

Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 2005 Annual Report



by Michael P. Gallinat and Lance A. Ross



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FISH AND WILDLIFE
Fish Program
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Abstract

Lyons Ferry Hatchery (LFH) and Tucannon Fish Hatchery (TFH) were built/modified under the Lower Snake River Fish and Wildlife Compensation Plan. One objective was to compensate for the estimated annual loss of 1,152-spring Chinook (Tucannon River stock) caused by hydroelectric projects on the Snake River. The standard supplementation production goal is 132,000 fish for release as yearlings at 30 g/fish (15 fish per pound). The captive brood production goal is 150,000 yearlings at 30 g/fish. This report summarizes activities of the Washington Department of Fish and Wildlife Lower Snake River Hatchery Evaluation Program for Tucannon River spring Chinook for the period April 2005 to April 2006.

Two hundred forty-five salmon were captured in the TFH trap in 2005 (125 natural adults, 6 natural jacks, 94 hatchery adults, and 20 hatchery jacks); 100 were collected and hauled to LFH for broodstock and the remaining fish were passed upstream. During 2005, five salmon that were collected for broodstock died. Prespawning mortality has been low since broodstock began being held at LFH in 1992, and is generally less than 10% each year.

Spawning of supplementation fish in 2005 at LFH occurred between August 23 and September 20, with peak eggtake on September 6. A total of 161,345 eggs were collected from 25 natural and 24 hatchery-origin fish. Egg mortality to eye-up was 3.2% (5,239 eggs), with an additional loss of 10,827 (6.9%) sac-fry. Total fry ponded for production in the rearing ponds was 145,279.

A total of 167 captive brood females were spawned from August 31 to October 11, 2005 producing 261,845 eggs. Egg mortality to eye-up was 60.4% leaving 103,812 live eggs. An additional 9,841 dead eggs/fry (9.5%) were picked at ponding leaving 93,971 fish for rearing.

WDFW staff conducted spawning ground surveys in the Tucannon River between August 31 and September 29, 2005. Forty-six redds and 22 carcasses were found above the adult trap and 56 redds and 29 carcasses were found below the trap. Based on redd counts, broodstock collection, and in-river pre-spawning mortalities, the estimated escapement for 2005 was 420 fish (286 natural adults, 3 natural jacks and 123 hatchery-origin adults, 8 hatchery jacks).

Snorkel surveys were conducted during the summer of 2005 to determine the population of subyearling and yearling spring Chinook in the Tucannon River. We estimated 30,809 subyearlings (BY 2004) and 586 yearlings (BY 2003) were present in the river. Evaluation staff also operated a downstream migrant trap. During the 2004/2005 emigration, we estimated that 23,003 (BY 2003) natural spring Chinook smolts emigrated from the Tucannon River.

Monitoring survival rate differences between natural and hatchery-reared salmon continues. Smolt-to-adult return rates (SAR) for natural salmon consistently average about five times higher than for hatchery salmon. However, hatchery salmon survive about three times greater than natural salmon from parent to adult progeny. Due to the low SAR for hatchery fish, the mitigation goal of 1,152 salmon of Tucannon River stock was not achieved as only 131 hatchery-origin fish returned in 2005. Beginning with the 2006 brood year, the annual smolt goal will be increased from 132,000 to 225,000 to help offset for the higher mortality of hatchery-origin fish after they leave the hatchery. In conjunction with this we also plan to conduct an experiment to examine size at release as a possible means to improve SAR of hatchery fish.

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Introduction

Program Objectives

Legislation under the Water Resources Act of 1976 authorized the establishment of the Lower Snake River Compensation Plan (LSRCP) to help mitigate for the expected losses of salmon and steelhead runs due to construction and operation of the Snake River dams and included hatcheries in Washington, Idaho, and Oregon (USACE 1975). In Washington, Lyons Ferry Hatchery (LFH) was constructed and Tucannon Fish Hatchery (TFH) was modified. One objective of these hatcheries is to compensate for the estimated annual loss of 1,152 Tucannon River spring Chinook salmon adults caused by hydroelectric projects on the Snake River. In 1984, Washington Department of Fish and Wildlife (WDFW) began to evaluate the success of these two hatcheries in meeting the mitigation goal, and identifying factors that would improve performance of the hatchery fish. The WDFW also initiated the Tucannon River Spring Chinook Captive Broodstock Program in 1997, which is funded by the Bonneville Power Administration (BPA) through its Fish and Wildlife Program. The project goal is to rear captive salmon selected from the supplementation program (1997-2002 brood years) to adults, rear their progeny, and release approximately 150,000 smolts (30 g/fish) annually into the Tucannon River between 2003-2007. These smolt releases, in combination with the current hatchery supplementation program (goal = 132,000 smolts; 30 g/fish) and natural production, are expected to produce 600-700 returning adult spring Chinook to the Tucannon River each year from 2005-2010. This report summarizes work performed by the WDFW Spring Chinook Evaluation Program from April 2005 through April 2006.

Facility Descriptions

Lyons Ferry Hatchery is located on the Snake River (rkm 90) at its confluence with the Palouse River (Figure 1). It is used for adult broodstock holding and spawning, and early life incubation and rearing. All juvenile fish are marked and returned to TFH for final rearing and acclimation. Tucannon Fish Hatchery, located at rkm 59 on the Tucannon River, has an adult collection trap on site (Figure 1). Juveniles rear at TFH through winter. In February, the fish are transported to Curl Lake Acclimation Pond (AP) and volitionally released.

Tucannon River Watershed Characteristics

The Tucannon River empties into the Snake River between Little Goose and Lower Monumental Dams approximately 622 rkm from the mouth of the Columbia River (Figure 1). Stream

elevation rises from 150 m at the mouth to 1,640 m at the headwaters (Bugert et al. 1990). Total watershed area is approximately 1,295 km². Local habitat problems related to logging, road building, recreation, and agriculture/livestock grazing have limited the production potential of spring Chinook in the Tucannon River. Land use in the Tucannon watershed is approximately 36% grazed rangeland, 33% dry cropland, 23% forest, 6% WDFW, and 2% other use (Tucannon Subbasin Summary 2001). Five unique strata have been distinguished by predominant land use, habitat, and landmarks (Figure 1; Table 1) and are referenced throughout this report.

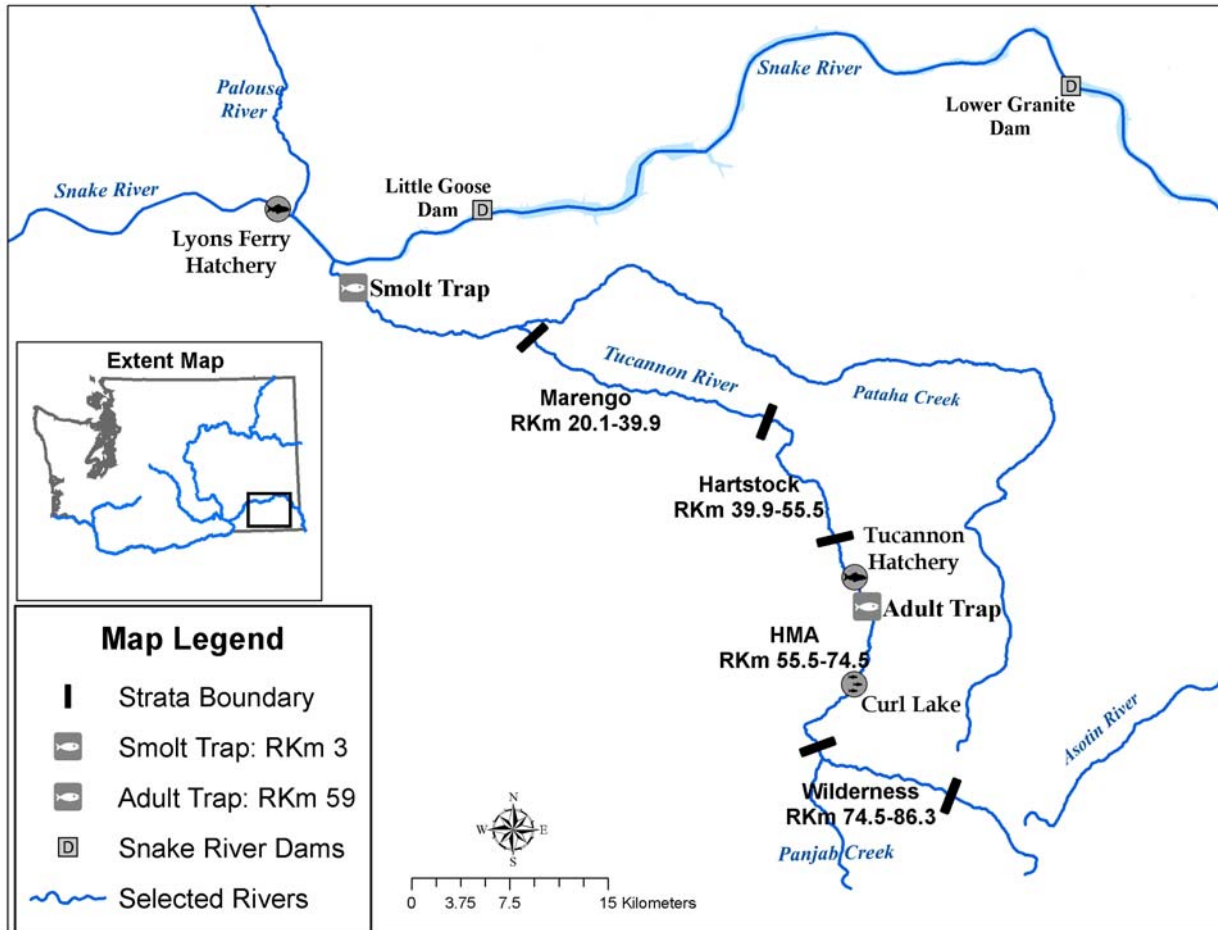


Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Hatcheries within the Snake River Basin.

Table 1. Description of five strata within the Tucannon River.

| Strata | Land Ownership/Usage | Spring Chinook Habitat | River Kilometer^a |
|---------------|--|----------------------------------|------------------------------------|
| Lower | Private/Agriculture & Ranching | Not-Usable (temperature limited) | 0.0-20.1 |
| Marengo | Private/Agriculture & Ranching | Marginal (temperature limited) | 20.1-39.9 |
| Hartsock | Private/Agriculture & Ranching | Fair to Good | 39.9-55.5 |
| HMA | State & Forest Service/Recreational | Good/Excellent | 55.5-74.5 |
| Wilderness | Forest Service/Recreational | Excellent | 74.5-86.3 |

^a Rkm descriptions: 0.0–mouth at the Snake River; 20.1-Territorial Rd.; 39.9–Marengo Br.; 55.5-HMA Boundary Fence; 74.5-Panjab Br.; 86.3-Rucherts Camp.

Evaluation program staff deployed 19 continuous recording thermographs throughout the Tucannon River to monitor daily minimum and maximum water temperatures (temperatures are recorded every hour) from May through October. Data from each of these water temperature recorders are kept on an electronic file in our Dayton office. During 2005, maximum temperatures where spring Chinook juveniles were rearing during the hottest part of the summer ranged from 15.1° C (59.1° F) in the upper HMA stratum (rkm 74.5) to 23.1° C (73.6° F) in the lower Hartsock stratum (rkm 43.3)(Figure 2).

The upper lethal temperature for Chinook fry is 25.1° C (77.2° F) while the preferred temperature range is 12-14° C (53.6-57.2° F) (Scott and Crossman 1973, McCullough 1999). The optimum range of temperature in freshwater, which controls the rate of growth and survival of young, is 13-17° C (55.4-62.6° F) (Becker 1983). Theurer et al. (1985) estimated that spring Chinook production in the Tucannon River would be zero for all stream reaches having maximum daily July water temperatures greater than 23.9° C (75° F) (or average mean temperature of 20° C (68.0° F)). Based on the preferred and optimum temperature limits, fish returning to the upper watershed have the best chance for survival (Figure 2).

It is hoped that recent initiatives to improve habitat within the Tucannon Basin, such as the Tucannon River Model Watershed Program, will: 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. Theurer et al. (1985) estimated that improving riparian cover and channel morphology in the Tucannon River mainstem would increase Chinook-rearing capacity present in the early 1980s by a factor of 2.5. Habitat restoration efforts should permit increased utilization of habitat by spring Chinook salmon in the marginal sections of the middle reaches of the Tucannon River and increase fish survival.

Noteworthy are the fact that drought conditions and a forest fire (52,000 acre School Fire) occurred in the Tucannon Watershed during 2005.

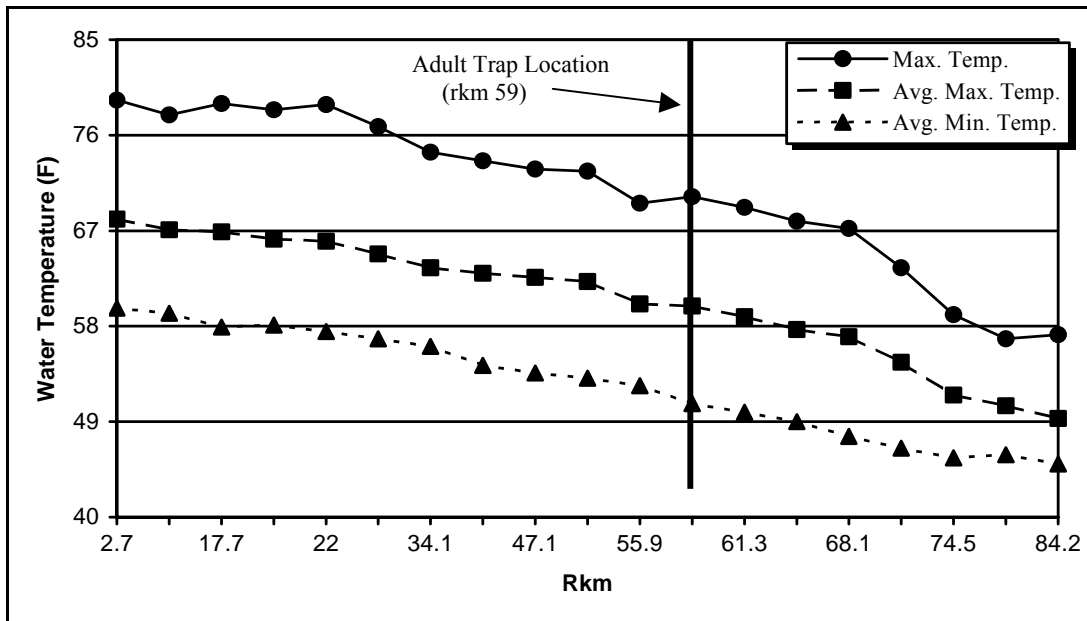


Figure 2. Maximum temperature, average maximum temperature, and average minimum temperature recorded by thermographs at 19 selected sites along the Tucannon River, May-October, 2005.

Adult Salmon Evaluation

Broodstock Trapping

The annual collection goal for broodstock is 50 natural and 50 hatchery adults collected throughout the duration of the run. Additional jack salmon may be collected to contribute to the broodstock if necessary. Jack contribution to the broodstock can be no more than their percentage in the overall run. Returning hatchery salmon were identified by coded-wire tag (CWT) in the snout or presence of a visible implant elastomer tag. Adipose clipped fish were killed outright as strays, as we no longer utilize that mark for management within the Tucannon River.

The TFH adult trap began operation in February (for steelhead) with the first spring Chinook captured May 7. The trap was operated through September. A total of 245 fish entered the trap (125 natural adults, 6 natural jacks, 94 hatchery adults, and 20 hatchery jacks), and 49 natural (48 adults, 1 jack) and 51 hatchery (50 adults, 1 jack) spring Chinook were collected and hauled to LFH for broodstock (Table 2, Appendix A). Fish not collected for broodstock were passed upstream. Adults collected for broodstock were injected with erythromycin and oxytetracycline (0.5 cc/4.5 kg); jacks were given half dosages. Fish received formalin drip treatments during holding at 167 ppm every other day at LFH to control fungus.

Based on previous years' returns, we anticipated catching unmarked Umatilla River origin hatchery fish. Prior to broodstock trapping we decided that scale samples would be collected from all unmarked fish for scale pattern analysis in the hope of identifying hatchery origin fish. Unmarked fish collected for broodstock were injected with a Passive Integrated Transponder (PIT) tag for individual identification. If scale analysis determined that a "natural" fish collected for broodstock was actually of hatchery origin, that fish would be identified by its PIT tag number and killed. None of the natural fish kept for broodstock in 2005 had hatchery origin scale patterns.

Table 2. Numbers of spring Chinook salmon captured, trap mortalities, fish collected for broodstock, or passed upstream to spawn naturally at the TFH trap from 1986-2005.

| Year | Captured at Trap | | Trap Mortality | | Broodstock Collected | | Passed Upstream | |
|-------------------|------------------|----------|----------------|----------|----------------------|----------|-----------------|----------|
| | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery |
| 1986 | 247 | 0 | 0 | 0 | 116 | 0 | 131 | 0 |
| 1987 | 209 | 0 | 0 | 0 | 101 | 0 | 108 | 0 |
| 1988 | 267 | 9 | 0 | 0 | 116 | 9 | 151 | 0 |
| 1989 | 156 | 102 | 0 | 0 | 67 | 102 | 89 | 0 |
| 1990 | 252 | 216 | 0 | 1 | 60 | 75 | 191 | 134 |
| 1991 | 109 | 202 | 0 | 0 | 41 | 89 | 68 | 105 |
| 1992 | 242 | 305 | 8 | 3 | 47 | 50 | 165 | 202 |
| 1993 | 191 | 257 | 0 | 0 | 50 | 47 | 130 | 167 |
| 1994 | 36 | 34 | 0 | 0 | 36 | 34 | 0 | 0 |
| 1995 | 10 | 33 | 0 | 0 | 10 | 33 | 0 | 0 |
| 1996 | 76 | 59 | 1 | 4 | 35 | 45 | 33 | 7 |
| 1997 | 99 | 160 | 0 | 0 | 43 | 54 | 47 | 76 |
| 1998 ^a | 50 | 43 | 0 | 0 | 48 | 41 | 1 | 1 |
| 1999 ^b | 1 | 139 | 0 | 1 | 1 | 135 | 0 | 0 |
| 2000 ^c | 28 | 177 | 0 | 17 | 12 | 69 | 13 | 94 |
| 2001 | 405 | 276 | 0 | 0 | 52 | 54 | 353 | 222 |
| 2002 | 168 | 610 | 0 | 0 | 42 | 65 | 126 | 545 |
| 2003 | 84 | 151 | 0 | 0 | 42 | 35 | 42 | 116 |
| 2004 | 311 | 155 | 0 | 0 | 51 | 41 | 260 | 114 |
| 2005 ^d | 131 | 114 | 0 | 3 | 49 | 51 | 82 | 60 |

^a Two males (one natural, one hatchery) captured were transported back downstream to spawn in the river.

^b Three hatchery males that were captured were transported back downstream to spawn in the river.

^c Seventeen stray LV and ADLV fish were killed at the trap.

^d Three AD clipped stray fish were killed at the trap.

Broodstock Mortality

Five of the 100 salmon collected for broodstock died prior to spawning in 2005 (Table 3). Table 3 shows that prespawning mortality in 2005 was comparable to the mortality documented since broodstock holding at LFH began in 1992. Higher mortality was experienced when fish were held at TFH (1986-1991).

Table 3. Numbers of pre-spawning mortalities and percent of fish collected for broodstock at TFH and held at TFH (1985-1991) or LFH (1992-2005).

| Year | Natural | | | % of collected | Hatchery | | | % of collected |
|------|---------|--------|------|----------------|----------|--------|------|----------------|
| | Male | Female | Jack | | Male | Female | Jack | |
| 1985 | 3 | 10 | 0 | 59.1 | — | — | — | — |
| 1986 | 15 | 10 | 0 | 21.6 | — | — | — | — |
| 1987 | 10 | 8 | 0 | 17.8 | — | — | — | — |
| 1988 | 7 | 22 | 0 | 25.0 | — | — | 9 | 100.0 |
| 1989 | 8 | 3 | 1 | 17.9 | 5 | 8 | 22 | 34.3 |
| 1990 | 12 | 6 | 0 | 30.0 | 14 | 22 | 3 | 52.0 |
| 1991 | 0 | 0 | 1 | 2.4 | 8 | 17 | 32 | 64.0 |
| 1992 | 0 | 4 | 0 | 8.2 | 2 | 0 | 0 | 4.0 |
| 1993 | 1 | 2 | 0 | 6.0 | 2 | 1 | 0 | 6.4 |
| 1994 | 1 | 0 | 0 | 2.8 | 0 | 0 | 0 | 0.0 |
| 1995 | 1 | 0 | 0 | 10.0 | 0 | 0 | 3 | 9.1 |
| 1996 | 0 | 2 | 0 | 5.7 | 2 | 1 | 0 | 6.7 |
| 1997 | 0 | 4 | 0 | 9.3 | 2 | 2 | 0 | 7.4 |
| 1998 | 1 | 2 | 0 | 6.3 | 0 | 0 | 0 | 0.0 |
| 1999 | 0 | 0 | 0 | 0.0 | 3 | 1 | 1 | 3.8 |
| 2000 | 0 | 0 | 0 | 0.0 | 1 | 2 | 0 | 3.7 |
| 2001 | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0.0 |
| 2002 | 0 | 0 | 0 | 0.0 | 1 | 1 | 0 | 3.1 |
| 2003 | 0 | 1 | 0 | 2.4 | 0 | 0 | 1 | 2.9 |
| 2004 | 0 | 3 | 0 | 5.9 | 0 | 0 | 1 | 2.4 |
| 2005 | 2 | 0 | 0 | 4.1 | 1 | 2 | 0 | 5.9 |

Broodstock Spawning

Spawning at LFH occurred once a week from August 23 to September 20, with peak eggtake occurring on September 6. A total of 161,345 eggs were collected (Table 4). Eggs were initially disinfected and water hardened for one hour in iodophor (100 ppm). Fungus on the incubating eggs was controlled with formalin applied every-other day at 1,667 ppm for 15 minutes. Mortality to eye-up was 3.2% with an additional 6.9% (10,827) loss of sac-fry, which left 145,279 fish for production.

To prevent any stray fish from contributing to the population, all CWTs were read prior to spawning. No hatchery strays were found in the broodstock in 2005. Scales from unmarked fish were read prior to spawning to check for hatchery growth patterns. As the broodstock were positive for IHN (Infectious Hematopoietic Necrosis), carcasses were not returned to the upper Tucannon River for stream nutrient enrichment.

Table 4. Number of fish spawned and killed, estimated egg collection, and egg mortality of Tucannon River spring Chinook salmon at LFH in 2005.

| Spawn Date | Natural | | | Hatchery | | |
|---------------|-------------------|-----------|---------------|-------------------|-----------|---------------|
| | Male ^a | Female | Eggs Taken | Male ^a | Female | Eggs Taken |
| 8/23 | | 1 | 5,669 | | | |
| 8/31 | | 5 | 17,818 | 2 | 6 | 17,543 |
| 9/06 | | 8 | 32,528 | 4 | 9 | 25,519 |
| 9/13 | | 5 | 17,842 | 6 | 5 | 14,690 |
| 9/20 | 22 | 6 | 20,472 | 12 | 4 | 9,264 |
| Totals | 22 | 25 | 94,329 | 24 | 24 | 67,016 |
| Egg Mortality | | | 1,419 | | | 3,820 |

^a Does not include live spawned fish.

Eggs were also collected as part of the Tucannon River Captive Broodstock Program. A total of 167 captive brood females were spawned from August 31 to October 11, 2005. From the total 261,845 captive brood eggs collected, mortality to eye-up was 60.4%, leaving 103,812 live eggs. An additional 9,841 dead eggs/fry (9.5%) were picked at ponding leaving 93,971 live fish for rearing. The Tucannon River Captive Broodstock Program results achieved to date are more thoroughly described in the annual Tucannon River Spring Chinook Captive Broodstock Report (Gallinat 2006).

Natural Spawning

Spawning ground surveys were conducted on the Tucannon River weekly from August 31 to September 29, 2005. One hundred two redds were counted and 41 natural and 10 hatchery origin carcasses were recovered (Table 5). Forty-six redds (45% of total) and 22 carcasses (43% of total) were found above the adult trap.

While conducting redd surveys in 2005 we also snorkeled 24 redds to look for the presence of precocial juveniles spawning with adults. We observed 15 adults (10 females, 5 males) and 1 jack on or near the redds. We observed and captured, using a cast net, 52 juvenile natural and one hatchery spring Chinook in or near the redds. Twenty-seven of the 52 natural fish were precociously mature (52%) and the one hatchery spring Chinook was a mature male.

Table 5. Numbers and general locations of salmon redds and carcasses recovered on the Tucannon River spawning grounds, 2005 (the Tucannon Hatchery adult trap is located at rkm 59).

| Stratum | Rkm ^a | Number of redds | Carcasses Recovered | |
|---------------------------------------|------------------|-----------------|---------------------|-----------|
| | | | Natural | Hatchery |
| Wilderness | 78-84 | 4 | 1 | |
| | 75-78 | | | |
| HMA | 73-75 | 4 | | |
| | 68-73 | 12 | 1 | |
| | 66-68 | 4 | | 1 |
| | 62-66 | 14 | 3 | 1 |
| | 59-62 | 8 | 9 | 6 |
| -----Tucannon Fish Hatchery Trap----- | | | | |
| Hartsock | 56-59 | 27 | 20 | 2 |
| | 52-56 | 16 | 5 | |
| | 47-52 | 7 | 2 | |
| | 43-47 | 2 | | |
| Marengo | 40-43 | | | |
| | 34-40 | 4 | | |
| | 28-34 | | | |
| Totals | 28-84 | 102 | 41 | 10 |

^a Rkm descriptions: 84-Sheep Cr.; 78-Lady Bug Flat CG; 75-Panjab Br.; 73-Cow Camp Bridge; 68-Tucannon CG; 66-Curl Lake; 62-Beaver/Watson Lakes Br.; 59-Tucannon Hatchery Intake/Adult Trap; 56-HMA Boundary Fence; 52-Br. 14; 47-Br. 12; 43-Br. 10; 40-Marengo Br.; 34-King Grade Br.; 28-Enrich Br.

Historical Trends

Two general trends were evident (Figure 3) from the program's inception in 1985 through 1999:

- 1) The proportion of the total number of redds occurring below the trap increased; and
- 2) The density of redds (redds/km) decreased in the Tucannon River.

In part, this resulted from a greater emphasis on broodstock collection to keep the spring Chinook population from extinction. However, increases in the SAR rates beginning with the 1995 brood have subsequently resulted in increased spawning above the trap and higher redd densities (Figure 3; Table 6). Also, moving the release location from TFH upstream to Curl Lake AP has affected the spawning distribution, with higher numbers of fish and redds in the Wilderness and HMA strata compared to previous years (Table 6).

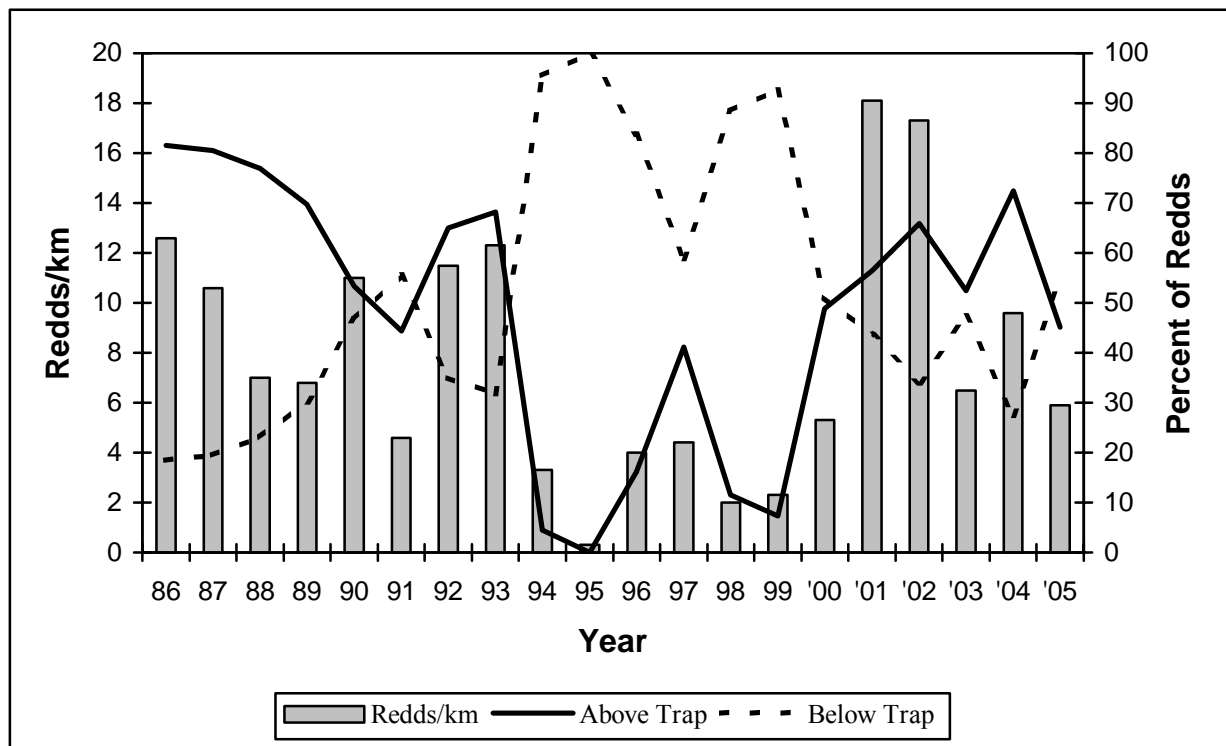


Figure 3. Number of redds/km and percentage of redds above and below the adult trap on the Tucannon River, 1986-2005.

