

# 2003 Annual Report of Winter Chinook Propagation Activities

A U.S. Fish & Wildlife Service Report

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## TABLE OF CONTENTS

<b>List of Figures</b> .....	ii
<b>List of Tables</b> .....	ii-iii
<b>Introduction</b> .....	4
<b>Methods</b> .....	4
<b>Broodstock</b> .....	4
<i>Collection</i> .....	4
<i>Handling and Transportation</i> .....	5
<i>Run Identification</i> .....	5
<i>Health</i> .....	6
<i>Spawning</i> .....	6
<b>Progeny</b> .....	14
<i>Eggs and Juvenile Rearing</i> .....	14
<i>Health</i> .....	14
<i>Marking and Tagging</i> .....	14
<b>Assessment of Potential Genetic Impacts</b> .....	17
<b>Results</b> .....	17
<b>Broodstock</b> .....	17
<i>Collection and Disposition</i> .....	17
<i>Health</i> .....	29
<i>Spawning and Production-Non-captive Broodstock</i> .....	31
<i>Spawning and Production-Captive Broodstock</i> .....	36
<b>Progeny</b> .....	43
<i>Rearing</i> .....	43
<i>Marking and Tagging</i> .....	43
<i>Health</i> .....	43
<i>Released</i> .....	43
<b>Assessment of Potential Genetic Impacts</b> .....	43
<b>References</b> .....	44
<b>Acknowledgements</b> .....	45
<b>Attachment A (2003 Effective Population Calculation)</b> .....	46-53

## Tables and Figures

### FIGURES

Figure 1	Capture timing of Chinook salmon from Keswick Dam trap by run-type, 2003.....	27
Figure 2	Spawning of winter Chinook salmon at Livingston Stone National Fish Hatchery, 2003 .....	31

### TABLES

Table 1	Drugs and treatments that may be applied to maintain the health of winter Chinook salmon held at Livingston Stone National Fish Hatchery .....	6
Table 2	Spawning and drug treatment history of individual female Chinook salmon held at Livingston Stone National Fish Hatchery, 2003 .....	8-9
Table 3	Spawning and drug treatment history of individual male Chinook salmon held at Livingston Stone National Fish Hatchery, 2003.....	10-13
Table 4	Brood year 2003 winter Chinook salmon released by coded-wire tag (CWT) code, family group and parental origin.....	15-16
Table 5	Chinook salmon captured and tissue sampled for genetic run assignment and final disposition.....	18-26
Table 6	Disposition of Chinook salmon trapped at the Keswick Dam trap, January 13, 2003-July 23, 2003, by run identity and gender.....	28
Table 7	Test results (positive or negative) for fish pathogens in brood year 2003 winter Chinook salmon broodstock and juveniles, conducted by the USFWS California-Nevada Fish Health Center .....	30
Table 8	Early survival of eggs and fry from winter Chinook salmon captured from the wild and spawned at Livingston Stone National Fish Hatchery, 2003 .....	32-35
Table 9	Early survival of eggs and fry from winter Chinook salmon crosses of captive-brood females raised at Bodega Marine Lab and natural-origin males, 2003 .....	37-41

Table 10	Early survival of eggs from winter Chinook salmon crosses of captive brood female by captive brood male, 2003.....	42
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## INTRODUCTION

Due to severe declines in adult returns, the National Marine Fisheries Service listed Sacramento River winter Chinook salmon as threatened under the emergency listing procedures for the Endangered Species Act (16 U.S.C.R. 1531-1543) on August 4, 1989 (54 Federal Register 32085). Winter Chinook were formally added to the list of federally threatened species by final rule on November 5, 1990 (55 Federal Register 46515). Despite early efforts to restore the population, adult returns of winter Chinook continued to decline. In January 1994, the National Marine Fisheries Service reclassified winter Chinook salmon as endangered.

To supplement natural production and reduce the risk of extinction, the U.S. Fish and Wildlife Service (Service) developed an artificial propagation program for winter Chinook salmon in 1989. The program was located at Coleman National Fish Hatchery (NFH), on Battle Creek, a tributary of the Sacramento River. However, fish reared at Coleman NFH tended to return to Battle Creek rather than the Sacramento River as desired. To alleviate this problem, a new hatchery facility, Livingston Stone National Fish Hatchery (NFH), was established in 1998 along the Sacramento River at the base of Shasta Dam. To ensure that the hatchery program spawned only winter Chinook, the Service implemented a genetic-based screening process to identify winter Chinook salmon.

In addition to the hatchery supplementation program, an experimental captive broodstock program was cooperatively developed in 1991 with Bodega Marine Lab (BML) and partner agencies of the winter Chinook captive brood stock technical committee. The winter Chinook captive broodstock program is sustained by rearing a small number of hatchery-origin juveniles to maturity at Livingston Stone NFH or the BML. The primary objective of the winter Chinook captive broodstock program is to determine if a captive brood program could be used to prevent extinction of the run by ensuring a source of gametes for the supplementation program in the event that run sizes continue to decline and too few fish are available for hatchery broodstock (in 1991 the winter Chinook run estimate was less than 200 individuals). The year 2003 marks the third year of juvenile releases for a study to evaluate the efficacy of fish produced from the captive-brood program to produce returning adults (USFWS 2003).

## METHODS

### **Broodstock**

#### *Collection*

Before collection of winter Chinook broodstock began in 2003, the Service developed a broodstock collection plan that defined brood fish collection targets spread throughout the run. The broodstock collection guidelines for winter Chinook allow capture of up to 15% of the run size, up to a maximum of 120 fish. A run size of 800 or greater, would allow for 120 fish to be retained as brood stock. In 2003, the pre-season run estimate was much greater than 800; therefore, up to 120 adult winter Chinook salmon could be collected. The timing of broodstock

collection was scheduled to mimic the historic migration timing past the Red Bluff Diversion Dam as follows: 1.8% (2 fish) in December, 5.1% (6 fish) in January, 9.6% (12 fish) in February, 36.0% (43 fish) in March, 28.6% (34 fish) in April, 8.9% (11 fish) in May, 6.8% (8 fish) in June, and 3.4% (4 fish) in July. Deviation from the broodstock collection plan can occur due to limitations of the available traps to function during the entire run, under all flow conditions, and other factors. The Keswick trap is operational only when discharge from Keswick dam is less than 32,000 cubic feet per second. As such, trap operation is affected by reservoir management. The Keswick Dam fish trap was the only trap used to collect winter Chinook broodstock in 2003 and was operated by Service personnel. The alternate trap located at the Red Bluff Diversion Dam was not used in 2003 because sufficient numbers of broodstock were collected at the Keswick Dam trap.

### *Handling and Transportation*

Once trapped in the Keswick Dam fish trap, the fish remained in water at all times. From the trap they swam into a 1,000 gallon bail-lift from which they were transferred directly into an aerated and insulated 1,200 or 1,600-gallon transport tank and driven a short distance to Livingston Stone NFH. At Livingston Stone NFH the fish were anaesthetized with CO<sub>2</sub> while still in the transport tank, after which they were handled and a preliminary run assignment was made (i.e., winter-run or non-winter-run) based on phenotypic characteristics (e.g., color, degree of ripeness, fish size, amount of fungus, and collection date). All fish received a floy tag below the dorsal fin, and a small piece of fin tissue was taken for genetic analysis. Fish classified as non-winter-run were transported back to the Sacramento River the same day they were removed from the trap, or were transported to Coleman NFH for use in the late-fall Chinook broodstock program. Fish classified as phenotypically winter-run were quarantined in a 20-foot circular tank pending genetic confirmation of their run type. Fish genetically confirmed as winter-run were transferred into a 20-foot circular adult holding tank until spawned. Those identified as non-winter-run were returned to the Sacramento River.

### *Run Identification*

A genetic-based run assignment was used to classify fish as either winter-run or non-winter-run Chinook (University of California, Davis - Bodega Marine Laboratory 2001). Analyses were conducted at Bodega Marine Lab. Tissue samples were analyzed at a suite of microsatellite markers selected for their diagnostic power in distinguishing winter Chinook from other Chinook salmon populations (University of California – Davis Bodega Marine Laboratory 2001). Following the methods described by Banks et al. (1999) and Greig and Banks (1999), extracted DNA from samples was amplified by polymerase chain reaction, analyzed, and overall genotypes converted to GENEPOP format. Duplicate samples were run to confirm genotypes. A log-of-the-odds (LOD) score was generated using the computer software WHICHRUN (Banks and Eichert 2000) and used to assign individual Chinook as either winter-run or non-winter-run. A LOD score of two or greater, based on seven loci, was used to determine which fish would be retained as broodstock. Run-assignments for individual fish were transmitted back to Livingston Stone NFH usually within 24 hours of receipt of the tissue sample by Bodega Marine Lab.

## Health

Various therapeutic and prophylactic treatments were used on winter Chinook salmon broodstock to increase survival of adults and reduce risks of disease transmission to offspring (Table 1). Additionally, effects of stress on broodstock were reduced with salt, Poly Aqua, and anesthetics. Hatchery personnel and staff from the California-Nevada Fish Health Center closely monitored fish health. Broodstock were treated with malachite green to prevent fungal infections and erythromycin injections (target dosage of 20 mg/kg) were used to prevent transmission of *Renibacterium salmoninarum* to the progeny. No chemical treatments were administered to fish while held in quarantine and fish returned to the river were not subjected to chemical treatments. California-Nevada Fish Health Center personnel tested for the presence of pathogens in the broodstock.

Table 1. Drugs and treatments that may be applied to maintain the health of winter Chinook salmon held at Livingston Stone National Fish Hatchery.

