x 2 mating scheme used by WDFW in the supplementation and captive broodstock program.

Because of the mating strategy, some progeny from the two females are likely related as a family unit. Therefore, we consider all crosses with identical males (whether as primary or secondary to the mating) as one family unit to avoid within-family matings in the future. So while only 15 "family" units are chosen for the program, actual contribution of male and female parents (population size) to the captive broodstock program on a yearly basis will be higher. The actual number of parents that comprise the 1997-2001 BYs are given in Appendix B. Effective population size for each brood year was calculated by the formula:

$$N_e = 4\,(N_M)(N_F)/(N_M + N_F)$$

Where: N_M = number of males
N_F = number of females

The effective population sizes of the 1997-2001 BYs were 53, 58, 42, 56, and 58, respectively. The effective population size for the 2002 BY (for extra males) was 59. Allendorf and Ryman (1987) and Verspoor (1988) have suggested that little (<1%) genetic variability will be lost in most salmonid species if the N_e of the founding population is greater than 50.

Selection of eggs/fry for the captive brood program is based on Bacterial Kidney Disease (BKD) and virology screening of females, parent origin, and matings (Appendix B). Spawned females were examined for BKD using the Enzyme Linked Immunosorbent Assay (ELISA) technique. Only females that are given a "Low" (0.11 - 0.19 Optical Density (OD)) or "Below Low" (< 0.11 OD) ELISA result are used for selection, with priority given to "Below Low" females. Priority for selection (in the following order) of eggs/fry is given to Wild x Wild, Wild x Hatchery

(Mixed), and Hatchery x Hatchery crosses. All BYs identified for the program will follow the same criteria.

Screening for BKD was a major factor in WDFW's decision to collect eggs/fry from the supplementation program. By having the test results prior to selection, and by having rearing criteria that called for minimal sampling/handling, we felt that BKD outbreaks would be minimized. To date, we know of no mortalities that can be attributed to BKD in the captive brood population.

After the eggs have hatched and absorbed their yolk sac, they are ready to be placed in the rearing vessels and the selection process begins. Eighty fish (or generally 40 fry/female) from each of the 15 "family units" are selected (1,200 total fish) from each BY and moved to the 1.2-m circular fiberglass tanks. After rearing for one year, each of the "family" groups is reduced to 30 fish/family (450 fish/BY) by random selection just prior to marking. Excess fish are returned to the supplementation production group. Fish destined for the captive broodstock program are marked by "family" group with a CWT in the snout and adipose fin (backup). This is to verify "family" groups during future spawning activities so that full or half-siblings are not mated together. In addition to the CWT, an alphanumeric visual implant (VI) tag is placed behind the left or right eye to identify each fish. The VI tag, should it be retained, will provide a quicker "family" identification method than the CWT. In addition, fish that retain the VI will provide individual growth rates. After the fish have been tagged, they are transferred to one of the 6.1-m circular fiberglass tanks for rearing to maturity. Once the fish have been transferred to the larger rearing tanks, they are not moved again unless survival rates are greater than anticipated, or density limits are exceeded within the rearing tanks. At maturity, fish are transferred to the adult raceway located in the spawning building. Family size and marking procedures will be the same for all brood years collected.

Density limits for each rearing tank were established prior to any stocking of fish. Most of the density limits prescribed were taken from the WDFW Dungeness River Captive Broodstock Program, where similar size starter and adult rearing tanks are used. Based on those density limits and expected survival and maturation rates, we were able to design the facilities needed. The current fish number maximums are as follows: 1.2-m circular tanks = no more than 200 fish/tank at Age 1; 6.1-m circular tanks = no more than 150 fish/tank at Age 3, or 100 fish/tank at Age 4.

Fry from each brood year were collected as described above, with appropriate families chosen for the program (Appendix B). Data on average length (mm), weight (g), and condition factor (K) for each "family" group were compiled during tagging (Appendix C).

Rearing, Spawning, and Release

Captive brood fish are being reared at LFH using standard fish culture practices and approved theraputants in pathogen free well water that is a constant 11ºC. Each 6.1-m circular captive tank is supplied with 581.3 L/min water flow, while the 1.2-m tanks receive 23.3 L/min. To reduce the risk of catastrophic fish loss due to hatchery facility or operational failure, a number of safeguards are in place. LFH is staffed full time by personnel living on-station, providing for the protection of fish from vandalism and predation. The hatchery is also equipped with back-up generators in the event of power outages. All staff are trained in proper fish handling, transport, rearing, biological sampling, and WDFW fish health maintenance procedures to minimize the risk of fish loss due to human error. All fish are handled, transported, and propagated in accordance with the WDFW Fish Health Manual (WDFW 1996) and Pacific Northwest Fish Health Protection Committee (PNFHPC 1989) disease prevention and control standards to minimize loss due to disease. Sanitation procedures are employed to reduce the transfer and incidence of fish diseases, and to promote quality fish in accordance with PNFHPC (1989) and Integrated Hatcheries Operations Team (1995) guidelines.

A variety of high quality commercial feed is provided through a state contract, and feed size varies with the estimated fish size of the different BYs. To date, we have used Moore-Clark Nutra™, Moore-Clark Fry™, Bio-Products Salmon Brood Feed™, and Moore-Clark Pedigree Trout Brood Feed™ on the captive brood. Estimated size only is generally used to prescribe feed, as WDFW decided initially that too much handling of the fish to determine growth and size would jeopardize a healthy population. This decision resulted from problems that Oregon Department of Fish and Wildlife (ODFW) and Idaho Department of Fish and Game (IDFG) captive programs experienced during their first years of operation with monthly fish sampling (Bumgarner and Gallinat 2001). Due to the degree of early maturation of females in the 1997 and 1998 brood years, size at age recommendations were revised to produce more mature Age 4 and 5 fish. Size at age goals are as follows for each of the brood years: Age 1, 20-25 g; Age 2, 150-200 g; Age 3, 900 g; and Age 4, 4,000 g. All captive brood fish are reared outside under natural photoperiod conditions. However, each of the 6.1-m circular tanks are covered with camouflage netting which shades the pond. The netting also prevents fish from jumping out of the tank, and seems to maintain a “fright” response in the fish.

During the summer (late June to early July), captive brood fish that are Age 2 or greater are examined for signs of sexual maturation. Maturation is determined by change in body coloration, as other morphological sexual characteristics are not as obvious. Mature female captive broodstock were injected with Erythromycin (0.5 cc/4.5 kg of body weight) at sorting to prevent Bacterial Kidney Disease. The broodstock are also treated with a formalin flush (167 ppm) every other day to control fungus. Mature fish (primarily Age 2 jacks) not used for spawning are sacrificed at the end of the spawning season.

All captive brood progeny smolts will be marked differently from supplementation progeny for identification upon adult return. Smolts will be unclipped and marked with an agency-only wire tag in the snout (production fish have an elastomer tag and CWT). When supplementation or captive brood fish return as adults at the TFH adult trap, each unmarked (no adipose clip) adult spring chinook will be scanned for wire in the snout and examined for a VI tag. If the fish is not adipose fin clipped, and wire is present in the snout and no VI is present, the fish is likely from the captive broodstock program and will be passed upstream to spawn in the river. Only if the run completely collapses would any of the captive broodstock fish be collected for hatchery broodstock.

We started the year (Jan. 1, 2003) with 8 98BY; 192 99BY; 339 00BY; 449 01BY, and 297 02BY fish on hand. As of January 1, 2004, WDFW had 18 BY99; 189 BY00; 405 BY01, and 277 BY02 (for extra males). The paragraphs below detail the selection, tagging, rearing, sorting, spawning activities, and mortalities for each BY during 2003.

1998 Brood Rearing

We began 2003 with 8 BY 1998 fish on hand. Fish from this brood have remained healthy throughout their rearing at LFH, with only one mortality during the year not related to maturation (Appendix D, Table 1). Since Age 1, there have been 39 (8.9%) mortalities not related to maturation. The captive broodstock were sorted for maturity on July 29, 2003. Since we are only keeping each broodstock to the age of 5, all 7 fish from the 98 BY were transported to the spawning raceway for holding. All mature captive brood fish at the spawning building were held upstream of the supplementation broodstock captured at the adult trap on the Tucannon River. Length and weight samples were not collected from the 98 BY before transport.

Mortalities by age for each stage of maturity have been followed since program inception (Figure 5). Fish from the captive brood program have matured earlier than fish from the supplementation program (Figure 5, Appendix D). Captive brood males begin maturing at Age 2 and captive brood females begin to mature at Age 3 (Figure 5). Mature fish not used for spawning are fish that were in excess of the number required for spawning or mature fish that did not become ripe in time for spawning (Figure 5). The results from spawning the mature fish from the 1998 BY during 2003 are provided in the spawning section of this report.