Table 6. Number of spring Chinook salmon redds and redds/km (in parenthesis) by stratum and year, and the number and percent of redds above and below the TFH adult trap in the Tucannon River, 1985-2005.

| Year | Strata | | | | Total Redds | TFH Adult Trap | | | |
|------|------------|------------|----------|----------|----------------|----------------|------|-------|-------|
| | Wilderness | HMA | Hartsock | Marengo | | Above | % | Below | % |
| 1985 | 97 (8.2) | 122 (6.2) | – | – | 219 | – | – | – | – |
| 1986 | 53 (4.5) | 117 (6.2) | 29 (1.9) | 0 (0.0) | 200 | 163 | 81.5 | 37 | 18.5 |
| 1987 | 15 (1.3) | 140 (7.4) | 30 (1.9) | – | 185 | 149 | 80.5 | 36 | 19.5 |
| 1988 | 18 (1.5) | 79 (4.2) | 20 (1.3) | – | 117 | 90 | 76.9 | 27 | 23.1 |
| 1989 | 29 (2.5) | 54 (2.8) | 23 (1.5) | – | 106 | 74 | 69.8 | 32 | 30.2 |
| 1990 | 20 (1.7) | 94 (4.9) | 64 (4.1) | 2 (0.3) | 180 | 96 | 53.3 | 84 | 46.7 |
| 1991 | 3 (0.3) | 67 (2.9) | 18 (1.1) | 2 (0.3) | 90 | 40 | 44.4 | 50 | 55.6 |
| 1992 | 17 (1.4) | 151 (7.9) | 31 (2.0) | 1 (0.2) | 200 | 130 | 65.0 | 70 | 35.0 |
| 1993 | 34 (3.4) | 123 (6.5) | 34 (2.2) | 1 (0.2) | 192 | 131 | 68.2 | 61 | 31.8 |
| 1994 | 1 (0.1) | 10 (0.5) | 28 (1.8) | 5 (0.9) | 44 | 2 | 4.5 | 42 | 95.5 |
| 1995 | 0 (0.0) | 2 (0.1) | 3 (0.2) | 0 (0.0) | 5 | 0 | 0.0 | 5 | 100.0 |
| 1996 | 1 (0.1) | 33 (1.7) | 34 (2.2) | 0 (0.0) | 68 | 11 | 16.2 | 58 | 83.8 |
| 1997 | 2 (0.2) | 43 (2.3) | 27 (1.7) | 1 (0.2) | 73 | 30 | 41.1 | 43 | 58.9 |
| 1998 | 0 (0.0) | 3 (0.2) | 20 (1.3) | 3 (0.5) | 26 | 3 | 11.5 | 23 | 88.5 |
| 1999 | 1 (0.1) | 34 (1.8) | 6 (0.4) | 0 (0.0) | 41 | 3 | 7.3 | 38 | 92.7 |
| 2000 | 4 (0.4) | 68 (3.6) | 20 (1.3) | 0 (0.0) | 92 | 45 | 48.9 | 47 | 51.1 |
| 2001 | 24 (2.7) | 189 (9.9) | 84 (5.3) | 1 (0.2) | 298 | 168 | 56.4 | 130 | 43.6 |
| 2002 | 13 (1.4) | 227 (11.9) | 46 (2.9) | 13 (1.1) | 299 | 197 | 65.9 | 102 | 34.1 |
| 2003 | 0 (0.0) | 90 (4.7) | 28 (1.8) | 0 (0.0) | 118 | 62 | 52.5 | 56 | 47.5 |
| 2004 | 17 (1.9) | 124 (6.5) | 19 (1.2) | 0 (0.0) | 160 | 116 | 72.5 | 44 | 27.5 |
| 2005 | 4 (0.4) | 69 (3.6) | 25 (1.6) | 4 (0.3) | 102 | 46 | 45.1 | 56 | 54.9 |

Note: – indicates the river was not surveyed in that section during that year.

Genetic Sampling

During 2005 we collected 148 DNA samples (operculum punches) from adult salmon (87 natural origin and 61 hatchery origin) and 200 samples from captive broodstock spawners. These samples were sent to the WDFW genetics lab in Olympia, Washington for analysis.

A total of 937 Tucannon River spring Chinook samples collected in 2003 and 2004 were genotyped at 14 microsatellite loci (Ogo-2, Ogo-4, Ots-3M, Ssa-197, Oki-100, Ots-201b, Ots-208b, Ssa-408, Omm-1080, Ots-213, Ots-G474, Ots-9, Ots-211, and Ots-212) using an Applied Biosystems 3730 DNA analyzer. Analysis to date (Appendix B) provides evidence that the captive broodstock program has been an effective method of preserving genetic variation in Tucannon River spring Chinook while providing additional smolts for release. Also, supplementation hatchery practices (despite using only a small percentage of the entire escapement each year) have been effective in minimizing differences between the hatchery

reared and natural-origin fish (Kassler and Hawkins 2006). Genotypes, allele frequencies, and tissue samples are stored at WDFW's Genetics Laboratory in Olympia.

Age Composition, Length Comparisons, and Fecundity

One objective of the monitoring program is to track the age composition of each year's returning adults. This allows us to annually compare ages of natural and hatchery-reared fish, and to examine long-term trends and variability in age structure. Overall, hatchery origin fish return at a younger age than natural origin fish (Figure 4). This difference is likely due to smolt size-at-release (hatchery origin smolts are generally 25-30 mm greater in length than natural smolts).

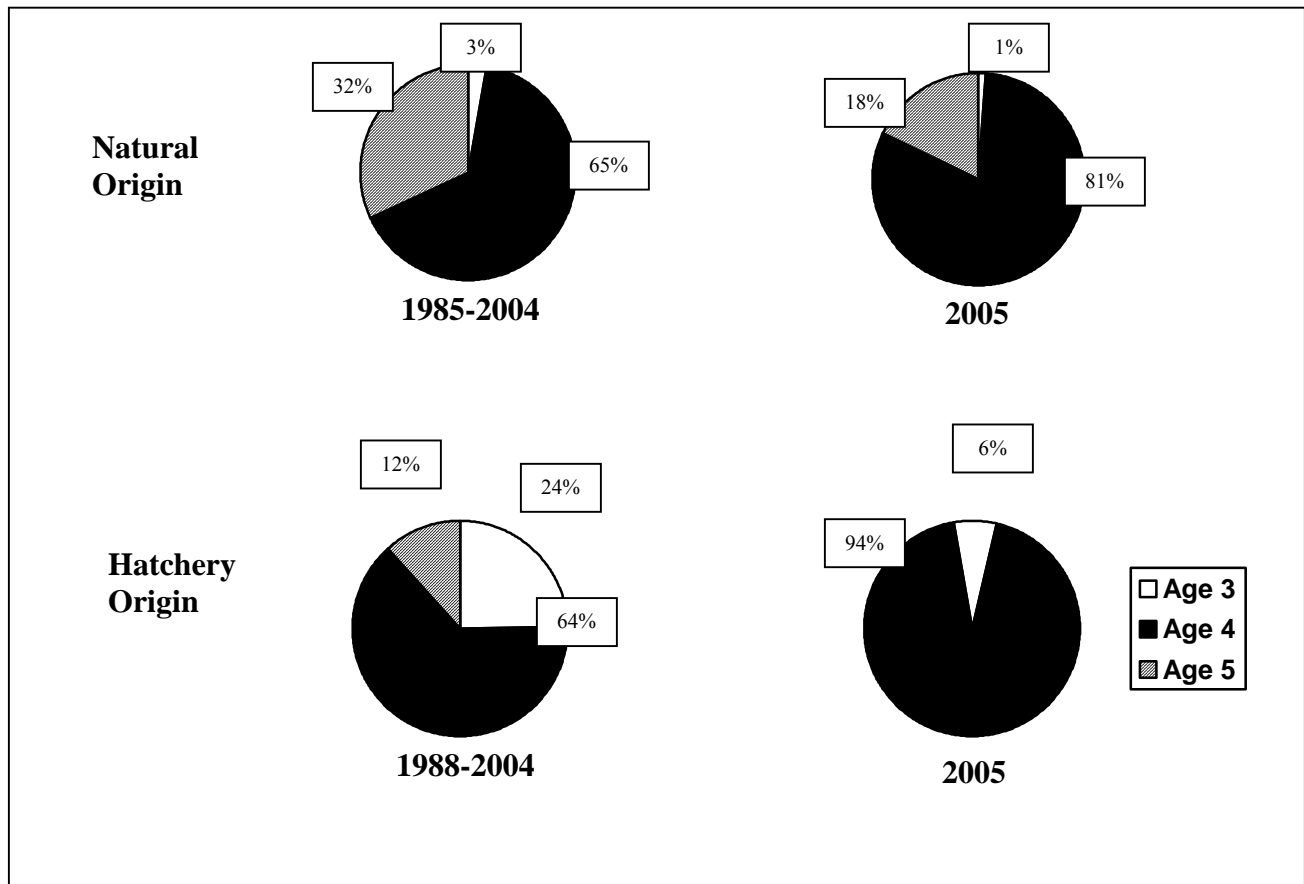


Figure 4. Historical (1985-2004), and 2005 age composition for spring Chinook in the Tucannon River.

Low proportions of Age 3 and Age 5 fish were observed during the 2005 run for both the hatchery and natural components of the population (Figure 4). This may have resulted from lower survival rates associated with recent drought events and poor ocean conditions.

Another comparison we conduct on returning adult natural and hatchery origin fish is the difference between mean post-eye to hypural-plate lengths. Bumgarner et al. (1994) reported in the past that hatchery fish were generally shorter than natural origin fish of the same age. For many of the early return years this appeared to be true. However, for returns to date, there is no significant difference ($P > 0.05$) in mean length between natural and hatchery-origin fish (Figure 5), even though they migrate as smolts at significantly different sizes (Bugert et al. 1990; Bugert et al. 1991).

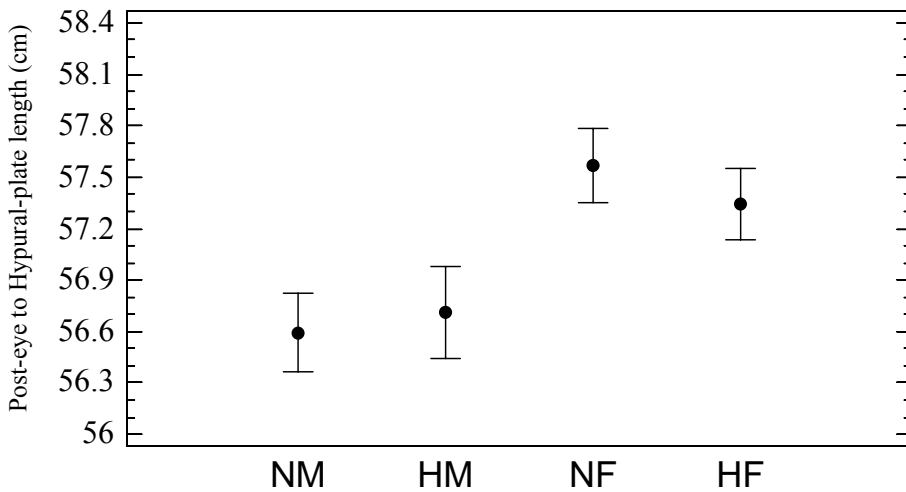


Figure 5. Mean post-eye to hypural-plate length comparisons between Age 4 natural and hatchery-origin males (NM and HM) and natural and hatchery-origin females (NF and HF) for the years 1985-2005.

Fecundities (number of eggs/female) of natural and hatchery origin fish from the Tucannon River program have been documented since 1990 (Table 7). Analysis of variance was performed to determine if there were significant differences in mean fecundities at the 95% confidence level. Natural origin females were significantly more fecund than hatchery origin fish for both Age 4 ($P < 0.001$) and Age 5 fish ($P < 0.001$).

Mean egg size of natural origin Age 4 spring Chinook from the Tucannon River was 0.225 g/egg and hatchery origin eggs averaged 0.237 g/egg. This difference was significant at the 95% confidence level ($P < 0.05$). This may explain why Age 4 hatchery origin females are less fecund. Mean egg size in Age 5 salmon was 0.270 g/egg for natural origin and 0.284 g/egg for hatchery origin females. Although the difference was not significant ($P = 0.09$), we suspect that egg size contributes to the fecundity difference.

Table 7. Average number of eggs/female (n, SD) by age group of Tucannon River natural and hatchery origin broodstock, 1990-2005.

| Year | Age 4 | | Age 5 | |
|-------------|--------------------|-------------------|--------------------|-------------------|
| | Natural | Hatchery | Natural | Hatchery |
| 1990 | 3,691 (13, 577.3) | 2,794 (18, 708.0) | 4,383 (8, 772.4) | No Fish |
| 1991 | 2,803 (5, 363.3) | 2,463 (9, 600.8) | 4,252 (11, 776.0) | 3,052 (1, 000.0) |
| 1992 | 3,691 (16, 588.3) | 3,126 (25, 645.1) | 4,734 (2, 992.8) | 3,456 (1, 000.0) |
| 1993 | 3,180 (4, 457.9) | 3,456 (5, 615.4) | 4,470 (1, 000.0) | 4,129 (1, 000.0) |
| 1994 | 3,688 (13, 733.9) | 3,280 (11, 630.3) | 4,906 (9, 902.0) | 3,352 (10, 705.9) |
| 1995 | No Fish | 3,584 (14, 766.4) | 5,284 (6, 136.1) | 3,889 (1, 000.0) |
| 1996 | 3,509 (17, 534.3) | 2,833 (18, 502.3) | 3,617 (1, 000.0) | No Fish |
| 1997 | 3,487 (15, 443.1) | 3,290 (24, 923.3) | 4,326 (3, 290.9) | No Fish |
| 1998 | 4,204 (1, 000.0) | 2,779 (7, 375.4) | 4,017 (28, 680.5) | 3,333 (6, 585.2) |
| 1999 | No Fish | 3,121 (34, 445.4) | No Fish | 3,850 (1, 000.0) |
| 2000 | 4,144 (2, 1,111.0) | 3,320 (34, 545.4) | 3,618 (1, 000.0) | 4,208 (1, 000.0) |
| 2001 | 3,612 (27, 508.4) | 3,225 (24, 690.6) | No Fish | 3,585 (2, 842.5) |
| 2002 | 3,584 (14, 740.7) | 3,368 (24, 563.7) | 4,774 (7, 429.1) | No Fish |
| 2003 | 3,342 (10, 738.1) | 2,723 (2, 107.0) | 4,428 (7, 894.7) | 3,984 (17, 772.1) |
| 2004 | 3,376 (26, 686.9) | 2,628 (17, 385.9) | 5,191 (1, 000.0) | 2,151 (1, 000.0) |
| 2005 | 3,399 (18, 545.9) | 2,903 (22, 654.2) | 4,734 (7, 1,025.0) | No Fish |
| Mean | 3,531 | 3,128 | 4,416 | 3,649 |
| SD | 617.4 | 662.9 | 862.3 | 771.4 |

Coded-Wire Tag Sampling

Broodstock collection, pre-spawn mortalities, and carcasses recovered during spawning ground surveys provide representatives of the annual run that can be sampled for CWT study groups (Table 8). In 2005, based on the estimated escapement of fish to the river, we sampled approximately 37% of the run (Table 9).

Table 8. Coded-wire tag codes of hatchery salmon sampled at LFH and the Tucannon River, 2005.

| CWT Code | Broodstock Collected | | | Recovered in Tucannon River | | | Totals |
|--------------|----------------------|-----------------|----------------|-----------------------------|---------------------|-----------|-----------|
| | Died in Pond | Killed Outright | Spawned | Dead in Trap | Pre-spawn Mortality | Spawned | |
| 63 (Age 4) | | | 2 | | | 5 | 7 |
| 63-06-81 | 3 | | 44 | | | 3 | 50 |
| 63-17-91 | | | 1 | | | 2 | 3 |
| No tags | | | 1 ^a | | | | 1 |
| AD/No wire | | | | 3 ^b | | | 3 |
| Total | 3 | 0 | 48 | 3 | 0 | 10 | 64 |

^a This fish did not have CWT but it did have a right red VIE and was Age 4 which would make it 63-06-81.

^b Adipose clipped/no wire fish were killed at the trap as strays.

Table 9. Spring Chinook salmon (natural and hatchery) sampled from the Tucannon River, 2005.

| | 2005 | | |
|---|---------|----------|-------|
| | Natural | Hatchery | Total |
| <i>Total escapement to river</i> | 289 | 131 | 420 |
| Broodstock collected | 49 | 51 | 100 |
| Fish dead in adult trap | 0 | 3 | 3 |
| Total hatchery sample | 49 | 54 | 103 |
| <i>Total fish left in river</i> | 240 | 77 | 317 |
| In-river pre-spawn mortality | 0 | 0 | 0 |
| Spawned carcasses recovered | 41 | 10 | 51 |
| Total river sample | 41 | 10 | 51 |
| Carcasses sampled | 90 | 64 | 154 |

Arrival and Spawn Timing Trends

Peak arrival and spawn timing have always been monitored to determine whether the hatchery program has caused a shift (Table 10). Peak arrival dates were based on greatest number of fish trapped on a single day. Peak spawn in the hatchery was determined by the day when the most females were spawned. Peak spawning in the river was determined by the highest weekly redd count.

Peak arrival to the trap during 2005 was within the expected historical range (Table 10). Peak spawning date of hatchery fish was also within the range found from previous years. The peak of active spawning in the Tucannon River was equal to the historical mean.

Table 10. Peak dates of arrival of natural and hatchery salmon to the TFH adult trap and peak (date) and duration (number of days) for spawning in the hatchery and river, 1986-2005.

| Year | Peak Arrival at Trap | | Spawning in Hatchery | | | Spawning in River | |
|-------------------|----------------------|-------------|----------------------|-------------|-----------|-------------------|-----------|
| | Natural | Hatchery | Natural | Hatchery | Duration | Combined | Duration |
| 1986 | 5/27 | – | 9/17 | – | 31 | 9/16 | 36 |
| 1987 | 5/15 | – | 9/15 | – | 29 | 9/23 | 35 |
| 1988 | 5/24 | – | 9/07 | – | 22 | 9/17 | 35 |
| 1989 | 6/06 | 6/12 | 9/15 | 9/12 | 29 | 9/13 | 36 |
| 1990 | 5/22 | 5/23 | 9/04 | 9/11 | 36 | 9/12 | 42 |
| 1991 | 6/11 | 6/04 | 9/10 | 9/10 | 29 | 9/18 | 35 |
| 1992 | 5/18 | 5/21 | 9/15 | 9/08 | 28 | 9/09 | 44 |
| 1993 | 5/31 | 5/27 | 9/13 | 9/07 | 30 | 9/08 | 52 |
| 1994 | 5/25 | 5/27 | 9/13 | 9/13 | 22 | 9/15 | 29 |
| 1995 ^a | – | 6/08 | 9/13 | 9/13 | 30 | 9/12 | 21 |
| 1996 | 6/06 | 6/20 | 9/17 | 9/10 | 21 | 9/18 | 35 |
| 1997 | 6/15 | 6/17 | 9/09 | 9/16 | 30 | 9/17 | 50 |
| 1998 | 6/03 | 6/16 | 9/08 | 9/16 | 36 | 9/17 | 16 |
| 1999 ^a | – | 6/16 | 9/07 | 9/14 | 22 | 9/16 | 23 |
| 2000 | 6/06 | 5/22 | – | 9/05 | 22 | 9/13 | 30 |
| 2001 | 5/23 | 5/23 | 9/11 | 9/04 | 20 | 9/12 | 35 |
| 2002 | 5/29 | 5/29 | 9/10 | 9/03 | 22 | 9/11 | 42 |
| 2003 | 5/25 | 5/25 | 9/09 | 9/02 | 36 | 9/12 | 37 |
| 2004 | 6/04 | 6/02 | 9/14 | 9/07 | 29 | 9/08 | 30 |
| Mean | 5/30 | 6/03 | 9/12 | 9/10 | 28 | 9/14 | 35 |
| 2005 | 6/01 | 5/31 | 9/06 | 9/06 | 28 | 9/14 | 28 |

^a Too few natural salmon were trapped in 1995 and 1999 to determine peak arrival.

Total Run-Size

In general, redd counts have been directly related to total run-size entering the Tucannon River and passage of adult salmon at the TFH adult trap (Bugert et al. 1991). For 2005, we used sex ratios from collected broodstock and sex ratio observations on the spawning grounds to estimate the number of fish/redd. The run-size estimate for 2005 was calculated by adding the estimated number of fish upstream of the TFH adult trap, the estimated fish below the weir calculated from the fish/redd ratio, the number of pre-spawn mortalities below the weir, and the number of broodstock collected (Table 11). Run-size for 2005 was estimated to be 420 fish (286 natural adults, 3 natural jacks and 123 hatchery-origin adults, 8 hatchery jacks). Historical estimates since 1985 are provided in Appendix C.

Table 11. Estimated spring Chinook salmon run to the Tucannon River, 1985-2005.

| Year^a | Total Redds | Fish/Redd Ratio^b | Spawning fish In the river | Broodstock Collected | Pre-spawning Mortalities^c | Total Run-Size | Percent Natural |
|-------------------------|--------------------|------------------------------------|-----------------------------------|-----------------------------|---|-----------------------|------------------------|
| 1985 | 219 | 2.60 | 569 | 22 | 0 | 591 | 100 |
| 1986 | 200 | 2.60 | 520 | 116 | 0 | 636 | 100 |
| 1987 | 185 | 2.60 | 481 | 101 | 0 | 582 | 100 |
| 1988 | 117 | 2.60 | 304 | 125 | 0 | 429 | 96 |
| 1989 | 106 | 2.60 | 276 | 169 | 0 | 445 | 76 |
| 1990 | 180 | 3.39 | 611 | 135 | 8 | 754 | 66 |
| 1991 | 90 | 4.33 | 390 | 130 | 8 | 528 | 49 |
| 1992 | 200 | 2.82 | 564 | 97 | 92 | 753 | 56 |
| 1993 | 192 | 2.27 | 436 | 97 | 56 | 589 | 54 |
| 1994 | 44 | 1.59 | 70 | 70 | 0 | 140 | 70 |
| 1995 | 5 | 2.20 | 11 | 43 | 0 | 54 | 39 |
| 1996 | 68 | 2.00 | 136 | 80 | 16 | 232 | 63 |
| 1997 | 73 | 2.00 | 146 | 97 | 45 | 288 | 47 |
| 1998 | 26 | 1.94 | 51 | 89 | 4 | 144 | 59 |
| 1999 | 41 | 2.60 | 107 | 136 | 2 | 245 | 1 |
| 2000 | 92 | 2.60 | 239 | 81 | 19 | 339 | 24 |
| 2001 | 298 | 3.00 | 894 | 106 | 12 | 1,012 | 71 |
| 2002 | 299 | 3.00 | 897 | 107 | 1 | 1,005 | 35 |
| 2003 | 118 | 3.10 | 366 | 77 | 1 | 444 | 56 |
| 2004 | 160 | 3.00 | 480 | 92 | 1 | 573 | 70 |
| 2005 | 102 | 3.10 | 317 | 100 | 0 | 420 | 69 |

^a In 1994, 1995, 1998 and 1999, fish were not passed upstream, and in 1996 and 1997, high pre-spawning mortality occurred in fish passed above the trap, therefore; fish/redd ratio was based on the sex ratio of broodstock collected.

^b From 1985-1989 the TFH trap was temporary, thereby underestimating total fish passed upstream of the trap. The 1985-1989 fish/redd ratios were calculated from the 1990-1993 average, excluding 1991 because of a large jack run.

^c Effort in looking for pre-spawn mortalities has varied from year to year with more effort expended during years with poor conditions.

Stray Salmon into the Tucannon River

Spring Chinook from other river systems (strays) have periodically been recovered in the Tucannon River, though generally at a low proportion of the total run (Bumgarner et al. 2000). Through 1998 the incidence of stray spring Chinook salmon was negligible (Appendix D). However, in 1999 and 2000, Umatilla River strays accounted for 8 and 12%, respectively, of the total Tucannon River run (Gallinat et al. 2001). The increased number of strays, particularly from the Umatilla River, is a concern since it exceeds the allowable 5% stray rate of hatchery fish deemed acceptable by NOAA Fisheries, and is contrary to WDFW's management intent for the Tucannon River. In addition, the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) did not mark a portion of Umatilla River origin spring Chinook with an RV or LV fin clip (65-70% of releases) for the 1997-1999 brood years. Because of this action, some stray fish that returned from those brood years were physically indistinguishable from natural origin Tucannon River spring Chinook. Scale samples were collected from adults in those brood years to determine hatchery-origin fish based on scale pattern analysis. However, scale analysis is not as accurate as genetic analysis and in future years we hope to identify a genetic marker that will allow us to separate unmarked Umatilla origin fish (1997-1999 BYs) from natural Tucannon origin fish. The proportion of hatchery and natural fish (Table 11) may change for the affected years after this analysis is completed. Beginning with the 2000 BY, Umatilla River hatchery-origin spring Chinook are 100% marked. This will help ensure that Tucannon River spring Chinook genetic integrity is maintained by allowing selective removal of strays from the hatchery broodstock.

No known (CWT) hatchery strays were recovered during 2005. However, we did recover three AD only clipped fish [2 - Age 4 (01BY) and 1 - Age 3 (02 BY)] on the spawning grounds. Based on our marks for those age classes (VIE/CWT), and past straying events, we believe those fish were likely Umatilla River origin strays. After expansions, those strays accounted for an estimated 1.4% of the total run (Appendix D).

Juvenile Salmon Evaluation

Hatchery Rearing, Marking, and Release

Hatchery Rearing and Marking

Conventional supplementation juveniles (2004 BY) were marked with a red elastomer tag (VIE) behind the right eye and tagged with CWTs on September 13-20, 2005 (67,722 fish).

Supplementation fish were transported to TFH during October. The 2004 BY captive brood juveniles (132,680 fish) were marked September 21-27 with a CWT in the snout and transported to TFH during October.

Length and weight samples were collected twice on the 2004 BY fish during the rearing cycle (Table 12). During February, fish were sampled for length, weight and mark quality, and were PIT tagged for outmigration comparisons (1,001 supplementation fish and 1,002 captive brood progeny) before transfer to Curl Lake AP.

Table 12. Sample sizes (N), mean lengths (mm), coefficients of variation (CV), condition factors (K), and fish/lb (fpp) of 2004 BY juveniles sampled at TFH and Curl Lake.

| Brood/ Date | Progeny Type | Sample Location | N | Mean Length | CV | K | FPP |
|------------------------|---------------------|------------------------|----------|------------------------|-----------|----------|------------|
| 2004 | | | | | | | |
| 2/06/06 | Supplementation | TFH | 250 | 127.2 | 9.7 | 1.21 | 17.9 |
| 4/04/06 | Supplementation | Curl Lake | 250 | 139.5 | 10.1 | 1.21 | 13.4 |
| 2/07/06 | Captive Brood | TFH | 250 | 122.6 | 9.8 | 1.22 | 19.8 |
| 4/04/06 | Captive Brood | Curl Lake | 250 | 132.9 | 13.3 | 1.21 | 15.3 |

2004 Brood Release

The 2004 BY pre-smolts were transported to Curl Lake in February 2006 for acclimation and volitional release. Volitional release began April 3 and continued until April 26 when the remaining fish were forced out. Mortalities were low in Curl Lake and WDFW released an estimated 67,542 supplementation fish (13.4 fish/lb) and 132,312 captive broodstock progeny (15.3 fish/lb) (Table 13). Historical hatchery releases are summarized in Appendix E.

Table 13. Yearling spring Chinook releases in the Tucannon River, 2004 brood year.

| Release Year | (BY) | Release Location | Release Date | CWT Code | Total Released | Number CWT | Additional Mark | lbs | Fish//lb |
|--------------|--------|------------------|--------------|----------|----------------|------------|-----------------|-------|----------|
| 2006 | (04) | Curl Lake | 4/03-4/26 | 63/28/87 | 67,542 | 67,272 | Rt. Red VIE | 5,040 | 13.4 |
| 2006 | (04CB) | Curl Lake | 4/03-4/26 | 63/28/65 | 132,312 | 127,162 | None | 8,648 | 15.3 |

Natural Parr Production

Program evaluation staff surveyed the Tucannon River at index sites in 2005 to estimate the density and population of subyearling (Table 14, Appendix F) and yearling spring Chinook salmon. Snorkel surveys were conducted using a total count method (Griffith 1981, Schill and Griffith 1984). Population size was determined by multiplying the mean fish density (fish/100 m²) for a stratum by the estimated total area within each stratum. Fifty 50 m sites were snorkeled in 2005 (July 18–August 25), representing approximately 5.2% of the suitable rearing habitat in the Tucannon River. A total of 1,574 subyearling and 31 yearling spring Chinook were counted during the surveys. We estimated that 30,809 (± 8,607) BY 04 subyearling and 586 (± 351) BY 03 yearling (residual) spring Chinook were present in the river (Table 14).

Table 14. Number of sites, area snorkeled, mean density (fish/100 m²), population estimates, and 95% confidence intervals for subyearling and yearling spring Chinook within the Tucannon River, 2005.

| Stratum | Number of sites | Area (m ²) Snorkeled | Subyearling | | | Yearling | | |
|--------------|-----------------|----------------------------------|--------------|---------------|--------------|--------------|---------------|------------|
| | | | Mean Density | Pop. Estimate | C.I. | Mean Density | Pop. Estimate | C.I. |
| Marengo | 6 | 3,164 | 2.87 | 1,755 | 1,920 | 0.23 | 142 | 167 |
| Hartsock | 14 | 9,079 | 4.36 | 7,807 | 4,882 | 0.01 | 10 | 20 |
| HMA | 20 | 11,666 | 7.91 | 17,541 | 6,691 | 0.20 | 434 | 321 |
| Wilderness | 10 | 3,682 | 5.19 | 3,706 | 2,380 | 0.00 | 0 | 0 |
| Total | 50 | 27,591 | 5.77 | 30,809 | 8,607 | 0.11 | 586 | 351 |

Natural Smolt Production

Program staff operated a 1.5 m rotary screw trap at rkm 3 on the Tucannon River from October 11, 2004 to June 30, 2005 to estimate numbers of migrating natural and hatchery spring Chinook. Numbers of selected species captured during the 2005 outmigration can be found in Appendix G. Other data such as peak outmigration, other species captured, etc., have not been reported here for simplicity. Those data are available upon request.