Drug/Treatment	Dosage	Administered by	Use
Erythromycin	20 mg/kg	dorsal sinus injection	antibacterial
Iodophor	75 ppm	bath	antibacterial
Malachite green	1 ppm	bath	antifungal
Formalin	167 ppm	flow through	antifungal
MS-222		bath	anesthetic
<i>Vibrio</i> spp. vaccine		bath	vaccination against salt-water <i>Vibrio</i> spp.
Poly Aqua	1 qt/1,200 gallons	bath/flow through	stress reducer
Salt		bath/flow through	stress reducer
Chloramine-T	15 ppm	bath	antibacterial

## Spawning

Winter Chinook held as broodstock were examined twice weekly to assess their state of sexual maturity. Fish were crowded into a pie-shaped containment area using a hinged crowder consisting of two solid vinyl-covered screens. Tricane methanesulfonate (MS-222) was added to anaesthetize the fish so they could be examined for maturity and overall fish health.

Luteinizing Hormone-Releasing Hormone analogue (LH-RH<sub>a</sub>) implants were administered to accelerate final gamete maturation in fish that had already undergone gametogenesis and to synchronize maturation of broodstock (Tables 2 and 3). The LH-RH<sub>a</sub> implants release 30% of their content in the first three days after injection and the remaining hormone over a 20-day period to sustain an effective concentration within the fish. The implant dosage was 150 or 250 µg (supplied by Syndel International Inc.). Implants were injected into the dorsal muscle lateral and anterior to the dorsal fin with the use of a Ralgro pellet injector. Thirty-three females and 12 males received LH-RH<sub>a</sub> injections.

When a female salmon was identified as being sexually mature, it was euthanized, removed from the tank, and rinsed in fresh water to remove any remaining MS-222. Each female was assigned a number and each male was assigned a letter. The caudal artery of the female was severed so that blood would not mix into the eggs. Eggs were removed by making an incision from the vent to the pectoral fin and separated into two approximately equal groups. Each group was fertilized with semen from a different male, forming two half-sibling family groups. For example, when female 1 was spawned with males A and B, “family groups” 1A and 1B were created. After mixing semen and eggs, tris-glycine buffer was added to extend sperm life and motility. Spawned males were either returned to the holding tank for additional spawning or euthanized. Males were spawned a maximum of four times. When possible, each fish captured from the Sacramento River was spawned with at least two others. Captive-origin females were only spawned with natural-origin males.

Table 2. Spawning and drug treatment history of individual female Chinook salmon held at Livingston Stone National Fish Hatchery, 2003.

Tag Number	Date Captured	Fork		Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
		Length (mm)	Weight (lbs)				Dose (ml)	Injections	Dose (ml)	Injections	
W-255	2/6/03	710	13	5/8/03	5/8/03	90	0.6	2	250	1	28
W-252	2/6/03	718	9.82	5/26/03	5/26/03	108	0.5	2	150	1	33
W-256	2/6/03	727	11.2	6/2/03	6/2/03	115	0.5	3	150	2	35
W-280	2/6/03	756	13.48	6/12/03	6/12/03	105	0.6	3	150	2	31
W-270	2/12/03	825	16.24	5/6/03	5/6/03	82	0.7	2	250	1	26
W-262	2/12/03	758	12.16	5/22/03	5/22/03	98	0.6	2	n/a <sup>a</sup>	none	30
W-264	2/12/03	809	16.1	6/24/03	6/24/03	131	0.7	4	n/a <sup>a</sup>	none	40
W-273	2/19/03	690	8.88	5/8/03	5/8/03	77	0.4	2	150	1	24
W-272	2/19/03	760	12.32	5/12/03	5/12/03	81	0.6	2	250	1	25
W-271	2/19/03	775	13.72	5/22/03	5/22/03	91	0.6	2	150	2	28
W-275	2/19/03	756	11.98	5/29/03	5/29/03	98	0.5	2	n/a <sup>a</sup>	none	30
W-278	2/19/03	811	16.2	6/16/03	6/16/03	116	0.7	3	150	1	35
W-284	3/11/03	738	13.8	6/5/03	6/5/03	85	0.6	2	150	2	25
W-292	3/11/03	783	13.56	6/10/03	6/10/03	90	0.6	3	n/a <sup>a</sup>	none	27
W-283	3/11/03	770	13.54	6/10/03	6/10/03	90	0.6	2	150	2	27
W-297	3/19/03	858	18.5	PSM <sup>b</sup>	4/7/03	18	0.8	1	n/a <sup>a</sup>	none	5
W-295	3/19/03	798	14.64	6/2/03	6/2/03	74	0.6	1	150	2	21
W-299	3/19/03	752	12.08	6/10/03	6/10/03	82	0.6	3	n/a <sup>a</sup>	none	24
W-300	3/19/03	670	6.8	6/19/03	6/19/03	91	0.3	1	150	2	27
OR-002	3/19/03	811	14.94	6/19/03	6/19/03	91	0.7	2	150	4	28
OR-023	4/23/03	705	9.48	PSM <sup>b</sup>	6/12/03	49	0.5	2	150	4	14
OR-028	4/23/03	861	18.58	5/15/03	5/15/03	21	0.7	1	150	2	5
OR-021	4/23/03	770	13.76	5/15/03	5/15/03	21	0.6	1	150	4	5
OR-034	4/23/03	747	10.66	5/22/03	5/22/03	28	0.5	1	150	2	7
OR-033	4/23/03	755	13.02	5/26/03	5/26/03	32	0.6	1	n/a <sup>a</sup>	none	7
OR-020	4/23/03	828	17.34	6/2/03	6/2/03	39	0.7	2	150	4	10
OR-007	4/23/03	715	10.36	6/2/03	6/2/03	39	0.5	1	150	1	10
OR-025	4/23/03	710	10.06	6/2/03	6/2/03	39	0.5	1	150	2	10

Table 2 — cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lbs)	Date Spawmed	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-008	4/23/03	758	11.36	6/5/03	6/5/03	42	0.5	2	n/a <sup>a</sup>	none	11
OR-011	4/23/03	738	10.56	6/10/03	6/10/03	47	0.5	2	150	2	13
OR-005	4/23/03	734	12.02	6/24/03	6/24/03	61	0.6	3	150	2	17
OR-030	4/23/03	730	11.62	6/24/03	6/24/03	61	0.5	2	150	2	17
OR-037	4/23/03	758	12.82	6/26/03	6/26/03	63	0.6	3	150	2	18
OR-036	4/23/03	750	11.73	6/26/03	6/26/03	63	0.5	1	150	2	18
OR-024	4/23/03	850	15.34	6/30/03	6/30/03	67	0.6	3	150	2	20
OR-006 <sup>c</sup>	4/23/03	771	13.16	6/30/03	6/30/03	67	0.6	3	150	2	20
OR-038	4/23/03	788	13.84	7/7/03	7/7/03	74	0.6	3	150	2	22
OR-043	5/14/03	670	8.72	6/5/03	6/5/03	21	0.4	1	150	1	5
OR-41	5/14/03	848	17.96	6/16/03	6/16/03	32	0.7	1	150	2	8
OR-048	5/21/03	776	14.66	5/29/03	5/29/03	7	n/a	none	n/a <sup>a</sup>	none	1
OR-059	5/28/03	623	6.36	6/19/03	6/19/03	21	0.3	1	150	1	6
OR-062	6/4/03	755	11.34	6/30/03	6/30/03	25	0.5	1	n/a <sup>a</sup>	none	10
OR-065	6/18/03	788	13.38	6/19/03	6/19/03	1	n/a	none	n/a <sup>a</sup>	none	0
OR-66	6/18/03	721	10.8	6/19/03	6/19/03	1	n/a	none	n/a <sup>a</sup>	none	0
OR-068	6/18/03	658	10.38	6/26/03	6/26/03	7	n/a	none	n/a <sup>a</sup>	none	1
OR-072	6/25/03	658	7.2	7/3/03	7/3/03	7	n/a	none	150	1	1
OR-073	7/2/03	820	14.72	7/9/03	7/9/03	6	n/a	none	n/a <sup>a</sup>	none	none
OR-082	7/23/03	880	20.06	7/23/03	7/23/03	1	n/a	none	n/a <sup>a</sup>	none	none

<sup>a</sup> Not applicable; <sup>b</sup> Pre-spawn mortality; <sup>c</sup> Initial genetic results for this female indicated a LOD score consistent with a winter-run Chinook. However, it was later discovered that an allele had been incorrectly scored and the fish did not meet the genetic criteria for winter-Chinook broodstock. No progeny were produced from this female.

Table 3. Spawning and drug treatment history of individual male Chinook salmon held at Livingston Stone National Fish Hatchery, 2003.