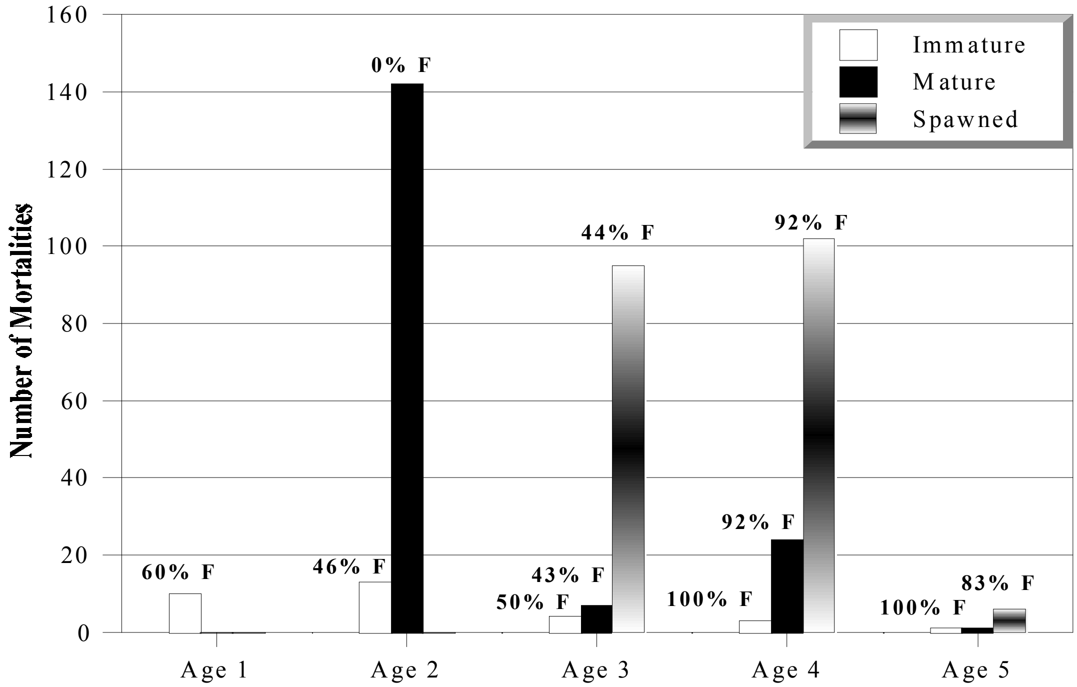

Figure 5. Number of mortalities by age and percent composition of females for each stage of maturity for the 1998 brood year. (Age 4 does not include 21 fish of unknown sex released as adult outplants).

1999 Brood Rearing

We started 2003 with 192 BY 1999 fish on hand. Fish from this brood have remained healthy throughout their rearing at LFH, with seven mortalities during the year not related to spawning (Appendix D, Table 2). Since Age 1, there have been only 10 (2.4%) mortalities not related to maturation. One hundred sixty-seven fish were determined to be mature based on coloration and were transported to the spawning building for holding on July 29. Nineteen immature fish were sampled for length and weight information and placed into Tank #2 (Table 1).

Table 1. Length and weight statistics of the 1999 brood year immature fish sampled on July 29, 2003.

Sample Size[1]	Mean Length (cm)	Mean Weight (g)	# Fish/lb	Coefficient of Variation	Condition Factor (K)
19	46.3	1,298.7	0.349	8.4	1.28

[1] Twenty fish are in Tank #2 but one fish was only 18 cm long and 90.7 g and was excluded from the calculations.

No mortalities of female fish occurred until Age 3 (Figure 6). Results from spawning the mature fish from the 1999 BY during 2003 are provided in the spawning section of this report.

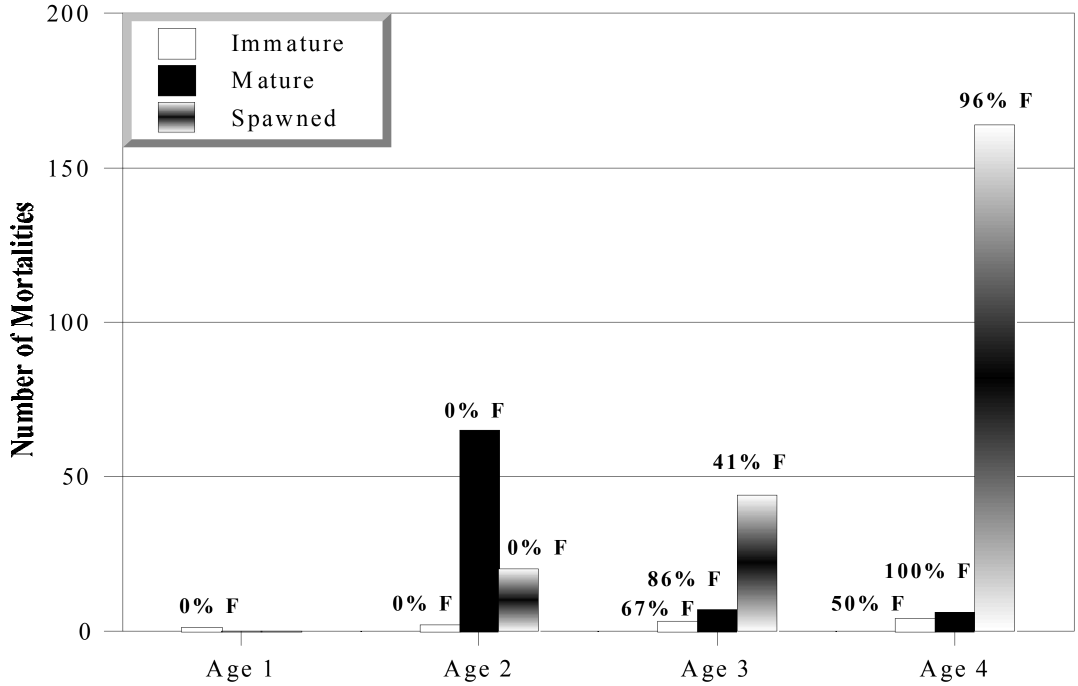

Figure 6. Number of mortalities by age and percent composition of females for each stage of maturity for the 1999 brood year. (Age 3 does not include 76 fish of unknown sex released as adult outplants).

2000 Brood Rearing

We began 2003 with 339 BY 2000 fish on hand. Fish from this brood have remained healthy throughout their rearing at LFH, with five mortalities during the year not related to maturation (Appendix D, Table 3). Since Age 1, there have been only 12 (2.7%) mortalities not related to maturation. One hundred forty-five mature fish were transported to the adult spawning building. The remaining 189 fish were immature, sampled for length and weight information, and split into two tanks (Tanks 3 and 4) to reduce rearing density (Table 2).

Table 2. Length and weight statistics of the 2000 brood year immature fish sampled on July 29, 2003.						
Tank #	Sample Size	Mean Length (cm)	Mean Weight (g)	# Fish/lb	Coefficient of Variation	Condition Factor (K)
3	50	42.7	1,108.6	0.409	7.5	1.40
4	50	43.1	1,179.3	0.385	6.9	1.46
Total	100	42.9	1,144.0	0.397	7.2	1.43

Percent composition of Age 3 females from the 2000 BY has been consistent with previous brood years (Figure 7). Results from spawning the mature fish from the 2000 BY during 2003 are provided in the spawning section of this report.

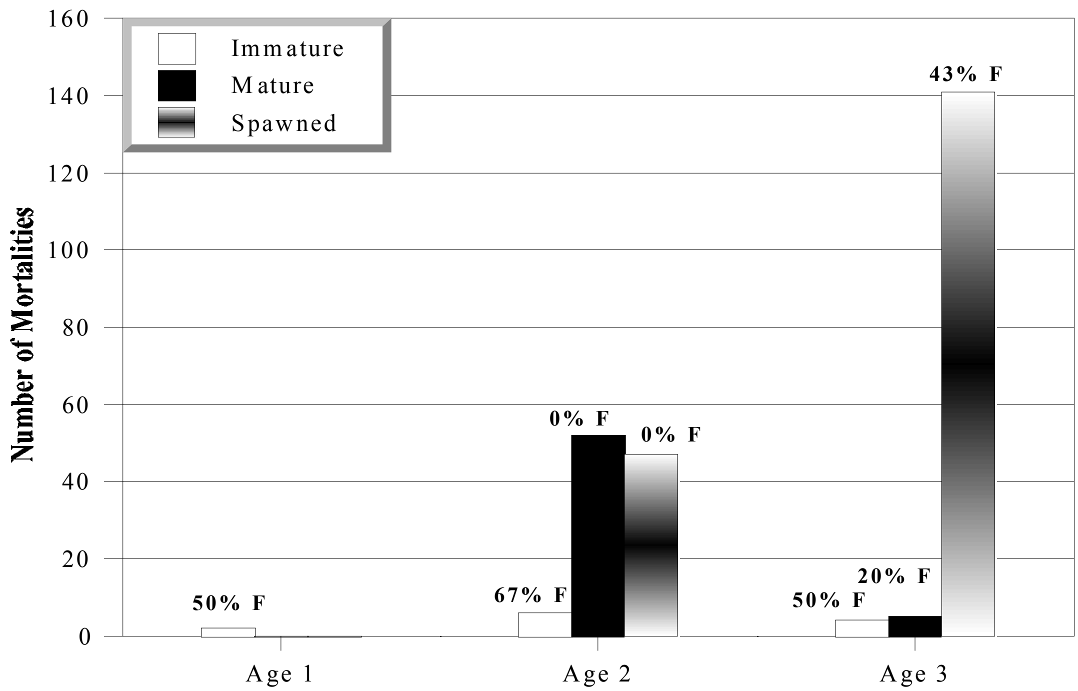

Figure 7. Number of mortalities by age and percent composition of females for each stage of maturity for the 2000 brood year.