Natural spring Chinook emigrating from the Tucannon River (BY 2003) averaged 107 mm (Figure 6). This is in comparison to an average length of 139 mm for hatchery-origin fish (BY 2003) released from Curl Lake Acclimation Pond (Gallinat and Ross 2005).

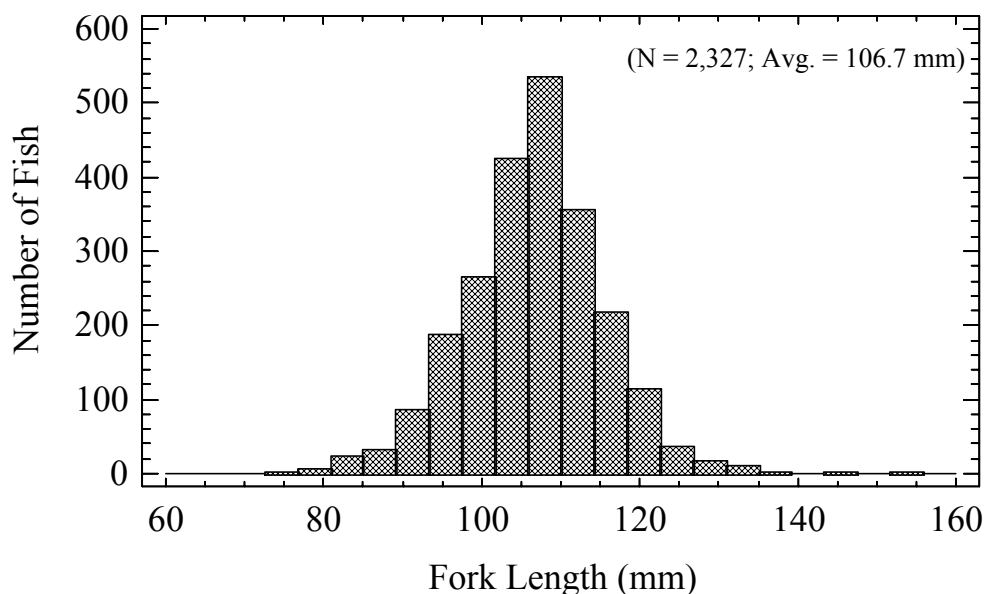


Figure 6. Length frequency distribution of sampled natural spring Chinook salmon captured in the Tucannon River smolt trap, 2004/2005 season.

Regression analysis was used to examine the influence of specific abiotic variables on spring Chinook emigration during the last eight trapping seasons (1997/1998 to 2004/2005). Significant relationships were found between the total number of natural spring Chinook smolts captured (\log_{10} transformed for normality) emigrating from the Tucannon River and flow (ft^3/sec) ($r^2 = 0.13$, $P < 0.01$), staff gauge level ($r^2 = 0.24$, $P < 0.01$), time of year ($r^2 = 0.12$, $P < 0.01$), and water temperature ($r^2 = 0.05$, $P < 0.01$). Although these variables are statistically significant, they account for only a small amount of the variability in the number of emigrating fish. This is understandable as smoltification is a physiological process and the resulting outmigration may only be slightly influenced by abiotic factors. No significant relationship ($P >$

0.05) was found between number of natural spring Chinook smolts emigrating and secchi disk reading (indicator of turbidity). Also, no significant relationships were found between the number of hatchery spring Chinook smolts captured (\log_{10} transformed) and flow, staff gauge level, time of year, water temperature, or, secchi disk reading. As the hatchery fish were raised in an artificial environment they may be less attuned to environmental triggers for emigration.

Each week we attempted to determine trap efficiency by clipping a portion of the caudal fin on a representative subsample of captured migrants and releasing them one kilometer upstream. The percent of marked fish recaptured was used as an estimate of weekly trapping efficiency.

To estimate potential juvenile migrants passing when the trap was not operated for short intervals, such as periods when freshets washed out large amounts of debris from the river, we calculated the average number of fish trapped for three days before and three days after non-trapping periods. The mean number of fish trapped daily was then divided by the estimated trap efficiency to calculate fish passage. The estimated number of fish passing each day was then applied to each day the trap was not operated.

In previous reports we attempted to relate trap efficiency to abiotic factors such as stream flow or staff gauge level based on similar juvenile outmigration studies (Groot and Margolis 1991, Seiler et al. 1999, Cheng and Gallinat 2004). Our relationships however were not significant. Using ANOVA, there was a significant ($P > 0.05$) year effect on trap efficiency (Annette Hoffman, WDFW, personal comm.) and so we used the average within year annual efficiency for each species following the work of Ryding (2001) on the Skagit River.

Smolt abundance on the i^{th} day was estimated by,

$$\hat{M}_i = \frac{C_i}{\hat{e}},$$

where, \hat{M}_i = the number of chinook smolts on the i^{th} day,

C_i = the number of fish caught in the trap i^{th} day,

\hat{e} = trap efficiency.

Using replicate releases of tagged fish released approximately one kilometer upstream of the trap, efficiency, e for each release group was estimated by,

$$\hat{e}_i = \frac{r_i}{m_i},$$

where, r_i = the number of marked fish recaptured in the trap from the i^{th} release group,

m_i = the number of marked fish in the i^{th} release group.

Overall trap efficiency, \hat{e} , was estimated by,

$$\hat{e} = \frac{\sum_{i=1}^n \hat{e}_i}{n}$$

where \hat{e}_i = the recapture rate of the i^{th} release group.

Variance for the smolt estimates was calculated by,

$$\text{Var}(\hat{M}) = \sum_{i=1}^N \hat{M}_i^2 \left(\frac{\hat{M}_i \hat{e} (1 - \hat{e})}{C_i^2} + \left(1 - \frac{n}{N}\right) \frac{\sum_{j=1}^n (e_j - \hat{e})^2}{n(n-1)\hat{e}^2} \right)$$

where C_i = the number of smolts caught in the trap on the i^{th} day, $i = 1, 2, \dots, N$;

\hat{M}_i = the estimated number of smolts migrating on the i^{th} day;

e_j = the j^{th} trap efficiency estimate, $j = 1, 2, \dots, n$;

n = the number of weeks with trap efficiency estimates;

N = the total number of weeks in the migration season;

\hat{e} = the average trap efficiency for the year, estimated by $\hat{e} = \frac{\sum_{j=1}^n e_j}{n}$;

A number of assumptions are required to attain unbiased estimates of smolt production. How well the assumptions are met will determine the reliability of the estimates. These assumptions are:

- Survival from release to the trap was 100%.
- All marked fish are identified and correctly enumerated.
- Fish do not lose their marks.
- All fish in the tag release group emigrate (i.e., do not residualize in the area of release).

We estimated that 23,003, or 56% of the 2003 BY parr estimates, passed the smolt trap during 2004-2005 (Table 15). We also estimated that 34% of the conventional hatchery supplementation fish and 37% of the captive brood progeny released from Curl Lake AP (2003 BY) passed the smolt trap.

Table 15. Monthly and total population estimates (with 95% confidence interval) for natural and hatchery origin (supplementation and captive brood) emigrants from the Tucannon River, 2005.

| Month | Natural | Supplementation | Captive Brood |
|-------------------------------|------------------|------------------------|----------------------|
| Sept.-Feb. | 3,911 | 0 | 0 |
| March | 1,809 | 0 | 4 |
| April | 9,597 | 11,142 | 24,851 |
| May | 7,566 | 12,817 | 23,120 |
| June | 120 | 109 | 248 |
| Total | 23,003 | 24,068 | 48,223 |
| (+/- 95% C.I.) | (+/- 790) | (+/- 1,145) | (+/- 2,109) |
| % Survival^a | 56.2 | 33.8 | 37.1 |

^a Percent survival to smolt based on estimated number of parr from summer snorkel surveys (natural origin) or from TFH release numbers (hatchery origin).

Juvenile Migration Studies

In 2005, we used passive integrated transponder (PIT) tags to study the emigration timing and relative success of our supplementation hatchery fish with our captive brood progeny. We tagged 1,000 supplementation and 1,000 captive brood progeny hatchery-origin fish during early February before transferring them to Curl Lake AP for acclimation and volitional release (Table 16). Seven fish from each group died or lost their tags after tagging. Detection rates were low, but similar to rates from previous releases at Curl Lake AP (Bumgarner et al. 1997).

Table 16. Cumulative detection (one unique detection per tag code) and travel time in days (TD) 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 2005 (Fish were volitionally released from 3/28/05-4/15/05).

| Hatchery Origin | Release Data | | | Mean Length | Recapture Data | | | | | | | | Total | |
|-----------------|--------------|-------------|------|-------------|----------------|------|----|------|----|------|---|------|-------|------|
| | N | Mean Length | SD | | N | TD | N | TD | N | TD | N | TD | N | % |
| Supplementation | 993 | 119.8 | 13.2 | 121.3 | 165 | 24.4 | 85 | 30.8 | 30 | 33.6 | 5 | 35.8 | 285 | 28.7 |
| Captive Brood | 993 | 123.8 | 16.1 | 127.1 | 142 | 21.8 | 65 | 30.9 | 28 | 33.3 | 9 | 39.4 | 244 | 24.6 |

Note: Mean travel times listed are from the total number of fish detected at each dam, not just unique recoveries for a tag code. Abbreviations are as follows: LMJ-Lower Monumental Dam, MCJ- McNary Dam, JDJ-John Day Dam, BONN-Bonneville Dam, 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 CAPHIST program. Data for input into CAPHIST was obtained directly from PTAGIS. Survival estimates from Curl Lake to Lower Monumental Dam were 0.45 (\pm 0.04) and 0.44 (\pm 0.05) for supplementation and captive brood progeny, respectively. While survival estimates were slightly lower for captive brood progeny fish the differences were not significant ($P > 0.05$).

Survival Rates

Point estimates of population sizes have been calculated for various life stages (Tables 17 and 18) of natural and hatchery-origin fish from spawning ground and juvenile mid-summer population surveys, smolt trapping, and fecundity estimates. From these two tables, survivals between life stages have been calculated for both natural and hatchery salmon to assist in the evaluation of the hatchery program. These survival estimates provide insight as to where efforts should be directed to improve not only the survival of fish produced within the hatchery, but fish in the river as well.

As expected, juvenile (egg-parr-smolt) survival rates for hatchery fish are considerably higher than for naturally reared salmon (Table 19) because they have been protected in the hatchery. However, smolt-to-adult return rates (SAR) of natural salmon were about five times higher than for hatchery-reared salmon (Tables 20 and 21). Mean hatchery SARs (0.15%) documented from the 1985-2000 broods were well below the LSRCP survival goal of 0.87%. Hatchery SARs for Tucannon River salmon need to substantially improve to meet the mitigation goal of 1,152 hatchery adult salmon.

Table 17. Estimates of natural Tucannon spring Chinook salmon abundance by life stage for 1985-2005 broods.

| Brood Year | Females in River | | Mean ^a Fecundity | | Number of Eggs | Number ^b of Parr | Number of Smolts | Progeny ^c (returning adults) |
|------------|------------------|----------|-----------------------------|----------|----------------|-----------------------------|------------------|---|
| | Natural | Hatchery | Natural | Hatchery | | | | |
| 1985 | 219 | - | 3,883 | - | 850,377 | 90,200 | 42,000 | 392 |
| 1986 | 200 | - | 3,916 | - | 783,200 | 102,600 | 58,200 | 468 |
| 1987 | 185 | - | 4,096 | - | 757,760 | 79,100 | 44,000 | 238 |
| 1988 | 117 | - | 3,882 | - | 454,194 | 69,100 | 37,500 | 527 |
| 1989 | 103 | 3 | 3,883 | 2,606 | 407,767 | 58,600 | 30,000 | 158 |
| 1990 | 128 | 52 | 3,993 | 2,697 | 651,348 | 86,259 | 49,500 | 94 |
| 1991 | 51 | 39 | 3,741 | 2,517 | 288,954 | 54,800 | 30,000 | 7 |
| 1992 | 119 | 81 | 3,854 | 3,295 | 725,521 | 103,292 | 50,800 | 194 |
| 1993 | 112 | 80 | 3,701 | 3,237 | 673,472 | 86,755 | 49,560 | 204 |
| 1994 | 39 | 5 | 4,187 | 3,314 | 179,863 | 12,720 | 7,000 | 12 |
| 1995 | 5 | 0 | 5,224 | 0 | 26,120 | 0 | 75 | 6 |
| 1996 | 53 | 16 | 3,516 | 2,843 | 231,836 | 2,845 | 1,612 | 69 |
| 1997 | 39 | 33 | 3,609 | 3,315 | 250,146 | 32,913 | 21,057 | 799 |
| 1998 | 19 | 7 | 4,023 | 3,035 | 97,682 | 8,453 | 5,508 | 375 |
| 1999 | 1 | 40 | 3,965 | 3,142 | 129,645 | 15,944 | 8,157 | 141 |
| 2000 | 26 | 66 | 3,969 | 3,345 | 323,964 | 44,618 | 20,045 | 446 |
| 2001 | 219 | 79 | 3,612 | 3,252 | 1,047,936 | 63,412 | 38,079 | 235 |
| 2002 | 104 | 195 | 3,981 | 3,368 | 1,070,784 | 72,197 | 60,530 | 3 |
| 2003 | 67 | 51 | 3,789 | 3,812 | 448,275 | 40,900 | 23,003 | |
| 2004 | 117 | 43 | 3,444 | 2,601 | 514,791 | 30,809 | | |
| 2005 | 77 | 25 | 3,773 | 2,903 | 363,096 | | | |

^a 1985 and 1989 mean fecundity of natural females is the average of 1986-88 and 1990-93 brood years.

^b Number of parr estimated from electrofishing (1985-1989), Line transect snorkel surveys (1990-1992), and Total Count snorkel surveys (1993-1999).

^c Numbers do not include down river harvest or other out-of-basin recoveries.

Table 18. Estimates of Tucannon spring Chinook salmon abundance (*spawned and reared in the hatchery*) by life stage for 1985-2005 broods.

| Brood Year | Females Spawned | | Mean ^a Fecundity | | Number of Eggs | Number of Parr | Number of Smolts | Progeny ^b (returning adults) |
|------------|-----------------|----------|-----------------------------|----------|----------------|----------------|---------------------|---|
| | Natural | Hatchery | Natural | Hatchery | | | | |
| 1985 | 4 | - | 3,883 | - | 14,843 | 13,401 | 12,922 | 45 |
| 1986 | 57 | - | 3,916 | - | 187,958 | 177,277 | 153,725 | 339 |
| 1987 | 48 | - | 4,096 | - | 196,573 | 164,630 | 152,165 | 190 |
| 1988 | 49 | - | 3,882 | - | 182,438 | 150,677 | 146,200 | 447 |
| 1989 | 28 | 9 | 3,883 | 2,606 | 133,521 | 103,420 | 99,060 | 243 |
| 1990 | 21 | 23 | 3,993 | 2,697 | 126,334 | 89,519 | 85,800 | 28 |
| 1991 | 17 | 11 | 3,741 | 2,517 | 91,275 | 77,232 | 74,060 | 25 |
| 1992 | 28 | 18 | 3,854 | 3,295 | 156,359 | 151,727 | 87,752 ^c | 81 |
| 1993 | 21 | 28 | 3,701 | 3,237 | 168,366 | 145,303 | 138,848 | 207 |
| 1994 | 22 | 21 | 4,187 | 3,314 | 161,707 | 132,870 | 130,069 | 34 |
| 1995 | 6 | 15 | 5,224 | 0 | 85,772 | 63,935 | 62,272 | 180 |
| 1996 | 18 | 19 | 3,516 | 2,843 | 117,287 | 80,325 | 76,219 | 260 |
| 1997 | 17 | 25 | 3,609 | 3,315 | 144,237 | 29,650 | 24,184 | 181 |
| 1998 | 30 | 14 | 4,023 | 3,035 | 161,019 | 136,027 | 127,939 | 830 |
| 1999 | 1 | 36 | 3,965 | 3,142 | 113,544 | 106,880 | 97,600 | 29 |
| 2000 | 3 | 35 | 3,969 | 3,345 | 128,980 | 123,313 | 102,099 | 175 |
| 2001 | 29 | 27 | 3,612 | 3,252 | 184,127 | 174,934 | 146,922 | 128 |
| 2002 | 22 | 25 | 3,981 | 3,368 | 169,364 | 151,531 | 123,586 | 8 |
| 2003 | 17 | 20 | 3,789 | 3,812 | 140,658 | 126,400 | 71,154 | |
| 2004 | 28 | 18 | 3,444 | 2,601 | 140,459 | 128,877 | 67,542 | |
| 2005 | 25 | 24 | 3,773 | 2,903 | 161,345 | 145,279 | | |

^a 1985 and 1989 mean fecundity of natural females is the average of 1986-88 and 1990-93 brood years; 1999 mean fecundity of natural fish is based on the mean of 1986-1998 brood years.

^b Numbers do not include down river harvest or other out-of-basin recoveries.

^c Number of smolts is less than actual release number. 57,316 parr were released in October 1993, with an estimated 7% survival. Total number of hatchery fish released from the 1992 brood year was 140,725. We therefore use the listed number of 87,752 as the number of smolts released.

Table 19. Percent survival by brood year for juvenile salmon and the multiplicative advantage of hatchery-reared salmon over naturally-reared salmon in the Tucannon River.

| Brood Year | Natural | | | Hatchery | | | Hatchery Advantage | | |
|-------------|-------------|---------------|--------------|-------------|---------------|--------------|--------------------|---------------|--------------|
| | Egg to Parr | Parr to Smolt | Egg to Smolt | Egg to Parr | Parr to Smolt | Egg to Smolt | Egg to Parr | Parr to Smolt | Egg to Smolt |
| 1985 | 10.6 | 46.6 | 4.9 | 90.3 | 96.4 | 87.1 | 8.5 | 2.1 | 17.6 |
| 1986 | 13.1 | 56.7 | 7.4 | 94.3 | 86.7 | 81.8 | 7.2 | 1.5 | 11.0 |
| 1987 | 10.4 | 55.6 | 5.8 | 83.8 | 92.4 | 77.4 | 8.0 | 1.7 | 13.3 |
| 1988 | 15.2 | 54.3 | 8.3 | 82.6 | 97.0 | 80.1 | 5.4 | 1.8 | 9.7 |
| 1989 | 14.4 | 51.2 | 7.4 | 77.5 | 95.8 | 74.2 | 5.4 | 1.9 | 10.1 |
| 1990 | 13.2 | 57.4 | 7.6 | 70.9 | 95.8 | 67.9 | 5.4 | 1.7 | 8.9 |
| 1991 | 19.0 | 54.7 | 10.4 | 84.6 | 95.9 | 81.1 | 4.5 | 1.8 | 7.8 |
| 1992 | 14.2 | 49.2 | 7.0 | 97.0 | 57.8 | 56.1 | 6.8 | 1.2 | 8.0 |
| 1993 | 12.9 | 57.1 | 7.4 | 86.3 | 95.6 | 82.5 | 6.7 | 1.7 | 11.2 |
| 1994 | 7.1 | 55.0 | 3.9 | 82.2 | 97.9 | 80.4 | 11.6 | 1.8 | 20.7 |
| 1995 | 0.0 | 0.0 | 0.3 | 74.5 | 97.4 | 72.6 | -- | -- | -- |
| 1996 | 1.2 | 56.7 | 0.7 | 68.5 | 94.9 | 65.0 | 55.8 | 1.7 | -- |
| 1997 | 13.2 | 64.0 | 8.4 | 20.6 | 81.6 | 16.8 | 1.6 | 1.3 | 2.0 |
| 1998 | 8.7 | 65.2 | 5.6 | 84.5 | 94.1 | 79.5 | 9.8 | 1.4 | 14.1 |
| 1999 | 12.3 | 51.2 | 6.3 | 94.1 | 91.3 | 86.0 | 7.7 | 1.8 | 13.7 |
| 2000 | 13.8 | 44.9 | 6.2 | 95.6 | 82.8 | 79.2 | 6.9 | 1.8 | 12.8 |
| 2001 | 6.1 | 60.1 | 3.6 | 95.0 | 84.0 | 79.8 | 15.7 | 1.4 | 22.0 |
| 2002 | 6.7 | 83.8 | 5.7 | 89.5 | 81.6 | 73.0 | 13.3 | 1.0 | 12.9 |
| 2003 | 9.1 | 56.2 | 5.1 | 89.9 | 56.3 | 50.6 | 9.8 | 1.0 | 9.9 |
| 2004 | 6.0 | | | 91.8 | 52.4 | 48.1 | 15.3 | | |
| 2005 | | | | 90.0 | | | | | |
| Mean | 10.4 | 53.7 | 5.9 | 83.0 | 86.4 | 71.0 | 10.8 | 1.6 | 12.1 |
| SD | 4.8 | 15.4 | 2.5 | 16.4 | 14.4 | 16.9 | 11.5 | 0.3 | 4.8 |

Table 20. Adult returns and SARs of natural salmon to the Tucannon River for brood years 1985-2000.

| Brood Year | Estimated Number of Smolts | Number of Adult Returns, observed (obs) and expanded (exp) ^a | | | | | | SAR (%) | |
|---|----------------------------|---|-----|-------|-----|-------|-----|-------------------|-------------------|
| | | Age 3 | | Age 4 | | Age 5 | | w/ Jacks | No Jacks |
| | | Obs | Exp | Obs | Exp | Obs | Exp | | |
| 1985 | 42,000 | 8 | 19 | 110 | 255 | 36 | 118 | 0.93 | 0.89 |
| 1986 ^b | 58,200 | 1 | 2 | 115 | 376 | 28 | 90 | 0.80 | 0.80 |
| 1987 | 44,000 | 0 | 0 | 52 | 167 | 29 | 71 | 0.54 | 0.54 |
| 1988 | 37,500 | 1 | 3 | 136 | 335 | 74 | 189 | 1.41 | 1.40 |
| 1989 | 30,000 | 5 | 12 | 47 | 120 | 23 | 26 | 0.53 | 0.49 |
| 1990 | 49,500 | 3 | 8 | 63 | 72 | 12 | 14 | 0.19 | 0.17 |
| 1991 | 30,000 | 0 | 0 | 4 | 5 | 1 | 2 | 0.02 | 0.02 |
| 1992 | 50,800 | 2 | 2 | 84 | 159 | 16 | 33 | 0.38 | 0.38 |
| 1993 | 49,560 | 1 | 2 | 62 | 127 | 58 | 75 | 0.41 | 0.41 |
| 1994 | 6,000 | 0 | 0 | 8 | 10 | 1 | 2 | 0.20 | 0.20 |
| 1995 | 75 | 0 | 0 | 1 | 1 | 2 | 5 | 8.00 ^c | 8.00 ^c |
| 1996 | 1,612 | 0 | 0 | 27 | 63 | 2 | 6 | 4.28 | 4.28 |
| 1997 | 21,057 | 6 | 14 | 234 | 703 | 29 | 82 | 3.79 | 3.73 |
| 1998 | 5,508 | 3 | 9 | 86 | 245 | 43 | 121 | 6.81 | 6.64 |
| 1999 | 8,157 | 3 | 9 | 44 | 124 | 3 | 8 | 1.73 | 1.62 |
| 2000 | 20,045 | 1 | 3 | 148 | 392 | 16 | 51 | 2.22 | 2.21 |
| Geometric Mean of 1985-2000 broods | | | | | | | | 0.76 | 0.74 |

^a Expanded numbers are calculated from the proportion of each known age salmon recovered in the river and from broodstock collections in relation to the total estimated return to the Tucannon River. Expansions do not include down river harvest or Tucannon River fish straying to other systems.

^b One known (expanded to two) Age 6 salmon was recovered.

^c 1995 SAR not included in mean.

Table 21. Adult returns and SARs of hatchery salmon to the Tucannon River for brood years 1985-2000.

| Brood Year | Estimated Number of Smolts | Number of Adult Returns, known and expanded (exp.) | | | | | | SAR (%) | |
|---|----------------------------|--|------|-------|------|-------|------|----------|----------|
| | | Age 3 | | Age 4 | | Age 5 | | w/ Jacks | No Jacks |
| | | Known | Exp. | Known | Exp. | Known | Exp. | | |
| 1985 | 12,922 | 9 | 19 | 25 | 26 | 0 | 0 | 0.35 | 0.20 |
| 1986 | 153,725 | 79 | 83 | 99 | 238 | 8 | 18 | 0.22 | 0.17 |
| 1987 | 152,165 | 9 | 22 | 70 | 151 | 8 | 17 | 0.12 | 0.11 |
| 1988 | 146,200 | 46 | 99 | 140 | 295 | 26 | 53 | 0.31 | 0.24 |
| 1989 | 99,057 | 7 | 15 | 100 | 211 | 14 | 17 | 0.25 | 0.23 |
| 1990 | 85,500 | 3 | 6 | 16 | 20 | 2 | 2 | 0.03 | 0.03 |
| 1991 | 74,058 | 4 | 5 | 20 | 20 | 0 | 0 | 0.03 | 0.03 |
| 1992 | 87,752 | 11 | 11 | 50 | 66 | 2 | 4 | 0.09 | 0.08 |
| 1993 | 138,848 | 11 | 15 | 93 | 174 | 15 | 18 | 0.15 | 0.14 |
| 1994 | 130,069 | 2 | 4 | 21 | 25 | 4 | 5 | 0.03 | 0.02 |
| 1995 | 62,272 | 13 | 16 | 117 | 160 | 2 | 4 | 0.29 | 0.26 |
| 1996 | 76,219 | 44 | 60 | 100 | 186 | 5 | 14 | 0.34 | 0.26 |
| 1997 | 24,186 | 7 | 13 | 59 | 168 | 0 | 0 | 0.75 | 0.69 |
| 1998 | 127,939 | 36 | 103 | 164 | 577 | 39 | 150 | 0.65 | 0.57 |
| 1999 | 97,600 | 2 | 7 | 5 | 19 | 1 | 3 | 0.03 | 0.02 |
| 2000 | 102,099 | 7 | 27 | 53 | 148 | 0 | 0 | 0.17 | 0.14 |
| Geometric Mean of 1985-2000 broods | | | | | | | | 0.15 | 0.12 |

As previously stated, overall survival of hatchery salmon to return as adults was higher than for naturally reared fish because of the early-life survival advantage (Table 19). With the exception of the 1988 and 1997-2000 brood years, naturally produced fish have been below the replacement level (Figure 7; Table 22). Based on adult returns from the 1985-2000 broods, naturally reared salmon produced only 0.6 adults for every spawner, while hatchery reared fish produced 1.8 adults.

Beginning with the 2006 brood year, the annual smolt goal will be increased from 132,000 to 225,000 to help offset for the higher mortality of hatchery-origin fish after they leave the hatchery. This should increase adult salmon returns back to the Tucannon River; however, based on current hatchery SARs this still would not produce enough adult returns to reach the current LSRCP mitigation goal. In conjunction with this we plan to conduct an experiment to examine size at release as a possible means to improve SAR of hatchery fish.

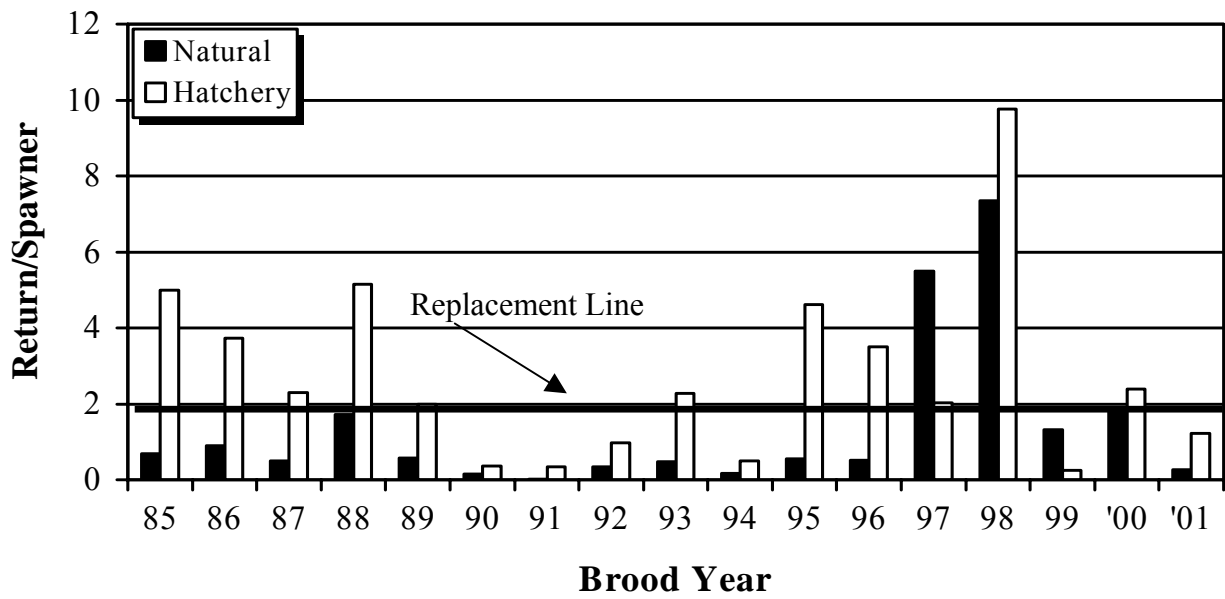


Figure 7. Return per spawner ratio (with replacement line) for the 1985-2001 brood years (2001 incomplete brood year).