Tag Number	Date Captured	Fork		Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
		Length (mm)	Weight (lb)				Dose (ml)	Injections	Dose (ml)	Injections	
W-253	2/6/03	725	12.4	PSM <sup>a</sup>	3/15/03	36	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	10
W-258	2/12/03	860	21.3	5/12/03 5/15/03 5/22/03	5/22/03	98	n/a <sup>b</sup>	none	150	2	30
W-276	2/19/03	1030	29.7	5/22/03 5/26/03 5/29/03	5/29/03	98	n/a <sup>b</sup>	none	150	2	30
W-279	2/19/03	725	9.86	6/19/03 6/19/03 6/26/03 7/9/03	7/11/03	141	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	44
W-277	2/19/03	887	19.98	6/30/03 6/30/03 7/9/03	7/15/03	145	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	45
W-293	3/11/03	740	10.76	PSM <sup>a</sup>	4/6/03	25	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	8
W-290	3/11/03	843	15.62	5/6/03 5/6/03	5/15/03	64	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	19
W-286	3/11/03	780	12.94	6/2/03 6/2/03 6/12/03	6/17/03	97	n/a <sup>b</sup>	none	150	1	29
W-285	3/11/03	881	16.98	6/5/03 6/5/03	6/10/03	90	n/a <sup>b</sup>	none	150	2	27
W-298	3/18/03	881	19.34	5/15/03 5/22/03 5/26/03	5/29/03	71	n/a <sup>b</sup>	none	150	2	20

Table 3—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawmed	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
W-294	3/19/03	941	25	6/10/03 6/16/03 6/16/03	7/3/03	105	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	31
OR-001	3/19/03	748	12.48	5/22/03 5/26/03 6/2/03	6/2/03	74	n/a <sup>b</sup>	none	150	1	21
OR-017	4/23/03	848	17.84	5/6/03 5/6/03 5/8/03	5/22/03	28	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	7
OR-018	4/23/03	808	16.04	5/8/03 5/12/03 5/22/03	5/22/03	28	n/a <sup>b</sup>	none	150	2	7
OR-014	4/23/03	820	13.9	5/15/03 5/15/03	5/15/03	21	n/a <sup>b</sup>	none	150	2	5
OR-035	4/23/03	801	14.98	5/29/03 6/2/02 6/2/03	6/10/03	47	n/a <sup>b</sup>	none	150	2	13
OR-009	4/23/03	736	10.48	6/2/03 6/5/03 6/10/03	7/3/03	70	n/a <sup>b</sup>	none	150	1	20
OR-013	4/23/03	788	13.68	6/5/03 6/10/03	6/10/03	47	n/a <sup>b</sup>	none	150	2	13
OR-031	4/23/03	848	15.84	6/30/03 7/3/03 7/23/03	7/23/03	90	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	25
OR-046	5/14/03	470	2.48	PSM <sup>a</sup>	6/2/03	18	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	4
OR-045	5/14/03	803	11.86	5/22/03 5/26/03	5/29/03	14	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	3

Table 3—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-050	5/21/03	829	14.58	5/29/03 6/2/03 6/2/03	6/10/03	19	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	5
OR-051	5/21/03	772	10.94	5/29/03 6/2/02 6/10/03	6/10/03	19	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	5
OR-054	5/21/03	610	6.1	6/2/03 6/5/03 6/10/03	7/8/03	47	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	14
OR-047	5/21/03	835	25.34	6/10/03 6/16/03 6/16/03	7/2/03	41	n/a <sup>b</sup>	none	150	2	12
OR-052	5/21/03	520	4.15	6/19/03 6/30/03	7/6/03	45	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	14
OR-057	5/28/03	540	4.12	6/5/03 6/10/03 6/12/03	7/4/03	36	n/a <sup>u</sup>	none	n/a <sup>u</sup>	none	11
OR-058	5/28/03	569	4.68	6/30/03 7/3/03	7/4/03	36	n/a <sup>u</sup>	none	n/a <sup>u</sup>	none	11
OR-060	6/4/03	817	12.82	6/19/03 6/19/03 6/26/03	6/29/03	24	n/a <sup>u</sup>	none	n/a <sup>u</sup>	none	7
OR-061	6/4/03	800	14.34	6/19/03 6/19/03	6/19/03	14	n/a <sup>u</sup>	none	n/a <sup>u</sup>	none	4
OR-063	6/4/03	801	12.48	6/19/03 7/7/03	7/7/03	32	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	10

Table 3—cont.

Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-064	6/4/03	468	2.6	6/19/03 6/19/03 6/26/03	7/1/03	26	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	8
OR-067	6/18/03	858	16.4	6/24/03 6/24/03 6/26/03	7/1/03	12	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	3
OR-069	6/18/03	505	5.78	6/24/03 6/26/03 6/26/03	7/3/03	14	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	3
OR-070	6/18/03	801	13.7	6/24/03 6/24/03 6/24/03	6/27/03	8	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	1
OR-071	6/18/03	548	7.48	6/30/03	7/6/03	17	n/a <sup>b</sup>	none	n/a <sup>b</sup>	none	12

<sup>a</sup> Pre-spawn mortality; <sup>b</sup> Not applicable

## Progeny

### *Eggs and Juvenile Rearing*

After fertilization, winter Chinook eggs were placed in Heath incubator trays and disinfected with a 75 parts per million (ppm) iodophor bath for 15 minutes. Incubating eggs were treated twice a week with a 15 minute flow-through treatment of 1,400 ppm formalin to prevent excessive fungus. Initial water flow in the incubator trays was four gallons per minute (gpm) and later increased to six gpm at eye-up. After eye-up, eggs were shocked and non-viable eggs were removed. Formalin treatments were discontinued once eggs had hatched. Sac fry were left in the incubator trays until button-up, at which time they were transferred to 30-inch diameter (10.2 cubic foot) circular tanks and started on commercial feed.

Juveniles were initially fed Bio-Oregon's starter #1. *Artemia nauplii* (Cyclop-eeze™ from Argent Chemical Laboratories) were added to increase interest in the feed. The fish were subsequently fed Bio-Oregon's starter #2 and starter #3 fish feed. Once they attained a size of approximately 500 to-the-pound, they were fed Bio-Oregon's Biodiet grower, size 1.3 mm pellets. At a size of about 250 to-the-pound they were fed Biodiet grower, size 1.5 mm pellets, until released. Feeding rates were determined using Bio-Oregon's feeding guidelines, which indicate the appropriate feed ration based on average monthly water temperature. Due to tank space limitations at Livingston Stone NFH, family groups were combined as fish size increased.

### *Health*

To maintain sanitary rearing environments, rearing units were typically cleaned two to five times per week. Juvenile winter Chinook were tested for the presence of pathogens by California-Nevada Fish Health Center personnel. Juveniles selected for incorporation into the captive broodstock program were vaccinated against *Vibrio*. Vaccinations were performed by mixing the formalin-inactivated bacteria solution with water (one to ten ratio), then dipping the fish in this solution for 20 seconds.

### *Marking and Tagging*

All winter Chinook juveniles were coded-wire tagged between December 18, 2003 and January 9, 2004. Each of the 27 natural-origin by natural-origin family group combinations received a unique tag code as did four hatchery-origin by natural-origin family group combinations and four captive-origin by natural-origin family group combinations (Table 4).

Juveniles retained for the captive broodstock program were tagged with passive integrated transponder (PIT) tags. At the time of tagging, a small piece of fin was removed for genetic-based determination of sex. Captive broodstock males and females were reared separately so that feeding schedules could be gender-specific. This was done to limit growth and fat deposition in males, reducing the likelihood of precocious maturation.

Table 4. Brood year 2003 winter Chinook salmon released by coded-wire tag (CWT) code, family group, and parental origin.

Tag Code	Family Group	Parental Origin <sup>a</sup>	Number Tagged	Tagging Mortalities	Proportion Tags Retained	Tagged Fish Released	Number Released	Average Fork Len. (mm)	Minimum Fork Len. (mm)	Maximum Fork Len. (mm)
051679	37CC, 42GG, 46CRYO F&G	N x N	5,248	13	1.000	5,235	5,235	79	64	89
051964	42FF, 43GG	N x N	3,604	12	0.995	3,574	3,592	84	66	96
051965	4C, 4D	N x N	3,793	14	0.980	3,703	3,779	95	81	110
051966	1B, 2B, 3B, 5F, 9C	N x N	4,297	3	0.990	4,251	4,294	88	57	105
051967	1B, 2B, 3B, 5F, 9C	N x N	4,425	9	0.995	4,394	4,416	87	62	103
051968	3C, 6D, 8I, 9D	N x N	5,475	10	0.995	5,438	5,465	86	69	103
051969	7H, 8F, 11H, 11I	N x N	4,351	24	0.985	4,262	4,327	92	79	107
051970	10F, 14K	N x N	5,450	12	0.995	5,411	5,438	84	69	96
051971	12J, 12K, 13H	N x N	5,162	31	0.995	5,105	5,131	84	52	101
051972	13L, 14J, 15K	N x N	4,366	29	0.995	4,315	4,337	88	69	105
051973	15L, 17N, 18I	N x N	4,670	12	1.000	4,658	4,658	88	77	107
051974	16M, 19M, 20Q, 24M	N x N	4,917	14	0.995	4,878	4,903	86	72	105
051975	21O, 22S, 24O	N x N	4,459	13	1.000	4,446	4,446	88	73	105
051976	16L, 17O, 18N	N x N	4,938	10	1.000	4,928	4,928	87	71	103
051977	23Q, 28T	N x N	4,426	11	0.995	4,393	4,415	87	69	108
051978	26Q, 30W, 31W	N x N	4,859	12	0.995	4,823	4,847	86	68	97
051979	23T, 28S	N x N	4,421	11	1.000	4,410	4,410	84	70	106
051980	26N, 32Z	N x N	4,436	14	0.995	4,400	4,422	85	73	101
051981	27S, 32Y	N x N	4,993	13	0.990	4,930	4,980	82	60	95
051982	29V, 33Y, 36AA	N x N	4,761	25	0.990	4,689	4,736	84	69	97
051983	27T, 33Z, 36CC	N x N	4,834	12	0.985	4,750	4,822	84	62	96

Table 4—cont.

Tag Code	Family Group	Parental Origin <sup>a</sup>	Number Tagged	Tagging Mortalities	Proportion Tags Retained	Tagged Fish Released	Number Released	Average Fork Len. (mm)	Minimum Fork Len. (mm)	Maximum Fork Len. (mm)
051984	35AA, 37BB, 38Z	N x N	4,906	17	1.000	4,889	4,889	82	49	96
051985	35CC, 39W, 39Y, 43EE	N x N	5,311	18	1.000	5,293	5,293	76	53	92
051986	38BB, 40V	N x N	4,809	12	1.000	4,797	4,797	81	65	98
051990	44FF, 45FF	N x N	4,466	11	0.995	4,433	4,455	80	64	92
051991	25J, 34AA, 34BB	N x N	4,476	17	0.990	4,414	4,459	84	72	99
051992	45Z, 46GG	N x N	4,401	12	0.995	4,367	4,389	80	53	90
			Subtotal	391	.	125,186	125,863			
051987	19P, 20P, 30U, 31X	H x N	5,103	1	0.990	5,051	5,102	90	73	109
051988	22R, 29U	H x N	5,216	10	0.995	5,180	5,206	85	70	100
051989	40DD, 44X	H x N	4,114	0	0.995	4,093	4,114	83	69	98
051993	1A, 2A, 5E, 6E, 7G, 10G, 12R	H x N	11,635	9	0.995	11,568	11,626	88	48	106
			Subtotal	20	.	25,892	26,048			
051994	BML 36-56	C x N	11,273	23	0.975	10,969	11,250	81	46	105
051995	BML 1-16	C x N	18,245	24	0.990	18,039	18,221	78	51	96
051996	BML 17-35	C x N	17,744	25	0.995	17,630	17,719	77	55	94
051997	BML 58-100	C x N	19,434	18	0.975	18,931	19,416	72	43	91
			Subtotal	90	.	65,569	66,606			

<sup>a</sup> "N" means natural-origin, "H" means hatchery-origin, "C" means captive-origin. All captive-origin fish were female.