2001 Brood Rearing

WDFW began 2003 with 449 BY 2001 fish on hand. Fish from this brood have remained healthy throughout their rearing at LFH, with nine mortalities during the year not related to maturation (Appendix D, Table 4). During sorting on July 29, 35 mature fish (presumably males) were placed into Tank #8 to be used as needed during spawning. The 412 immature remaining fish were split into two tanks to reduce rearing density. A total of 206 immature fish (50 sampled for length and weight) were placed into Tank #6 and 206 immature fish (50 sampled for length and weight) were placed into Tank #7 (Table 3).

Table 3. Length and weight statistics of the 2001 brood year immature fish sampled on July 29, 2003.						
Tank #	Sample Size	Mean Length (cm)	Mean Weight (g)	# Fish/lb	Coefficient of Variation	Condition Factor (K)
6	50	24.0	215.9	2.10	6.8	1.54
7	50	24.3	211.4	2.15	6.9	1.44
Total	100	24.2	213.6	2.12	6.9	1.49

2002 Extra Males

We determined that there would be insufficient captive brood males to spawn with females towards the end of the captive broodstock program. To prevent this from occurring, 20 fish from 15 families (300 fish total) were selected from the 2002 supplementation fish in order to have extra males on hand in the future.

WDFW began 2003 with 297 BY 2002 fish on hand. There were 20 mortalities during the year not related to maturation, leaving 277 BY 02 fish on hand at the end of 2003. Priority for the utilization of females from this brood year will be to spawn them (provided there is funding available from BPA and agreement from NOAA Fisheries). The other option will be to outplant mature females into the river(s) based on fisheries management recommendations.

2003 Spawning with Comparisons to the Supplementation Broodstock

One of the 7 mature fish from the 1998 brood year (Age 5) was male and was used during spawning. The length and weight for the Age 5 mature male was 60.0 cm and 2,633 g (Appendix E, Table 1). The remaining 6 mature fish were females. Of those, 5 were spawned (2 were partially ripe) and one died before spawning. Mean length and weight of Age 5 mature females was 52.5 cm and 2,126 g, respectively (Appendix E, Table 1). Length-weight relationships for males, females, and both sexes combined are found in Appendix E, Table 2.

Eggs were initially disinfected and water hardened for one hour in iodophor (100 ppm). During incubation, formalin (1,000 ppm) was added every other day for a 30 min treatment period to control fungus on the eggs. Eggtake from the 1998 brood year was 8,378 eggs and egg survival was 64%. Mean fecundity of the three fully spawned females was 1,794 eggs/female. The fecundity by size relationship for Age 5 females is not presented because of the small sample size.

Peak spawning was two weeks later than observed for the supplementation fish (Figure 8). All five females were crossed with captive brood males. We did not attempt to cryo-preserve any semen from wild males but instead placed semen from wild origin fish into plastic bags with oxygen and stored them in a refrigerator for up to one week.

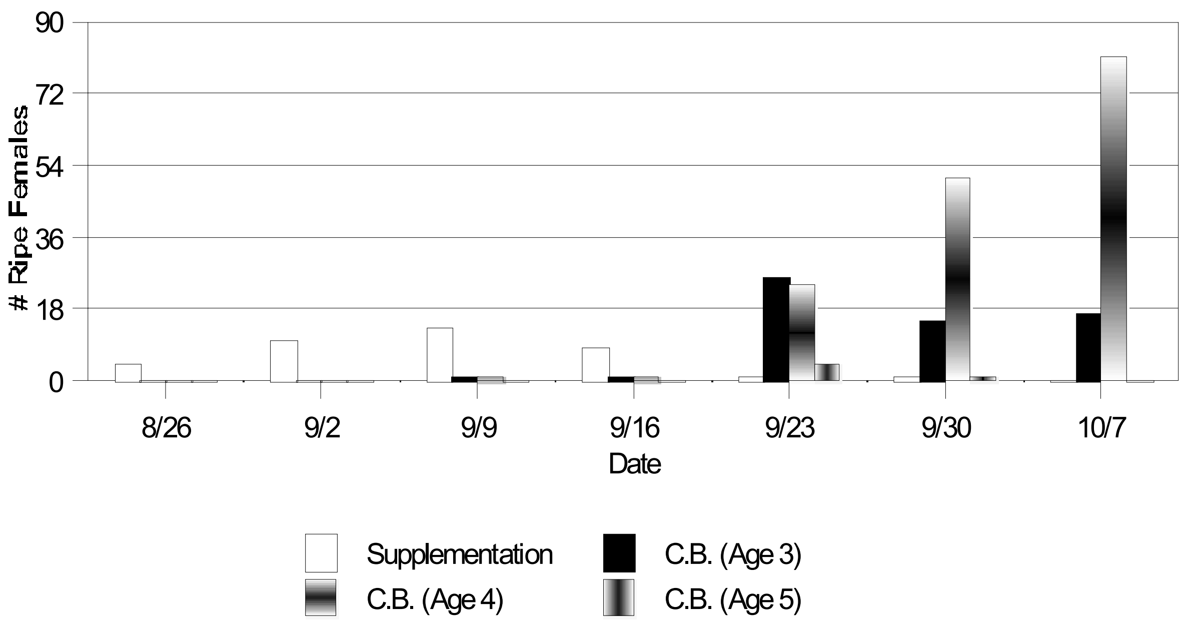

Figure 8. Spawn timing comparison by origin for the 2003 spawning season.

Six of the 167 mature fish from the 1999 brood year (Age 4) were males and were used for spawning. Average length and weight for mature Age 4 males was 47.1 cm and 1,529 g (Appendix E, Table 1). One hundred sixty-one of the mature fish were females. Of those, 158 were spawned (1 was a partial spawn), and three were killed outright (green). Average length and weight for mature Age 4 females was 50.2 cm and 1,939 g (Appendix E, Table 1). Length-weight relationships for males, females, and both sexes combined are found in Appendix E, Table 2. Eggtake was 226,043 eggs and egg survival was 65%. This compared favorably to

29% survival to the eyed-egg stage for Age 4 fish (1998 BY) spawned in 2002. Mean fecundity based on the 157 fully spawned females was 1,433 eggs/female. This is lower than the fecundity of Age 4 fish spawned in 2002 (1,650 eggs/female) and 2001 (1,990 eggs/female). Fecundity by size relationship for Age 4 females was expressed by the formula:

Fecundity = -1,998.47 + 68.41 x Fork Length (cm) ($r^2 = 0.35$; $P < 0.01$)

Five of the 158 spawned females were crossed with wild (unmarked) males from the supplementation program and the remaining 153 crossed with mature captive brood males. Peak spawning was four weeks later than observed for the supplementation fish (Figure 8).

Eighty-three of the 145 mature fish from the 2000 brood year (Age 3) were males, of which 80 were used in spawning, one died before spawning and 2 were killed outright. Mean length and weight for Age 3 mature males was 42.9 cm and 1,077 g (Appendix E, Table 1). The remaining 62 mature fish were females. Of those, 60 were spawned; one died before spawning and one was green and killed outright. Mean length and weight of Age 3 mature females was 46.8 cm and 1,569 g (Appendix E, Table 1). Eggtake was 74,995 eggs and egg survival was 45%. This is in comparison to 55% egg survival for Age 3 females in 2002 (1999 BY). Mean fecundity based on the 59 fully spawned fish was 1,250 eggs/female. This is similar to fecundity of Age 3 females (1999 BY) during 2002 spawning (1,092 eggs/female). Fecundity by size relationship for Age 3 females was expressed by the formula:

Fecundity = -784.06 + 43.28 x Fork Length (cm) ($r^2 = 0.30$; $P < 0.01$)

Peak spawning was two weeks later than observed for the supplementation fish (Figure 8). Forty-one females were crossed with wild (unmarked) males and 19 with captive males.

All 35 of the mature fish from the 2001 BY (Age 2) were males and were used for spawning. Mean length and weight for the males was 28.0 cm and 291 g (Appendix E, Table 1).

The total eggtake for the captive brood program was 309,416 eggs. A total of 122,673 dead eggs (39.6%) were removed leaving 186,743 live eggs in the incubators. An additional 21,943 dead eggs/fry (11.8%) were picked at ponding leaving 164,800 fish for rearing.

Multiple comparison analysis was performed to determine if there were significant differences (at the 95% confidence interval) in mean fecundities between captive brood (Age 4) and wild and hatchery origin females (Age 4) trapped from the Tucannon River for the supplementation program. Age 4 fish trapped for the supplementation program (both hatchery and wild origin) had significantly higher fecundities than Age 4 captive brood females ($P < 0.05$) (Figure 9). Fecundities of hatchery and wild origin fish trapped in the river for the supplementation program were not significantly different ($P > 0.05$).