Table 22. Parent-to-progeny survival estimates of Tucannon River spring Chinook salmon from 1985 through 2001 brood years (2001 incomplete).

| Brood Year | Natural Salmon | | | Hatchery Salmon | | | Hatchery to Natural Advantage |
|-----------------------|--------------------|-------------------|----------------|--------------------|-------------------|----------------|-------------------------------|
| | Number of Spawners | Number of Returns | Return/Spawner | Number of Spawners | Number of Returns | Return/Spawner | |
| 1985 | 569 | 392 | 0.69 | 9 | 45 | 5.00 | 7.2 |
| 1986 | 520 | 468 | 0.90 | 91 | 339 | 3.73 | 4.1 |
| 1987 | 481 | 238 | 0.49 | 83 | 190 | 2.29 | 4.7 |
| 1988 | 304 | 527 | 1.73 | 87 | 447 | 5.14 | 3.0 |
| 1989 | 276 | 158 | 0.57 | 122 | 243 | 1.99 | 3.5 |
| 1990 | 611 | 94 | 0.15 | 78 | 28 | 0.36 | 2.4 |
| 1991 | 390 | 7 | 0.02 | 72 | 25 | 0.35 | 17.5 |
| 1992 | 564 | 194 | 0.34 | 83 | 81 | 0.98 | 2.9 |
| 1993 | 436 | 204 | 0.47 | 91 | 207 | 2.27 | 4.8 |
| 1994 | 70 | 12 | 0.17 | 69 | 34 | 0.49 | 2.9 |
| 1995 | 11 | 6 | 0.55 | 39 | 180 | 4.62 | 8.4 |
| 1996 | 136 | 69 | 0.51 | 74 | 260 | 3.51 | 6.9 |
| 1997 | 146 | 799 | 5.47 | 89 | 181 | 2.03 | 0.4 |
| 1998 | 51 | 375 | 7.35 | 85 | 830 | 9.76 | 1.3 |
| 1999 | 107 | 141 | 1.32 | 122 | 29 | 0.24 | 0.2 |
| 2000 | 239 | 446 | 1.87 | 73 | 175 | 2.40 | 1.3 |
| 2001 | 894 | 235 | 0.26 | 104 | 128 | 1.23 | 4.7 |
| Geometric Mean | | | 0.60 | | | 1.75 | 2.9 |

Fishery Contribution

An original goal of the LSRCP supplementation program was to enhance natural returns of salmon to the Tucannon River by providing 1,152 hatchery-reared fish (the number estimated to have been lost due to the construction of the Lower Snake River hydropower system) to the river. Such an increase would allow for limited harvest and increased spawning. However, hatchery adult returns have always been below the program goal. Moreover, natural escapement, with the exception of the 2001 run, has been low (Figure 8). Based on 1985-2000 brood year CWT recoveries from the RMIS database (Appendix H), sport and commercial harvest combined has only accounted for 8.2% of the adult hatchery fish recovered annually. However, fishing mortality (both sport and commercial) has increased in recent years to 33% and 22% for the 1997 and 1998 brood years, respectively (Appendix H). Fishing mortality is one form of mortality managers can control. Adipose clipped hatchery fish have traditionally been targeted in the sport fishery. This hatchery fin clip was abandoned for Tucannon River spring Chinook smolts starting with the 2000 BY to mitigate fishing mortality on this ESA listed population (Gallinat et al. 2001). Supplementation fish are now marked with a CWT and a red VIE tag behind the right

eye. Captive brood progeny are marked only with agency-only wire tags or CWT to distinguish them from supplementation origin fish. Out-of-basin stray rates of Tucannon River spring Chinook have been low (Appendix H), with an average of 3.2% of the adult hatchery fish straying to other river systems/hatcheries for brood years 1985-2000 (range 0-20%).

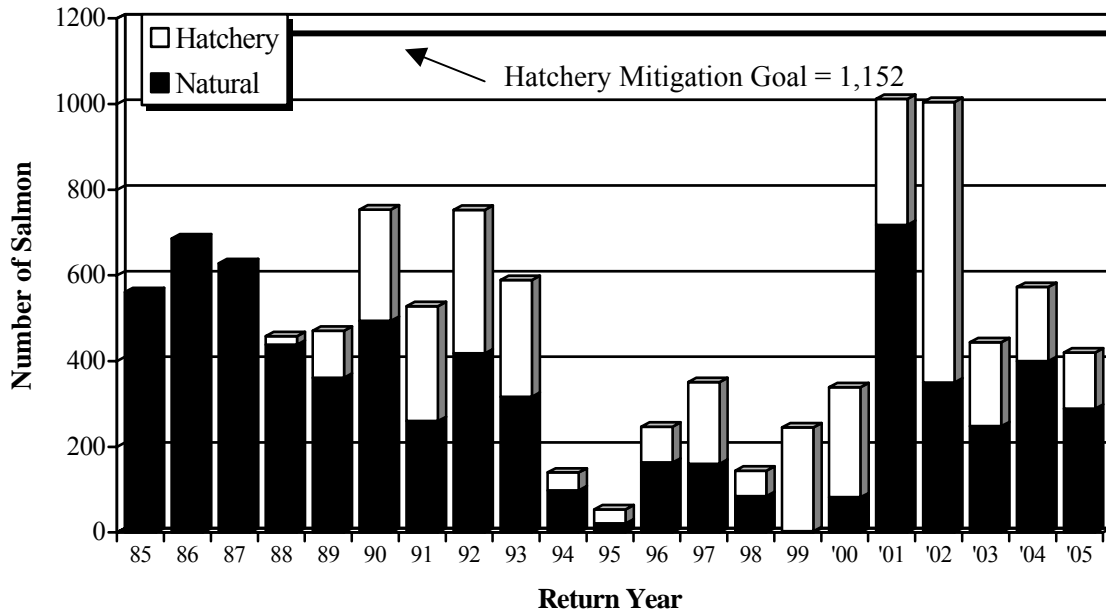


Figure 8. Total escapement for Tucannon River spring Chinook salmon for the 1985-2005 run years.

Conclusions and Recommendations

Washington's LSRCP hatchery spring Chinook salmon program has failed to return adequate numbers of adults to meet the mitigation goal. This has occurred because SARs of hatchery origin fish have consistently been lower than predicted, even though hatchery returns have generally been at 2-3 times the replacement level. Further, the natural spring Chinook population in the river has declined and remained below the replacement level for most years, with the majority (95%) of the mortality occurring between the green egg and smolt stages. Ocean conditions and mortality within the mainstem migration corridor have also contributed to poor survival. While this neither was, nor is the desired result of the program, in many ways the hatchery program has helped conserve the natural population by returning adults to spawn in the river. System survivals (in-river, migration corridor, ocean) must increase in the future for the hatchery program and the natural run to reach their full potential, and be sustainable over the long-term.

Until that time, the evaluation program will continue to document and study life history survivals, genotypic and phenotypic traits, and examine procedures within the hatchery that can be improved to benefit the hatchery program and the natural population. Based on our previous studies and current data involving survival and physical characteristics we recommend the following:

1. We continue to see annual differences in phenotypic characteristics of returning salmon (i.e., hatchery fish are generally younger in age and less fecund than natural origin fish), yet other traits such as run and spawn time are little changed over the program's history. Further, genetic analysis to date indicates little change in the natural population as a result of hatchery actions.

Recommendation: Continue to collect as many carcasses as possible for the most accurate age composition data. Continue to assist hatchery staff with picking eyed eggs to obtain fecundity estimates for each spawned female. Collect other biological data (length, run timing, spawn timing, DNA samples, juvenile parr production, smolt trapping, and life stage survival) to continue the documentation of the effects (positive or negative) that the hatchery program may have on the natural population.

2. The success of hatchery origin fish spawning in the river has become an important topic among managers within the Snake River Basin and with NOAA Fisheries. Little data exists on this subject. With the hatchery population in the Tucannon River intermixing with the natural population, we have an opportunity to study the effects of the hatchery spawners in the natural environment.

Recommendation: Continue to seek funding for a DNA based pedigree analysis study to examine the reproductive success of hatchery fish in the natural environment. Continue to use snorkel surveys during the summer months to estimate spring Chinook parr production in the river. Examine the relationship between redd counts and the following-year's parr production, smolt numbers and returning adults in context of the proportion of hatchery spawners in the river. Publish the results.

3. Subbasin and recovery planning for ESA listed species in the Tucannon River will identify factors limiting the spring Chinook population and strategies to recover the population. Development of a recovery goal for the population that is consistent with NOAA's Viable Salmonid Population criteria would be helpful in developing and evaluating recovery strategies for habitat, hydropower, harvest, and hatcheries.

Recommendation: Assist subbasin planning in the development of a recovery goal for spring Chinook in the Tucannon River. Determine carrying capacity of the Tucannon River so that hatchery stocking is appropriate. Determine impacts to other species (e.g., steelhead).

4. We have documented that hatchery juvenile (egg-parr-smolt) survival rates are considerably higher than naturally reared salmon, and hatchery smolt-to-adult return rates are much lower. We need to identify and address the factors that limit hatchery SARs in order to meet mitigation goals. Beginning with the 2006 brood year, the annual hatchery smolt goal will be increased from 132,000 to 225,000 to help offset for the higher mortality of hatchery-origin fish after they leave the hatchery. This should increase adult salmon returns back to the river, however, based on current hatchery SARs this would still not produce enough adult returns to reach the LSRCP mitigation goal.

Recommendation: Conduct an experiment to examine size at release as a possible means to improve SAR of hatchery fish. Evaluate survival rates from other watersheds to see if the LSRCP goal of 0.87% is a realistic goal under existing conditions. Increase PIT tagging to ascertain where the mortality is occurring.

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**Appendix A: Spring Chinook Captured, Collected, or
Passed Upstream at the Tucannon Hatchery Trap in
2005**

Appendix A. Spring Chinook salmon captured, collected, or passed upstream at the Tucannon Hatchery trap in 2005. (Trapping began in February; last day of trapping was September 30).

| Date | Captured in Trap | | Collected for Broodstock | | Passed Upstream | | Killed Outright | |
|---|------------------|------------|--------------------------|-----------|-----------------|-----------|-----------------|----------|
| | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery | Natural | Hatchery |
| 5/7 | 1 | | | | 1 | | | |
| 5/19 | | 1 | | 1 | | | | |
| 5/20 | 2 | 5 | 1 | 3 | 1 | 2 | | |
| 5/22 | 2 | 1 | 1 | 1 | 1 | | | |
| 5/23 | | 2 | | | | | 2 | |
| 5/24 | 1 | 1 | 1 | | | | 1 | |
| 5/25 | 2 | 2 | 1 | | 1 | 2 | | |
| 5/26 | 2 | 1 | 2 | 1 | | | | |
| 5/27 | 14 | 7 | 9 | 4 | 5 | 3 | | |
| 5/28 | 4 | 3 | | | 4 | 3 | | |
| 5/29 | 7 | 1 | | | 7 | 1 | | |
| 5/31 | 12 | 11 | 6 | 9 | 6 | 1 | | 1 |
| 6/1 | 14 | 9 | 10 | 7 | 4 | 2 | | |
| 6/2 | 7 | 8 | 4 | 5 | 3 | 2 | | 1 |
| 6/3 | 5 | 7 | 3 | 2 | 2 | 5 | | |
| 6/5 | 3 | | | | 3 | | | |
| 6/6 | 7 | 4 | 4 | 1 | 3 | 3 | | |
| 6/7 | 2 | 2 | 1 | 1 | 1 | 1 | | |
| 6/8 | 1 | 2 | 1 | 2 | | | | |
| 6/9 | 1 | 1 | | | 1 | 1 | | |
| 6/10 | | 1 | | 1 | | | | |
| 6/13 | 6 | 2 | 3 | | 3 | 2 | | |
| 6/15 | 1 | 1 | | 1 | 1 | | | |
| 6/16 | 1 | | | | 1 | | | |
| 6/20 | 4 | 3 | 2 | 1 | 2 | 2 | | |
| 6/21 | 2 | | 1 | | 1 | | | |
| 6/22 | 2 | 3 | | 1 | 2 | 2 | | |
| 6/23 | | 2 | | 1 | | 1 | | |
| 6/24 | | 1 | | 1 | | | | |
| 6/27 | 4 | 7 | | 1 | 4 | 6 | | |
| 6/29 | 1 | | | | 1 | | | |
| 6/30 | | 2 | | | | 2 | | |
| 7/1 | | 1 | | 1 | | | | |
| 7/2 | 1 | | | | 1 | | | |
| 7/7 | | 2 | | 1 | | 1 | | |
| 7/18 | 1 | | | | 1 | | | |
| 7/20 | | 1 | | | | 1 | | |
| 7/25 | | 1 | | 1 | | | | |
| 8/1 | | 1 | | 1 | | | | |
| 8/29 | 1 | | | | 1 | | | |
| 8/31 | 1 | 1 | | 1 | 1 | | | |
| 9/4 | | 2 | | | | 2 | | |
| 9/6 | 4 | 6 | 1 | 2 | 3 | 3 | | 1 |
| 9/7 | 1 | 3 | | | 1 | 3 | | |
| 9/9 | 6 | 2 | | | 6 | 2 | | |
| 9/10 | 3 | | | | 3 | | | |
| 9/11 | 2 | | | | 2 | | | |
| 9/12 | 1 | 1 | | | 1 | 1 | | |
| 9/14 | 2 | 2 | | | 2 | 2 | | |
| 9/16 | 1 | | | | 1 | | | |
| 9/19 | 1 | 1 | | | 1 | 1 | | |
| Totals | 133 | 114 | 51 | 51 | 82 | 60 | 0 | 3 |
| Corrected #'s After spawning^a | 131 | 114 | 49 | 51 | 82 | 60 | 0 | 3 |

^a We were short two natural fish collected for broodstock at the end of spawning.

Appendix B: 2003 & 2004 Microsatellite DNA Analysis

Genetic assessment of the spring Chinook captive brood program in the Tucannon River (2003 & 2004) using a Microsatellite DNA Analysis.

Genetic Assessment of the Spring Chinook Captive Brood Program in the Tucannon River (2003 & 2004) Using a Microsatellite DNA Analysis

by

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Abstract

A total of 937 spring Chinook samples from the Tucannon River were analyzed from collections made in 2003 and 2004 using 14 microsatellite loci. Analyses were performed on captive brood samples, supplementation spawners, and in-river spawners. The supplementation and in-river spawners were identified to be of natural or hatchery-origin and were partitioned into those groups to be re-analyzed. All collections were found to exhibit relatively high and similar levels of genetic diversity. Genotypic tests of differentiation indicated highly significant differences between the captive brood spawners and either the supplementation spawners or in-river spawners, but the supplementation spawners and in-river spawners were not different. Analysis of the collections re-grouped into hatchery and natural-origin (based on coded-wire tags) indicated highly significant differences among all groups. This provides evidence that the supplementation program has been effective in homogenizing the two-spawner groups (supplementation and in-river) based on the differences between the hatchery and natural-origin fish. The captive broodstock program has also been effective at maintaining genetic variation in spring-run Chinook in the Tucannon River while providing additional smolts for release.

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Introduction

Prior to 1985, only two fry releases of spring Chinook salmon (*O. tshawytscha*) occurred in the Tucannon River. In August 1962, 16,000 Klickitat River spring Chinook fry were released and in June 1964 there were 10,500 Willamette, Oregon spring Chinook fry released by the Washington Department of Fisheries into the Tucannon River. Neither of these releases is believed to have returned any significant number of adults (Gallinat 2004). In 1985, the hatchery spring Chinook production program was started by the Washington Department of Fisheries in the Tucannon River by capturing wild (unmarked) adults from the Tucannon River. Since 1988, hatchery-origin spring Chinook have been returning to the Tucannon River and beginning in 1989 the hatchery broodstock has consisted of both natural and hatchery-origin fish. This supplementation program is part of the Lower Snake River Compensation Plan (LSRCP) mitigation program, and will continue as long as mitigation is required under the LSRCP.

In 1994, the adult escapement declined severely to less than 150 fish, and the run in 1995 was estimated at 54 fish. In 1995, the Tucannon River spring Chinook population was listed as threatened under the ESA because of declining numbers of returning spring Chinook despite the supplementation program. As a result, WDFW and the co-managers believed intervention beyond the supplementation program was warranted in the form a captive broodstock program.

The plans for the captive broodstock program were determined and spring Chinook from the Tucannon River supplementation program were collected from 1997-2001 brood years (BY) to be raised to adults and spawned. Males were also collected from the 2002 BY in order to have enough to spawn with the captive brood females towards the end of the program. Each year, fish that mature from the initial group of captive broodstock are spawned. The captive brood program is scheduled to produce smolts for release through 2008.

Both the supplementation and captive brood programs are being conducted with the understanding that artificial propagation may have potentially deleterious direct and indirect effects on spring Chinook in the Tucannon River. These effects could include genetic and ecological changes that result in maladaptive genetic, physiological, or behavioral changes in the donor or target populations, thereby causing losses in natural productivity. A report by Gallinat (2004) describes the restoration program for spring Chinook in the Tucannon River.

The goal of this report is to analyze spring Chinook collected in 2003 and 2004 to assess the genetic differences in the captive brood program, the supplementation program, and fish that are spawning naturally in-river. Additional analyses will assess the genetic differentiation of hatchery-origin and natural-origin spawners to determine if the artificial production programs are having any genetic effects on the natural-origin Chinook.

Materials and Methods

A total of 937 spring-run Chinook samples from collections made from the Tucannon River supplementation program, captive brood program, and natural origin in 2003 and 2004 (Table 1) were analyzed at 14 microsatellite loci. Collections were grouped in two ways for analysis. The first comparisons (spawner) involved groups comprised of fish that actually spawned in the various environments (i.e., supplementation hatchery, in-river, or part of the captive brood program). Both the supplementation spawner and in-river spawner groups are comprised of natural and hatchery-origin fish. Marking and tagging operations in the hatchery made it possible to identify each Chinook as hatchery or natural-origin. Based on the identity of each fish they were re-distributed into groups based on their genetic-origin. The second comparison involved Chinook from the hatchery versus natural-origin (genetic origin). The captive brood group was the same in both sets of comparisons.

Tissue samples were collected for all fish spawned in both the supplementation and captive broodstock programs in 2003 and 2004. However, not all of the fish that spawned in-river were genetically sampled, therefore, the entire Tucannon River spring Chinook escapement was not represented. Collection codes, number of samples analyzed per collection, sample types and collection sources are given in Table 1.

DNA was extracted using silica membrane based kits obtained from Machery-Nagel. The protocol was: incubate tissue fragments 6 hours to overnight at 56°C in 200 µl proteinase K solution, add 200 µl Buffer B3 and 200 µl 100% ethanol, mix and transfer the supernatant into a Tissue Binding Plate containing the silica binding membranes, centrifuge 10 min, add 500 µl Buffer BW, centrifuge 2 min, add 700 µl Buffer B5, centrifuge 4 min, place Tissue Binding Plate on a collection rack, incubate 10 min at 70°C to remove residual ethanol, add 100 µl Buffer BE (elution buffer) at 70°C, incubate 1 min, centrifuge 2 min, dispose of Tissue Binding Plate, refrigerate eluted DNA or store at -20°C.

Descriptions of the loci assessed in this study and polymerase chain reaction (PCR) conditions are given in Table 2. PCR reactions were run separately for each microsatellite locus using an MJ Research PTC-200 thermalcycler, with a simple thermal profile consisting of: denaturation at 95°C for 3 min, denaturation at 95°C for 15 sec, anneal for 30 sec at the appropriate temperature for each locus (Table 2), extension at 72°C for 1 min, repeat cycle (steps 2-4), final extension at 72°C for 30 minutes. PCR products for each locus were subsequently combined into poolplexes to be processed with an ABI-3730 DNA Analyzer. Genotypes were visualized with a known size standard (GS500LIZ 3730) using GeneMapper 3.0 software. Allele binning and naming were accomplished using MicrosatelliteBinner-v.1.h (Young, WDFW available from the author).

MicrosatelliteBinner creates groups (bins) of alleles with similar mobilities (presumably alleles with the same number of repeat units). The upper and lower bounds of the bins are determined by identifying clusters of alleles separated by gaps (nominally 0.4 base pairs in size) in the distribution of allele sizes. The bins are then named as the mean allele size for the cluster rounded to an integer.

Both the 2003 and 2004 collections (grouped for both the spawner comparisons and the genetic origin comparisons) were genetically characterized and compared. Global tests (heterozygote deficiency and excess) of loci and populations was conducted to determine if there were any deviations from Hardy-Weinberg equilibrium (HWE) using GENEPOP v 3.4 (Raymond and Rousset 1995) with 10,000 dememorizations, 100 batches, and 2,000 iterations. Each locus was also tested individually to determine if there was any deviation from HWE (GENEPOP v 3.4 with 10,000 dememorizations, 100 batches, and 5,000 iterations per batch). Linkage disequilibrium was compared for each collection using GENEPOP v 3.4 (10,000 dememorizations, 100 batches, and 5,000 iterations per batch). Linkage disequilibrium can be caused by genetic drift, inclusion of family groups within collections, assortative mating and/or analysis of an admixed collection. Allele frequencies were calculated with CONVERT 1.3 (Glaubitz 2003). Measures of within-population genetic diversity were calculated for each group (gene diversity, number of alleles per locus, and allelic richness – the number of alleles corrected for sample size (FSTAT 2.9.3, Goudet 2001); observed and expected heterozygosity (GDA 1.1 Lewis and Zaykin 2001); and the number of unique alleles found in each group (CONVERT 1.3, Glaubitz 2003). Weir and Cockerham's (1984) inbreeding coefficient (F_{IS}) was also calculated using GDA for each group across all loci to look for genetic effects of small population size. To explore population structure among the groups, pairwise F_{ST} values and pairwise genotypic population differentiation tests were calculated using GENEPOP 3.4. Statistical significance of all tests was determined using a Bonferroni corrected P-value to account for multiple, simultaneous tests (Rice 1989).

Results and Discussion

Good quality DNA was obtained and analyzed for all collections. Nearly complete genotypes were collected for most samples. All samples with genotypes for seven or more loci were included in the analysis, and over all six collections only 49 samples were excluded. The number of samples excluded for each collection is shown in Table 1. The hatchery-origin and in-river spawner groups had the lowest number of individuals that were scored at all loci and included in the analysis (Table 1). Samples collected from fish carcasses in-river were of lower quality given the state of tissue decomposition when collected. All other samples were handled in the hatchery facility while the fish were still alive providing higher quality tissue.

Tests for Hardy-Weinberg Equilibrium (HWE) revealed no significant deviations from expected values at any locus and therefore no loci were dropped from analysis (Table 2). All collections analyzed were also within the expected HWE expectations suggesting random mating within each group (Table 3).

Tests for linkage for the 2003 sample groups was consistent with those reported by Hawkins and Frye (2005). The largest number of significant linkage disequilibrium tests in both the 2003 and 2004 samples occurred in the captive brood spawners (Table 3). The linkage disequilibria detected in the captive brood collection is likely the result of sampling a relatively small number of families of related individuals, effectively creating an admixed collection. Two other groups in the 2004 samples demonstrated significant linkage disequilibrium tests (in-river spawners 2004 and natural-origin spawners 2004) that were not seen in the 2003 groups (Hawkins and Frye 2005). The increased linkage in the 2004 natural-origin spawners suggests they were more closely related or from fewer parents than the natural-origin spawners from 2003.

The 2004 in-river samples and supplementation spawners have a subset of both natural and hatchery-origin Chinook (Table 1). The 2004 in-river samples had more than four times natural-origin samples versus hatchery-origin samples while the 2004 supplementation group included approximately 50% of both natural and hatchery-origin samples. It is, therefore not surprising to see an increase in the number of significant linkages in the in-river spawners versus the supplementation spawners.

A large positive value of the inbreeding coefficient (F_{IS}) is an indication of an excess of homozygotes in a collection and can result from small population size and inbreeding (Table 3). Allelic richness is an additional measure of population diversity and therefore an indication of the health and stability of the population; high values indicate increased genetic diversity (Table 3). In general, all groups individually exhibited relatively high and similar levels of allelic

richness (10.90 – 12.53), and neither the F_{IS} values nor the observed heterozygosities indicated an excess of homozygotes (which would be an indication of inbreeding).

Tests for allelic richness averaged over all loci for each of the collection types did not reveal any significant difference in the total number of alleles observed when the 2003 and 2004 data sets were combined. When comparing genetic-origin groups allelic richness was highest for the natural-origin samples (11.81), second for the captive brood samples (11.39), and lowest for the hatchery-origin samples (11.10). In spawner group comparisons, the in-river samples had the highest allelic richness value (12.14) compared with the supplementation samples (12.09), or captive brood. The in-river samples had a higher proportion of natural-origin fish than hatchery-origin; therefore it is not surprising to have a higher allelic richness value.

The overall number of alleles per locus ranged from 4 – 36 (*Ots-9** and *Omm-1080** respectively; Table 4). In theory, it would be expected that a natural population would exhibit higher genetic diversity and thus contain more alleles than captive broodstock or hatchery-origin samples derived from a limited number of founders. The analysis of the 2003 samples (Hawkins and Frye 2005), contradicts that theory because the captive brood group had more alleles observed than the natural-origin group for 11 of the 14 loci examined (Table 4). This may be explained because the captive brood collection had three times as many samples as the natural-origin collection. The captive brood in 2003 also included fish from four consecutive brood years (ages 2-5) while the natural-origin fish from 2003 was comprised mostly of adults from two brood years (ages 4 and 5). There were two age 3 fish included with the natural-origin samples, 44 samples that were age 4, and 43 age 5 samples. The analysis of the 2004 samples identifies more alleles at approximately half of the loci in the captive brood and half in the natural-origin samples. The 2004 captive brood samples included adults from three brood years and the natural-origin from two brood years (ages 4 and 5). However, the 2004 natural-origin samples were predominately age 4 (97 age 4 samples and only 2 age 5 samples). There are fewer total alleles over all loci in the 2004 captive broodstock than in the 2003 captive broodstock likely due to the representation of more family groups from more brood years in the 2003 captive brood than in the 2004 captive brood. The overall number of alleles present in both the 2003 and 2004 captive broodstock in comparison to the natural-origin spawners suggests that the captive brood program has maintained a similar level of genetic diversity similar to the natural-origin spring Chinook spawners in the Tucannon River.

Assessment of private alleles provides an understanding of the genetic differentiation among collections. A collection with a lot of private alleles indicates the collection has been isolated and alleles were lost in one collection while maintained in another, the sample was not random, or the sample sizes of each collection was not large enough to observe all alleles that exists in that collection area. In the case of a captive brood program, the presence of private alleles in the

brood indicates alleles have been maintained through the program and may contribute to the overall genetic variation in the river where they are introduced.

Assessment of the private alleles detected in the 2003 samples versus the analysis of the combined datasets from 2003 and 2004 revealed some interesting patterns (Appendix 1a and 1b). Overall, the 2003 samples have a larger number of unique alleles than the 2004 samples for all groups analyzed. The highest number of unique alleles detected in the 2003 samples alone was in the captive brood spawners (36 alleles) and the lowest (4 alleles) in the hatchery-origin samples (Hawkins and Frye 2005). When data for both 2003 and 2004 were analyzed together, the highest number of unique alleles was found in the natural-origin spawners (24 alleles) and the lowest in the hatchery-origin spawners (4 alleles; Table 3). The number of unique alleles in the 2003 captive brood spawners dropped from 36 to 12 when the samples from 2003 and 2004 were analyzed together. Six of the 24 alleles that were no longer unique in the 2003 captive brood samples were found in the 2004 captive brood samples only. Eight of the 24 alleles were found in the 2004 captive brood, 2004 hatchery, and 2004 natural-origin samples. The remaining unique alleles to the 2003 captive brood were found in one or more of the 2004 collections. This result is expected as more samples are analyzed, the potential of detecting alleles that are present in only one collection goes down, however half of the 2003 captive brood unique alleles are still found in the captive brood samples alone. This suggests that releases from the captive brood may contribute to the genetic variation of the Tucannon River spring-run Chinook population and not cause a reduction in the overall genetic variability.

The number and distribution of the alleles observed in each group can give insights into the relationship among the different collection types. A side-by-side comparison of the unique alleles (Appendix 1a and 1b) provides an understanding of how the results differ depending on how the fish are grouped. In many cases, alleles that are unique to the natural- origin fish have been split between the supplementation and in-river spawners, effectively homogenizing the two groups and spreading the genetic diversity between the two-spawner groups. Because this hatchery program is a supplementation hatchery designed to augment the natural production, this homogenization and spreading of the natural genetic diversity is a desired result. The alleles of *Oki-100* are a good example of this effect. Two alleles, 315 and 327, are only observed in the natural groups. However, allele 315 is distributed between the supplementation spawners and the in-river spawners, while allele 327 is only present in the supplementation spawners.

The combined results of the pairwise F_{ST} tests and tests of genotypic differentiation (Table 5a and 5b) suggest that the collections are genetically differentiated with the exception of the supplementation and in-river spawners (Table 5a). The pairwise F_{ST} values are between 0.0006 - 0.0132 indicating a relatively low level of genetic difference among the collections (Table 5b). The F_{ST} values are highly affected by the level of heterozygosity at each locus and may limit the

usefulness of these comparisons (Table 2). The tests for genotypic differentiation of captive brood, hatchery-origin, and natural-origin revealed that all three groups are highly significantly different from each other (Table 5a). Yet, when the hatchery-origin and natural-origin fish are re-grouped as either supplementation or in-river spawners, they are not significantly different (Table 5a).