## Assessment of Potential Genetic Impacts

Prior to and following the release of juvenile winter Chinook into the Sacramento River, the Service estimated the “effective population size” of the winter Chinook salmon population, both with and without the influence of hatchery-origin fish. The effective population size estimate ( $N_e$ ) measures the rate of genetic drift within a population and provides an assessment of risk of inbreeding resulting from the release of the juveniles from the hatchery propagation program. The  $N_e$  is directly related to the rate of loss of genetic diversity and the rate of increase in inbreeding within a population (Riemann and Allendorf 2001), and is an important concept in managing conservation programs for threatened or endangered salmonid populations, including Sacramento River winter Chinook. In most cases  $N_e$  is expected to be smaller than the actual number of adults in a spawning population.

The estimation of  $N_e$  was based on the estimated total run size of winter Chinook salmon to the Sacramento River in 2003. Two estimates of  $N_e$  were calculated: one assuming genetic contribution by 10% of the run size estimate (Bartley et al., 1992) and one assuming genetic contribution by 33% of the run size estimate (Robin Waples, NMFS, Northwest Fisheries Center, Seattle, WA, personal communication). The Service’s estimate of effective population size was sent to NOAA Fisheries and the California Department of Fish and Game for review and approval prior to releasing juvenile winter Chinook.

## RESULTS

### Broodstock

#### *Collection and Disposition*

The first winter-run Chinook was captured on January 13 and the last was captured on July 23 (Table 5, Figure 1). Large increases in the proportion of winter-run collected occurred on February 19 and April 23 (Table 5, Figure 1). Non-winter-run were collected at a relatively constant rate throughout the collection period (Table 5, Figure 1). A total of 400 Chinook salmon were captured at the Keswick Dam trap (Table 6). Of those, 71.3% ( $n = 285$ ) were identified as winter-run based on genetic data or phenotypic characteristics. Females comprised 54.4% ( $n = 155$ ) of the winter Chinook salmon captured, males comprised 44.9% ( $n = 128$ ), and gender could not be determined at the time of capture for 0.7% ( $n = 2$ ). Hatchery-origin fish comprised 50.9% ( $n = 145$ ) of the winter Chinook captured and 40% ( $n = 160$ ) of all Chinook captured.

One hundred eighty-seven winter-run Chinook and 40 non-winter-run Chinook were collected and released without being quarantined, as were nine Chinook of undetermined run (Table 6). All non-quarantined fish were tissue sampled. Forty Chinook were held in quarantine and later released back into the Sacramento River; thirteen of these fish were winter-run, twenty-five were non-winter-run, and two were of undetermined run (Table 6). Quarantined fish were held for no more than 7 days. Eighty-five winter Chinook salmon were retained for broodstock. Among these, 78 were spawned and seven died before they could be spawned. Thirty-two non-winter

Chinook were transferred to Coleman NFH for use as late-fall Chinook salmon broodstock. There was one pre-spawn mortality, and six non-winter Chinook were euthanized.

Table 5. Chinook salmon captured and tissue sampled for genetic run assignment and final disposition. Fish with adipose fin status “present” were natural-origin, fish with adipose fin status “absent” were hatchery-origin.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
1/13/03	80701	R-04148	Present	Female	880	Non-Winter	Transferred to CNFH
1/13/03	80702	R-04147	Present	Male	950	Non-Winter	Transferred to CNFH
1/13/03	80703	R-04146	Present	Male	830	Non-Winter	Transferred to CNFH
1/13/03	80704	R-04145	Present	Male	680	Non-Winter	Transferred to CNFH
1/13/03	80706	R-04144	Present	Male	1010	Non-Winter	Transferred to CNFH
1/13/03	80707	R-04143	Present	Male	960	Non-Winter	Transferred to CNFH
1/13/03	80708	none	Present	Female	not measured	Winter <sup>a</sup>	Released
1/13/03	80709	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
1/13/03	80710	R-04142	Present	Female	860	Non-Winter	Transferred to CNFH
1/13/03	80711	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
1/13/03	80712	R-04141	Present	Female	760	Non-Winter	Transferred to CNFH
1/13/03	80713	R-04140	Present	Male	900	Non-Winter	Transferred to CNFH
1/13/03	80714	none	Present	Male	not measured	Non-Winter <sup>a</sup>	Released
1/13/03	80715	none	Present	Male	not measured	Non-Winter <sup>a</sup>	Released
1/13/03	80716	R-04139	Present	Male	730	Non-Winter	Transferred to CNFH
1/13/03	80717	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
1/22/03	80718	R-04138	Present	Female	1020	Non-Winter	Transferred to CNFH
1/22/03	80719	R-04137	Present	Male	1000	Non-Winter	Transferred to CNFH
1/22/03	80720	R-04136	Present	Female	810	Non-Winter	Transferred to CNFH
1/22/03	80721	R-04135	Present	Male	930	Non-Winter	Transferred to CNFH
1/22/03	80722	R-04134	Present	Female	690	Non-Winter	Transferred to CNFH
1/22/03	80723	R-04133	Present	Male	770	Non-Winter	Transferred to CNFH
1/22/03	80724	R-04132	Present	Male	740	Non-Winter	Transferred to CNFH
1/22/03	80725	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
1/22/03	80726	R-04131	Present	Female	1010	Non-Winter	Transferred to CNFH
1/22/03	80727	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
1/28/03	80728	R-04129	Present	Female	900	Non-Winter	Transferred to CNFH
2/6/03	9701	W-251	Absent	Male	825	Non-Winter	Sacrificed
2/6/03	9702	W-252	Present	Female	721	Winter	Spawned
2/6/03	9703	W-253	Present	Male	722	Winter	DIP
2/6/03	9704	W-254	Present	Male	780	Winter	Released
2/6/03	9705	W-255	Present	Female	732	Winter	Spawned
2/6/03	9706	W-256	Present	Female	728	Winter	Spawned
2/6/03	9707	W-257	Present	Male	831	Winter	Released
2/6/03	80729	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
2/6/03	80730	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
2/6/03	80731	R-04127	Present	Male	1120	Non-Winter	Transferred to CNFH
2/6/03	80732	R-04125	Present	Male	950	Non-Winter	Transferred to CNFH
2/6/03	80733	none	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
2/6/03	9730	W-280	Present	Female	758	Winter	Spawned
2/12/03	9708	W-258	Present	Male	880	Winter	Spawned
2/12/03	9709	W-259	Present	Female	820	Non-Winter	Released
2/12/03	9710	W-260	Absent	Female	700	Winter	Released
2/12/03	9711	W-261	Absent	Male	760	Winter	Released
2/12/03	9712	W-262	Present	Female	740	Winter	Spawned
2/12/03	9713	W-263	Absent	Female	690	Winter	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
2/12/03	9714	W-264	Present	Female	790	Winter	Spawned
2/12/03	9715	W-265	Present	Female	720	Winter	Released
2/12/03	9716	W-266	Absent	Female	720	Winter	Released
2/12/03	9717	W-267	Absent	Male	660	Non-Winter	Sacrificed
2/12/03	9718	W-269	Absent	Female	770	Winter	Released
2/12/03	9719	W-270	Present	Female	not measured	Winter	Spawned
2/12/03	80734	R-04124	Present	Male	740	Winter <sup>a</sup>	Released
2/12/03	80735	R-04123	Present	Female	780	Winter <sup>a</sup>	Released
2/12/03	80736	R-04122	Present	Male	1040	Non-Winter	Transferred to CNFH
2/12/03	80737	R-04121	Present	Female	820	Non-Winter	Transferred to CNFH
2/12/03	80738	R-04120	Present	Female	870	Non-Winter	Transferred to CNFH
2/12/03	80739	R-04119	Present	Female	not measured	Winter <sup>a</sup>	Released
2/12/03	80740	R-04118	Present	Female	not measured	Winter <sup>a</sup>	Released
2/12/03	80741	R-04117	Present	Male	not measured	Undetermined	Released
2/12/03	80742	R-04116	Present	Female	not measured	Non-Winter <sup>a</sup>	Released
2/12/03	80743	R-04115	Present	Female	770	Non-Winter	Transferred to CNFH
2/12/03	80744	R-04114	Present	Female	850	Non-Winter	Transferred to CNFH
2/12/03	80745	R-04113	Present	Female	910	Non-Winter	Transferred to CNFH
2/12/03	80746	R-04112	Present	Male	710	Winter <sup>a</sup>	Released
2/12/03	80747	R-04111	Present	Female	730	Winter <sup>a</sup>	Released
2/19/03	9720	W-271	Present	Female	773	Winter	Spawned
2/19/03	9721	W-272	Present	Female	760	Winter	Spawned
2/19/03	9722	W-273	Present	Female	680	Winter	Spawned
2/19/03	9723	W-274	Present	Female	783	Non-Winter	Released
2/19/03	9724	R-04110	Absent	Male	not measured	Non-Winter	Sacrificed
2/19/03	9725	W-275	Present	Female	753	Winter	Spawned
2/19/03	9726	W-276	Present	Male	1000	Winter	Spawned
2/19/03	9727	W-277	Present	Male	930	Winter	Spawned
2/19/03	9728	W-278	Present	Female	not measured	Winter	Spawned
2/19/03	9729	W-279	Present	Male	705	Winter	Spawned
2/19/03	80748	R-04109	Present	Male	740	Non-Winter	Transferred to CNFH
2/19/03	80749	R-04108	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80750	R-04107	Present	Male	920	Non-Winter	Transferred to CNFH
2/19/03	80751	R-04106	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80752	R-04105	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80753	R-04104	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80754	R-04103	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80755	R-04102	Absent	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80756	R-04101	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80757	R-04100	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80758	R-04150	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80759	R-04151	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80760	R-04152	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80761	R-04153	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80762	R-04154	Absent	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80763	R-04155	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80764	R-04156	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80765	R-04157	Absent	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80766	R-04158	Present	Female	920	Non-Winter	Transferred to CNFH