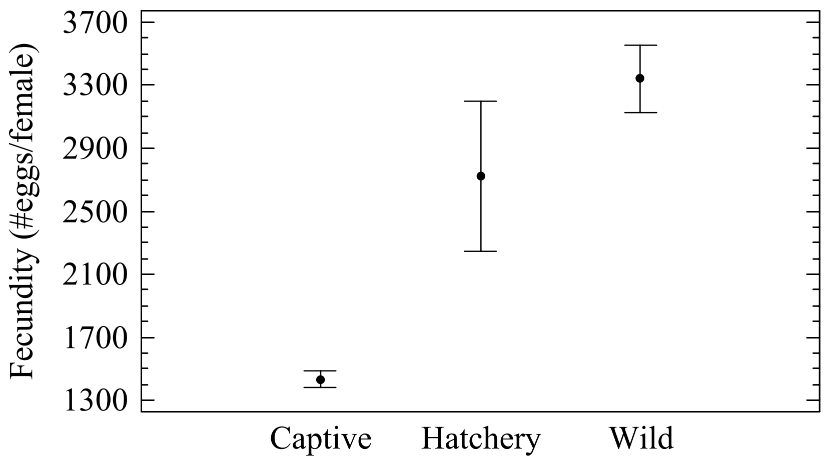

Figure 9. Mean fecundity (with 95% confidence intervals) of Age 4 captive, wild, and hatchery origin spawned females, 2003.

Egg size (g/egg) has been tracked in the supplementation program since 1988. Mean egg size for 4-year-old females was significantly different at the 95% confidence level between hatchery-origin, wild-origin, and captive brood fish ($P < 0.05$) (Figure 10). Mean egg size of Age 5 captive brood females was not significantly different ($P > 0.05$) from Age 5 females (hatchery and wild) from the supplementation program. Heath et al. (2003) found that chinook salmon raised in a commercial hatchery in Canada developed significantly smaller eggs within four generations in captivity. Our findings to date have found the opposite, with hatchery and captive brood eggs significantly larger than eggs from wild origin fish (Figure 10).

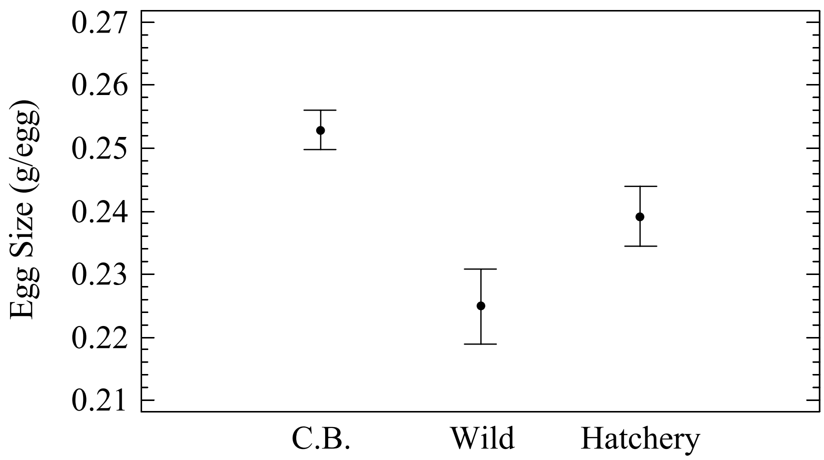

Figure 10. Mean egg size (g/egg) with 95% confidence intervals for Age 4 captive brood females (2001-2003) compared to Age 4 wild and hatchery origin females from the supplementation program, 1988-2003.

Surprisingly, captive brood eggs are significantly larger than eggs from broodstock trapped from the Tucannon River even though captive broodstock females are significantly smaller ($P < 0.05$) (Table 4). Captive brood females may be able to allocate more energy into producing larger eggs with their protection in the hatchery environment. These large eggs in small fish results in captive broodstock with lower fecundities than fish trapped from the wild.

Table 4. Comparison of mean fork length (cm) and mean egg size (g/egg) from female captive broodstock (2000-2003) and female supplementation broodstock (1988-2003).

Female Origin (Age)	N	Mean Fork Length (cm)	S.D.	Mean Egg Size (g/egg)	S.D.	Range
Captive Brood (Age 3)	127	46.6	3.0	0.22	0.04	0.15-0.31
Captive Brood (Age 4)	375	52.3	5.4	0.25	0.05	0.15-0.45
Captive Brood (Age 5)	14	53.8	5.6	0.26	0.05	0.19-0.36
Wild Origin (Age 4)	105	71.6	4.2	0.22	0.03	0.15-0.33
Hatchery Origin (Age 4)	158	71.6	3.7	0.24	0.03	0.10-0.32
Wild Origin (Age 5)	72	84.0	4.1	0.27	0.04	0.13-0.35
Hatchery Origin (Age 5)	38	80.6	5.0	0.28	0.04	0.20-0.36

Using analysis of variance, mortality to the eyed egg stage was significantly higher for captive brood origin eggs than eggs from the supplementation program ($P < 0.05$) (Figure 11). It is unknown why egg mortality was so high for the captive brood fish. It may be nutritionally or hatchery environment related. The effect of male origin (captive, wild, hatchery) was examined using multiple comparison analysis to determine the influence of male origin on egg survival, but no statistically significant differences were found ($P = 0.64$).

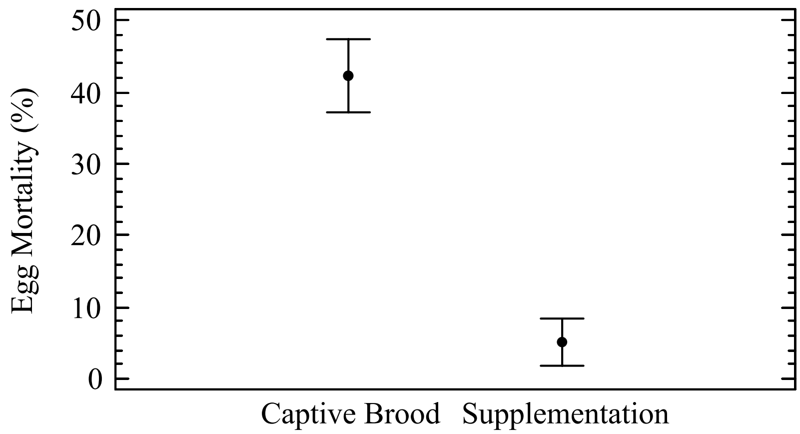

Figure 11. Mean percent egg mortality (with 95% confidence intervals) of captive brood and supplementation origin eggs from the 2003 spawning season.

Incubator Comparison Experiment

Since the beginning of the program, all captive broodstock eggs have been hatched in colander incubators and all eggs from the supplementation broodstock are hatched in Heath tray incubators. To exclude the possibility that colander incubators were causing higher mortalities to eye-up, we compared mortalities for the two types of incubators. Ninety-six captive brood females were randomly chosen (partial spawns were excluded) with 48 of the female's eggs incubated in Heath tray incubators and the other 48 incubated in colander incubators (Appendix F). Analysis of variance was used to test for significant differences (at the 95% confidence interval) in mortality to eye-up between Heath tray and colander incubators. Surprisingly, mortality to eye-up was slightly higher in the Heath tray incubators (46.3%) than for the colander incubators (42.5%), however the difference was not significantly different ($P > 0.05$).

2002 Progeny

The 2002 BY captive brood juveniles (45,236 fish) were marked with an agency-only wire tag in the snout on September 25-26, 2003. Marked fish were transported to the Tucannon Fish Hatchery during October. Fish were sampled for length, weight, hatchery mark quality, and Passive Integrated Transponder (PIT) tagged for outmigration comparisons (1,016 supplementation fish and 1,029 captive brood progeny) before transfer to Curl Lake Acclimation Pond (Table 5). Length and weight samples were collected twice from the 2002 BY fish during the rearing cycle (Table 6). Approximately 44,801 BY02 captive brood progeny were moved to Curl Lake for final rearing on February 5. Volitional release began April 1 and continued until April 20 when the remaining fish were forced out. Mortalities were low in Curl Lake and 44,784

BY 2002 captive broodstock progeny were released into the Tucannon River (Table 7). These fish were marked with agency-only wire tag and no fin clips in order to differentiate them from the supplementation fish (CWT/Right Red VIE/No Finclip). Monitoring their survival and future releases to adult returns, along with future natural production levels, will determine the success or failure of the captive broodstock program. Fish releases from the program to date can be found in Appendix G.

Table 5. Length and weight statistics of the 2002 brood year supplementation and captive brood progeny PIT tagged in February 2004.

Origin	N	Mean Length (mm)	Mean Weight (g)	Coefficient of Variation	Condition Factor (K)	Number PIT Tagged
Supp.	266	139	25.1	13.7	0.88	1,016
C.B.	254	136	23.8	10.7	0.92	1,029

Table 6. Summary of sample sizes (N), mean lengths (mm), coefficients of variation (CV), condition factors (K), and fish/lb (FPP) of 2002 BY juveniles sampled at TFH and Curl Lake.