Interestingly, the F_{ST} values between the 2003 and 2004 annual collections of hatchery-origin, natural-origin, supplementation, and in-river samples are larger than most other comparisons (Table 5b). This implies the samples between years are variable and support the observed differences seen in other analysis that there is genetic variability between years. In contrast, the 2003 and 2004 captive brood samples have a low F_{ST} value indicating these samples are not very different as would be expected in a captive brood program.

Conclusions

The measures of genetic diversity reported here suggest that the analyzed groups have not undergone a severe loss of diversity. Despite the fact that these groups were recently derived from natural-origin spring run Chinook in the Tucannon River, there were significant genetic differences observed among the groups (with the exception of the supplementation and in-river spawners). This result is most likely due to the high numbers and distribution of unique alleles and is not surprising given the overall small population size (causing genetic drift to have a strong affect), and the relatively small number of families (varying in the number of individuals per family) of both the supplementation spawners and the captive brood spawners. Non-random sampling for each year can also affect the quantity and distribution of alleles. The results and comparisons of the different collection types provides evidence both that the captive broodstock program has been an effective method of preserving genetic variation, and that the supplementation hatchery practices (despite using only a small percentage of the entire escapement each year) have been effective in minimizing differences between the hatchery and natural-origin fish.

Acknowledgements

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Table 1. Collection code, collection description, and number of samples collected and used in the 2003 and 2004 samples. Collection description includes the following: hatchery-origin, natural-origin, and captive broodstock (hatchery-origin fish originated in the hatchery in their respective brood year and all natural-origin fish were spawned naturally and originated in the river in their respective broodyear). The hatchery-origin and natural-origin samples were divided into supplementation hatchery and in-river spawners and re-analyzed.

| Collection Description | Collection Code | # collected | # excluded ^a | # used in analysis |
|-----------------------------------|-----------------|-------------|-------------------------|--------------------|
| hatchery-origin | 03EK | 50 | 7 | 43 |
| natural-origin | 03EL | 84 | 9 | 75 |
| hatchery-origin | 04EY | 58 | 6 | 49 |
| natural-origin | 04EZ | 99 | 10 | 89 |
| supplementation - hatchery-origin | 03EK | 34 | 0 | 34 |
| supplementation - natural-origin | 03EL | 41 | 0 | 41 |
| supplementation spawners - total | 03EK and 03EL | 75 | 0 | 75 |
| in-river - hatchery-origin | 03EK | 16 | 7 | 9 |
| in-river - natural-origin | 03EL | 43 | 9 | 34 |
| in-river spawners - total | 03EK and 03EL | 59 | 16 | 43 |
| supplementation - hatchery-origin | 04EY | 40 | 1 | 39 |
| supplementation - natural-origin | 04EZ | 42 | 1 | 41 |
| supplementation spawners - total | 04EY and 04EZ | 82 | 2 | 80 |
| in-river - hatchery-origin | 04EY | 14 | 4 | 10 |
| in-river - natural-origin | 04EZ | 50 | 7 | 43 |
| in-river spawners - total | 04EY and 04EZ | 64 | 11 | 53 |
| captive broodstock | 03EM | 346 | 5 | 341 |
| captive broodstock | 04FA | 300 | 12 | 288 |

^a - Individual samples were excluded if data was not available for seven or more loci.

Table 2. PCR conditions and microsatellite locus information (number alleles/locus and allele size range) for poolplexed loci. Also included are the observed and expected heterozygosity (H_e and H_o) for each locus and P-values for deviations from Hardy-Weinberg equilibrium tested for heterozygote deficiency (HWE). Because HWE is dependent on the fish combined in a group, values are given for both the spawner group collections and the genetic origin collections (see text for detailed description of these groups).

| PCR Conditions | | | | | | Locus statistics | | Heterozygosity | | HWE | HWE |
|----------------|------------------|-----------|---------------------|-------------------|--------|---------------------|---------------------------|----------------|----------------|------------------|-------------------|
| Poolplex | Locus | Dye Label | Annealing temp (°C) | Primer conc. (mM) | Cycles | # Alleles/ Locus | Allele Size Range (bp) | H _o | H _e | Spawner group | Genetic origin |
| Ots-M | <i>Oki-100*</i> | vic | 50 | 0.36 | 40 | 21 | 248-327 | 0.9122 | 0.9064 | 0.9341 | 0.9168 |
| | <i>Ots-201b*</i> | 6fam | 50 | 0.32 | 40 | 28 | 182-330 | 0.9327 | 0.9143 | 0.9893 | 0.9984 |
| | <i>Ots-208b*</i> | ned | 50 | 0.18 | 40 | 27 | 184-291 | 0.9305 | 0.9190 | 0.4347 | 0.6850 |
| | <i>Ssa-408*</i> | pet | 50 | 0.20 | 40 | 25 | 211-324 | 0.8808 | 0.8943 | 0.1979 | 0.2167 |
| Ots-N | <i>Ogo-2*</i> | pet | 63 | 0.07 | 40 | 11 | 231-261 | 0.6579 | 0.6581 | 0.9125 | 0.9744 |
| | <i>Ssa-197*</i> | ned | 63 | 0.25 | 40 | 22 | 189-301 | 0.8791 | 0.8704 | 0.8306 | 0.7859 |
| Ots-O | <i>Ogo-4*</i> | 6fam | 56 | 0.18 | 40 | 12 | 165-198 | 0.7822 | 0.7866 | 0.5953 | 0.6559 |
| | <i>Omm-1080*</i> | vic | 56 | 0.22 | 40 | 36 | 217-377 | 0.9153 | 0.9185 | 0.1603 | 0.1544 |
| | <i>Ots-213*</i> | ned | 56 | 0.18 | 40 | 23 | 252-359 | 0.8859 | 0.8934 | 0.1899 | 0.1949 |
| | <i>Ots-G474*</i> | pet | 56 | 0.14 | 40 | 9 | 187-235 | 0.5565 | 0.5178 | 0.9986 | 0.9992 |
| Ots-P | <i>Ots-3M*</i> | 6fam | 63 | 0.12 | 40 | 11 | 146-183 | 0.5121 | 0.4956 | 0.9405 | 0.9496 |
| | <i>Ots-9*</i> | ned | 63 | 0.04 | 40 | 4 | 132-138 | 0.6286 | 0.6114 | 0.8928 | 0.9134 |
| Ots-Q | <i>Ots-211*</i> | ned | 63 | 0.07 | 40 | 24 | 237-348 | 0.8780 | 0.8861 | 0.5275 | 0.5064 |
| | <i>Ots-212*</i> | 6fam | 63 | 0.30 | 40 | 18 | 160-258 | 0.8794 | 0.8769 | 0.5445 | 0.6197 |

Table 3. Descriptive statistics of the collections analyzed, including the number of significant pairwise linkage disequilibria detected (Linkage), observed and expected heterozygosities (H_o and H_e), P-values for deviations from Hardy Weinberg Equilibrium tested for heterozygote deficiency (HWE), allelic richness (number of alleles corrected for sample size, averaged over all loci), inbreeding coefficient (F_{IS}), and the number of private alleles found in each collection when 2003 and 2004 samples were analyzed together and the total per collection group.

| Collection | Collection Code | Number of Fish Included in Analysis (scored at 8 or more loci) | Linkage | Heterozygosity | | HWE P-value | Allelic Richness ^b | F_{IS} | Number of private alleles |
|--------------------------|-----------------|--|---|----------------|-------|-------------|-------------------------------|----------|---------------------------|
| | | | (# locus pairs significant before/after Bonferroni correction) ^a | H_o | H_e | | | | |
| Captive brood spawners | 03EM | 341 | 86 / 75 | 0.787 | 0.791 | 0.024 | 11.60 | 0.005 | 12 |
| | 04FA | 288 | 85 / 64 | 0.808 | 0.796 | 0.998 | 11.20 | -0.015 | 2 |
| | | | | | | | | | 14 |
| Supplementation spawners | 03EK and 03EL | 75 | 11 / 2 | 0.795 | 0.798 | 0.305 | 12.53 | 0.003 | 9 |
| | 04EY and 04EZ | 80 | 12 / 3 | 0.823 | 0.792 | 0.998 | 11.77 | -0.039 | 1 |
| | | | | | | | | | 10 |
| In-river spawners | 03EK and 03EL | 43 | 13 / 4 | 0.827 | 0.789 | 0.996 | 11.96 | -0.049 | 7 |
| | 04EY and 04EZ | 53 | 59 / 33 | 0.821 | 0.799 | 0.966 | 12.32 | -0.028 | 5 |
| | | | | | | | | | 12 |
| Hatchery origin | 03EK | 43 | 18 / 4 | 0.796 | 0.787 | 0.625 | 10.90 | -0.012 | 2 |
| | 04EY | 49 | 14 / 3 | 0.800 | 0.793 | 0.855 | 11.30 | -0.009 | 2 |
| | | | | | | | | | 4 |
| Natural origin | 03EL | 75 | 21 / 4 | 0.813 | 0.795 | 0.997 | 12.00 | -0.022 | 18 |
| | 04EZ | 89 | 55 / 25 | 0.836 | 0.793 | 1.000 | 11.63 | -0.055 | 6 |
| | | | | | | | | | 24 |

a: 91 Pairwise comparisons and Bonferroni corrected P-value = 0.0006 (0.05/91)

b: Allelic richness based on 14 loci, and 33 individuals (spawner groups) or 30 individuals (genetic origin).

Table 4. Number of alleles observed per locus for each collection. See text for detailed description of the collections.

| Collection | Collection Code | Average number of samples per locus included in analysis | Oki-100 | Ots-201b | Ots-208b | Ssa-408 | Ogo-2 | Ssa-197 | Ogo-4 | Omm-1080 | Ots-213 | Ots-G474 | Ots-3M | Ots-9 | Ots-211 | Ots-212 |
|--------------------------------------|-----------------|--|---------|----------|----------|---------|-------|---------|-------|----------|---------|----------|--------|-------|---------|---------|
| Captive brood spawners | 03EM | 322 | 18 | 25 | 21 | 19 | 9 | 18 | 12 | 30 | 19 | 7 | 7 | 4 | 19 | 15 |
| | 04FA | 271 | 18 | 18 | 20 | 18 | 9 | 15 | 9 | 30 | 15 | 5 | 5 | 4 | 18 | 13 |
| Supplementation spawners | 03EK and 03EL | 71 | 17 | 22 | 20 | 19 | 7 | 15 | 11 | 26 | 19 | 5 | 6 | 4 | 17 | 12 |
| | 04EY and 04EZ | 77 | 19 | 20 | 22 | 18 | 8 | 13 | 9 | 23 | 14 | 5 | 5 | 4 | 17 | 13 |
| In-river spawners | 03EK and 03EL | 39 | 16 | 16 | 15 | 19 | 7 | 13 | 10 | 23 | 17 | 4 | 7 | 4 | 12 | 11 |
| | 04EY and 04EZ | 49 | 19 | 20 | 22 | 14 | 8 | 13 | 10 | 23 | 16 | 5 | 4 | 4 | 18 | 12 |
| Hatchery origin | 03EK | 40 | 15 | 16 | 17 | 14 | 5 | 12 | 10 | 22 | 16 | 4 | 4 | 4 | 13 | 9 |
| | 04EY | 46 | 15 | 18 | 20 | 17 | 7 | 12 | 9 | 17 | 14 | 4 | 5 | 4 | 17 | 12 |
| Natural origin | 03EL | 70 | 18 | 23 | 19 | 21 | 7 | 17 | 10 | 25 | 18 | 5 | 6 | 4 | 18 | 14 |
| | 04EZ | 84 | 19 | 21 | 20 | 15 | 8 | 14 | 10 | 25 | 16 | 6 | 4 | 4 | 19 | 13 |
| Number of alleles in all collections | | | 20 | 26 | 27 | 24 | 10 | 21 | 12 | 36 | 23 | 9 | 11 | 4 | 23 | 17 |

Table 5a. P-values for genotypic differentiation values across all loci (Fisher's method). Values in white type that are highlighted in black are not significantly different from zero. H.S. indicates highly significant results with a chi-squared value of infinity.

| | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive |
|-------------|-------------|------------|------------|-------------|------------|------------|
| 03 Hatchery | X | | | | | |
| 03 Natural | H.S. | X | | | | |
| 03 Captive | H.S. | H.S. | X | | | |
| 04 Hatchery | 0.00000 | H.S. | 0.00000 | X | | |
| 04 Natural | H.S. | H.S. | H.S. | 0.00001 | X | |
| 04 Captive | H.S. | H.S. | H.S. | 0.00000 | H.S. | X |

| | 03 Supplement | 03 In-River | 03 Captive | 04 Supplement | 04 In-River | 04 Captive |
|---------------|---------------|-------------|------------|---------------|-------------|------------|
| 03 Supplement | X | | | | | |
| 03 In-River | 0.0884 | X | | | | |
| 03 Captive | H.S. | H.S. | X | | | |
| 04 Supplement | H.S. | 0.00000 | 0.00000 | X | | |
| 04 In-River | 0.00000 | 0.00000 | 0.00000 | 0.06441 | X | |
| 04 Captive | H.S. | H.S. | H.S. | 0.00000 | H.S. | X |

Table 5b. Pairwise FST values across all loci (Fisher's method).

| | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive |
|-------------|---------------|---------------|---------------|---------------|---------------|------------|
| 03 Hatchery | X | | | | | |
| 03 Natural | 0.0079 | X | | | | |
| 03 Captive | 0.0102 | 0.0064 | X | | | |
| 04 Hatchery | 0.0102 | 0.0091 | 0.0018 | X | | |
| 04 Natural | 0.0132 | 0.0108 | 0.0072 | 0.0050 | X | |
| 04 Captive | 0.0078 | 0.0075 | 0.0023 | 0.0028 | 0.0086 | X |

| | 03 Supplement | 03 In-River | 03 Captive | 04 Supplement | 04 In-River | 04 Captive |
|---------------|---------------|---------------|---------------|---------------|---------------|------------|
| 03 Supplement | X | | | | | |
| 03 In-River | 0.0006 | X | | | | |
| 03 Captive | 0.0056 | 0.0069 | X | | | |
| 04 Supplement | 0.0090 | 0.0095 | 0.0037 | X | | |
| 04 In-River | 0.0065 | 0.0100 | 0.0063 | 0.0015 | X | |
| 04 Captive | 0.0051 | 0.0075 | 0.0023 | 0.0047 | 0.0076 | X |

Appendix 1A. Allele frequencies for the hatchery-origin, natural-origin, and captive broodstock spring Chinook in the Tucannon River in 2003 and 2004. The column labeled "private" identifies specific alleles that were only scored in the collection that is identified.

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Oki-100 | 248 | 0.0256 | 0.0135 | 0.0393 | 0.0795 | 0.0244 | 0.0421 | |
| Oki-100 | 256 | | | 0.0030 | 0.0114 | 0.0122 | 0.0096 | |
| Oki-100 | 260 | 0.0128 | 0.0068 | 0.0166 | 0.0455 | 0.0488 | 0.0192 | |
| Oki-100 | 264 | 0.0256 | 0.0338 | 0.0393 | 0.0795 | 0.0610 | 0.0211 | |
| Oki-100 | 268 | 0.1282 | 0.0878 | 0.1254 | 0.1250 | 0.1280 | 0.1015 | |
| Oki-100 | 272 | 0.0769 | 0.0270 | 0.0408 | 0.0795 | 0.0732 | 0.0824 | |
| Oki-100 | 276 | 0.0385 | 0.0541 | 0.1012 | 0.0682 | 0.0671 | 0.0977 | |
| Oki-100 | 280 | 0.0256 | 0.0203 | 0.0196 | | 0.0244 | 0.0019 | |
| Oki-100 | 284 | 0.0513 | 0.0338 | 0.0363 | 0.0227 | 0.0122 | 0.0421 | |
| Oki-100 | 287 | 0.1026 | 0.1824 | 0.0937 | 0.0455 | 0.0366 | 0.0900 | |
| Oki-100 | 291 | | | 0.0030 | 0.0341 | 0.0061 | 0.0019 | |
| Oki-100 | 295 | 0.0897 | 0.0811 | 0.0861 | 0.0455 | 0.0488 | 0.0766 | |
| Oki-100 | 297 | 0.0769 | 0.0270 | 0.0438 | 0.0455 | 0.0793 | 0.0575 | |
| Oki-100 | 299 | 0.1923 | 0.1959 | 0.1782 | 0.1705 | 0.1951 | 0.1801 | |
| Oki-100 | 303 | 0.0769 | 0.1149 | 0.0166 | 0.0114 | 0.0244 | 0.0287 | |
| Oki-100 | 307 | 0.0256 | 0.0135 | 0.0196 | | 0.0366 | 0.0115 | |
| Oki-100 | 311 | 0.0513 | 0.0743 | 0.1239 | 0.1364 | 0.0793 | 0.1303 | |
| Oki-100 | 315 | | 0.0203 | | | 0.0183 | | |
| Oki-100 | 323 | | 0.0068 | 0.0136 | | 0.0244 | 0.0057 | |
| Oki-100 | 327 | | 0.0068 | | | | | 03 Natural |
| # of samples | | 39 | 74 | 331 | 44 | 82 | 261 | |

Appendix 1A. (continued)

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ots-201b | 182 | | | 0.0015 | | | | 03_Captive |
| Ots-201b | 184 | 0.0500 | 0.0846 | 0.0540 | 0.0417 | 0.0349 | 0.0335 | |
| Ots-201b | 196 | | 0.0154 | 0.0170 | | | 0.0112 | |
| Ots-201b | 200 | | | 0.0015 | 0.0312 | 0.0058 | | |
| Ots-201b | 204 | | | 0.0031 | | 0.0058 | | |
| Ots-201b | 208 | 0.1125 | 0.0615 | 0.0586 | 0.0208 | 0.0640 | 0.0688 | |
| Ots-201b | 211 | 0.0500 | 0.0462 | 0.0756 | 0.0521 | 0.1221 | 0.0855 | |
| Ots-201b | 215 | 0.1875 | 0.1077 | 0.1451 | 0.1458 | 0.0814 | 0.1357 | |
| Ots-201b | 219 | 0.1000 | 0.1077 | 0.1728 | 0.2292 | 0.1860 | 0.1654 | |
| Ots-201b | 223 | 0.0625 | 0.0923 | 0.0478 | 0.0417 | 0.0291 | 0.0651 | |
| Ots-201b | 227 | 0.0125 | 0.0385 | 0.0370 | 0.0417 | 0.0174 | 0.0223 | |
| Ots-201b | 231 | | 0.0231 | 0.0262 | | 0.0349 | | |
| Ots-201b | 235 | 0.0125 | 0.0231 | 0.0093 | | 0.0465 | | |
| Ots-201b | 239 | 0.0375 | 0.0385 | 0.0139 | 0.0521 | 0.0349 | 0.0204 | |
| Ots-201b | 243 | | 0.0231 | 0.0324 | 0.0104 | 0.0116 | 0.0465 | |
| Ots-201b | 247 | 0.0625 | 0.0538 | 0.0633 | 0.0625 | 0.0523 | 0.0781 | |
| Ots-201b | 251 | 0.0750 | 0.1000 | 0.1204 | 0.1354 | 0.1105 | 0.1208 | |
| Ots-201b | 254 | 0.0625 | 0.0231 | 0.0309 | 0.0521 | 0.0640 | 0.0465 | |
| Ots-201b | 258 | | 0.0077 | 0.0062 | 0.0208 | 0.0465 | 0.0130 | |
| Ots-201b | 262 | 0.0625 | 0.0077 | 0.0093 | 0.0104 | 0.0174 | 0.0167 | |
| Ots-201b | 266 | 0.0500 | 0.0538 | 0.0247 | 0.0104 | 0.0058 | 0.0279 | |
| Ots-201b | 275 | | | 0.0015 | | | | 03_Captive |
| Ots-201b | 278 | | 0.0077 | 0.0015 | | | | |
| Ots-201b | 282 | | 0.0154 | 0.0123 | | 0.0058 | | |
| Ots-201b | 294 | | | | 0.0104 | | 0.0037 | |
| Ots-201b | 306 | 0.0500 | 0.0462 | 0.0340 | 0.0312 | 0.0233 | 0.0390 | |
| Ots-201b | 314 | 0.0125 | 0.0077 | | | | | |
| Ots-201b | 330 | | 0.0154 | | | | | 03_Natural |
| # of samples | | 40 | 65 | 324 | 48 | 86 | 269 | |

Appendix 1A. (continued)

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|-------------|
| Ots-208b | 184 | | | | 0.0319 | | | 04_Hatchery |
| Ots-208b | 188 | 0.0698 | 0.0685 | 0.0564 | 0.0106 | 0.0904 | 0.0436 | |
| Ots-208b | 193 | | | 0.0030 | | | 0.0018 | |
| Ots-208b | 200 | 0.0233 | | | | | | 03_Hatchery |
| Ots-208b | 204 | 0.0116 | | 0.0198 | 0.0213 | 0.0181 | 0.0145 | |
| Ots-208b | 208 | | 0.0137 | 0.0488 | 0.0319 | 0.0181 | 0.0418 | |
| Ots-208b | 212 | | 0.0479 | 0.0091 | 0.0319 | 0.0120 | 0.0182 | |
| Ots-208b | 216 | | | 0.0168 | 0.0957 | 0.0301 | 0.0236 | |
| Ots-208b | 219 | 0.0233 | 0.0068 | 0.0381 | 0.0426 | 0.0301 | 0.0182 | |
| Ots-208b | 224 | 0.1744 | 0.1301 | 0.1341 | 0.0638 | 0.1024 | 0.1182 | |
| Ots-208b | 228 | 0.0814 | 0.0753 | 0.0168 | 0.0319 | 0.0602 | 0.0382 | |
| Ots-208b | 232 | 0.0465 | 0.0342 | 0.0030 | 0.0106 | 0.0181 | 0.0055 | |
| Ots-208b | 236 | 0.0233 | 0.0479 | 0.0259 | 0.0213 | 0.0241 | 0.0400 | |
| Ots-208b | 240 | 0.0465 | 0.0068 | 0.0610 | 0.0213 | 0.0241 | 0.0673 | |
| Ots-208b | 244 | | 0.0548 | | | 0.0060 | | |
| Ots-208b | 248 | 0.0349 | 0.0068 | 0.0534 | 0.0426 | 0.0361 | 0.0236 | |
| Ots-208b | 251 | 0.0233 | 0.0137 | 0.0091 | | 0.0482 | 0.0218 | |
| Ots-208b | 255 | 0.0581 | 0.0479 | 0.0381 | 0.0426 | 0.0120 | 0.0291 | |
| Ots-208b | 259 | 0.1395 | 0.1301 | 0.1448 | 0.1596 | 0.1205 | 0.1600 | |
| Ots-208b | 263 | 0.1744 | 0.0342 | 0.0991 | 0.1170 | 0.1145 | 0.0945 | |
| Ots-208b | 267 | 0.0349 | 0.1370 | 0.1372 | 0.1489 | 0.1386 | 0.1218 | |
| Ots-208b | 271 | 0.0233 | 0.0616 | 0.0198 | 0.0106 | 0.0361 | 0.0545 | |
| Ots-208b | 275 | 0.0116 | 0.0753 | 0.0564 | 0.0426 | 0.0422 | 0.0636 | |
| Ots-208b | 279 | | | 0.0091 | | 0.0120 | | |
| Ots-208b | 283 | | | | 0.0213 | | | 04_Hatchery |
| Ots-208b | 287 | | 0.0068 | | | | | 03_Natural |
| Ots-208b | 291 | | | | | 0.0060 | | 04_Natural |
| # of samples | | 43 | 73 | 328 | 47 | 83 | 275 | |

Appendix 1A. (continued)

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ssa-408 | 211 | 0.0571 | 0.0685 | 0.0579 | 0.0612 | 0.0730 | 0.0508 | |
| Ssa-408 | 215 | 0.1714 | 0.1781 | 0.1409 | 0.1122 | 0.1685 | 0.1250 | |
| Ssa-408 | 218 | 0.0429 | 0.0479 | 0.0401 | 0.0306 | 0.0112 | 0.0586 | |
| Ssa-408 | 222 | 0.1429 | 0.1644 | 0.2255 | 0.1837 | 0.1742 | 0.2246 | |
| Ssa-408 | 226 | 0.0857 | 0.0137 | 0.0208 | 0.0510 | 0.0506 | 0.0254 | |
| Ssa-408 | 230 | 0.0286 | 0.1027 | 0.0519 | 0.1122 | 0.0337 | 0.0684 | |
| Ssa-408 | 234 | 0.2000 | 0.1096 | 0.1261 | 0.1224 | 0.1180 | 0.1504 | |
| Ssa-408 | 238 | 0.0857 | 0.0274 | 0.0401 | 0.0204 | 0.0562 | 0.0566 | |
| Ssa-408 | 242 | | 0.0137 | 0.0134 | 0.0204 | 0.0449 | 0.0391 | |
| Ssa-408 | 249 | 0.0429 | 0.0548 | 0.0593 | 0.0816 | 0.0899 | 0.0605 | |
| Ssa-408 | 253 | 0.0143 | 0.0137 | 0.0163 | 0.0102 | 0.0056 | 0.0059 | |
| Ssa-408 | 257 | | 0.0205 | 0.0178 | | 0.0056 | | |
| Ssa-408 | 261 | | 0.0068 | | | | | 03_Natural |
| Ssa-408 | 265 | 0.0429 | 0.0068 | | 0.0102 | 0.0056 | 0.0078 | |
| Ssa-408 | 269 | 0.0286 | | 0.0163 | 0.0102 | | 0.0098 | |
| Ssa-408 | 273 | | 0.0068 | 0.0104 | | | | |
| Ssa-408 | 277 | | 0.0068 | | | | | 03_Natural |
| Ssa-408 | 296 | | 0.0137 | | | | | 03_Natural |
| Ssa-408 | 300 | | | 0.0119 | 0.0714 | | 0.0137 | |
| Ssa-408 | 306 | | 0.0068 | | | | | 03_Natural |
| Ssa-408 | 308 | | 0.0137 | 0.0015 | | | 0.0137 | |
| Ssa-408 | 312 | 0.0143 | 0.0479 | 0.0608 | 0.0408 | 0.0955 | 0.0410 | |
| Ssa-408 | 320 | 0.0429 | 0.0753 | 0.0846 | 0.0510 | 0.0674 | 0.0449 | |
| Ssa-408 | 324 | | | 0.0045 | 0.0102 | | 0.0039 | |
| # of samples | | 35 | 73 | 337 | 49 | 89 | 256 | |

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ogo-2 | 231 | | | 0.0015 | | | | 03_Captive |
| Ogo-2 | 242 | 0.2333 | 0.1186 | 0.1369 | 0.1224 | 0.2378 | 0.0921 | |
| Ogo-2 | 244 | 0.5667 | 0.5000 | 0.5893 | 0.5510 | 0.3963 | 0.5469 | |
| Ogo-2 | 246 | | 0.0254 | 0.0164 | 0.0306 | 0.0122 | 0.0325 | |
| Ogo-2 | 248 | 0.1333 | 0.2203 | 0.1205 | 0.0714 | 0.1585 | 0.1245 | |
| Ogo-2 | 250 | 0.0167 | 0.0932 | 0.0536 | 0.1020 | 0.0732 | 0.0704 | |
| Ogo-2 | 252 | | | | | | 0.0036 | 04_Captive |
| Ogo-2 | 254 | | 0.0254 | 0.0134 | | 0.0183 | 0.0271 | |
| Ogo-2 | 256 | 0.0500 | | 0.0283 | 0.0510 | 0.0244 | 0.0451 | |
| Ogo-2 | 260 | | 0.0169 | 0.0402 | 0.0714 | 0.0793 | 0.0578 | |
| # of samples | | 30 | 59 | 336 | 49 | 82 | 277 | |

Appendix 1A. (continued)

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ssa-197 | 189 | | 0.0133 | | | | | 03_Natural |
| Ssa-197 | 201 | 0.1163 | 0.0400 | 0.0791 | 0.1277 | 0.0488 | 0.1019 | |
| Ssa-197 | 209 | | 0.0133 | 0.0657 | 0.0319 | 0.0427 | 0.0389 | |
| Ssa-197 | 217 | | | 0.0030 | | | | 03_Captive |
| Ssa-197 | 221 | 0.0116 | 0.0133 | | | | | |
| Ssa-197 | 233 | | 0.0067 | | | 0.0061 | | |
| Ssa-197 | 242 | | | 0.0015 | | | | 03_Captive |
| Ssa-197 | 249 | | 0.0067 | 0.0149 | | 0.0122 | 0.0148 | |
| Ssa-197 | 253 | 0.0233 | 0.0400 | 0.0179 | | | 0.0185 | |
| Ssa-197 | 257 | 0.0116 | 0.0400 | 0.1149 | 0.1064 | 0.0732 | 0.1056 | |
| Ssa-197 | 261 | 0.0581 | 0.0733 | 0.0299 | 0.0638 | 0.0549 | 0.0389 | |
| Ssa-197 | 265 | 0.1744 | 0.1933 | 0.2179 | 0.1596 | 0.2134 | 0.2204 | |
| Ssa-197 | 269 | 0.0465 | 0.1200 | 0.0448 | 0.0851 | 0.0549 | 0.0148 | |
| Ssa-197 | 273 | 0.2674 | 0.2133 | 0.1970 | 0.2447 | 0.3049 | 0.2500 | |
| Ssa-197 | 277 | 0.0581 | 0.0667 | 0.0433 | 0.0426 | 0.0549 | 0.0333 | |
| Ssa-197 | 281 | | 0.0133 | 0.0299 | 0.0426 | 0.0427 | 0.0333 | |
| Ssa-197 | 285 | 0.0698 | 0.0467 | 0.0567 | 0.0426 | 0.0244 | 0.0500 | |
| Ssa-197 | 289 | 0.0233 | 0.0133 | 0.0104 | | 0.0061 | 0.0093 | |
| Ssa-197 | 293 | 0.1395 | 0.0867 | 0.0612 | 0.0426 | 0.0610 | 0.0444 | |
| Ssa-197 | 297 | | | 0.0060 | | | 0.0259 | |
| Ssa-197 | 301 | | | 0.0060 | 0.0106 | | | |
| # of samples | | 43 | 75 | 335 | 47 | 82 | 270 | |