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
2/19/03	80767	R-04159	Present	Male	not measured	Non-Winter <sup>d</sup>	Released
2/19/03	80768	R-04160	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80769	R-04161	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80770	R-04162	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80771	R-04163	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80772	R-04164	Present	Male	not measured	Undetermined	Released
2/19/03	80773	R-04165	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80774	R-04166	Absent	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80775	R-04167	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80776	R-04168	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80777	R-04169	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80778	R-04170	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80779	R-04171	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80780	R-04172	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80781	R-04173	Absent	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80782	R-04174	Present	Unknown	not measured	Winter <sup>a</sup>	Released
2/19/03	80783	R-04175	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80784	R-04176	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80785	R-04177	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80786	R-04178	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80787	R-04179	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80788	R-04180	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80789	R-04181	Present	Female	not measured	Non-Winter	Transferred to CNFH
2/19/03	80790	R-04182	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80791	R-04183	Present	Male	740	Non-Winter	Transferred to CNFH
2/19/03	80792	R-04184	Present	Male	not measured	Winter <sup>a</sup>	Released
2/19/03	80793	R-04185	Present	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80794	R-04186	Absent	Female	not measured	Winter <sup>a</sup>	Released
2/19/03	80795	R-04187	Absent	Male	not measured	Winter <sup>a</sup>	Released
3/5/03	9731	R-04188	Present	Female	720	Non-Winter	Released
3/5/03	9732	R-04189	Present	Male	700	Winter	Released
3/11/03	9733	R-04190	Absent	Female	765	Non-Winter	Released
3/11/03	9734	R-04191	Present	Female	810	Non-Winter	Released
3/11/03	9735	R-04192	Absent	Male	770	Winter	Released
3/11/03	9736	R-04193	Present	Female	732	Winter	Released
3/11/03	9737	R-04194	Absent	Female	757	Winter	Released
3/11/03	9738	R-04195	Present	Female	810	Winter	Released
3/11/03	9739	R-04196	Absent	Male	740	Winter	Released
3/11/03	9740	R-04197	Absent	Female	680	Winter	Released
3/11/03	9741	R-04198	Absent	Female	785	Winter	Released
3/11/03	9742	R-04199	Absent	Male	830	Winter	Released
3/11/03	9743	R-04200	Present	Female	820	Winter	Released
3/11/03	9744	R-04201	Absent	Female	777	Winter	Released
3/11/03	9745	R-04202	Absent	Male	766	Winter	Released
3/11/03	9746	R-04203	Absent	Male	742	Winter	Released
3/11/03	9747	R-04204	Present	Female	713	No call <sup>b</sup>	Released
3/11/03	9748	R-04205	Present	Female	685	No call <sup>b</sup>	Released
3/11/03	9749	R-04206	Absent	Male	812	No call <sup>b</sup>	Released
3/11/03	9750	R-04207	Absent	Female	676	No call <sup>b</sup>	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
3/11/03	9751	R-04208	Absent	Female	766	No call <sup>b</sup>	Released
3/11/03	9752	R-04209	Absent	Female	763	Winter	Released
3/11/03	9753	R-04210	Absent	Male	743	Winter	Released
3/11/03	9755	R-04212	Present	Female	780	Winter	Released
3/11/03	9756	R-04213	Absent	Male	773	Winter	Released
3/11/03	9757	W-282	Present	Male	840	Non-Winter	Released
3/11/03	9760	W-285	Absent	Male	878	Winter	Spawned
3/11/03	9761	W-286	Present	Male	780	Winter	Spawned
3/11/03	9762	W-287	Present	Unknown	698	Non-Winter	Released
3/11/03	9763	W-288	Present	Male	750	Non-Winter	Released
3/11/03	9764	W-289	Present	Male	815	Non-Winter	Released
3/11/03	9765	W-290	Absent	Male	846	Winter	Spawned
3/11/03	9766	W-291	Present	Male	950	Non-Winter	Released
3/11/03	9767	W-292	Present	Female	790	Winter	Spawned
3/11/03	9768	W-293	Absent	Male	738	Winter	DIP
3/11/03	9758	W-283	Present	Female	778	Winter	Spawned
3/11/03	9754	R-04211	Absent	Male	709	Winter	Released
3/11/03	9759	W-284	Present	Female	749	Winter	Spawned
3/19/03	9769	R-04274	Present	Female	842	Non-Winter	Released
3/19/03	9770	W-294	Present	Male	535	Winter	Spawned
3/19/03	9771	W-295	Present	Female	790	Winter	Spawned
3/19/03	9773	W-296	Present	Female	850	Winter	Released
3/19/03	9774	W-297	Present	Female	860	Winter	DIP
3/19/03	9775	R-04216	Present	Male	1030	Non-Winter	Released
3/19/03	9776	W-298	Present	Male	882	Winter	Spawned
3/19/03	9777	R-04217	Absent	Male	732	Winter	Released
3/19/03	9778	R-04218	Present	Female	800	Winter	Released
3/19/03	9779	W-299	Present	Female	760	Winter	Spawned
3/19/03	9781	W-300	Present	Female	660	Winter	Spawned
3/19/03	9782	R-04220	Absent	Female	700	Winter	Released
3/19/03	9783	R-04222	Present	Unknown	758	Winter	Released
3/19/03	9784	OR-001	Present	Male	750	Winter	Spawned
3/19/03	9785	R-04223	Present	Female	808	Winter	Released
3/19/03	9786	OR-002	Present	Female	830	Winter	Spawned
3/19/03	9787	R-04224	Absent	Female	730	Winter	Released
3/19/03	9788	R-04425	Absent	Female	775	Winter	Released
3/19/03	9789	R-04426	Partial	Female	775	Winter	Released
3/19/03	9780	R-04219	Present	Unknown	635	Non-Winter	Released
3/19/03	9772	R-04215	Absent	Male	750	Winter	Released
3/26/03	9790	R-04427	Present	Male	930	Non-Winter	Released
4/2/03	9791	OR-003	Present	Female	920	Non-Winter	Released
4/2/03	9792	OR-004	Present	Male	685	Non-Winter	Released
4/2/03	9793	R-04428	Present	Male	808	Winter	Released
4/9/03	9794	R-04429	Absent	Male	794	Winter	Released
4/9/03	9795	R-04430	Present	Female	815	Non-Winter	Released
4/9/03	9796	R-04431	Present	Female	882	Non-Winter	Released
4/9/03	9797	R-04432	Present	Female	785	Non-Winter	Released
4/9/03	9798	R-04433	Partial	Male	775	Winter	Released
4/9/03	9799	R-04434	Absent	Female	728	Winter	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
4/9/03	9800	R-04435	Absent	Male	682	Winter	Released
4/9/03	9801	R-04436	Absent	Female	790	Winter	Released
4/9/03	9802	R-04437	Absent	Male	610	Non-Winter	Released
4/9/03	9803	R-04438	Unknown	Male	741	Winter	Released
4/9/03	9804	R-04439	Present	Male	656	Non-Winter	Released
4/9/03	9805	R-04440	Absent	Male	440	Winter	Released
4/23/03	9806	R-04441	Absent	Male	804	Winter	Released
4/23/03	9807	R-04442	Absent	Male	770	Winter	Released
4/23/03	9808	R-04443	Absent	Male	845	Winter	Released
4/23/03	9809	R-04444	Absent	Female	830	Winter	Released
4/23/03	9810	R-04445	Partial	Female	730	Winter	Released
4/23/03	9811	R-04446	Absent	Male	704	Winter	Released
4/23/03	9813	R-04448	Absent	Female	730	Winter	Released
4/23/03	9812	R-04447	Absent	Female	722	Winter	Released
4/23/03	9814	R-04450	Absent	Female	728	Winter	Released
4/23/03	9816	R-04452	Absent	Female	740	Winter	Released
4/23/03	9817	R-04454	Absent	Male	771	Winter	Released
4/23/03	9818	R-04455	Partial	Male	807	Winter	Released
4/23/03	9819	R-04457	Absent	Female	771	Winter	Released
4/23/03	9820	R-04458	Absent	Female	not measured	Winter	Released
4/23/03	9821	R-04460	Partial	Female	708	Winter	Released
4/23/03	9822	R-04461	Absent	Male	750	Winter	Released
4/23/03	9823	R-04463	Absent	Female	not measured	Winter	Released
4/23/03	9824	R-04464	Absent	Male	722	Winter	Released
4/23/03	9825	R-04466	Absent	Female	not measured	Winter	Released
4/23/03	9826	R-04468	Absent	Female	708	Non-Winter	Released
4/23/03	9827	R-04469	Absent	Female	not measured	Winter	Released
4/23/03	9828	R-04472	Absent	Female	711	Winter	Released
4/23/03	9829	R-04473	Absent	Male	789	Winter	Released
4/23/03	9830	R-04474	Absent	Female	720	Winter	Released
4/23/03	9831	R-04225	Absent	Male	840	Winter	Released
4/23/03	9832	R-04226	Absent	Female	778	Winter	Released
4/23/03	9833	R-04227	Absent	Female	730	Winter	Released
4/23/03	9834	R-04229	Present	Female	743	Non-Winter	Released
4/23/03	9835	R-04230	Absent	Male	471	Winter	Released
4/23/03	9837	R-04233	Absent	Female	742	Winter	Released
4/23/03	9838	R-04234	Present	Female	800	Winter	Released
4/23/03	9839	R-04235	Absent	Male	812	Winter	Released
4/23/03	9901	R-04236	Absent	Female	740	Undetermined	Released
4/23/03	9840	R-04237	Absent	Female	730	Winter	Released
4/23/03	9841	R-04238	Absent	Female	not measured	Winter	Released
4/23/03	80501	OR-005	Present	Female	735	Winter	Spawned
4/23/03	80502	R-04239	Present	Female	835	Winter	Released
4/23/03	80505	OR-006	Present	Female	768	Winter	Spawned
4/23/03	80503	OR-007	Present	Female	705	Winter	Spawned
4/23/03	80504	OR-008	Present	Female	756	Winter	Spawned
4/23/03	80507	OR-010	Present	Male	798	Non-Winter	Released
4/23/03	80508	OR-011	Present	Female	736	Winter	Spawned
4/23/03	80510	OR-013	Absent	Male	792	Winter	Spawned