Date	Progeny Type	Sample Location	N	Mean Length	CV	K	FPP
2/15/04	Captive Brood	TFH	254	135.5	10.7	0.92	19.1
4/05/04	Captive Brood	Curl Lake	250	135.0	15.1	1.33	13.2

Table 7. Summary of yearling spring chinook smolt releases in the Tucannon River, 2002 brood year.

Release Year	(BY)	Release Location	Release Date	Total Released	CWT Code	Number Tagged	Ad-only Marked	kg
2004	2002	Curl Lake	4/01-4/20	44,784	63	42,875	N.A.	1,540.4

N.A. = Not Applicable.

2003 Progeny

As of May 1, 2004 we had 153,038 BY 2003 captive brood progeny on hand at Lyons Ferry Hatchery. These fish will be coded-wire tagged and volitionally released during March-April 2005.

PIT Tagging

In 2003, WDFW used PIT tags to compare emigration travel timing and relative success of the 2001 BY captive brood progeny with our regular supplementation hatchery fish. We tagged 1,007 captive brood progeny and 1,010 supplementation fish during the middle of February before transferring them to Curl Lake Acclimation Pond for acclimation and volitional release (Table 8). No fish were killed during PIT tagging, though it is likely some delayed mortality occurred after release. Detection rates and mean travel days were slightly higher for hatchery spring chinook from the supplementation program than from captive brood progeny. Differences may be due to the slightly larger size of the supplementation fish.

Table 8. Cumulative detection (one unique detection per tag code) and travel time (TD) summaries of PIT tagged hatchery spring chinook salmon released from Curl Lake Acclimation Pond (rkm 65.6) on the Tucannon River at downstream Snake and Columbia River Dams during 2003. (Fish were volitionally released from 4/01/03-4/21/03).

	Release Data			Recapture Data										
Hatchery		Mean		Mean	LMJ		MCJ		JDJ		BONN		Total	
Origin	N	Length	S.D.	Length	N	TD	N	TD	N	TD	N	TD	N	(%)
Supp.	1,010	125.5	19.5	124.3	119	13.5	178	18.6	53	25.0	23	24.4	373	(36.9)
C.B.	1,007	116.5	14.8	117.5	101	12.1	134	18.3	37	24.0	13	24.2	285	(28.3)

Note: Mean travel times listed are from total number of fish detected at each dam, not unique recoveries for a tag code. Abbreviations are as follows: LMJ-Lower Monumental Dam, MCJ-McNary Dam, JDJ-John Day Dam, Bonn-Bonneville Dam, S.D.-standard deviation, TD – Mean Travel Days.

Survival probabilities were estimated by the Cormack Jolly-Seber methodology using the Survival Under Proportional Hazards (SURPH2) computer model. The data files were created using the CAPTHIST program. Data for input into CAPTHIST was obtained directly from PTAGIS. Survival estimates from Curl Lake to Lower Monumental Dam were 0.62 (± 0.06) and 0.55 (± 0.06) for supplementation and captive brood progeny, respectively. While the survival estimate was slightly lower for captive brood progeny fish the difference was not significant.

DNA Genetic Samples

2003 Brood Year

Since the beginning of the program in 1997, evaluation staff has collected DNA samples from all spring chinook parents that eventually contributed gametes to the captive broodstock population. Additional samples are also collected on an annual basis from other Tucannon River origin spring chinook carcasses to provide a large genetic data set that will describe the population. Opercle punches for DNA analysis were collected from 2003 spawners, including 346 captive brood spawners. All 2003 DNA samples were sent to the WDFW genetics lab in Olympia for baseline microsatellite DNA analysis.

2002 Brood Year

Two hundred two samples from the 2002 brood year were genotyped at 14 microsatellite loci (Ogo-2, Ogo-4, One-8, Ocl-1, One-100, Ots-107, Ots-3M, Ots-101, Ots-1, Ots-2M, Ssa-197, Omm-1142, Omm-1135, and Omy-1001) using an Applied Biosystems 3730 DNA analyzer. Genotypes, allele frequencies, and tissue samples are stored at WDFW's Genetics Laboratory in Olympia, Washington.

Coordination and Reporting

Since BPA funding was acquired, WDFW has joined other researchers in a group known as the Captive Broodstock Technical Oversight Committee (CBTOC). The CBTOC is a forum for all BPA funded projects working with captive broodstock or captive rearing programs. The CBTOC goal is to ensure that all groups are coordinated, and communication is occurring between projects. The CBTOC also gives each of the researchers a chance to ask questions about other program's successes and failures, so each respective program can be adapted for better results.

In addition, WDFW formed its own Technical Working Group (TWG), which consists of WDFW project personnel, and representatives from the NPT and CTUIR. The group was formed so that WDFW and co-managers could make unified decisions about the Tucannon Spring Chinook captive broodstock program.

To satisfy ESA Section 10 permit requirements, WDFW also provides NMFS with a monthly update on the captive broodstock and supplementation program activities. This monthly program update is also sent to the co-managers to inform them of fish on hand, mortalities incurred, and any up-coming actions (i.e., sorting of mature fish) that may warrant their attention.

This annual progress report is produced by WDFW to disseminate the information gathered from this project to other researchers in the Columbia and Snake River basins. Additional reports and papers will also be published following complete returns of all captive brood origin fish back to the Tucannon River.

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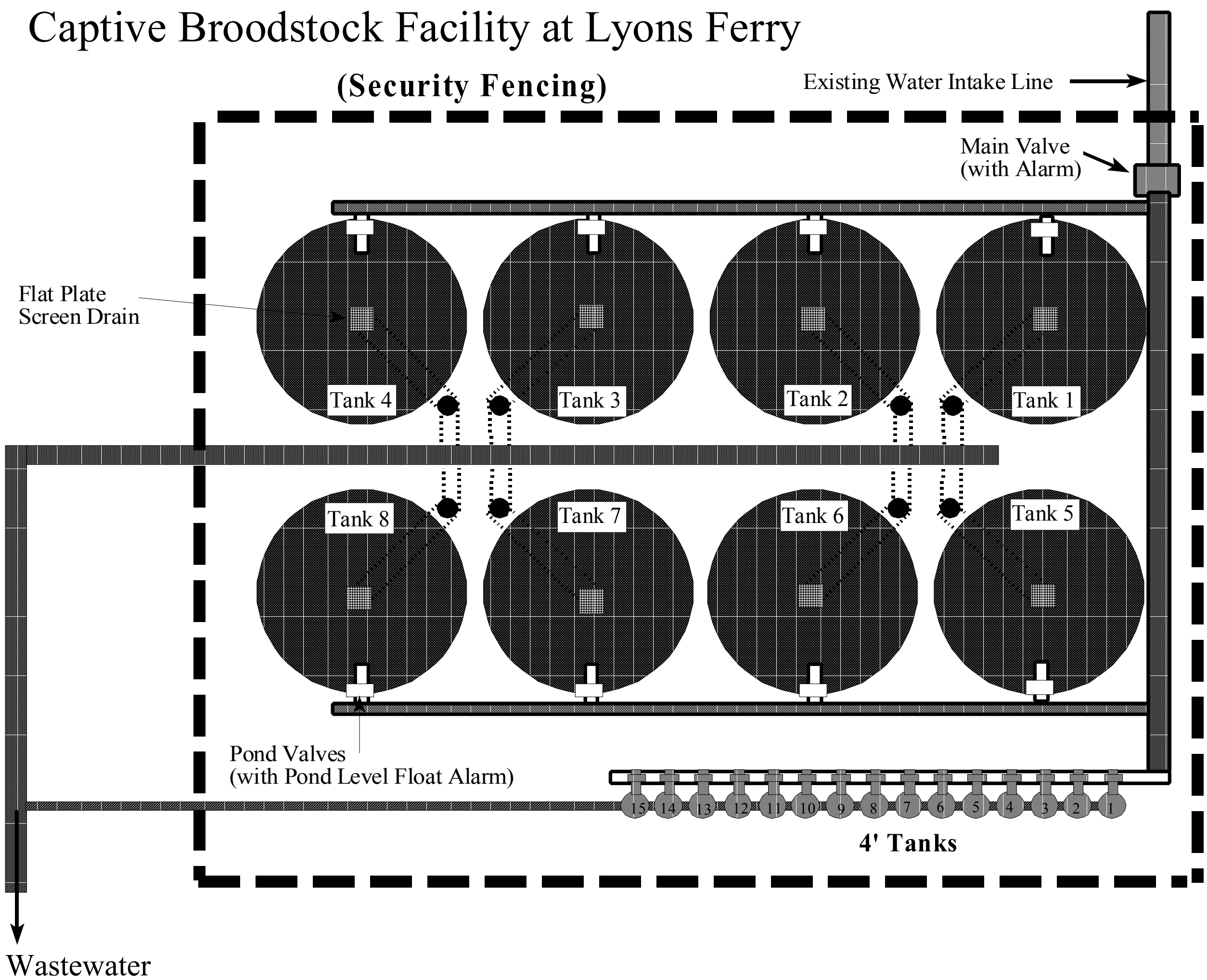
APPENDIX A


Captive Broodstock Facility at Lyons Ferry
(Security Fencing)
Existing Water Intake Line
Main Valve
(with Alarm)
Flat Plate
Screen Drain
Tank 4
Tank 3
Tank 2
Tank 1
Tank 8
Tank 7
Tank 6
Tank 5
Pond Valves
(with Pond Level Float Alarm)
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
4' Tanks
Wastewater

APPENDIX B

Table 1. Selection of progeny for the Tucannon River spring chinook captive broodstock program based on origin, crosses, and BKD ELISA results, 1997 and 1998 BYs.