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ogo-4 | 165 | 0.0119 | 0.0400 | 0.0178 | | 0.0233 | | |
| Ogo-4 | 169 | 0.0476 | 0.0867 | 0.0237 | 0.0326 | 0.0233 | 0.0326 | |
| Ogo-4 | 171 | 0.0119 | | 0.0074 | 0.0326 | 0.0116 | 0.0145 | |
| Ogo-4 | 182 | 0.2143 | 0.2267 | 0.3269 | 0.3370 | 0.2674 | 0.2609 | |
| Ogo-4 | 184 | | | 0.0104 | | | | 03_Captive |
| Ogo-4 | 186 | | 0.0133 | 0.0059 | | | | |
| Ogo-4 | 188 | 0.0357 | 0.0733 | 0.0266 | 0.0326 | 0.0349 | 0.0362 | |
| Ogo-4 | 190 | 0.2857 | 0.3067 | 0.3107 | 0.2826 | 0.2674 | 0.2880 | |
| Ogo-4 | 192 | 0.3214 | 0.1533 | 0.1450 | 0.1630 | 0.2558 | 0.2192 | |
| Ogo-4 | 194 | 0.0476 | 0.0267 | 0.0355 | 0.0217 | 0.0233 | 0.0725 | |
| Ogo-4 | 196 | 0.0119 | 0.0533 | 0.0399 | 0.0109 | 0.0233 | 0.0308 | |
| Ogo-4 | 198 | 0.0119 | 0.0200 | 0.0503 | 0.0870 | 0.0698 | 0.0453 | |
| # of samples | | 42 | 75 | 338 | 46 | 86 | 276 | |

Appendix 1A. (continued)

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Omm-1080 | 217 | 0.0125 | | 0.0341 | 0.0375 | 0.0380 | 0.0360 | |
| Omm-1080 | 221 | 0.0125 | 0.0294 | | | 0.0127 | | |
| Omm-1080 | 233 | | 0.0956 | 0.0735 | 0.0875 | 0.0570 | 0.0780 | |
| Omm-1080 | 241 | | 0.0074 | 0.0072 | | 0.0127 | 0.0120 | |
| Omm-1080 | 245 | | 0.0074 | 0.0305 | | 0.0506 | 0.0060 | |
| Omm-1080 | 249 | | | 0.0072 | 0.0625 | 0.0063 | 0.0120 | |
| Omm-1080 | 253 | | | | | | 0.0020 | 04_Captive |
| Omm-1080 | 257 | 0.1750 | 0.1765 | 0.2437 | 0.1625 | 0.1772 | 0.1960 | |
| Omm-1080 | 261 | 0.0250 | 0.0368 | 0.0161 | 0.0125 | 0.0633 | 0.0260 | |
| Omm-1080 | 269 | 0.0250 | 0.0147 | 0.0036 | | | 0.0060 | |
| Omm-1080 | 273 | | 0.0074 | | | | | 03_Natural |
| Omm-1080 | 277 | | 0.0074 | | | | | 03_Natural |
| Omm-1080 | 281 | | 0.0074 | | | | 0.0060 | |
| Omm-1080 | 285 | 0.0125 | 0.0368 | 0.0645 | 0.1250 | 0.0696 | 0.1280 | |
| Omm-1080 | 289 | 0.0750 | 0.0074 | 0.0627 | 0.0750 | 0.0443 | 0.0420 | |
| Omm-1080 | 293 | | | 0.0054 | | | 0.0040 | |
| Omm-1080 | 297 | 0.0125 | 0.0515 | 0.0125 | | 0.0063 | 0.0100 | |
| Omm-1080 | 301 | | 0.0147 | 0.0018 | | | | |
| Omm-1080 | 309 | 0.0250 | 0.0147 | 0.0305 | 0.0250 | 0.0127 | 0.0060 | |
| Omm-1080 | 313 | 0.0125 | 0.0588 | 0.0018 | 0.0125 | 0.0253 | 0.0020 | |
| Omm-1080 | 317 | 0.0250 | 0.0074 | 0.0108 | | 0.0063 | 0.0060 | |
| Omm-1080 | 322 | 0.0250 | 0.0221 | 0.0090 | 0.0125 | 0.0633 | 0.0180 | |
| Omm-1080 | 326 | 0.0875 | 0.0515 | 0.0699 | 0.1000 | 0.0886 | 0.0540 | |
| Omm-1080 | 330 | 0.1250 | 0.0735 | 0.0538 | 0.1125 | 0.0316 | 0.0680 | |
| Omm-1080 | 334 | 0.0250 | 0.0221 | 0.0090 | | | 0.0120 | |
| Omm-1080 | 338 | 0.0375 | | 0.0018 | | 0.0316 | | |
| Omm-1080 | 342 | 0.0250 | 0.0588 | 0.0143 | | 0.0316 | 0.0080 | |
| Omm-1080 | 346 | 0.0625 | 0.0515 | 0.0412 | 0.0375 | 0.0253 | 0.0600 | |
| Omm-1080 | 350 | 0.0250 | | 0.0197 | | 0.0253 | 0.0120 | |
| Omm-1080 | 354 | 0.0375 | 0.0735 | 0.0860 | 0.0625 | 0.0316 | 0.0920 | |
| Omm-1080 | 358 | | | 0.0090 | 0.0250 | 0.0506 | 0.0080 | |
| Omm-1080 | 362 | | | | | 0.0063 | | 04_Natural |
| Omm-1080 | 365 | 0.1000 | 0.0662 | 0.0520 | 0.0125 | 0.0316 | 0.0580 | |
| Omm-1080 | 369 | | | 0.0161 | 0.0375 | | 0.0220 | |
| Omm-1080 | 373 | 0.0375 | | 0.0018 | | | 0.0080 | |
| Omm-1080 | 377 | | | 0.0108 | | | 0.0020 | |
| # of samples | | 40 | 68 | 279 | 40 | 79 | 250 | |

Appendix 1A. (continued)

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ots-213 | 252 | 0.0233 | 0.0200 | 0.0442 | 0.0106 | 0.0482 | 0.0434 | |
| Ots-213 | 255 | | | 0.0030 | 0.0319 | 0.0060 | | |
| Ots-213 | 260 | 0.0698 | 0.0200 | | | | | |
| Ots-213 | 263 | 0.0465 | 0.0267 | 0.0244 | 0.0213 | 0.0181 | 0.0208 | |
| Ots-213 | 267 | | 0.0133 | 0.0076 | | | | |
| Ots-213 | 275 | 0.0233 | 0.0133 | | | | | |
| Ots-213 | 279 | | | 0.0030 | | | | 03_Captive |
| Ots-213 | 283 | | 0.0333 | | | | | 03_Natural |
| Ots-213 | 287 | 0.1047 | 0.1267 | 0.1570 | 0.1702 | 0.1807 | 0.2075 | |
| Ots-213 | 291 | 0.0233 | 0.0333 | 0.0229 | 0.0532 | 0.0663 | 0.0170 | |
| Ots-213 | 295 | 0.2442 | 0.2133 | 0.2043 | 0.1702 | 0.2229 | 0.1868 | |
| Ots-213 | 299 | | 0.0933 | 0.0107 | 0.0319 | 0.0422 | 0.0321 | |
| Ots-213 | 303 | 0.0349 | 0.0467 | 0.0701 | 0.1277 | 0.0783 | 0.0660 | |
| Ots-213 | 307 | 0.0581 | 0.0067 | 0.0137 | | 0.0301 | 0.0189 | |
| Ots-213 | 311 | | | | | 0.0060 | | 04_Natural |
| Ots-213 | 315 | 0.0349 | 0.0467 | 0.0366 | 0.0426 | 0.0120 | 0.0396 | |
| Ots-213 | 319 | 0.0349 | 0.0733 | 0.1082 | 0.0745 | 0.0663 | 0.1377 | |
| Ots-213 | 323 | 0.0349 | 0.0800 | 0.0366 | 0.0106 | 0.0663 | 0.0528 | |
| Ots-213 | 327 | 0.1047 | 0.0933 | 0.1037 | 0.1277 | 0.0482 | 0.0717 | |
| Ots-213 | 331 | 0.0116 | 0.0467 | 0.0732 | 0.0106 | 0.0060 | 0.0170 | |
| Ots-213 | 335 | 0.0116 | 0.0133 | 0.0137 | | | 0.0340 | |
| Ots-213 | 339 | 0.1395 | | 0.0625 | 0.1170 | 0.1024 | 0.0547 | |
| Ots-213 | 359 | | | 0.0046 | | | | 03_Captive |
| # of samples | | 43 | 75 | 328 | 47 | 83 | 265 | |

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ots-G474 | 187 | 0.6163 | 0.6533 | 0.6441 | 0.6562 | 0.7024 | 0.6259 | |
| Ots-G474 | 195 | | | 0.0074 | | | 0.0018 | |
| Ots-G474 | 199 | 0.3488 | 0.2000 | 0.2294 | 0.3021 | 0.2083 | 0.2806 | |
| Ots-G474 | 211 | | | 0.0044 | | | | 03_Captive |
| Ots-G474 | 215 | | 0.0133 | | | | | 03_Natural |
| Ots-G474 | 219 | | | 0.0015 | | 0.0060 | | |
| Ots-G474 | 223 | 0.0116 | 0.0733 | 0.0588 | 0.0208 | 0.0417 | 0.0468 | |
| Ots-G474 | 231 | 0.0233 | 0.0600 | 0.0544 | 0.0208 | 0.0357 | 0.0450 | |
| Ots-G474 | 235 | | | | | 0.0060 | | 04_Natural |
| # of samples | | 43 | 75 | 340 | 48 | 84 | 278 | |

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|---------|
| Ots-9 | 132 | 0.0349 | 0.0068 | 0.0185 | 0.0204 | 0.0115 | 0.0284 | |
| Ots-9 | 134 | 0.4884 | 0.4054 | 0.3611 | 0.3061 | 0.2989 | 0.4202 | |
| Ots-9 | 136 | 0.3953 | 0.5270 | 0.4938 | 0.5510 | 0.4885 | 0.4450 | |
| Ots-9 | 138 | 0.0814 | 0.0608 | 0.1265 | 0.1224 | 0.2011 | 0.1064 | |
| # of samples | | 43 | 74 | 324 | 49 | 87 | 282 | |

Appendix 1A. (continued)

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ots-211 | 237 | | 0.0424 | 0.0196 | 0.0114 | | 0.0036 | |
| Ots-211 | 253 | | 0.0169 | | | | | 03_Natural |
| Ots-211 | 264 | | | 0.0375 | 0.0227 | 0.0179 | 0.0217 | |
| Ots-211 | 268 | 0.0429 | 0.0763 | 0.0857 | 0.0568 | 0.0476 | 0.0704 | |
| Ots-211 | 272 | 0.0286 | 0.0254 | 0.0607 | 0.1364 | 0.0714 | 0.0812 | |
| Ots-211 | 276 | | | | 0.0227 | 0.0060 | | |
| Ots-211 | 280 | | 0.0169 | 0.0054 | | 0.0119 | | |
| Ots-211 | 284 | 0.0143 | 0.0085 | 0.0143 | 0.0227 | 0.0238 | 0.0253 | |
| Ots-211 | 288 | 0.0286 | 0.0085 | 0.0125 | 0.0227 | 0.0119 | 0.0253 | |
| Ots-211 | 292 | | 0.0085 | 0.0071 | 0.0114 | 0.0060 | 0.0090 | |
| Ots-211 | 296 | 0.0714 | 0.0508 | 0.0732 | 0.0795 | 0.1190 | 0.0975 | |
| Ots-211 | 300 | 0.0571 | 0.0847 | 0.0625 | 0.0682 | 0.0476 | 0.0704 | |
| Ots-211 | 304 | 0.3714 | 0.3898 | 0.2482 | 0.2614 | 0.2857 | 0.2112 | |
| Ots-211 | 308 | 0.0714 | 0.0424 | 0.0321 | 0.0795 | 0.0298 | 0.0379 | |
| Ots-211 | 312 | 0.1714 | 0.1610 | 0.0911 | 0.0909 | 0.0536 | 0.1354 | |
| Ots-211 | 316 | 0.0286 | 0.0169 | 0.0839 | 0.0341 | 0.2024 | 0.0560 | |
| Ots-211 | 320 | | 0.0085 | 0.0411 | 0.0227 | 0.0179 | 0.0433 | |
| Ots-211 | 324 | | | 0.0125 | | | 0.0217 | |
| Ots-211 | 328 | | | | | 0.0060 | | 04_Natural |
| Ots-211 | 332 | 0.0857 | 0.0254 | 0.0893 | 0.0455 | 0.0238 | 0.0650 | |
| Ots-211 | 336 | 0.0143 | 0.0085 | 0.0089 | | | 0.0036 | |
| Ots-211 | 340 | 0.0143 | 0.0085 | 0.0143 | 0.0114 | 0.0119 | 0.0217 | |
| Ots-211 | 348 | | | | | 0.0060 | | 04_Natural |
| # of samples | | 35 | 59 | 280 | 44 | 84 | 277 | |

| Locus | Size | 03 Hatchery | 03 Natural | 03 Captive | 04 Hatchery | 04 Natural | 04 Captive | Private |
|--------------|------|-------------|------------|------------|-------------|------------|------------|------------|
| Ots-212 | 160 | | 0.0078 | 0.0222 | 0.0233 | 0.0305 | 0.0500 | |
| Ots-212 | 165 | 0.0417 | 0.1172 | 0.0819 | 0.0930 | 0.0671 | 0.0259 | |
| Ots-212 | 169 | 0.0833 | 0.0547 | 0.0751 | 0.0465 | 0.0610 | 0.0704 | |
| Ots-212 | 173 | 0.1250 | 0.1484 | 0.1877 | 0.1628 | 0.1098 | 0.2074 | |
| Ots-212 | 177 | 0.0833 | 0.0938 | 0.0188 | 0.0465 | 0.0366 | 0.0556 | |
| Ots-212 | 181 | 0.2361 | 0.1406 | 0.1604 | 0.3023 | 0.2561 | 0.1574 | |
| Ots-212 | 185 | 0.2778 | 0.1797 | 0.1792 | 0.1395 | 0.1037 | 0.1370 | |
| Ots-212 | 189 | 0.0972 | 0.1719 | 0.1160 | 0.0814 | 0.1463 | 0.1352 | |
| Ots-212 | 193 | 0.0278 | 0.0078 | 0.0666 | 0.0233 | 0.0732 | 0.0778 | |
| Ots-212 | 197 | | 0.0156 | 0.0137 | 0.0116 | 0.0183 | 0.0111 | |
| Ots-212 | 201 | 0.0278 | 0.0234 | 0.0512 | 0.0465 | 0.0732 | 0.0407 | |
| Ots-212 | 210 | | 0.0234 | 0.0085 | | | | |
| Ots-212 | 214 | | 0.0078 | | | | | 03_Natural |
| Ots-212 | 234 | | | 0.0068 | | 0.0183 | 0.0111 | |
| Ots-212 | 238 | | | 0.0102 | 0.0233 | 0.0061 | 0.0204 | |
| Ots-212 | 254 | | 0.0078 | | | | | 03_Natural |
| Ots-212 | 258 | | | 0.0017 | | | | 03_Captive |
| # of samples | | 36 | 64 | 293 | 43 | 82 | 270 | |

Appendix 1B. Allele frequencies for the supplementation spawners (includes both natural- and hatchery-origin), in-river spawners (includes both natural- and hatchery-origin), and captive broodstock spring Chinook in the Tucannon River in 2003 and 2004. The column labeled "private" identifies specific alleles that were only scored in the collection that is identified.

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|---------|
| Oki-100 | 248 | 0.0135 | 0.0256 | 0.0393 | 0.0541 | 0.0312 | 0.0421 | |
| Oki-100 | 256 | | | 0.003 | 0.0135 | 0.0104 | 0.0096 | |
| Oki-100 | 260 | 0.0135 | | 0.0166 | 0.0405 | 0.0625 | 0.0192 | |
| Oki-100 | 264 | 0.0338 | 0.0256 | 0.0393 | 0.0743 | 0.0625 | 0.0211 | |
| Oki-100 | 268 | 0.1081 | 0.0897 | 0.1254 | 0.1351 | 0.125 | 0.1015 | |
| Oki-100 | 272 | 0.0473 | 0.0385 | 0.0408 | 0.0946 | 0.0521 | 0.0824 | |
| Oki-100 | 276 | 0.0473 | 0.0513 | 0.1012 | 0.0608 | 0.0625 | 0.0977 | |
| Oki-100 | 280 | 0.027 | 0.0128 | 0.0196 | 0.0135 | 0.0208 | 0.0019 | |
| Oki-100 | 284 | 0.0541 | 0.0128 | 0.0363 | 0.0135 | 0.0104 | 0.0421 | |
| Oki-100 | 287 | 0.1419 | 0.1795 | 0.0937 | 0.0405 | 0.0312 | 0.09 | |
| Oki-100 | 291 | | | 0.003 | 0.0135 | 0.0208 | 0.0019 | |
| Oki-100 | 295 | 0.0743 | 0.1026 | 0.0861 | 0.0405 | 0.0521 | 0.0766 | |
| Oki-100 | 297 | 0.0541 | 0.0256 | 0.0438 | 0.0743 | 0.0625 | 0.0575 | |
| Oki-100 | 299 | 0.1959 | 0.1923 | 0.1782 | 0.1622 | 0.2292 | 0.1801 | |
| Oki-100 | 303 | 0.0946 | 0.1154 | 0.0166 | 0.0068 | 0.0312 | 0.0287 | |
| Oki-100 | 307 | 0.0203 | 0.0128 | 0.0196 | 0.027 | 0.0104 | 0.0115 | |
| Oki-100 | 311 | 0.0541 | 0.0897 | 0.1239 | 0.1149 | 0.0833 | 0.1303 | |
| Oki-100 | 315 | 0.0135 | 0.0128 | | 0.0135 | 0.0104 | | |
| Oki-100 | 323 | | 0.0128 | 0.0136 | 0.0068 | 0.0312 | 0.0057 | |
| Oki-100 | 327 | 0.0068 | | | | | | 03 Supp |
| # of samples | | 74 | 39 | 331 | 74 | 48 | 261 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Ots-201b | 182 | | | 0.0015 | | | | 03 Captive |
| Ots-201b | 184 | 0.0903 | 0.0303 | 0.054 | 0.0321 | 0.049 | 0.0335 | |
| Ots-201b | 196 | 0.0139 | | 0.017 | | | 0.0112 | |
| Ots-201b | 200 | | | 0.0015 | 0.0064 | 0.0196 | | |
| Ots-201b | 204 | | | 0.0031 | | 0.0098 | | |
| Ots-201b | 208 | 0.1042 | 0.0303 | 0.0586 | 0.0513 | 0.049 | 0.0688 | |
| Ots-201b | 211 | 0.0486 | 0.0455 | 0.0756 | 0.0833 | 0.1078 | 0.0855 | |
| Ots-201b | 215 | 0.1181 | 0.1818 | 0.1451 | 0.1026 | 0.1176 | 0.1357 | |
| Ots-201b | 219 | 0.0972 | 0.1212 | 0.1728 | 0.2179 | 0.1765 | 0.1654 | |
| Ots-201b | 223 | 0.0625 | 0.1212 | 0.0478 | 0.0321 | 0.0196 | 0.0651 | |
| Ots-201b | 227 | 0.0417 | | 0.037 | 0.0449 | | 0.0223 | |
| Ots-201b | 231 | 0.0208 | | 0.0262 | 0.0128 | 0.0294 | | |
| Ots-201b | 235 | 0.0139 | 0.0303 | 0.0093 | 0.0321 | 0.0294 | | |
| Ots-201b | 239 | 0.0486 | 0.0152 | 0.0139 | 0.0321 | 0.0588 | 0.0204 | |
| Ots-201b | 243 | 0.0208 | | 0.0324 | 0.0128 | 0.0098 | 0.0465 | |
| Ots-201b | 247 | 0.0764 | 0.0152 | 0.0633 | 0.0513 | 0.0588 | 0.0781 | |
| Ots-201b | 251 | 0.0625 | 0.1515 | 0.1204 | 0.1218 | 0.1275 | 0.1208 | |
| Ots-201b | 254 | 0.0417 | 0.0303 | 0.0309 | 0.0705 | 0.049 | 0.0465 | |
| Ots-201b | 258 | 0.0069 | | 0.0062 | 0.0385 | 0.0294 | 0.013 | |
| Ots-201b | 262 | 0.0208 | 0.0455 | 0.0093 | 0.0192 | 0.0098 | 0.0167 | |
| Ots-201b | 266 | 0.0417 | 0.0758 | 0.0247 | 0.0064 | 0.0098 | 0.0279 | |
| Ots-201b | 275 | | | 0.0015 | | | | 03 Captive |
| Ots-201b | 278 | 0.0069 | | 0.0015 | | | | |
| Ots-201b | 282 | 0.0139 | | 0.0123 | | 0.0098 | | |
| Ots-201b | 294 | | | | 0.0064 | | 0.0037 | |
| Ots-201b | 306 | 0.0417 | 0.0606 | 0.034 | 0.0256 | 0.0294 | 0.039 | |
| Ots-201b | 314 | 0.0069 | 0.0152 | | | | | |
| Ots-201b | 330 | | 0.0303 | | | | | 03 In-river |
| # of samples | | 72 | 33 | 324 | 78 | 51 | 269 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Ots-208b | 184 | | | | 0.0064 | 0.0213 | | |
| Ots-208b | 188 | 0.0548 | 0.093 | 0.0564 | 0.0641 | 0.0426 | 0.0436 | |
| Ots-208b | 193 | | | 0.003 | | | 0.0018 | |
| Ots-208b | 200 | 0.0137 | | | | | | 03 Supp |
| Ots-208b | 204 | 0.0068 | | 0.0198 | 0.0256 | 0.0106 | 0.0145 | |
| Ots-208b | 208 | | 0.0233 | 0.0488 | 0.0385 | | 0.0418 | |
| Ots-208b | 212 | 0.0137 | 0.0581 | 0.0091 | 0.0192 | 0.0213 | 0.0182 | |
| Ots-208b | 216 | | | 0.0168 | 0.0705 | 0.0319 | 0.0236 | |
| Ots-208b | 219 | 0.0205 | | 0.0381 | 0.0513 | 0.0106 | 0.0182 | |
| Ots-208b | 224 | 0.1644 | 0.1163 | 0.1341 | 0.0577 | 0.1383 | 0.1182 | |
| Ots-208b | 228 | 0.0822 | 0.0698 | 0.0168 | 0.0385 | 0.0745 | 0.0382 | |
| Ots-208b | 232 | 0.0411 | 0.0349 | 0.003 | 0.0064 | 0.0319 | 0.0055 | |
| Ots-208b | 236 | 0.0479 | 0.0233 | 0.0259 | 0.0192 | 0.0319 | 0.04 | |
| Ots-208b | 240 | 0.0342 | | 0.061 | 0.0256 | 0.0213 | 0.0673 | |
| Ots-208b | 244 | 0.0274 | 0.0465 | | | 0.0106 | | |
| Ots-208b | 248 | 0.0274 | | 0.0534 | 0.0321 | 0.0532 | 0.0236 | |
| Ots-208b | 251 | 0.0205 | 0.0116 | 0.0091 | 0.0256 | 0.0319 | 0.0218 | |
| Ots-208b | 255 | 0.0479 | 0.0581 | 0.0381 | 0.0256 | 0.0213 | 0.0291 | |
| Ots-208b | 259 | 0.137 | 0.1279 | 0.1448 | 0.1218 | 0.1702 | 0.16 | |
| Ots-208b | 263 | 0.0822 | 0.093 | 0.0991 | 0.1346 | 0.0851 | 0.0945 | |
| Ots-208b | 267 | 0.1027 | 0.093 | 0.1372 | 0.141 | 0.1277 | 0.1218 | |
| Ots-208b | 271 | 0.0479 | 0.0465 | 0.0198 | 0.0385 | 0.0106 | 0.0545 | |
| Ots-208b | 275 | 0.0205 | 0.1047 | 0.0564 | 0.0449 | 0.0319 | 0.0636 | |
| Ots-208b | 279 | | | 0.0091 | 0.0064 | | | |
| Ots-208b | 283 | | | | 0.0064 | 0.0106 | | |
| Ots-208b | 287 | 0.0068 | | | | | | 03 Supp |
| Ots-208b | 291 | | | | | 0.0106 | | 04 In-river |
| # of samples | | 73 | 43 | 328 | 78 | 47 | 275 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Ssa-408 | 211 | 0.0652 | 0.0641 | 0.0579 | 0.0625 | 0.0755 | 0.0508 | |
| Ssa-408 | 215 | 0.1594 | 0.2051 | 0.1409 | 0.1187 | 0.1792 | 0.125 | |
| Ssa-408 | 218 | 0.0362 | 0.0641 | 0.0401 | 0.0187 | 0.0094 | 0.0586 | |
| Ssa-408 | 222 | 0.1377 | 0.1923 | 0.2255 | 0.175 | 0.1887 | 0.2246 | |
| Ssa-408 | 226 | 0.0435 | 0.0256 | 0.0208 | 0.0375 | 0.066 | 0.0254 | |
| Ssa-408 | 230 | 0.0725 | 0.0897 | 0.0519 | 0.0875 | 0.0283 | 0.0684 | |
| Ssa-408 | 234 | 0.1594 | 0.1026 | 0.1261 | 0.1313 | 0.1038 | 0.1504 | |
| Ssa-408 | 238 | 0.0652 | 0.0128 | 0.0401 | 0.0312 | 0.066 | 0.0566 | |
| Ssa-408 | 242 | 0.0145 | | 0.0134 | 0.0563 | 0.0094 | 0.0391 | |
| Ssa-408 | 249 | 0.0652 | 0.0256 | 0.0593 | 0.0875 | 0.0755 | 0.0605 | |
| Ssa-408 | 253 | 0.0145 | 0.0128 | 0.0163 | 0.0063 | 0.0094 | 0.0059 | |
| Ssa-408 | 257 | 0.0145 | 0.0128 | 0.0178 | 0.0063 | | | |
| Ssa-408 | 261 | 0.0072 | | | | | | 03 Supp |
| Ssa-408 | 265 | 0.0145 | 0.0256 | | 0.0063 | 0.0094 | 0.0078 | |
| Ssa-408 | 269 | 0.0145 | | 0.0163 | 0.0063 | | 0.0098 | |
| Ssa-408 | 273 | | 0.0128 | 0.0104 | | | | |
| Ssa-408 | 277 | | 0.0128 | | | | | 03 In-river |
| Ssa-408 | 296 | 0.0072 | 0.0128 | | | | | |
| Ssa-408 | 300 | | | 0.0119 | 0.0437 | | 0.0137 | |
| Ssa-408 | 306 | | 0.0128 | | | | | 03 In-river |
| Ssa-408 | 308 | 0.0072 | 0.0128 | 0.0015 | | | 0.0137 | |
| Ssa-408 | 312 | 0.0362 | 0.0385 | 0.0608 | 0.075 | 0.0849 | 0.041 | |
| Ssa-408 | 320 | 0.0652 | 0.0641 | 0.0846 | 0.0437 | 0.0943 | 0.0449 | |
| Ssa-408 | 324 | | | 0.0045 | 0.0063 | | 0.0039 | |
| # of samples | | 69 | 39 | 337 | 80 | 53 | 256 | |

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|------------|
| Ogo-2 | 231 | | | 0.0015 | | | | 03 Captive |
| Ogo-2 | 242 | 0.1818 | 0.1176 | 0.1369 | 0.1772 | 0.234 | 0.0921 | |
| Ogo-2 | 244 | 0.5364 | 0.5 | 0.5893 | 0.4937 | 0.3617 | 0.5469 | |
| Ogo-2 | 246 | 0.0182 | 0.0147 | 0.0164 | 0.019 | 0.0213 | 0.0325 | |
| Ogo-2 | 248 | 0.1818 | 0.2059 | 0.1205 | 0.1203 | 0.1277 | 0.1245 | |
| Ogo-2 | 250 | 0.0364 | 0.1176 | 0.0536 | 0.0886 | 0.0851 | 0.0704 | |
| Ogo-2 | 252 | | | | | | 0.0036 | 04 Captive |
| Ogo-2 | 254 | 0.0182 | 0.0147 | 0.0134 | 0.0063 | 0.0213 | 0.0271 | |
| Ogo-2 | 256 | 0.0273 | | 0.0283 | 0.019 | 0.0638 | 0.0451 | |
| Ogo-2 | 260 | | 0.0294 | 0.0402 | 0.0759 | 0.0851 | 0.0578 | |
| # of samples | | 55 | 34 | 336 | 79 | 47 | 277 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|------------|
| Ssa-197 | 189 | 0.0133 | | | | | | 03 Supp |
| Ssa-197 | 201 | 0.06 | 0.0814 | 0.0791 | 0.0855 | 0.0714 | 0.1019 | |
| Ssa-197 | 209 | 0.0133 | | 0.0657 | 0.0329 | 0.051 | 0.0389 | |
| Ssa-197 | 217 | | | 0.003 | | | | 03 Captive |
| Ssa-197 | 221 | 0.02 | | | | | | 03 Supp |
| Ssa-197 | 233 | 0.0067 | | | | 0.0102 | | |
| Ssa-197 | 242 | | | 0.0015 | | | | 03 Captive |
| Ssa-197 | 249 | | 0.0116 | 0.0149 | | 0.0204 | 0.0148 | |
| Ssa-197 | 253 | 0.0467 | 0.0116 | 0.0179 | | | 0.0185 | |
| Ssa-197 | 257 | 0.02 | 0.0465 | 0.1149 | 0.125 | 0.0204 | 0.1056 | |
| Ssa-197 | 261 | 0.0533 | 0.093 | 0.0299 | 0.0461 | 0.0714 | 0.0389 | |
| Ssa-197 | 265 | 0.1867 | 0.186 | 0.2179 | 0.1908 | 0.1837 | 0.2204 | |
| Ssa-197 | 269 | 0.0667 | 0.1395 | 0.0448 | 0.0526 | 0.0918 | 0.0148 | |
| Ssa-197 | 273 | 0.2467 | 0.2093 | 0.197 | 0.2632 | 0.3163 | 0.25 | |
| Ssa-197 | 277 | 0.08 | 0.0349 | 0.0433 | 0.0329 | 0.0816 | 0.0333 | |
| Ssa-197 | 281 | | 0.0233 | 0.0299 | 0.0526 | 0.0306 | 0.0333 | |
| Ssa-197 | 285 | 0.0733 | 0.0233 | 0.0567 | 0.0395 | 0.0204 | 0.05 | |
| Ssa-197 | 289 | 0.02 | 0.0116 | 0.0104 | 0.0066 | | 0.0093 | |
| Ssa-197 | 293 | 0.0933 | 0.1279 | 0.0612 | 0.0658 | 0.0306 | 0.0444 | |
| Ssa-197 | 297 | | | 0.006 | | | 0.0259 | |
| Ssa-197 | 301 | | | 0.006 | 0.0066 | | | |
| # of samples | | 75 | 43 | 335 | 76 | 49 | 270 | |