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
4/23/03	80511	OR-014	Absent	Male	810	Winter	Spawned
4/23/03	80512	OR-015	Present	Male	839	Non-Winter	Sacrificed
4/23/03	80515	OR-018	Present	Male	809	Winter	Spawned
4/23/03	80516	OR-019	Absent	Male	806	Winter	DIP
4/23/03	80517	R-04241	Present	Female	867	Winter	Released
4/23/03	80519	OR-021	Present	Female	768	Winter	Spawned
4/23/03	80520	OR-022	Present	Female	818	Winter	Released
4/23/03	80522	OR-024	Present	Female	845	Winter	Spawned
4/23/03	80523	OR-025	Present	Female	710	Winter	Spawned
4/23/03	80525	R-04243	Present	Female	791	Winter	Released
4/23/03	80524	OR-026	Present	Female	851	Non-Winter	Released
4/23/03	80521	OR-023	Present	Female	701	Winter	DIP
4/23/03	80518	OR-020	Present	Female	827	Winter	Spawned
4/23/03	80526	OR-027	Present	Male	750	Winter	DIP
4/23/03	9815	R-04451	Absent	Male	813	Winter	Released
4/23/03	80506	OR-009	Present	Male	730	Winter	Spawned
4/23/03	80509	OR-012	Present	Female	807	No call <sup>b</sup>	Released
4/23/03	80513	OR-016	Present	Female	725	Non-Winter	Released
4/23/03	80514	OR-017	Present	Male	845	Winter	Spawned
4/23/03	80527	OR-028	Present	Female	850	Winter	Spawned
4/23/03	80528	OR-029	Present	Female	820	Winter	Released
4/23/03	80529	OR-030	Present	Female	735	Winter	Spawned
4/23/03	80530	OR-031	Present	Male	840	Winter	Spawned
4/23/03	80531	OR-032	Present	Male	830	No call <sup>b</sup>	Released
4/23/03	80532	OR-033	Present	Female	780	Winter	Spawned
4/23/03	80533	OR-034	Present	Female	742	Winter	Spawned
4/23/03	80534	OR-035	Present	Male	822	Winter	Spawned
4/23/03	80535	OR-036	Present	Female	742	Winter	Spawned
4/23/03	80536	OR-037	Present	Female	739	Winter	Spawned
4/23/03	80537	OR-038	Present	Female	792	Winter	Spawned
4/23/03	80538	R-04244	Absent	Female	800	Winter	Released
4/23/03	80539	R-04245	Absent	Female	762	Winter	Released
4/23/03	80540	R-04247	Present	Female	742	Winter	Released
4/23/03	80541	R-04325	Absent	Female	808	Winter	Released
4/23/03	80542	R-04326	Absent	Male	670	Winter	Released
4/23/03	80543	R-04327	Absent	Female	850	Winter	Released
4/23/03	80545	R-04329	Absent	Male	672	Winter	Released
4/23/03	80544	R-04328	Absent	Male	708	Winter	Released
4/23/03	80546	R-04330	Absent	Male	not measured	Winter	Released
4/23/03	80547	none	Present	Male	820	Non-Winter	DIP
4/23/03	9836	R-04231	Absent	Male	738	Winter	Released
4/23/03	9900	R-04232	Absent	Female	764	Undetermined	Released
5/14/03	80560	R-04255	Absent	Male	510	Winter	Released
5/14/03	80561	R-04256	Absent	Male	490	Winter	Released
5/14/03	80562	R-04257	Absent	Female	659	Winter	Released
5/14/03	80563	R-04258	Absent	Male	412	Winter	Released
5/14/03	80564	R-04260	Absent	Male	470	Winter	Released
5/14/03	80565	R-04261	Absent	Male	471	Winter	Released
5/14/03	80553	OR-044	Present	Male	657	Non-Winter	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
5/14/03	80554	OR-045	Absent	Male	793	Winter	Spawned
5/14/03	80555	R-04250	Absent	Female	772	Winter	Released
5/14/03	80556	OR-046	Present	Male	460	Winter	DIP
5/14/03	80557	R-04251	Absent	Female	700	Winter	Released
5/14/03	80558	R-04252	Absent	Female	780	Winter	Released
5/14/03	80559	R-04254	Absent	Male	462	Winter	Released
5/14/03	80548	OR-039	Present	Male	925	Non-Winter	Released
5/14/03	80549	OR-040	Present	Male	888	Non-Winter	Released
5/14/03	80550	OR-041	Present	Female	840	Winter	Spawned
5/14/03	80551	OR-042	Present	Male	642	Non-Winter	Released
5/14/03	80552	OR-043	Present	Female	672	Winter	Spawned
5/21/03	80566	OR-047	Present	Male	920	Winter	Spawned
5/21/03	80567	OR-048	Present	Female	750	Winter	Spawned
5/21/03	80568	OR-049	Present	Male	875	Non-Winter	Released
5/21/03	80569	OR-050	Present	Male	820	Winter	Spawned
5/21/03	80570	OR-051	Present	Male	771	Winter	Spawned
5/21/03	80571	OR-052	Present	Male	520	Winter	Spawned
5/21/03	80572	OR-053	Present	Female	540	Non-Winter	Released
5/21/03	80573	OR-054	Present	Male	611	Winter	Spawned
5/21/03	80574	OR-055	Present	Female	733	Winter	Released
5/21/03	80575	R-04262	Present	Female	870	Non-Winter	Released
5/21/03	80576	R-04263	Present	Male	780	Non-Winter	Released
5/21/03	80577	R-04264	Absent	Male	800	Winter	Released
5/21/03	80578	R-04265	Absent	Male	520	Winter	Released
5/21/03	80579	R-04266	Absent	Male	420	Winter	Released
5/21/03	80580	R-04267	Present	Female	783	Non-Winter	Released
5/21/03	80581	R-04268	Present	Female	703	Non-Winter	Released
5/21/03	80582	R-04269	Present	Female	not measured	Non-Winter	Released
5/21/03	80583	R-04270	Absent	Female	690	Winter	Released
5/21/03	80584	R-04271	Absent	Male	825	Winter	Released
5/21/03	80585	R-04272	Absent	Male	512	Winter	Released
5/21/03	80586	R-04276	Absent	Male	not measured	Winter	Released
5/21/03	80587	R-04277	Absent	Male	460	Winter	Released
5/28/03	80588	OR-056	Present	Female	not measured	Non-Winter	Released
5/28/03	80589	OR-057	Present	Male	536	Winter	Spawned
5/28/03	80590	OR-058	Present	Male	565	Winter	Spawned
5/28/03	80591	OR-059	Present	Female	620	Winter	Spawned
5/28/03	80593	R-04279	Absent	Male	546	Winter	Released
5/28/03	80594	R-04280	Absent	Male	470	Winter	Released
5/28/03	80595	R-04281	Absent	Male	492	Winter	Released
5/28/03	80596	R-04282	Absent	Male	480	Winter	Released
5/28/03	80597	R-04283	Absent	Male	430	Winter	Released
5/28/03	80592	R-04278	Absent	Female	702	Winter	Released
6/4/03	80603	R-04285	Absent	Female	610	Winter	Released
6/4/03	80602	OR-063	Absent	Male	792	Winter	Spawned
6/4/03	80601	R-04284	Present	Male	670	Non-Winter	Released
6/4/03	80600	OR-062	Present	Female	750	Winter	Spawned
6/4/03	80599	OR-061	Absent	Male	795	Winter	Spawned
6/4/03	80598	OR-060	Present	Male	820	Winter	Spawned