Brood Year	Eggtake Date	Female Numbers	Male Numbers	Crosses	BKD ELISA[1]	Tank/Family Number
97	09/16	H885 + H886	W108 + W110	Mixed	LOW, BL	TANK 1
97	09/16	H889	W116 + W120	Mixed	BL	TANK 2
97	09/23	W958 + W957	H122 + H123	Mixed	BL	TANK 3
97	09/16	W897 + W898	H156 + H199	Mixed	BL	TANK 4
97	09/09	H872 + H871	W159 + W161	Mixed	BL	TANK 5
97	09/09	H873	W163 + W165	Mixed	LOW	TANK 6
97	09/09	W881 + W882	H167 + H175	Mixed	BL	TANK 7
97	09/16	W951 + W952	H149 + H157	Mixed	BL	TANK 8
97	09/09	W874 + W875	H171 + H173	Mixed	BL	TANK 9
97	09/09	W878 + W876	H179 + H181	Mixed	LOW, BL	TANK 10
97	09/02	W869 + W867	H191 + H193	Mixed	BL	TANK 11
97	09/09	H879	W169 + W177	Mixed	BL	TANK 12
97	09/16	W899	H153 + H154	Mixed	BL	TANK 13
97	09/02	W870	H183 + H185	Mixed	BL	TANK 14
97	09/02	H868	W187 + W189	Mixed	BL	TANK 15
98	08/25	W1003 + W1004	H754 + H753	Mixed	BL	TANK 1
98	08/25	W1005 + W1006	H751 + W131	Mixed	LOW, BL	TANK 2
98	09/08	W3001 + W3002	H758 + H759	Mixed	LOW, BL	TANK 3
98	09/08	W3003 + W3004	H755 + H756	Mixed	BL	TANK 4
98	09/08	W3005 + W3006	H757 + H760	Mixed	BL	TANK 5
98	09/08	W3007 + W3008	W128 + W129	Mixed	BL	TANK 6
98	09/08	H3009 + H3010	W130 + W133	Mixed	LOW, BL	TANK 7
98	09/11	H4001 + H4002	W135 + W134	Mixed	LOW, BL	TANK 8
98	09/11	W4003 + W4004	H762 + H761	Mixed	LOW, BL	TANK 9
98	09/11	W4007 + W4008	H767 + H765	Mixed	LOW, BL	TANK 10
98	09/11	W4009 + W4010	H769 + H768	Mixed	BL	TANK 11
98	09/15	W5002	H777 + H773	Mixed	LOW	TANK 12
98	09/15	W5003	H772 + H771	Mixed	LOW	TANK 13
98	09/22	W6005 + W6006	H781 + H780	Mixed	BL	TANK 14
98	09/22	W6007 + W6008	H783 + H782	Mixed	BL	TANK 15

[1] Low = 0.11-0.19 Optical Density; Below Low = < 0.11 Optical Density.

Table 2. Selection of progeny for the Tucannon River spring chinook captive broodstock program based on origin, crosses, and BKD ELISA results, 1999 and 2000 BYs.

Brood Year	Eggtake Date	Female Numbers	Male Numbers	Crosses	BKD ELISA[1]	Tank/Family Number
99	08/31	H101	H1+H2+H526	Hatchery	LOW	TANK 1
99	09/07	H203	H12+H13+H536	Hatchery	BL	TANK 2
99	09/07	H204	H15+H530+H531	Hatchery	LOW	TANK 3
99	09/07	W205	H18+H532+H533	Mixed	LOW	TANK 4
99	09/07	H206	H528+H529+H534	Hatchery	BL	TANK 5
99	09/07	H212	H19+H20	Hatchery	BL	TANK 6
99	09/14	H305	W31+H571	Mixed	LOW	TANK 7
99	09/14	H306	W21+H576	Mixed	LOW	TANK 8
99	09/14	H307	H40+H550	Hatchery	LOW	TANK 9
99	09/14	H309	H23+H549	Hatchery	BL	TANK 10
99	09/14	H310	H39+H572	Hatchery	LOW	TANK 11
99	09/14	H311	H36+H568	Hatchery	LOW	TANK 12
99	09/14	H312	H24+H544	Hatchery	LOW	TANK 13
99	09/21	H403	H45+H580	Hatchery	LOW	TANK 14
99	09/21	H404	H581+H582+H583	Hatchery	LOW	TANK 15
00	8/29	H102	H1 + H2	Hatchery	BL	TANK 1
00	8/29	H103 + H104	H3 + H4	Hatchery	BL	TANK 2
00	8/29	H105 + W106	H5 + H6	Mixed	BL	TANK 3
00	9/05	H202	W1 + H19	Mixed	BL	TANK 4
00	9/05	H203 + H204	W2 + H7	Mixed	BL	TANK 5
00	9/05	H205 + H206	H8 + H9	Hatchery	BL	TANK 6
00	9/05	H209 + H210	H12 + H13	Hatchery	BL	TANK 7
00	9/05	H211	H14 + H15	Hatchery	BL	TANK 8
00	9/05	H213 + H214	H16 + H17	Hatchery	BL	TANK 9
00	9/05	W215	H10 + H11	Mixed	BL	TANK 10
00	9/12	H301 + H302	H20 + H24	Hatchery	BL	TANK 11
00	9/12	H303 + H304	W3 + H23	Mixed	BL	TANK 12
00	9/12	H308 + H311	W5 + H22	Mixed	BL	TANK 13
00	9/19	W401 + H402	H30 + H31	Mixed	BL	TANK 14
00	9/19	H403 + H404	W6 + H32	Mixed	BL	TANK 15

[1] Low = 0.11-0.19 Optical Density; Below Low = < 0.11 Optical Density.

Table 3. Selection of progeny for the Tucannon River spring chinook captive broodstock program based on origin, crosses, and BKD ELISA results, 2001 and 2002 (for extra males) BYs.

Brood Year	Eggtake Date	Female Numbers	Male Numbers	Crosses	BKD ELISA[1]	Tank/Family Number
01	8/28	H101 + H103	28A2 + BCCC	Mixed	BL	TANK 1
01	9/04	W201 + W203	HM8 + HM9	Mixed	BL	TANK 2
01	9/04	W205 + W207	HM4 + HM5	Mixed	BL	TANK 3
01	9/04	H206 + H208	B2F4 + AAE7	Mixed	BL	TANK 4
01	9/04	W211 + W212	HM3 + HM6	Mixed	BL	TANK 5
01	9/04	H210 + H213	AOFB + DB6E	Mixed	BL	TANK 6
01	9/04	W214 + W220	HM2 + HM7	Mixed	BL	TANK 7
01	9/11	W301 + W303	HM10 + HM11	Mixed	BL	TANK 8
01	9/11	W314	HM16 + HM23	Mixed	BL	TANK 9
01	9/11	W304 + W305	HM12 + HM14	Mixed	BL	TANK 10
01	9/11	W307 + W308	HM13 + HM17	Mixed	BL	TANK 11
01	9/11	H309 + H311	9890 + 2912	Mixed	BL	TANK 12
01	9/11	H312	FEAC + 5F6F	Mixed	BL	TANK 13
01	9/18	W401 + W409	HM25 + HM26	Mixed	BL	TANK 14
01	9/18	W410 + W411	2626 + AF96	Wild	BL	TANK 15
02	8/27	W103 + W104	HM1 + HM2	Mixed	BL	TANK 1
02	8/27	H110	D0AA + AB01	Mixed	BL	TANK 2
02	9/03	W203 + W204	HM5 + HM6	Mixed	BL/LOW	TANK 3
02	9/03	W211 + W215	HM7 + HM8	Mixed	BL	TANK 4
02	9/03	W217 + W219	HM9 + HM10	Mixed	BL	TANK 5
02	9/03	H209 + H210	B5BD + 8D07	Mixed	BL	TANK 6
02	9/03	H212 + H213	A6CE + BC25	Mixed	BL	TANK 7
02	9/03	H214 + H216	A0CD + 29BC	Mixed	BL	TANK 8
02	9/10	W301 + W303	HM11 + HM12	Mixed	BL	TANK 9
02	9/10	W307 + W309	HM15 + HM16	Mixed	BL/LOW	TANK 10
02	9/17	H401 + H402	1515 + 98BA	Mixed	BL	TANK 11
02	9/17	H403 + H404	C045 + BF27	Mixed	BL	TANK 12
02	9/17	H405 + H408	A58C + BEB0	Mixed	BL	TANK 13
02	9/17	W406 + W407	HM24 + HM25	Mixed	BL	TANK 14
02	9/17	W409 + W410	HM19 + HM20	Mixed	LOW/BL	TANK 15

[1] Low = 0.11-0.19 Optical Density; Below Low = < 0.11 Optical Density.