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|------------|
| Ogo-4 | 165 | 0.0405 | 0.0116 | 0.0178 | | 0.0392 | | |
| Ogo-4 | 169 | 0.0541 | 0.1047 | 0.0237 | 0.0263 | 0.0294 | 0.0326 | |
| Ogo-4 | 171 | 0.0068 | | 0.0074 | 0.0263 | 0.0098 | 0.0145 | |
| Ogo-4 | 182 | 0.1892 | 0.2791 | 0.3269 | 0.3224 | 0.2647 | 0.2609 | |
| Ogo-4 | 184 | | | 0.0104 | | | | 03 Captive |
| Ogo-4 | 186 | 0.0068 | 0.0116 | 0.0059 | | | | |
| Ogo-4 | 188 | 0.0676 | 0.0465 | 0.0266 | 0.0395 | 0.0196 | 0.0362 | |
| Ogo-4 | 190 | 0.3108 | 0.2791 | 0.3107 | 0.2632 | 0.2549 | 0.288 | |
| Ogo-4 | 192 | 0.2432 | 0.1628 | 0.145 | 0.2105 | 0.2451 | 0.2192 | |
| Ogo-4 | 194 | 0.0473 | 0.0116 | 0.0355 | 0.0197 | 0.0294 | 0.0725 | |
| Ogo-4 | 196 | 0.0203 | 0.0698 | 0.0399 | 0.0197 | 0.0196 | 0.0308 | |
| Ogo-4 | 198 | 0.0135 | 0.0233 | 0.0503 | 0.0724 | 0.0882 | 0.0453 | |
| # of samples | | 74 | 43 | 338 | 76 | 51 | 276 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Omm-1080 | 217 | 0.0068 | | 0.0341 | 0.0473 | 0.0125 | 0.036 | |
| Omm-1080 | 221 | 0.0135 | 0.0441 | | 0.0068 | 0.0125 | | |
| Omm-1080 | 233 | 0.0405 | 0.1029 | 0.0735 | 0.0743 | 0.0625 | 0.078 | |
| Omm-1080 | 241 | | 0.0147 | 0.0072 | 0.0068 | 0.0125 | 0.012 | |
| Omm-1080 | 245 | 0.0068 | | 0.0305 | 0.027 | 0.05 | 0.006 | |
| Omm-1080 | 249 | | | 0.0072 | 0.0405 | | 0.012 | |
| Omm-1080 | 253 | | | | | | 0.002 | 04 Captive |
| Omm-1080 | 257 | 0.2027 | 0.1176 | 0.2437 | 0.1486 | 0.2375 | 0.196 | |
| Omm-1080 | 261 | 0.0338 | 0.0294 | 0.0161 | 0.0338 | 0.05 | 0.026 | |
| Omm-1080 | 269 | 0.0203 | 0.0147 | 0.0036 | | | 0.006 | |
| Omm-1080 | 273 | | 0.0147 | | | | | 03 In-river |
| Omm-1080 | 277 | 0.0068 | | | | | | 03 Supp |
| Omm-1080 | 281 | | 0.0147 | | | | 0.006 | |
| Omm-1080 | 285 | 0.0338 | 0.0147 | 0.0645 | 0.1081 | 0.025 | 0.128 | |
| Omm-1080 | 289 | 0.0405 | 0.0147 | 0.0627 | 0.0541 | 0.0625 | 0.042 | |
| Omm-1080 | 293 | | | 0.0054 | | | 0.004 | |
| Omm-1080 | 297 | 0.0338 | 0.0441 | 0.0125 | | 0.0125 | 0.01 | |
| Omm-1080 | 301 | 0.0135 | | 0.0018 | | | | |
| Omm-1080 | 309 | 0.0203 | 0.0147 | 0.0305 | 0.0203 | 0.0125 | 0.006 | |
| Omm-1080 | 313 | 0.0338 | 0.0588 | 0.0018 | 0.0068 | 0.05 | 0.002 | |
| Omm-1080 | 317 | 0.0135 | 0.0147 | 0.0108 | | 0.0125 | 0.006 | |
| Omm-1080 | 322 | 0.027 | 0.0147 | 0.009 | 0.0541 | 0.0375 | 0.018 | |
| Omm-1080 | 326 | 0.0473 | 0.1029 | 0.0699 | 0.0743 | 0.1125 | 0.054 | |
| Omm-1080 | 330 | 0.1014 | 0.0735 | 0.0538 | 0.0676 | 0.05 | 0.068 | |
| Omm-1080 | 334 | 0.0338 | | 0.009 | | | 0.012 | |
| Omm-1080 | 338 | 0.0135 | 0.0147 | 0.0018 | 0.0203 | 0.025 | | |
| Omm-1080 | 342 | 0.0405 | 0.0588 | 0.0143 | 0.027 | 0.0125 | 0.008 | |
| Omm-1080 | 346 | 0.0608 | 0.0441 | 0.0412 | 0.0338 | 0.025 | 0.06 | |
| Omm-1080 | 350 | 0.0135 | | 0.0197 | 0.0135 | 0.025 | 0.012 | |
| Omm-1080 | 354 | 0.0473 | 0.0882 | 0.086 | 0.0473 | 0.025 | 0.092 | |
| Omm-1080 | 358 | | | 0.009 | 0.0338 | 0.0625 | 0.008 | |
| Omm-1080 | 362 | | | | | 0.0125 | | 04 In-river |
| Omm-1080 | 365 | 0.0878 | 0.0588 | 0.052 | 0.0338 | | 0.058 | |
| Omm-1080 | 369 | | | 0.0161 | 0.0203 | | 0.022 | |
| Omm-1080 | 373 | 0.0068 | 0.0294 | 0.0018 | | | 0.008 | |
| Omm-1080 | 377 | | | 0.0108 | | | 0.002 | |
| # of samples | | 74 | 34 | 279 | 74 | 40 | 250 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Ots-213 | 252 | 0.0333 | | 0.0442 | 0.04 | 0.02 | 0.0434 | |
| Ots-213 | 255 | | | 0.003 | 0.02 | 0.01 | | |
| Ots-213 | 260 | 0.0467 | 0.0233 | | | | | |
| Ots-213 | 263 | 0.04 | 0.0233 | 0.0244 | 0.0133 | 0.02 | 0.0208 | |
| Ots-213 | 267 | 0.0133 | | 0.0076 | | | | |
| Ots-213 | 275 | 0.02 | 0.0116 | | | | | |
| Ots-213 | 279 | | | 0.003 | | | | 03 Captive |
| Ots-213 | 283 | 0.02 | 0.0233 | | | | | |
| Ots-213 | 287 | 0.1333 | 0.093 | 0.157 | 0.16 | 0.21 | 0.2075 | |
| Ots-213 | 291 | 0.0067 | 0.0698 | 0.0229 | 0.0533 | 0.08 | 0.017 | |
| Ots-213 | 295 | 0.2067 | 0.2558 | 0.2043 | 0.1867 | 0.21 | 0.1868 | |
| Ots-213 | 299 | 0.04 | 0.093 | 0.0107 | 0.0267 | 0.06 | 0.0321 | |
| Ots-213 | 303 | 0.0467 | 0.0349 | 0.0701 | 0.12 | 0.07 | 0.066 | |
| Ots-213 | 307 | 0.0267 | 0.0233 | 0.0137 | | 0.05 | 0.0189 | |
| Ots-213 | 311 | | | | | 0.01 | | 04 In-river |
| Ots-213 | 315 | 0.0333 | 0.0581 | 0.0366 | 0.0267 | 0.02 | 0.0396 | |
| Ots-213 | 319 | 0.0467 | 0.0814 | 0.1082 | 0.0933 | 0.03 | 0.1377 | |
| Ots-213 | 323 | 0.0533 | 0.0814 | 0.0366 | 0.04 | 0.05 | 0.0528 | |
| Ots-213 | 327 | 0.1067 | 0.0814 | 0.1037 | 0.08 | 0.08 | 0.0717 | |
| Ots-213 | 331 | 0.04 | 0.0233 | 0.0732 | 0.0067 | 0.01 | 0.017 | |
| Ots-213 | 335 | 0.0133 | 0.0116 | 0.0137 | | | 0.034 | |
| Ots-213 | 339 | 0.0733 | 0.0116 | 0.0625 | 0.1333 | 0.07 | 0.0547 | |
| Ots-213 | 359 | | | 0.0046 | | | | 03 Captive |
| # of samples | | 75 | 43 | 328 | 75 | 50 | 265 | |

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|------------|
| Ots-G474 | 187 | 0.62 | 0.6744 | 0.6441 | 0.6923 | 0.6633 | 0.6259 | |
| Ots-G474 | 195 | | | 0.0074 | | | 0.0018 | |
| Ots-G474 | 199 | 0.2733 | 0.2209 | 0.2294 | 0.2308 | 0.2653 | 0.2806 | |
| Ots-G474 | 211 | | | 0.0044 | | | | 03 Captive |
| Ots-G474 | 215 | 0.0133 | | | | | | 03 Supp |
| Ots-G474 | 219 | | | 0.0015 | | 0.0102 | | |
| Ots-G474 | 223 | 0.0533 | 0.0465 | 0.0588 | 0.0256 | 0.051 | 0.0468 | |
| Ots-G474 | 231 | 0.04 | 0.0581 | 0.0544 | 0.0449 | 0.0102 | 0.045 | |
| Ots-G474 | 235 | | | | 0.0064 | | | 04 Supp |
| # of samples | | 75 | 43 | 340 | 78 | 49 | 278 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Ots-3M | 146 | | 0.0116 | | | | | 03 In-river |
| Ots-3M | 159 | | 0.0116 | | | | | 03 In-river |
| Ots-3M | 163 | | | 0.0015 | | | | 03 Captive |
| Ots-3M | 169 | 0.0133 | | 0.041 | 0.025 | | 0.0195 | |
| Ots-3M | 171 | | | 0.0046 | | | | 03 Captive |
| Ots-3M | 173 | 0.0133 | 0.0349 | | | | | |
| Ots-3M | 175 | | | 0.0198 | 0.0375 | 0.049 | 0.023 | |
| Ots-3M | 177 | 0.3133 | 0.3023 | 0.2432 | 0.2375 | 0.2059 | 0.3032 | |
| Ots-3M | 179 | 0.6333 | 0.6163 | 0.6657 | 0.6813 | 0.7353 | 0.6348 | |
| Ots-3M | 181 | 0.02 | 0.0116 | 0.0243 | 0.0187 | 0.0098 | 0.0195 | |
| Ots-3M | 183 | 0.0067 | 0.0116 | | | | | |
| # of samples | | 75 | 43 | 329 | 80 | 51 | 282 | |

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|---------|
| Ots-9 | 132 | 0.02 | 0.0119 | 0.0185 | 0.0125 | 0.0196 | 0.0284 | |
| Ots-9 | 134 | 0.4467 | 0.4167 | 0.3611 | 0.2938 | 0.3235 | 0.4202 | |
| Ots-9 | 136 | 0.46 | 0.5119 | 0.4938 | 0.55 | 0.4412 | 0.445 | |
| Ots-9 | 138 | 0.0733 | 0.0595 | 0.1265 | 0.1437 | 0.2157 | 0.1064 | |
| # of samples | | 75 | 42 | 324 | 80 | 51 | 282 | |

Appendix 1B (continued)

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Ots-211 | 237 | 0.0246 | 0.0303 | 0.0196 | | 0.0104 | 0.0036 | |
| Ots-211 | 253 | 0.0082 | 0.0152 | | | | | |
| Ots-211 | 264 | | | 0.0375 | 0.0133 | 0.0312 | 0.0217 | |
| Ots-211 | 268 | 0.0902 | 0.0152 | 0.0857 | 0.06 | 0.0417 | 0.0704 | |
| Ots-211 | 272 | 0.0164 | 0.0455 | 0.0607 | 0.12 | 0.0625 | 0.0812 | |
| Ots-211 | 276 | | | | 0.0067 | 0.0104 | | |
| Ots-211 | 280 | 0.0164 | | 0.0054 | 0.0067 | 0.0104 | | |
| Ots-211 | 284 | 0.0164 | | 0.0143 | 0.04 | | 0.0253 | |
| Ots-211 | 288 | 0.0246 | | 0.0125 | 0.0133 | 0.0208 | 0.0253 | |
| Ots-211 | 292 | 0.0082 | | 0.0071 | 0.0133 | | 0.009 | |
| Ots-211 | 296 | 0.041 | 0.0909 | 0.0732 | 0.12 | 0.0625 | 0.0975 | |
| Ots-211 | 300 | 0.0902 | 0.0455 | 0.0625 | 0.0467 | 0.0625 | 0.0704 | |
| Ots-211 | 304 | 0.3361 | 0.4697 | 0.2482 | 0.2733 | 0.2917 | 0.2112 | |
| Ots-211 | 308 | 0.0656 | 0.0303 | 0.0321 | 0.0467 | 0.0521 | 0.0379 | |
| Ots-211 | 312 | 0.1475 | 0.197 | 0.0911 | 0.0867 | 0.0417 | 0.1354 | |
| Ots-211 | 316 | 0.0246 | 0.0152 | 0.0839 | 0.1 | 0.1979 | 0.056 | |
| Ots-211 | 320 | | 0.0152 | 0.0411 | 0.02 | 0.0208 | 0.0433 | |
| Ots-211 | 324 | | | 0.0125 | | | 0.0217 | |
| Ots-211 | 328 | | | | | 0.0104 | | 04 In-river |
| Ots-211 | 332 | 0.0574 | 0.0303 | 0.0893 | 0.0267 | 0.0417 | 0.065 | |
| Ots-211 | 336 | 0.0164 | | 0.0089 | | | 0.0036 | |
| Ots-211 | 340 | 0.0164 | | 0.0143 | 0.0067 | 0.0208 | 0.0217 | |
| Ots-211 | 348 | | | | | 0.0104 | | 04 In-river |
| # of samples | | 61 | 33 | 280 | 75 | 48 | 277 | |

| Locus | Size | 03 Supp | 03 In-river | 03 Captive | 04 Supp | 04 In-river | 04 Captive | Private |
|--------------|------|---------|-------------|------------|---------|-------------|------------|-------------|
| Ots-212 | 160 | 0.0076 | | 0.0222 | 0.0203 | 0.0435 | 0.05 | |
| Ots-212 | 165 | 0.0909 | 0.0882 | 0.0819 | 0.1014 | 0.0435 | 0.0259 | |
| Ots-212 | 169 | 0.0606 | 0.0735 | 0.0751 | 0.0676 | 0.0326 | 0.0704 | |
| Ots-212 | 173 | 0.1136 | 0.1912 | 0.1877 | 0.1216 | 0.1304 | 0.2074 | |
| Ots-212 | 177 | 0.0909 | 0.0882 | 0.0188 | 0.027 | 0.0543 | 0.0556 | |
| Ots-212 | 181 | 0.1894 | 0.1471 | 0.1604 | 0.3041 | 0.2391 | 0.1574 | |
| Ots-212 | 185 | 0.2348 | 0.1765 | 0.1792 | 0.1014 | 0.1413 | 0.137 | |
| Ots-212 | 189 | 0.1364 | 0.1618 | 0.116 | 0.1149 | 0.1304 | 0.1352 | |
| Ots-212 | 193 | 0.0227 | | 0.0666 | 0.0473 | 0.0652 | 0.0778 | |
| Ots-212 | 197 | | 0.0294 | 0.0137 | 0.0068 | 0.0326 | 0.0111 | |
| Ots-212 | 201 | 0.0303 | 0.0147 | 0.0512 | 0.0541 | 0.0761 | 0.0407 | |
| Ots-212 | 210 | 0.0152 | 0.0147 | 0.0085 | | | | |
| Ots-212 | 214 | | 0.0147 | | | | | 03 In-river |
| Ots-212 | 234 | | | 0.0068 | 0.0135 | 0.0109 | 0.0111 | |
| Ots-212 | 238 | | | 0.0102 | 0.0203 | | 0.0204 | |
| Ots-212 | 254 | 0.0076 | | | | | | 03 Supp |
| Ots-212 | 258 | | | 0.0017 | | | | 03 Captive |
| # of samples | | 66 | 34 | 293 | 74 | 46 | 270 | |

Appendix C: Total Estimated Run-Size of Tucannon River Spring Chinook Salmon (1985-2005)

**Appendix C. Total estimated run-size of spring Chinook salmon to the Tucannon River, 1985-2005.
(Includes breakdown of conventional hatchery supplementation and captive brood hatchery program components).**

| Run Year | Natural Jacks | Natural Adults | Total Natural | Hatchery Jacks | Hatchery Adults | Total Hatchery | Total Conventional | Total Captive Brood | Total Run-Size |
|-----------------|----------------------|-----------------------|----------------------|-----------------------|------------------------|-----------------------|---------------------------|----------------------------|-----------------------|
| 1985 | 0 | 591 | 591 | 0 | 0 | 0 | 0 | 0 | 591 |
| 1986 | 6 | 630 | 636 | 0 | 0 | 0 | 0 | 0 | 636 |
| 1987 | 6 | 576 | 582 | 0 | 0 | 0 | 0 | 0 | 582 |
| 1988 | 19 | 391 | 410 | 19 | 0 | 19 | 19 | 0 | 429 |
| 1989 | 2 | 334 | 336 | 83 | 26 | 109 | 109 | 0 | 445 |
| 1990 | 0 | 494 | 494 | 22 | 238 | 260 | 260 | 0 | 754 |
| 1991 | 3 | 257 | 260 | 99 | 169 | 268 | 268 | 0 | 528 |
| 1992 | 12 | 406 | 418 | 15 | 320 | 335 | 335 | 0 | 753 |
| 1993 | 8 | 309 | 317 | 6 | 266 | 272 | 272 | 0 | 589 |
| 1994 | 0 | 98 | 98 | 5 | 37 | 42 | 42 | 0 | 140 |
| 1995 | 2 | 19 | 21 | 11 | 22 | 33 | 33 | 0 | 54 |
| 1996 | 2 | 145 | 147 | 15 | 70 | 85 | 85 | 0 | 232 |
| 1997 | 0 | 134 | 134 | 3 | 151 | 154 | 154 | 0 | 288 |
| 1998 | 0 | 85 | 85 | 16 | 43 | 59 | 59 | 0 | 144 |
| 1999 | 0 | 3 | 3 | 60 | 182 | 242 | 242 | 0 | 245 |
| 2000 | 14 | 68 | 82 | 16 | 241 | 257 | 257 | 0 | 339 |
| 2001 | 9 | 709 | 718 | 111 | 183 | 294 | 294 | 0 | 1,012 |
| 2002 | 9 | 341 | 350 | 11 | 644 | 655 | 655 | 0 | 1,005 |
| 2003 | 3 | 245 | 248 | 27 | 169 | 196 | 196 | 0 | 444 |
| 2004 | 0 | 400 | 400 | 22 ^a | 151 | 173 | 170 | 3 | 573 |
| 2005 | 3 | 286 | 289 | 8 | 123 ^b | 131 | 117 | 14 | 420 |

^a Three of which are captive brood progeny.

^b Fourteen of which are captive brood progeny.

**Appendix D: Stray Hatchery-Origin Spring Chinook
Salmon in the Tucannon River (1990-2005)**

Appendix D. Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2005).

| Year | CWT Code or Fin clip | Agency | Origin (stock) | Release Location / Release River | Number Observed/Expanded ^a | % of Tuc. Run |
|------|----------------------|--------|-----------------------------|----------------------------------|---------------------------------------|---------------|
| 1990 | 074327 | ODFW | Carson (Wash.) | Meacham Cr. / Umatilla River | 2 / 5 | |
| | 074020 | ODFW | Rapid River | Lookingglass Cr. / Grande Ronde | 1 / 2 | |
| | 232227 | NMFS | Mixed Col. | Columbia River / McNary Dam | 2 / 5 | |
| | 232228 | NMFS | Mixed Col. | Columbia River / McNary Dam | 1 / 2 | |
| | | | Total Strays | 14 | 1.9 | |
| | | | Total Umatilla River | 5 | 0.7 | |
| 1992 | 075107 | ODFW | Lookingglass Cr. | Bonifer Pond / Columbia River | 2 / 6 | |
| | 075111 | ODFW | Lookingglass Cr. | Meacham Cr. / Umatilla River | 1 / 2 | |
| | 075063 | ODFW | Lookingglass Cr. | Meacham Cr. / Umatilla River | 1 / 2 | |
| | | | Total Strays | 10 | 1.3 | |
| | | | Total Umatilla River | 4 | 0.5 | |
| 1993 | 075110 | ODFW | Lookingglass Cr. | Meacham Cr. / Umatilla River | 1 / 2 | |
| | | | | Total Strays | 2 | 0.3 |
| | | | Total Umatilla River | 2 | 0.3 | |
| 1996 | 070251 | ODFW | Carson (Wash.) | Imeques AP / Umatilla River | 1 / 1 | |
| | LV clip | ODFW | Carson (Wash.) | Imeques AP / Umatilla River | 1 / 2 | |
| | | | Total Strays | 3 | 1.3 | |
| | | | Total Umatilla River | 3 | 1.3 | |
| 1997 | 103042 | IDFG | South Fork Salmon | Knox Bridge / South Fork Salmon | 1 / 2 | |
| | 103518 | IDFG | Powell | Powell Rearing Ponds / Lochsa R. | 1 / 2 | |
| | RV clip | ODFW | Carson (Wash.) | Imeques AP / Umatilla River | 3 / 5 | |
| | | | Total Strays | 9 | 2.6 | |
| | | | Total Umatilla River | 5 | 1.4 | |
| 1999 | 091751 | ODFW | Carson (Wash.) | Imeques AP / Umatilla River | 2 / 3 | |
| | 092258 | ODFW | Carson (Wash.) | Imeques AP / Umatilla River | 1 / 1 | |
| | 104626 | UI | Eagle Creek NFH | Eagle Creek NFH / Clackamas R. | 1 / 1 | |
| | LV clip | ODFW | Carson (Wash.) | Imeques AP / Umatilla River | 2 / 2 | |
| | RV clip | ODFW | Carson (Wash.) | Imeques AP / Umatilla River | 8 / 13 | |
| | | | Total Strays | 20 | 8.2 | |
| | | | Total Umatilla River | 19 | 7.8 | |

^a All CWT codes recovered from groups that were 100% marked were given a 1:1 expansion rate. Groups that were not 100% marked were expanded based on the percentage of unmarked fish. The expansion is based on the percent of stray carcasses to Tucannon River origin carcasses and the estimated total run in the river.

Appendix D (continued). Summary of identified stray hatchery origin spring Chinook salmon that escaped into the Tucannon River (1990-2005).

| Year | CWT Code or Fin clip | Agency | Origin (stock) | Release Location / Release River | Number Observed/Expanded ^a | % of Tuc. Run |
|------|----------------------|---------|-----------------------------|---|---------------------------------------|------------------------|
| 2000 | 092259 | ODFW | Carson (Wash.) | Imeqes AP / Umatilla River | 4 / 4 | |
| | 092260 | ODFW | Carson (Wash.) | Imeqes AP / Umatilla River | 1 / 1 | |
| | 092262 | ODFW | Carson (Wash.) | Imeqes AP / Umatilla River | 1 / 3 | |
| | 105137 | IDFG | Powell | Walton Creek/ Lochsa R. | 1 / 3 | |
| | 636330 | WDFW | Klickitat (Wash.) | Klickitat Hatchery | 1 / 1 | |
| | 636321 | WDFW | Lyons Ferry (Wash.) | Lyons Ferry / Snake River | 1 / 1 | |
| | LV clip | ODFW | Carson (Wash.) | Imeqes AP / Umatilla River | 18 / 31 | |
| | Ad clip | ODFW | Carson (Wash.) | Imeqes AP / Umatilla River | 2 / 2 | |
| | | | Total Strays | 46 | 13.6 | |
| | | | Total Umatilla River | 41 | 12.1 | |
| 2001 | 076040 | ODFW | Umatilla R. | Umatilla Hatch. /Umatilla River | 1/7 | |
| | 092828 | ODFW | Imnaha R. & Tribs. | Lookingglass/Imnaha River | 1/3 | |
| | 092829 | ODFW | Imnaha R. & Tribs. | Lookingglass/Imnaha River | 1/3 | |
| | | | | Total Strays | 13 | 1.3 |
| | | | Total Umatilla River | 7 | 0.7 | |
| 2002 | 054208 | USFWS | Dworshak | Dworshak NFH/Clearwater R. | 1/29 | |
| | 076039 | ODFW | Umatilla R. | Umatilla Hatch./Umatilla River | 1/8 | |
| | 076040 | ODFW | Umatilla R. | Umatilla Hatch./Umatilla River | 2/16 | |
| | 076041 | ODFW | Umatilla R. | Umatilla Hatch./Umatilla River | 2/16 | |
| | 076049 | ODFW | Umatilla R. | Umatilla Hatch./Umatilla River | 1/8 | |
| | 076051 | ODFW | Umatilla R. | Umatilla Hatch./Umatilla River | 1/8 | |
| | 076138 | ODFW | Umatilla R. | Umatilla Hatch./Umatilla River | 1/8 | |
| | 105412 | IDFG | Powell | Clearwater Hatch./Powell Ponds | 1/4 | |
| | | | | Total Strays | 97 | 9.7 |
| | | | Total Umatilla River | 64 | 6.4 | |
| 2003 | 100472 | IDFG | Salmon R. | Sawtooth Hatch./Nature's Rear. | 1/1 | |
| | | | | Total Strays | 1 | 0.2 |
| | | | | Total Umatilla River | 0 | 0.0 |
| 2004 | Ad clip | Unknown | Unknown ^b | Unknown | 6/17 | |
| | | | | Total Strays | 17 | 3.0 |
| | | | | Total Umatilla River^b | 17 | 3.0^b |
| 2005 | Ad clip | Unknown | Unknown ^c | Unknown | 3/6 | |
| | | | | Total Strays | 6 | 1.4 |
| | | | | Total Umatilla River^c | 6 | 1.4^c |

^a All CWT codes recovered from groups that were 100% marked were given a 1:1 expansion rate. Groups that were not 100% marked were expanded based on the percentage of unmarked fish. The expansion is based on the percent of stray carcasses to Tucannon River origin carcasses and the estimated total run in the river.

^b Based on the mark (Ad clip, no wire), brood year (2000), historical stray rates, and large number of releases (670,570) we believe these fish are probable Umatilla River origin strays.

^c Based on the mark (Ad clip, no wire), brood years (2001 and 2002), historical stray rates, and large number of releases (602,347 BY01 and 701,798 BY02) we believe these fish are probable Umatilla River origin strays.