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
6/4/03	80608	R-04289	Absent	Male	540	Winter	Released
6/4/03	80607	R-04288	Absent	Male	480	Winter	Released
6/4/03	80606	R-04287	Absent	Male	630	Winter	Released
6/4/03	80605	OR-064	Present	Male	470	Winter	Spawned
6/4/03	80604	R-04286	Present	Female	711	Non-Winter	Released
6/11/03	80609	R-04290	Absent	Male	870	Winter	Released
6/18/03	80613	OR-066	Present	Female	715	Winter	Spawned
6/18/03	80612	R-04292	Absent	Female	694	Winter	Released
6/18/03	80611	R-04291	Present	Female	895	Non-Winter	Released
6/18/03	80610	OR-065	Present	Female	788	Winter	Spawned
6/18/03	80614	R-04293	Absent	Female	715	Winter	Released
6/18/03	80615	OR-067	Present	Male	830	Winter	Spawned
6/18/03	80616	OR-068	Present	Female	656	Winter	Spawned
6/18/03	80617	OR-069	Present	Male	505	Winter	Spawned
6/18/03	80618	OR-070	Present	Male	835	Winter	Spawned
6/18/03	80619	OR-071	Absent	Male	550	Winter	Spawned
6/25/03	80620	R-04294	Absent	Female	733	Winter	Released
6/25/03	80621	R-04295	Absent	Female	750	Winter	Released
6/25/03	80622	OR-072	Present	Female	640	Winter	Spawned
6/25/03	80623	R-04296	Absent	Male	520	Winter	Released
6/25/03	80624	R-04297	Absent	Male	520	Winter	Released
6/25/03	80625	R-04299	Absent	Male	507	Winter	Released
6/25/03	80626	R-04350	Absent	Male	780	Non-Winter	Released
7/2/03	80627	OR-073	Present	Female	780	Winter	Spawned
7/2/03	80629	OR-075	Absent	Female	829	Non-Winter	Sacrificed
7/2/03	80630	OR-078	Present	Male	480	Winter	Released
7/2/03	80631	OR-079	Present	Male	670	Non-Winter	Released
7/2/03	80632	R-04352	Present	Female	846	Non-Winter	Released
7/2/03	80633	R-04353	Present	Female	890	Non-Winter	Released
7/2/03	80634	R-04354	Absent	Male	480	Winter	Released
7/2/03	80635	R-04355	Absent	Male	490	Winter	Released
7/2/03	80636	OR-081	Present	Male	not measured	Non-Winter	Released
7/2/03	80637	R-04356	Absent	Female	685	Non-Winter	Released
7/2/03	80638	R-04357	Absent	Male	490	Winter	Released
7/2/03	80639	R-04359	Absent	Male	460	Winter	Released
7/2/03	80640	R-04360	Absent	Female	680	Winter	Released
7/2/03	80641	R-04361	Absent	Female	538	Winter	Released
7/2/03	80642	R-04362	Absent	Female	780	Winter	Released
7/2/03	80643	R-04363	Absent	Male	520	Winter	Released
7/2/03	80644	R-04364	Absent	Male	530	Winter	Released
7/2/03	80645	R-04365	Absent	Male	500	Winter	Released
7/2/03	80646	R-04366	Absent	Male	425	Winter	Released
7/2/03	80628	OR-074	Present	Male	720	Non-Winter	Released
7/9/03	80647	R-04367	Absent	Male	720	Winter	Released
7/9/03	80648	R-04368	Absent	Female	680	Winter	Released
7/9/03	80649	R-04369	Absent	Male	539	Winter	Released
7/9/03	80650	R-04370	Absent	Female	740	Winter	Released
7/9/03	80651	R-04371	Absent	Female	734	Winter	Released
7/9/03	80652	R-04372	Absent	Female	746	Non-Winter	Released

Table 5—cont.

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
7/9/03	80653	R-04373	Absent	Female	744	Winter	Released
7/9/03	80654	R-04374	Absent	Female	711	Winter	Released
7/9/03	80655	R-04375	Present	Male	457	Winter	Released
7/9/03	80656	R-04376	Present	Male	950	Non-Winter	Released
7/23/03	80657	R-04377	Present	Female	915	Non-Winter	Released
7/23/03	80658	OR-082	Present	Female	880	Winter	Spawned
7/23/03	80659	R-04378	Absent	Female	673	Winter	Released
7/23/03	80660	R-04379	Absent	Female	746	Winter	Released
7/23/03	80661	R-04380	Present	Female	767	Non-Winter	Released
7/23/03	80662	R-04381	Absent	Male	573	Winter	Released
7/23/03	80663	R-04382	Present	Male	403	Non-Winter	Released

<sup>a</sup> Run assignment based on phenotypic characteristics; <sup>b</sup> Genetic-based run assignment unsuccessful.

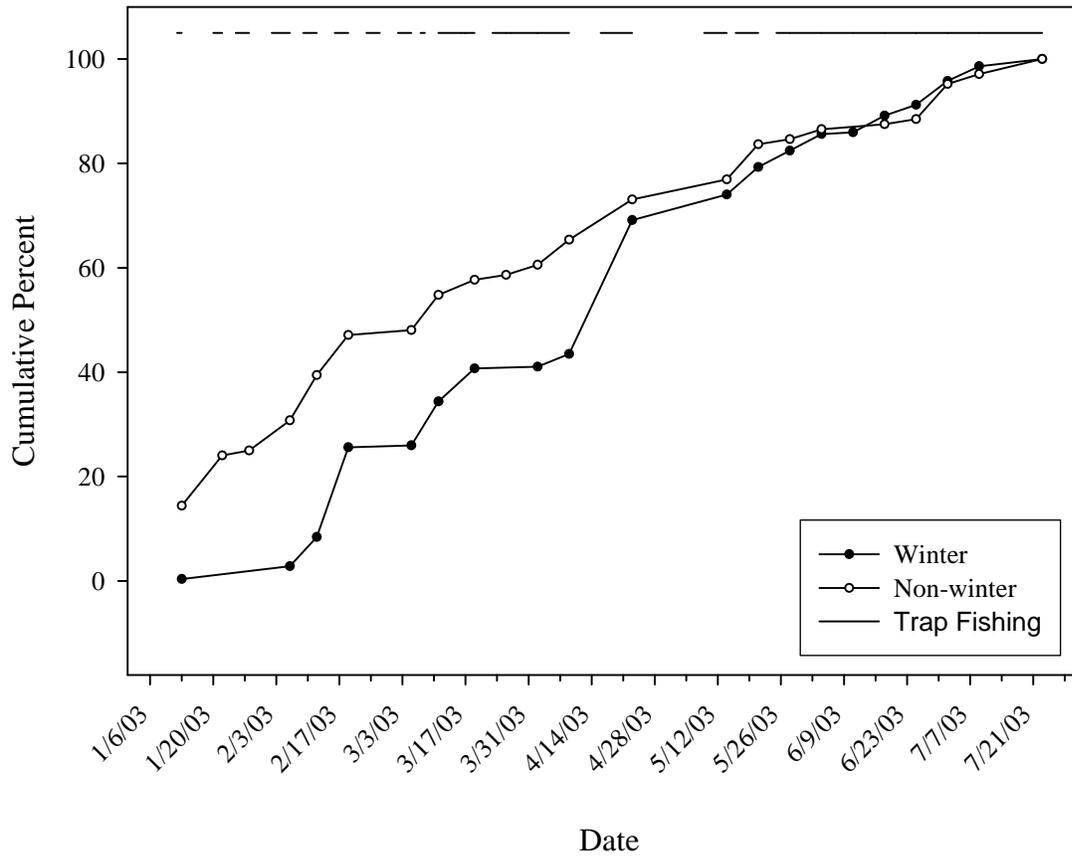


Figure 1. Capture timing of Chinook salmon from Keswick Dam trap by run-type, 2003. Dashed line across the top represents days when trap was fishing.

Table 6. Disposition of Chinook salmon trapped at the Keswick Dam trap, January 13, 2003 - July 23, 2003, by run identity and gender. Numbers in parentheses indicate the number of hatchery-origin fish included in the category total.

Run Identity	Disposition	Total	Males	Females	Unknown Gender
Winter	Trapped and spawned	78 (8)	33 (8)	45 (0)	0 (0)
Winter	Pre-spawn mortality	7 (2)	5 (2)	2 (0)	0 (0)
Winter	Trapped, quarantined, and released back into river	13 (5)	4 (1)	9 (4)	0 (0)
Winter	Trapped and released back into river without quarantine	187 (130)	87 (70)	98 (60)	2 (0)
	Total	285 (145)	129 (81)	154 (64)	2 (0)
Non-winter	Pre-spawn mortality	1 (0)	1 (0)	0 (0)	0 (0)
Non-winter	Trapped, quarantined, and released back into river	25 (0)	14 (0)	10 (0)	1 (0)
Non-winter	Trapped and released back into river without quarantine	40 (6)	12 (2)	27 (4)	1 (0)
Non-winter	Transferred to Coleman National Fish Hatchery	32 (0)	17 (0)	15 (0)	0 (0)
Non-winter	Killed	6 (4)	4 (3)	2 (1)	0 (0)
	Total	104 (10)	48 (5)	54 (5)	2 (0)
Undetermined	Pre-spawn mortality	0 (0)	0 (0)	0 (0)	0 (0)
Undetermined	Trapped, quarantined, and released back into river	2 (0)	1 (0)	1 (0)	0 (0)
Undetermined	Trapped and released back into river without quarantine	9 (5)	3 (1)	6 (4)	0 (0)
	Total	11 (5)	4 (1)	7 (4)	0 (0)
	Overall Total	400 (160)	181 (87)	215 (73)	4 (0)

## *Health*

The causative agent of bacterial kidney disease (*Renibacterium salmoninarum*) was present in broodstock from the Sacramento River and BML (Table 7). Sacramento River broodstock also tested positive for infectious hematopoietic necrosis virus and *Ceratomyxa shasta*. The captive broodstock from Livingston Stone were negative for all pathogens tested for (Table 7).

Table 7. Test results (positive or negative) for fish pathogens in brood year 2003 winter Chinook salmon broodstock and juveniles, conducted by the USFWS California - Nevada Fish Health Center.