APPENDIX C

Average length (mm), weight (g), and condition factor (K) with standard deviations for each family unit from the 1997, 1998, 1999, 2000 and 2001 BYs of captive broodstock at the time of tagging.							
Brood Year	Family Unit	Number of Fish	Mean Length	S.D.	Mean Weight	S.D.	K
1997	1	29	113	7.8	19.4	4.4	1.31
1997	2	14	110	5.2	17.3	2.7	1.29
1997	3	31	125	9.1	28.4	6.0	1.44
1997	4	29	118	9.3	22.7	6.0	1.37
1997	5	31	119	9.3	22.7	5.8	1.30
1997	6	30	119	8.6	22.6	5.2	1.33
1997	7	30	117	7.2	21.3	4.3	1.32
1997	8	29	121	10.2	24.8	6.8	1.36
1997	9	30	117	8.1	21.8	5.0	1.32
1997	10	30	115	11.0	19.7	6.1	1.27
1997	11	30	101	6.4	13.1	2.6	1.25
1997	12	30	120	12.5	24.5	8.0	1.38
1997	13	30	121	9.3	24.4	6.6	1.34
1997	14	30	112	6.2	18.8	3.2	1.33
1997	15	30	109	9.6	18.7	4.8	1.41
Totals / Means		**433**	**116**	**10.5**	**21.5**	**6.4**	**1.34**
1998	1	30	120	15.6	22.3	8.6	1.23
1998	2	29	108	10.0	15.9	5.0	1.25
1998	3	30	112	13.1	18.6	7.8	1.26
1998	4	30	112	11.5	17.7	6.4	1.24
1998	5	30	117	16.0	20.5	9.9	1.20
1998	6	28	117	15.0	21.6	11.0	1.26
1998	7	32	120	18.0	23.2	11.6	1.26
1998	8	30	129	12.0	26.5	7.8	1.21
1998	9	30	121	16.9	23.0	9.9	1.24
1998	10	28	130	9.0	26.0	4.9	1.18
1998	11	25	120	13.6	22.3	7.7	1.26
1998	12	31	127	10.1	24.0	4.9	1.16
1998	13	29	122	11.4	22.0	6.7	1.19
1998	14	27	120	13.2	21.6	7.7	1.20
1998	15	29	138	11.0	30.3	6.7	1.14
Totals / Means		**438**	**121**	**15.2**	**22.4**	**8.7**	**1.22**
1999	1	27	147	14.6	41.1	11.3	1.25
1999	2	28	138	13.1	35.7	8.9	1.34
1999	3	28	133	11.6	33.9	11.3	1.42
1999	4	30	145	8.9	39.2	6.7	1.27
1999	5	25	136	15.8	35.4	11.8	1.34
1999	6	30	136	10.7	33.8	8.9	1.32
1999	7	27	129	20.9	30.0	14.8	1.29
1999	8	29	129	12.0	29.9	9.0	1.35
1999	9	25	128	16.3	29.3	11.6	1.33
1999	10	23	130	18.9	31.0	14.4	1.32
1999	11	23	137	13.1	36.0	10.7	1.37
1999	12	28	141	13.5	38.4	10.2	1.33
1999	13	30	133	13.9	31.9	9.1	1.34
1999	14	30	133	10.7	31.6	7.6	1.32
1999	15	26	132	16.6	34.1	14.1	1.39
Totals / Means		**409**	**135**	**15.1**	**34.1**	**11.2**	**1.33**

Appendix C (cont.). Average length (mm), weight (g), and condition factor (K) with standard deviations for each family unit from the 1997, 1998, 1999, 2000 and 2001 BYs of captive broodstock at the time of tagging.

Brood Year	Family Unit	Number of Fish	Mean Length	S.D.	Mean Weight	S.D.	K
2000	1	30	164	11.8	52.3	8.4	1.19
2000	2	30	157	11.1	45.5	8.1	1.16
2000	3	30	152	10.1	37.9	5.9	1.08
2000	4	30	152	11.0	43.0	8.0	1.20
2000	5	30	152	8.4	38.6	5.9	1.09
2000	6	30	138	11.3	31.2	6.1	1.18
2000	7	30	140	10.1	31.4	5.4	1.14
2000	8	30	147	8.4	35.0	5.4	1.10
2000	9	30	151	9.5	37.3	6.3	1.07
2000	10	30	151	7.7	37.4	5.7	1.08
2000	11	30	143	13.9	34.9	8.3	1.18
2000	12	30	147	9.1	35.4	5.2	1.12
2000	13	30	144	13.5	34.1	8.7	1.13
2000	14	30	136	9.4	27.1	4.5	1.08
2000	15	30	132	10.8	25.1	5.1	1.10
Totals / Means		**450**	**147**	**13.4**	**36.4**	**9.4**	**1.13**
2001	1	30	95	6.7	10.4	2.1	1.22
2001	2	30	101	8.7	12.6	3.0	1.22
2001	3	30	100	5.0	12.8	1.9	1.27
2001	4	30	107	6.9	14.8	3.9	1.21
2001	5	30	110	8.3	17.5	3.2	1.30
2001	6	30	104	7.7	14.7	3.6	1.29
2001	7	30	101	6.9	13.1	2.4	1.27
2001	8	30	105	8.2	14.6	2.6	1.25
2001	9	30	106	9.2	13.8	3.1	1.17
2001	10	30	97	6.5	11.4	2.4	1.24
2001	11	30	101	7.5	12.7	2.7	1.21
2001	12	30	101	5.0	12.5	1.8	1.21
2001	13	30	100	7.5	12.2	2.9	1.20
2001	14	30	100	8.8	12.2	2.9	1.22
2001	15	30	99	7.6	12.2	2.7	1.25
Totals / Means		**450**	**102**	**8.3**	**13.2**	**3.2**	**1.24**

APPENDIX D

Appendix D, Table 1. Tucannon River spring chinook captive broodstock mortalities by family unit, sex, age, and maturity for the 1998 Brood Year.

		Males											Females													
		Age 1	Age 2		Age 3			Age 4			Age 5		Age 1	Age 2		Age 3			Age 4			Age 5				
Family Unit	N	IM	IM	MA	IM	MA	SP	IM	MA	SP	MA	SP	IM	IM	MA	IM	MA	SP	IM	MA	SP	IM	MA	SP	Total Mort.[1]	% Mort.[2]
1	30			12		1			1	1								1	2	2	8			1	29	97
2	29			9			6			1										1	8				25	86
3	30			11			1						1	2				2		1	8			1	27	90
4	30		1	10		1	6		1					2				1			9				31	103
5	30			8			5			1				1				4		2	6				27	90
6	28		2	5			6			2								2			9				26	93
7	32		1	8			7					1						2			8			1	28	88
8	30		1	9			7										1	1		2	6				27	90
9	30			5		1	3			1				1		1		2		7	6				27	90
10	28			15						1							1	9			3				29	104
11	25			10	2		1											6		1	3				23	92
12	31	1		11			3			1			1					7	1		6				31	100
13	29		1	8		1	6										1			1	6	1	1	1	27	93
14	27		1	10			1									1		1		4	6			1	25	93
15	29	3		11			1						4					4		1	2				26	90
Totals	438	4	7	142	2	4	53		2	8		1	6	6		2	3	42	3	22	94	1	1	5	437	99.8

IM = Immature, MA = Mature, SP = Spawned
[1]Total includes 8 fish of unknown sex and 21 adult outplants.
[2]Some percentages higher than 100% due to misreading of visible implant tags.

Appendix D, Table 2. Tucannon River spring chinook captive broodstock mortalities by family unit, sex, age, and maturity for the 1999 Brood Year.

Family Unit	N	Males													Females										Total Mort.[1]	% Mort.
		Age 1	Age 2			Age 3			Age 4			Age 5		Age 1	Age 2	Age 3			Age 4			Age 5				
		IM	IM	MA	SP	IM	MA	SP	IM	MA	SP	MA	SP	IM	IM	IM	MA	SP	IM	MA	SP	IM	MA	SP		
1	27			6	3		1											1			10				21	78
2	28		1	6	1			2			2							4			8				24	86
3	28			4	2			5			1						1				13				26	93
4	30		1	3				4									2	1			8				19	63
5	25			3	4			2										2		1	11				23	92
6	30			5	2	1		2										1		1	9				21	70
7	27			5				2	1		1									1	6				16	59
8	29			3	2			1			1						1	1	1		11				21	72
9	25			5	2			1	1									1			11				21	84
10	23			4	1			1			1						1	1		1	11				21	91
11	23			4	1			1													11				17	74
12	28			4				1										1			12				18	64
13	30	1		7	1												1	4		1	13				28	93
14	30			5				3												1	15				24	80
15	26			1	1			1								2		1	1		9				16	62
Totals	409	1	2	65	20	1	1	26	2		6					2	6	18	2	6	158				392	96

IM = Immature, MA = Mature, SP = Spawned

[1]Total includes 76 adult outplants.