Appendix E: Historical Hatchery Releases (1985-2004 Brood Years)

Appendix E. Historical hatchery spring Chinook releases from the Tucannon River, 1985-2004 brood years. (Totals are summation by brood year and release year.)

| Release Year | Brood | Release | | CWT Code ^b | Number CWT | Ad-only marked | Additional Tag/location/cross ^c | Lbs | Fish/lb |
|--------------|-------|-------------------|-----------|-----------------------|----------------|----------------|--|--------|---------|
| | | Type ^a | Date | | | | | | |
| 1987 | 1985 | H-Acc | 4/6-10 | 34/42 | 12,922 | | | 2,172 | 6 |
| Total | | | | | 12,922 | | | | |
| 1988 | 1986 | H-Acc | 3/7 | 33/25 | 12,328 | 512 | | 1,384 | 10 |
| | | " | " | 41/46 | 12,095 | 465 | | 1,256 | 10 |
| | | " | " | 41/48 | 13,097 | 503 | | 1,360 | 10 |
| | | " | 4/13 | 33/25 | 37,893 | 1,456 | | 3,735 | 10 |
| | | " | " | 41/46 | 34,389 | 1,321 | | 3,571 | 10 |
| | | " | " | 41/48 | 37,235 | 1,431 | | 3,867 | 10 |
| Total | | | | | 147,037 | 5,688 | | | |
| 1989 | 1987 | H-Acc | 4/11-13 | 49/50 | 151,100 | 1,065 | | 16,907 | 9 |
| Total | | | | | 151,100 | 1,065 | | | |
| 1990 | 1988 | H-Acc | 3/30-4/10 | 55/01 | 68,591 | 3,007 | | 6,509 | 11 |
| Total | | | | | 139,050 | 6,096 | | | |
| 1991 | 1989 | H-Acc | 4/1-12 | 14/61 | 75,661 | 989 | | 8,517 | 9 |
| Total | | | | | 97,779 | 1,278 | | | |
| 1992 | 1990 | H-Acc | 3/30-4/10 | 40/21 | 51,149 | | BWT, RC, WxW | 4,649 | 11 |
| | | " | " | 43/11 | 21,108 | | BWT, LC, HxH | 1,924 | 11 |
| | | " | " | 37/25 | 13,480 | | Mixed | 1,225 | 11 |
| Total | | | | | 85,737 | | | | |
| 1993 | 1991 | H-Acc | 4/6-12 | 46/25 | 55,716 | 796 | VI, LR, WxW | 3,714 | 15 |
| | | " | " | 46/47 | 16,745 | 807 | VI, RR, HxH | 1,116 | 15 |
| Total | | | | | 72,461 | 1,603 | | | |
| 1993 | 1992 | Direct | 10/22-25 | 48/23 | 24,883 | 251 | VI, LR, WxW | 698 | 36 |
| | | " | " | 48/24 | 24,685 | 300 | VI, RR, HxH | 694 | 36 |
| | | " | " | 48/56 | 7,111 | 86 | Mixed | 200 | 36 |
| Total | | | | | 56,679 | 637 | | | |
| 1994 | 1992 | H-Acc | 4/11-18 | 48/10 | 35,405 | 871 | VI, LY, WxW | 2,591 | 14 |
| | | " | " | 49/05 | 35,469 | 2,588 | VI, RY, HxH | 2,718 | 14 |
| | | " | " | 48/55 | 8,277 | 799 | Mixed | 648 | 14 |
| Total | | | | | 79,151 | 4,258 | | | |
| 1995 | 1993 | H-Acc | 3/15-4/15 | 53/43 | 45,007 | 140 | VI, RG, HxH | 3,166 | 14 |
| | | " | " | 53/44 | 42,936 | 2,212 | VI, LG, WxW | 3,166 | 14 |
| | | P-Acc | 3/20-4/3 | 56/15 | 11,661 | 72 | VI, RR, HxH | 782 | 15 |
| | | " | " | 56/17 | 10,704 | 290 | VI, LR, WxW | 733 | 15 |
| | | " | " | 56/18 | 13,705 | 47 | Mixed | 917 | 15 |
| | | Direct | 3/20-4/3 | 56/15 | 3,860 | 24 | VI, RR, HxH | 259 | 15 |
| | | " | " | 56/17 | 3,542 | 96 | VI, LR, WxW | 243 | 15 |
| | | " | " | 56/18 | 4,537 | 15 | Mixed | 303 | 15 |
| Total | | | | | 135,952 | 2,896 | | | |
| 1996 | 1994 | H-Acc | 3/16-4/22 | 56/29 | 89,437 | | VI, RR, Mixed | 5,123 | 17.7 |
| | | P-Acc | 3/27-4/19 | 57/29 | 35,334 | 35 | VI, RG, Mixed | 2,628 | 15.2 |
| | | Direct | 3/27 | 43/23 | 5,263 | | VI, LG, Mixed | 369 | 13.3 |
| Total | | | | | 130,034 | 35 | | | |

Appendix E (continued). Historical hatchery spring Chinook releases from the Tucannon River, 1985-2004 brood years. (Totals are summation by brood year and release year.)

| Release Year | Brood | Release | | CWT Code ^b | Number CWT | Ad-only marked | Additional Tag/location/cross ^c | Lbs | Fish/lb |
|--------------|--------|-------------------|-----------|-----------------------|----------------|--------------------------|--|--------|---------|
| | | Type ^a | Date | | | | | | |
| 1997 | 1995 | H-Acc | 3/07-4/18 | 59/36 | 42,160 | 40 | VI, RR, Mixed | 2,411 | 17.5 |
| | | P-Acc | 3/24-3/25 | 61/41 | 10,045 | 50 | VI, RB, Mixed | 537 | 18.8 |
| | | Direct | 3/24 | 61/40 | 9,811 | 38 | VI, LB, Mixed | 593 | 16.6 |
| Total | | | | | 62,016 | 128 | | | |
| 1998 | 1996 | H-Acc | 3/11-4/17 | 03/60 | 14,308 | 27 | Mixed | 902 | 15.9 |
| | | C-Acc | 3/11-4/18 | 61/25 | 23,065 | 62 | “ | 1,498 | 15.8 |
| | | “ | “ | 61/24 | 24,554 | 50 | “ | 1,557 | 15.8 |
| | | Direct | 4/03 | 03/59 | 14,101 | 52 | “ | 863 | 16.4 |
| Total | | | | | 76,028 | 191 | | | |
| 1999 | 1997 | C-Acc | 3/11-4/20 | 61/32 | 23,664 | 522 | Mixed | 1,550 | 15.6 |
| Total | | | | | 23,664 | 522 | | | |
| 2000 | 1998 | C-Acc | 3/20-4/26 | 12/11 | 125,192 | 2,747 | Mixed | 10,235 | 12.5 |
| Total | | | | | 125,192 | 2,747 | | | |
| 2001 | 1999 | C-Acc | 3/19-4/25 | 02/75 | 96,736 | 864 | Mixed | 9,207 | 10.6 |
| Total | | | | | 96,736 | 864 | | | |
| 2002 | 2000 | C-Acc | 3/15-4/23 | 08/87 | 99,566 | 2,533 ^e | VI, RR, Mixed | 6,587 | 15.5 |
| Total | | | | | 99,566 | 2,533^e | | | |
| 2002 | 2000CB | C-Acc | 3/15/4/23 | 63 | 3,031 | 24 ^f | CB, Mixed | 343 | 8.9 |
| Total | | | | | 3,031 | 24^f | | | |
| 2002 | 2001 | Direct | 5/06 | 14/29 | 19,948 | 1,095 | Mixed | 170.5 | 123.4 |
| Total | | | | | 19,948 | 1,095 | | | |
| 2002 | 2001CB | Direct | 5/06 | 14/30 | 20,435 | 157 | CB, Mixed | 124.8 | 165 |
| Total | | | | | 20,435 | 157 | | | |
| 2003 | 2001 | C-Acc | 4/01-4/21 | 06/81 | 144,013 | 2,909 ^e | Mixed | 11,389 | 12.9 |
| Total | | | | | 144,013 | 2,909^e | | | |
| 2003 | 2001CB | C-Acc | 4/01-4/21 | 63 | 134,401 | 5,995 ^f | CB, Mixed | 10,100 | 13.9 |
| Total | | | | | 134,401 | 5,995^f | | | |
| 2004 | 2002 | C-Acc | 4/01-4/20 | 17/91 | 121,774 | 1,812 ^e | Mixed | 10,563 | 11.7 |
| Total | | | | | 121,774 | 1,812^e | | | |
| 2004 | 2002CB | C-Acc | 4/01-4/20 | 63 | 42,875 | 1,909 ^f | CB, Mixed | 3,393 | 13.2 |
| Total | | | | | 42,875 | 1,909^f | | | |
| 2005 | 2003 | C-Acc | 3/28-4/15 | 24/82 | 69,831 | 1,323 ^e | Mixed | 5,603 | 12.7 |
| Total | | | | | 69,831 | 1,323^e | | | |
| 2005 | 2003CB | C-Acc | 3/28-4/15 | 27/78 | 125,304 | 4,760 ^f | CB, Mixed | 9,706 | 13.4 |
| Total | | | | | 125,304 | 4,760^f | | | |
| 2006 | 2004 | C-Acc | 4/03-4/26 | 28/87 | 67,272 | 270 ^e | Mixed | 5,040 | 13.4 |
| Total | | | | | 67,272 | 270^e | | | |
| 2006 | 2004CB | C-Acc | 4/03-4/26 | 28/65 | 127,162 | 5,150 ^f | CB, Mixed | 8,648 | 15.3 |
| Total | | | | | 127,162 | 5,150^f | | | |

^a Release types are: Tucannon Hatchery Acclimation Pond (H-Acc); Portable Acclimation Pond (P-Acc); Curl Lake Acclimation Pond (C-Acc); and Direct Stream Release (Direct).

^b All tag codes start with agency code 63.

^c Codes listed in column are as follows: BWT - Blank Wire Tag; CB - Captive Brood; VI-Visual Implant (elastomer); LR - Left Red, RR - Right Red, LG-Left Green, RG - Right Green, LY - Left Yellow, RY - Right Yellow, LB - Left Blue, RB - Right Blue; Crosses: WxW - wild x wild progeny, HxH - hatchery x hatchery progeny, Mixed – wild x hatchery progeny.

^d No tag loss data due to presence of both CWT and BWT in fish.

^e VI tag only.

^f No wire.

**Appendix F: Numbers and Density Estimates (Fish/100
m²) of Juvenile Salmon Counted by Snorkel Surveys
in the Tucannon River in 2005**

Appendix F. Numbers and density estimates of subyearling and yearling natural spring Chinook salmon counted by snorkel surveys in the Tucannon River, 2005.

| Stratum | Site ^a | Date | Number of Salmon | | Snorkeled Area (m ²) | Density (fish/100m ²) | |
|---------------|-------------------|------|------------------|------|----------------------------------|-----------------------------------|---------|
| | | | 0+ | > 1+ | | Natural | Natural |
| Marengo ↓ | TUC01 | 7/26 | 0 | 0 | 542 | 0.00 | 0.00 |
| | 01A | 7/26 | 4 | 0 | 481 | 0.83 | 0.00 |
| | TUC02 | 7/18 | 0 | 0 | 502 | 0.00 | 0.00 |
| | 02A | 7/18 | 17 | 2 | 554 | 3.07 | 0.36 |
| | TUC03 | 7/26 | 18 | 1 | 625 | 2.88 | 0.16 |
| Hartsock ↓ | 03A | 7/26 | 48 | 4 | 460 | 10.43 | 0.87 |
| | TUC04 | 7/26 | 1 | 0 | 472 | 0.21 | 0.00 |
| | 04A | 7/26 | 18 | 0 | 790 | 2.28 | 0.00 |
| | TUC05 | 7/26 | 4 | 0 | 679 | 0.59 | 0.00 |
| | 05A | 7/26 | 15 | 0 | 470 | 3.19 | 0.00 |
| | TUC06 | 7/26 | 5 | 0 | 569 | 0.88 | 0.00 |
| | 06A | 7/26 | 3 | 0 | 630 | 0.48 | 0.00 |
| | TUC07 | 7/25 | 60 | 1 | 1247 | 4.81 | 0.08 |
| | 07A | 7/25 | 51 | 0 | 1248 | 4.09 | 0.00 |
| | TUC08 | 7/26 | 73 | 0 | 424 | 17.22 | 0.00 |
| | 08A | 7/26 | 7 | 0 | 568 | 1.23 | 0.00 |
| | TUC09 | 7/26 | 18 | 0 | 641 | 2.81 | 0.00 |
| | 09A | 7/26 | 9 | 0 | 528 | 1.70 | 0.00 |
| | TUC10 | 8/24 | 33 | 0 | 456 | 7.24 | 0.00 |
| | 010A | 8/24 | 51 | 0 | 357 | 14.29 | 0.00 |
| HMA ↓ | TUC11 | 7/26 | 65 | 0 | 619 | 10.50 | 0.00 |
| | 011A | 7/26 | 66 | 1 | 572 | 11.54 | 0.17 |
| | TUC13 | 7/26 | 18 | 0 | 597 | 3.02 | 0.00 |
| | 13A | 7/26 | 56 | 0 | 594 | 9.43 | 0.00 |
| | TUC14 | 7/27 | 168 | 8 | 593 | 28.33 | 1.35 |
| | 14A | 7/27 | 14 | 0 | 636 | 2.20 | 0.00 |
| | TUC16 | 7/27 | 23 | 1 | 436 | 5.28 | 0.23 |
| | 16A | 7/27 | 14 | 0 | 546 | 2.56 | 0.00 |
| | TUC17 | 7/27 | 41 | 1 | 730 | 5.62 | 0.14 |
| | 17A | 7/27 | 45 | 0 | 687 | 6.55 | 0.00 |
| TUC19 | 8/23 | 105 | 3 | 673 | 15.60 | 0.45 | |
| 19A | 8/23 | 21 | 1 | 498 | 4.22 | 0.20 | |
| TUC20 | 7/27 | 12 | 0 | 562 | 2.14 | 0.00 | |
| 20A | 7/27 | 12 | 1 | 495 | 2.42 | 0.20 | |

Appendix F (continued). Numbers and density estimates of subyearling and yearling natural spring Chinook salmon counted by snorkel surveys in the Tucannon River, 2005.

| Stratum | Site ^a | Date | Number of Salmon | | Snorkeled Area (m ²) | Density (fish/100m ²) | |
|---------------|-------------------|------|------------------|-----------|-------------------------------------|-----------------------------------|-------------|
| | | | Natural 0+ | > 1+ | | Natural 0+ | > 1+ |
| HMA | TUC21 | 7/27 | 21 | 0 | 666 | 0.00 | 0.00 |
| (cont.) | 21A | 7/27 | 22 | 1 | 469 | 0.21 | 0.21 |
| ↓ | TUC22 | 8/25 | 37 | 0 | 513 | 0.00 | 0.00 |
| | 22A | 8/25 | 72 | 1 | 492 | 0.20 | 0.20 |
| | TUC23 | 7/27 | 5 | 0 | 630 | 0.00 | 0.00 |
| | 23A | 7/27 | 121 | 5 | 658 | 0.76 | 0.76 |
| Wilderness | TUC24 | 8/24 | 61 | 0 | 385 | 0.00 | 0.00 |
| ↓ | 24A | 8/24 | 22 | 0 | 482 | 0.00 | 0.00 |
| | TUC25 | 7/28 | 6 | 0 | 315 | 0.00 | 0.00 |
| | 25A | 7/28 | 22 | 0 | 360 | 0.00 | 0.00 |
| | TUC26 | 7/28 | 48 | 0 | 406 | 0.00 | 0.00 |
| | 26A | 7/28 | 27 | 0 | 312 | 0.00 | 0.00 |
| | TUC27 | 7/28 | 4 | 0 | 410 | 0.00 | 0.00 |
| | 27A | 7/28 | 11 | 0 | 547 | 0.00 | 0.00 |
| | TUC28 | 7/28 | 0 | 0 | 219 | 0.00 | 0.00 |
| | 28A | 7/28 | 0 | 0 | 246 | 0.00 | 0.00 |
| Totals | | | 1,574 | 31 | 27,591 | 5.77 | 0.11 |

^a Specific site locations are available by request from the Snake River Lab.

**Appendix G: Numbers of Selected Species Captured
in the Tucannon River Smolt Trap During the 2005
Outmigration**

Appendix G. Numbers of selected species captured in the Tucannon River smolt trap during the 2005 outmigration.

| Coho Salmon | Fall Chinook | Bull Trout | Grass Pickerel | Sand Roller | Tench | Mountain Whitefish | Shad | Steelhead Smolts | Steelhead Parr | Pacific Lamprey | | |
|----------------|-----------------|---------------|-------------------|----------------|-------|-----------------------|------|---------------------|-------------------|-----------------|----------------|--------|
| | | | | | | | | | | Ammocoetes | Macrophthalmia | Adults |
| 1,298 | 11,691 | 3 | 3 | 1 | 1 | 4 | 7 | 2,134 | 583 | 324 | 724 | 3 |

**Appendix H: Recoveries of Coded-Wire Tagged
Salmon Released Into the Tucannon River for the
1985-2001 Brood Years**

Appendix H. Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2001 brood years. (Data from RMIS database.)

| Brood Year | 1985 | | 1986 | | 1987 | |
|----------------------------------|-----------------|------------------|---------------------|------------------|-----------------|------------------|
| Smolts Released | 12,922 | | 147,037 | | 151,100 | |
| Fish/Lb | 6.0 | | 10.0 | | 9.0 | |
| CWT Codes^a | 34/42 | | 33/25, 41/46, 41/48 | | 49/50 | |
| Release Year | 1987 | | 1988 | | 1989 | |
| Agency (fishery/location) | Observed Number | Estimated Number | Observed Number | Estimated Number | Observed Number | Estimated Number |
| WDFW | | | | | | |
| Tucannon River | | | 30 | 84 | 28 | 130 |
| Kalama R., Wind R. | | | | | | |
| Fish Trap - F.W. | | | | | | |
| Treaty Troll | | | 1 | 2 | | |
| Lyons Ferry Hatch. ^b | 32 | 38 | 136 | 280 | 53 | 71 |
| F.W. Sport | | | 1 | 4 | | |
| ODFW | | | | | | |
| Test Net, Zone 4 | 1 | 1 | 1 | 1 | | |
| Treaty Ceremonial | | | 2 | 4 | 1 | 2 |
| Three Mile, Umatilla R. | | | | | | |
| Spawning Ground | | | | | | |
| Fish Trap - F.W. | | | | | | |
| F.W. Sport | | | | | | |
| Hatchery | | | | | | |
| CDFO | | | | | | |
| Non-treaty Ocean Troll | | | 1 | 4 | | |
| Mixed Net & Seine | | | | | | |
| Ocean Sport | | | | | | |
| USFWS | | | | | | |
| Warm Springs Hatchery | | | | | | |
| Dworshak NFH | | | | | | |
| IDFG | | | | | | |
| Hatchery | | | | | | |
| Total Returns | 33 | 39 | 172 | 379 | 82 | 203 |
| Tucannon (%) | | 97.4 | | 96.0 | | 99.0 |
| Out-of-Basin (%) | | 0.0 | | 0.0 | | 0.0 |
| Commercial Harvest (%) | | 2.6 | | 1.3 | | 1.0 |
| Sport Harvest (%) | | 0.0 | | 2.6 | | 0.0 |
| Survival | | 0.30 | | 0.26 | | 0.13 |

^a WDFW agency code prefix is 63. ^b Fish trapped at TFH and held at LFH for spawning.

Appendix H (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2001 brood years. (Data from RMIS database.)

| Brood Year | 1988 | | 1989 | | 1990 | |
|----------------------------------|-----------------|------------------|-----------------|------------------|---------------------|------------------|
| Smolts Released | 139,050 | | 97,779 | | 85,737 | |
| Fish/Lb | 11.0 | | 9.0 | | 11.0 | |
| CWT Codes^a | 01/42, 55/01 | | 01/31, 14/61 | | 37/25, 40/21, 43/11 | |
| Release Year | 1990 | | 1991 | | 1992 | |
| Agency (fishery/location) | Observed Number | Estimated Number | Observed Number | Estimated Number | Observed Number | Estimated Number |
| WDFW | | | | | | |
| Tucannon River | 107 | 370 | 61 | 191 | 2 | 6 |
| Kalama R., Wind R. | | | | | | |
| Fish Trap - F.W. | 1 | 1 | | | | |
| Treaty Troll | | | 2 | 2 | | |
| Lyons Ferry Hatch. ^b | 83 | 86 | 55 | 55 | 19 | 19 |
| F.W. Sport | 1 | 4 | | | | |
| ODFW | | | | | | |
| Test Net, Zone 4 | 3 | 3 | 2 | 2 | | |
| Treaty Ceremonial | 8 | 17 | 4 | 8 | | |
| Three Mile, Umatilla R. | | | | | | |
| Spawning Ground | | | | | | |
| Fish Trap - F.W. | | | | | | |
| F.W. Sport | | | | | | |
| Hatchery | | | | | | |
| CDFO | | | | | | |
| Non-treaty Ocean Troll | | | | | | |
| Mixed Net & Seine | | | | | | |
| Ocean Sport | | | | | | |
| USFWS | | | | | | |
| Warm Springs Hatchery | | | | | | |
| Dworshak NFH | 1 | 1 | | | | |
| IDFG | | | | | | |
| Hatchery | | | | | | |
| Total Returns | 204 | 482 | 124 | 258 | 21 | 25 |
| Tucannon (%) | | 94.6 | | 95.3 | | 100.0 |
| Out-of-Basin (%) | | 0.4 | | 0.0 | | 0.0 |
| Commercial Harvest (%) | | 4.1 | | 3.9 | | 0.0 |
| Sport Harvest (%) | | 0.8 | | 0.8 | | 0.0 |
| Survival | | 0.35 | | 0.26 | | 0.03 |

^aWDFW agency code prefix is 63. ^b Fish trapped at TFH and held at LFH for spawning.

Appendix H (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2001 brood years. (Data from RMIS database.)

| Brood Year | 1991 | | 1992 | | 1992 | |
|---|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Smolts Released | 72,461 | | 56,679 | | 79,151 | |
| Fish/Lb | 15.0 | | 36.0 | | 14.0 | |
| CWT Codes^a | 46/25, 46/47 | | 48/23, 48/24, 48/56 | | 48/10, 48/55, 49/05 | |
| Release Year | 1993 | | 1993 | | 1994 | |
| Agency (fishery/location) | Observed Number | Estimated Number | Observed Number | Estimated Number | Observed Number | Estimated Number |
| WDFW | | | | | | |
| Tucannon River Kalama R., Wind R. Fish Trap - F.W. Treaty Troll Lyons Ferry Hatch. ^b F.W. Sport | 24 | 24 | 2 | 2 | 45 | 49 |
| ODFW | | | | | | |
| Test Net, Zone 4 Treaty Ceremonial Three Mile, Umatilla R. Spawning Ground Fish Trap - F.W. F.W. Sport Hatchery | 1 1 | 3 3 | 1 | 1 | 5 2 | 9 2 |
| CDFO | | | | | | |
| Non-treaty Ocean Troll Mixed Net & Seine Ocean Sport | | | 1 | 2 | | |
| USFWS | | | | | | |
| Warm Springs Hatchery Dworshak NFH | | | | | 3 | 3 |
| IDFG | | | | | | |
| Hatchery | | | | | | |
| Total Returns | 26 | 30 | 4 | 5 | 69 | 102 |
| Tucannon (%) | 80.0 | | 40.0 | | 81.4 | |
| Out-of-Basin (%) | 10.0 | | 20.0 | | 15.7 | |
| Commercial Harvest (%) | 10.0 | | 40.0 | | 0.9 | |
| Sport Harvest (%) | 0.0 | | 0.0 | | 2.0 | |
| Survival | 0.04 | | 0.01 | | 0.13 | |

^a WDFW agency code prefix is 63.

^b Fish trapped at TFH and held at LFH for spawning.

Appendix H (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2001 brood years. (Data from RMIS database.)

| Brood Year | 1993 | | 1994 | | 1995 | |
|---|---------------------------|------------------|---------------------|------------------|---------------------|------------------|
| Smolts Released | 135,952 | | 130,034 | | 62,016 | |
| Fish/Lb | 14.0-15.0 | | 13.0-18.0 | | 17.0-19.0 | |
| CWT Codes^a | 56/15, 56/17-18, 53/43-44 | | 43/23, 56/29, 57/29 | | 59/36, 61/40, 61/41 | |
| Release Year | 1995 | | 1996 | | 1997 | |
| Agency (fishery/location) | Observed Number | Estimated Number | Observed Number | Estimated Number | Observed Number | Estimated Number |
| WDFW | | | | | | |
| Tucannon River Kalama R., Wind R. Fish Trap - F.W. Treaty Troll | 42 | 138 | 3 | 8 | 36 | 92 |
| Lyons Ferry Hatch. ^b F.W. Sport | 66 | 138 | 21 | 24 | 94 | 93 |
| ODFW | | | | | | |
| Test Net, Zone 4 Treaty Ceremonial Three Mile, Umatilla R. Spawning Ground | 3 | 3 | | | | |
| Fish Trap - F.W. F.W. Sport Hatchery | 3 1 1 | 3 1 1 | | | 1 1 1 | 1 1 1 |
| CDFO | | | | | | |
| Non-treaty Ocean Troll Mixed Net & Seine Ocean Sport | 1 | 3 | | | | |
| USFWS | | | | | | |
| Warm Springs Hatchery Dworshak NFH | | | | | | |
| IDFG | | | | | | |
| Hatchery | | | | | | |
| Total Returns | 117 | 287 | 24 | 32 | 132 | 187 |
| Tucannon (%) | 96.2 | | 100.0 | | 98.9 | |
| Out-of-Basin (%) | 1.7 | | 0.0 | | 1.1 | |
| Commercial Harvest (%) | 1.0 | | 0.0 | | 0.0 | |
| Sport Harvest (%) | 1.0 | | 0.0 | | 0.0 | |
| Survival | 0.21 | | 0.02 | | 0.30 | |

^a WDFW agency code prefix is 63.

^b Fish trapped at TFH and held at LFH for spawning.

Appendix H (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2001 brood years. (Data from RMIS database.)

| Brood Year | 1996 | | 1997 | | 1998 | |
|----------------------------------|--------------------|------------------|-----------------|------------------|-----------------|------------------|
| Smolts Released | 76,028 | | 23,509 | | 124,093 | |
| Fish/Lb | 16.0 | | 16.0 | | 13.0 | |
| CWT Codes^a | 03/59-60, 61/24-25 | | 61/32 | | 12/11 | |
| Release Year | 1998 | | 1999 | | 2000 | |
| Agency (fishery/location) | Observed Number | Estimated Number | Observed Number | Estimated Number | Observed Number | Estimated Number |
| WDFW | | | | | | |
| Tucannon River | 43 | 139 | 17 | 85 | 147 | 680 |
| Kalama R., Wind R. | | | | | | |
| Fish Trap - F.W. | | | | | | |
| Treaty Troll | | | | | | |
| Lyons Ferry Hatch. ^b | 96 | 99 | 44 | 46 | 83 | 121 |
| F.W. Sport | | | | | 3 | 13 |
| Non-treaty Ocean Troll | | | | | 1 | 2 |
| ODFW | | | | | | |
| Test Net, Zone 4 | | | | | 1 | 1 |
| Treaty Ceremonial | | | | | 5 | 5 |
| Three Mile, Umatilla R. | | | | | | |
| Spawning Ground | | | | | 1 | 1 |
| Fish Trap - F.W. | 1 | 1 | 2 | 2 | 8 | 10 |
| F.W. Sport | | | | | 2 | 4 |
| Hatchery | 2 | 2 | 1 | 1 | | |
| Columbia R. Gillnet | | | 7 | 50 | 32 | 111 |
| Columbia R. Sport | | | 2 | 15 | 17 | 94 |
| CDFO | | | | | | |
| Non-treaty Ocean Troll | | | | | | |
| Mixed Net & Seine | | | | | | |
| Ocean Sport | | | | | | |
| USFWS | | | | | | |
| Warm Springs Hatchery | | | | | | |
| Dworshak NFH | | | | | | |
| IDFG | | | | | | |
| Hatchery | 1 | 1 | 1 | -- | | |
| Total Returns | 143 | 242 | 74 | 199 | 300 | 1,042 |
| Tucannon (%) | 98.3 | | 65.8 | | 76.9 | |
| Out-of-Basin (%) | 1.7 | | 1.5 | | 1.6 | |
| Commercial Harvest (%) | 0.0 | | 25.1 | | 10.8 | |
| Sport Harvest (%) | 0.0 | | 7.5 | | 10.7 | |
| Survival | 0.32 | | 0.85 | | 0.84 | |

^a WDFW agency code prefix is 63.

^b Fish trapped at TFH and held at LFH for spawning.

Appendix H (continued). Observed and estimated recoveries of coded-wire tagged salmon released into the Tucannon River with percent return to the Tucannon Basin, out-of-basin returns, and estimated survival and exploitation rates for the 1985-2001 brood years. (Data from RMIS database.)

| Brood Year | 1999 | | 2000 | | 2001 ^c | |
|----------------------------------|-----------------|------------------|-----------------|------------------|-------------------|------------------|
| Smolts Released | 97,600 | | 102,099 | | 146,922 | |
| Fish/Lb | 10.6 | | 15.5 | | 12.9 | |
| CWT Codes^a | 02/75 | | 08/87 | | 06/81 | |
| Release Year | 2001 | | 2002 | | 2003 | |
| Agency (fishery/location) | Observed Number | Estimated Number | Observed Number | Estimated Number | Observed Number | Estimated Number |
| WDFW | | | | | | |
| Tucannon River | 2 | 12 | 13 | 37 | 3 | 7 |
| Kalama R., Wind R. | | | | | | |
| Fish Trap - F.W. | | | | | | |
| Treaty Troll | | | | | | |
| Lyons Ferry Hatch. ^b | 6 | 10 | 39 | 44 | 4 | 4 |
| F.W. Sport | | | | | | |
| Non-treaty Ocean Troll | | | | | | |
| ODFW | | | | | | |
| Test Net, Zone 4 | | | | | | |
| Treaty Ceremonial | | | | | | |
| Three Mile, Umatilla R. | | | | | | |
| Spawning Ground | | | | | | |
| Fish Trap - F.W. | | | | | | |
| F.W. Sport | | | | | | |
| Hatchery | | | | | | |
| Columbia R. Gillnet | 1 | 3 | 1 | 1 | | |
| Columbia R. Sport | | | | | | |
| CDFO | | | | | | |
| Non-treaty Ocean Troll | | | | | | |
| Mixed Net & Seine | | | | | | |
| Ocean Sport | | | | | | |
| USFWS | | | | | | |
| Warm Springs Hatchery | | | | | | |
| Dworshak NFH | | | | | | |
| IDFG | | | | | | |
| Hatchery | | | | | | |
| Total Returns | 9 | 25 | 53 | 82 | 7 | 11 |
| Tucannon (%) | 88.0 | | 98.8 | | 100.0 | |
| Out-of-Basin (%) | 0.0 | | 0.0 | | 0.0 | |
| Commercial Harvest (%) | 12.0 | | 1.2 | | 0.0 | |
| Sport Harvest (%) | 0.0 | | 0.0 | | 0.0 | |
| Survival | 0.03 | | 0.08 | | 0.01 | |

^a WDFW agency code prefix is 63.

^b Fish trapped at TFH and held at LFH for spawning.

^c Data for the 2001 brood year is incomplete.



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