Appendix D, Table 3. Tucannon River spring chinook captive broodstock mortalities by family unit, sex, age, and maturity for the 2000 Brood Year.

Family Unit	N	Males												Females												Total Mort.	% Mort.
		Age 1	Age 2			Age 3			Age 4			Age 5		Age 1	Age 2		Age 3			Age 4			Age 5				
		IM	IM	MA	SP	IM	MA	SP	IM	MA	SP	MA	SP	IM	IM	MA	IM	MA	SP	IM	MA	SP	IM	MA	SP		
1	30	1		2	3														8							14	47
2	30			4	3			3											1							11	37
3	30			1	3			7											1							12	40
4	30			6	5		1							1	1				4							18	60
5	30			3	8	1		2											2							16	53
6	30			3	2	1	1	10											1							18	60
7	30			3	1			11							1				1							17	57
8	30			4	2			2							1				16							25	83
9	30			2	6		1	9											4							22	73
10	30			3	3			9											1							16	53
11	30			7				2											4							13	43
12	30			2	5		1	3									1	1	11							24	80
13	30		1	5	2			8											3							19	63
14	30			7	4			5							1				1							18	60
15	30		1					10									1		2							14	47
Totals	450	1	2	52	47	2	4	81						1	4		2	1	60							257	57

IM = Immature, MA = Mature, SP = Spawned

Appendix D, Table 4. Tucannon River spring chinook captive broodstock mortalities by family unit, sex, age, and maturity for the 2001 Brood Year.

		Males												Females													
		Age 1	Age 2			Age 3			Age 4			Age 5		Age 1	Age 2		Age 3			Age 4			Age 5				
Family Unit	N	IM	IM	MA	SP	IM	MA	SP	IM	MA	SP	MA	SP	IM	IM	MA	IM	MA	SP	IM	MA	SP	IM	MA	SP	Total Mort.[1]	% Mort.
1	30				2																					2	7
2	30																									3	10
3	30		1		1																					2	7
4	30		1		3										2											6	20
5	30				3																					3	10
6	30																									1	3
7	30		1												1											2	7
8	30				1																					1	3
9	30				8																					8	27
10	30				7																					7	23
11	30				3																					3	10
12	30				4																					4	13
13	30																									0	0
14	30				1										1											2	7
15	30		1		2																					3	10
Totals	450		4		35										4											47	10

IM = Immature, MA = Mature, SP = Spawned

[1] Total includes 4 fish of unknown sex. (Three died from family 2 during tagging).

APPENDIX E

Table 1. Fork length (cm) and weight (g) statistics for male, female, and both sexes combined by brood year for mature captive brood fish sampled during spawning, 2003.								
Brood Year	**Sex**	**N**	**Mean Length (cm)**	**Range**	**S.D.**	**Mean Wt. (g)**	**Range**	**S.D.**
1998	M	1	60.0	---	---	2633.2	---	---
1998	F	6	52.5	46.0-58.0	4.1	2126.2	817.2-3178.0	739.3
1998	*Both*	*7*	*53.6*	*46.0-60.0*	*4.6*	*2198.7*	*817.2-3178.0*	*707.0*
1999	M	6	47.1	39.0-53.0	5.0	1528.5	635.6-2224.6	497.1
1999	F	161	50.2	40.0-60.0	3.9	1938.7	908.0-3495.8	522.6
1999	*Both*	*167*	*50.0*	*39.0-60.0*	*4.0*	*1923.9*	*635.6-3495.8*	*527.2*
2000	M	83	42.9	29.0-52.5	5.0	1076.5	227.0-1906.8	373.2
2000	F	62	46.8	37.5-54.0	2.7	1569.2	726.4-2179.2	297.9
2000	*Both*	*145*	*44.6*	*29.0-54.0*	*4.6*	*1287.2*	*227.0-2179.2*	*420.8*
2001	M	35	28.0	24.0-33.0	2.3	290.6	181.6-544.8	87.0
2001	F	0	---	---	---	---	---	---
2001	*Both*	*35*	*28.0*	*24.0-33.0*	*2.3*	*290.6*	*181.6-544.8*	*87.0*

Table 2. Length-weight relationship for male, female, and both sexes combined by brood year for the captive brood during spawning, 2003.				
Brood Year	**Sex**	**Length-Weight Relationship**	**r^2**	**Probability**
1998	Female	Fork Length (cm) = 45.258 + 0.0034 x Wt (g)	0.38	> 0.01
1998	Male[a]	N/A	---	---
1998	*Combined*	*Fork Length (cm) = 44.506 + 0.0041 x Wt (g)*	*0.40*	*> 0.01*
1999	Female	Fork Length (cm) = 37.024 + 0.0067 x Wt (g)	0.82	< 0.01
1999	Male	Fork Length (cm) = 32.496 + 0.0095 x Wt (g)	0.90	< 0.01
1999	*Combined*	*Fork Length (cm) = 36.815 + 0.0069 x Wt (g)*	*0.82*	*< 0.01*
2000	Female	Fork Length (cm) = 34.574 + 0.0078 x Wt (g)	0.72	< 0.01
2000	Male	Fork Length (cm) = 29.279 + 0.0127 x Wt (g)	0.88	< 0.01
2000	*Combined*	*Fork Length (cm) = 31.658 + 0.0100 x Wt (g)*	*0.83*	*< 0.01*
2001	Female[b]	N/A	---	---
2001	Male	Fork Length (cm) = 21.145 + 0.0237 x Wt (g)	0.82	< 0.01
2001	*Combined*	N/A	---	---

[a] Small sample size.
[b] No samples.

APPENDIX F

Sample data used in the statistical analysis of captive brood egg eye-up mortality rates (%) from Heath tray and colander type incubators.					
		Heath Tray Incubator		Colander Incubator	
Sample	Date	Fish ID#	Mortality (%)	Fish ID #	Mortality (%)
1	9/23/03	502	2.31	503	9.00
2	"	504	65.80	505	13.42
3	"	506	22.47	507	29.70
4	"	508	36.61	509	100.00
5	"	510	35.41	511	17.35
6	"	512	55.73	513	16.99
7	"	514	40.53	515	92.06
8	"	518	96.64	517	31.25
9	"	520	83.68	519	57.81
10	"	522	91.77	521	88.17
11	"	524	2.14	523	10.32
12	"	526	7.42	525	50.95
13	"	529	3.99	527	52.27
14	"	531	3.40	528	8.47
15	9/30/03	602	84.52	623	1.22
16	"	603	26.49	624	93.56
17	"	605	99.32	625	53.09
18	"	606	61.28	626	7.10
19	"	607	37.12	627	76.30
20	"	608	23.13	628	1.68
21	"	609	100.00	629	2.97
22	"	610	11.08	630	1.38
23	"	611	82.00	631	36.44
24	"	612	82.37	632	93.88
25	"	613	23.45	633	17.41
26	"	614	13.40	634	2.03
27	"	615	23.13	635	8.89
28	"	616	2.63	637	4.83
29	"	617	6.03	638	65.70
30	"	618	99.31	639	99.91
31	"	619	86.91	640	7.24
32	"	620	2.47	641	53.25
33	"	621	15.64	642	65.62
34	"	622	100.00	643	100.00
35	10/07/03	701	2.86	715	12.38
36	"	702	77.44	716	100.00
37	"	703	69.10	717	100.00
38	"	704	96.85	718	3.01
39	"	705	7.02	719	97.93
40	"	706	100.00	720	94.32
41	"	707	4.27	721	7.06
42	"	708	78.03	722	2.06
43	"	709	46.28	723	100.00
44	"	710	99.37	724	4.94
45	"	711	6.72	725	83.25
46	"	712	100.00	726	43.51
47	"	713	4.03	727	6.42
48	"	714	3.98	728	12.77

APPENDIX G

Summary of captive brood progeny releases from the Tucannon River Spring Chinook Captive Broodstock Program.								
Release Year	**BY[1]**	**Release Date**	**CWT**	**No Wire**	**Wire**	**Total Released**	**Lbs**	**Fish/Lb**
2002	2000 (S)	3/15-4/23	63	24	3,031	3,055	343	8.9
2002	2001 (P)	5/06	63/14/30	157	20,435	20,592	124.8	165.0
2003	2001 (S)	4/01-4/21	63	5,995	134,401	140,396	10,100	13.9
2004	2002 (S)	4/01-4/20	63	1,909	42,875	44,784	3,393	13.2

[1] S = Smolt release; P = Parr release.

This program receives Federal financial assistance from the U.S. Fish and Wildlife Service. It is the policy of the Washington State Department of Fish and Wildlife (WDFW) to adhere to the following: Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972. The U.S. Department of the Interior and its bureaus prohibit discrimination on the bases of race, color, national origin, age, disability and sex (in educational programs). If you believe that you have been discriminated against in any program, activity or facility, please contact the WDFW ADA Coordinator at 600 Capitol Way North, Olympia, Washington 98501-1091 or write to:

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