Pathogen	Brood stock origin			Juveniles <sup>a</sup>
	Sacramento River positive / negative	Livingston Stone Captive positive / negative	Bodega Marine Lab Captive positive / negative	
<i>Aeromonas salmonicida</i>	negative	negative	negative	negative
<i>Yersinia ruckeri</i>	negative	negative	negative	negative
<i>Renibacterium salmoninarum</i>	positive	negative	positive	negative
Infectious hematopoietic necrosis virus	positive	negative	negative	negative
Viral hemorrhagic septicemia virus	negative	negative	negative	negative
Infectious pancreatic necrosis virus	negative	negative	negative	negative
<i>Oncorhynchus masou</i> virus	negative	negative	negative	negative
<i>Ceratomyxa shasta</i>	positive	no test	no test	no test
<i>Sphaerothecum destruens</i> (Rosette Agent)	negative	negative	negative	no test

<sup>a</sup> Juveniles from all brood stock types were combined for the assay.

*Spawning & Production- Non-captive Broodstock*

In 2003, winter Chinook salmon were spawned between May 6 and July 23 and spawning occurred at a relatively constant rate between those dates (Tables 2 and 3, Figure 2). A total of 45 female (Table 2) and 33 male (Table 3) winter Chinook salmon were spawned in 2003 producing 90 family groups (Table 8). Fork length of spawned females ranged from 623 to 880 mm and averaged 756 mm (SD 56 mm) (Table 2). Fork length of spawned males ranged from 468 to 1,030 mm and averaged 767 mm (SD 135 mm) (Table 3). Females produced an average of 4,852 green eggs yielding a total of 218,346 green eggs with 89.6% of these developing into eyed eggs (Table 8). The percent of green eggs that hatched averaged 86.0%, and 82.5% of the green eggs resulted in juveniles that were transferred to rearing tanks (Table 8).

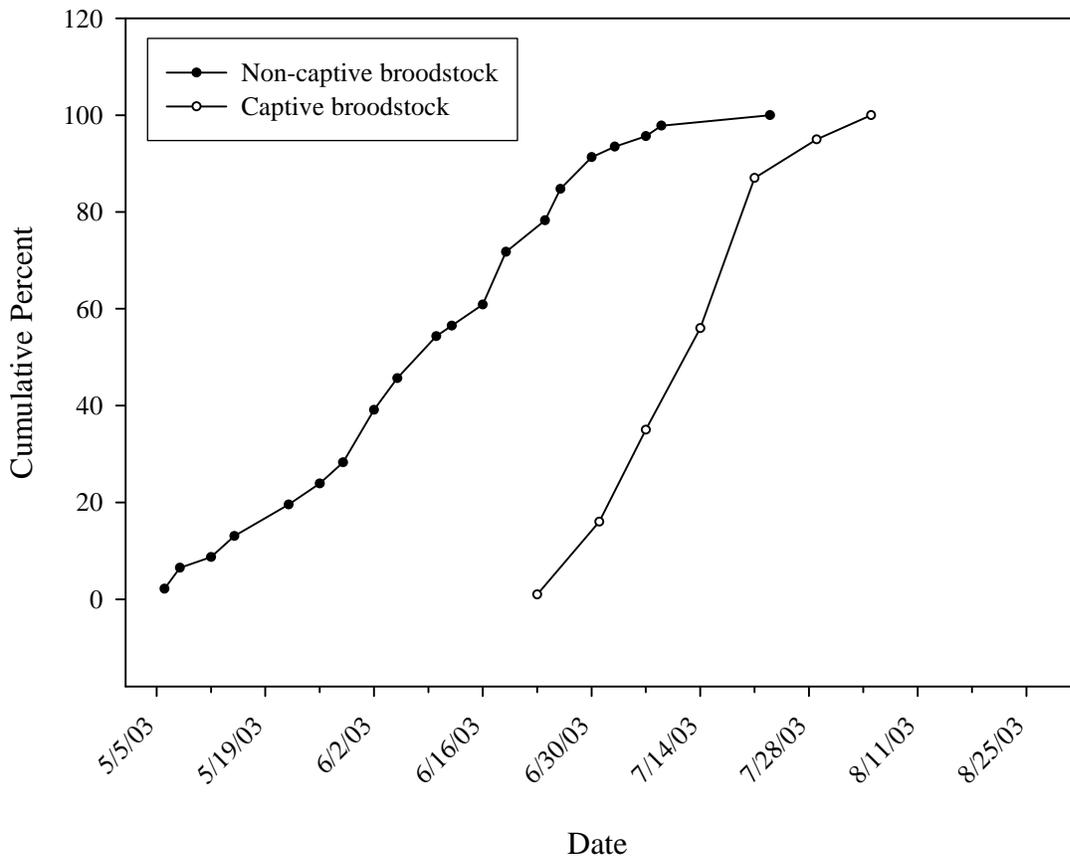


Figure 2. Spawning of winter Chinook salmon at Livingston Stone National Fish Hatchery, 2003.

Table 8. Early survival of eggs and fry from winter Chinook salmon captured from the wild and spawned at Livingston Stone National Fish Hatchery, 2003.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green	Number Tanked	Percent Tanked from Green	Percent Tanked from Eyed
Female	Male							Eggs Hatched		Eggs	Eggs
W-270	W-290	1A	5/6/03	3,230	2,930	90.7	2,825	87.5	2,748	85.1	93.8
W-270	OR-017	1B	5/6/03	2,888	2,661	92.1	2,568	88.9	2,609	90.3	98.0
W-255	W-290	2A	5/8/03	2,501	2,005	80.2	1,787	71.5	1,695	67.8	84.5
W-255	OR-017	2B	5/8/03	1,960	1,573	80.3	1,302	66.4	1,223	62.4	77.7
W-273	OR-017	3B	5/8/03	1,700	1,687	99.2	1,684	99.1	1,683	99.0	99.8
W-273	OR-018	3C	5/8/03	1,488	1,483	99.7	1,482	99.6	1,401	94.2	94.5
W-272	OR-018	4C	5/12/03	2,475	2,122	85.7	1,962	79.3	1,937	78.3	91.3
W-272	W-258	4D	5/12/03	2,411	2,147	89.1	2,061	85.5	2,042	84.7	95.1
OR-028	OR-014	5E	5/15/03	3,246	3,193	98.4	3,163	97.4	3,048	93.9	95.5
OR-028	W-298	5F	5/15/03	3,206	3,082	96.1	3,058	95.4	3,050	95.1	99.0
OR-021	OR-014	6E	5/15/03	1,799	831	46.2	448	24.9	418	23.2	50.3
OR-021	W-258	6D	5/15/03	2,068	788	38.1	477	23.1	398	19.2	50.5
W-262	OR-045	7G	5/22/03	2,855	2,767	96.9	2,735	95.8	2,488	87.1	89.9
W-262	W-276	7H	5/22/03	3,237	3,064	94.7	3,035	93.8	3,038	93.9	99.2
OR-034	W-298	8F	5/22/03	1,720	1,618	94.1	1,616	94.0	1,439	83.7	88.9
OR-034	OR-001	8I	5/22/03	1,768	1,672	94.6	1,620	91.6	1,549	87.6	92.6
W-271	OR-018	9C	5/22/03	2,736	2,727	99.7	2,724	99.6	2,678	97.9	98.2
W-271	W-258	9D	5/22/03	2,414	2,401	99.5	2,397	99.3	2,410	99.8	100.4 <sup>a</sup>
OR-033	W-298	10F	5/26/03	2,970	2,890	97.3	2,875	96.8	2,860	96.3	99.0
OR-033	OR-045	10G	5/26/03	2,908	2,805	96.5	2,792	96.0	2,659	91.4	94.8
W-252	W-276	11H	5/26/03	2,137	1,484	69.4	1,383	64.7	1,167	54.6	78.6
W-252	OR-001	11I	5/26/03	1,747	1,277	73.1	1,192	68.2	972	55.6	76.1
OR-048	OR-051	12J	5/29/03	3,131	3,096	98.9	3,086	98.6	3,075	98.2	99.3

Table 8—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked From Eyed Eggs
Female	Male							Eggs Hatched		Eggs	
OR-048	OR-050	12K	5/29/03	2,560	2,547	99.5	2,537	99.1	2,509	98.0	98.5
W-275	W-276	13H	5/29/03	2,567	2,261	88.1	1,949	75.9	1,787	69.6	79.0
W-275	OR-035	13L	5/29/03	2,343	2,133	91.0	1,904	81.3	1,840	78.5	86.3
OR-020	OR-051	14J	6/2/03	2,947	2,840	96.4	2,827	95.9	2,760	93.7	97.2
OR-020	OR-050	14K	6/2/03	2,916	2,745	94.1	2,732	93.7	2,776	95.2	101.1 <sup>a</sup>
OR-007	OR-050	15K	6/2/03	2,598	2,319	89.3	2,109	81.2	2,056	79.1	88.7
OR-007	OR-035	15L	6/2/03	2,368	1,992	84.1	1,617	68.3	1,504	63.5	75.5
W-295	OR-035	16L	6/2/03	2,941	2,849	96.9	2,779	94.5	2,563	87.1	90.0
W-295	OR-054	16M	6/2/03	2,717	2,607	96.0	2,584	95.1	2,559	94.2	98.2
W-256	W-286	17N	6/2/03	2,186	1,954	89.4	1,934	88.5	1,922	87.9	98.4
W-256	OR-009	17O	6/2/03	2,214	1,938	87.5	1,918	86.6	1,911	86.3	98.6
OR-025	OR-001	18I	6/2/03	2,435	2,194	90.1	2,113	86.8	2,089	85.8	95.2
OR-025	W-286	18N	6/2/03	2,285	2,171	95.0	2,113	92.5	2,090	91.5	96.3
OR-008	OR-054	19M	6/5/03	2,439	2,423	99.3	2,407	98.7	2,388	97.9	98.6
OR-008	W-285	19P	6/5/03	2,407	2,395	99.5	2,384	99.0	2,363	98.2	98.7
W-284	W-285	20P	6/5/03	2,211	1,093	49.4	721	32.6	648	29.3	59.3
W-284	OR-057	20Q	6/5/03	2,140	1,052	49.2	719	33.6	635	29.7	60.4
OR-043	OR-009	21O	6/5/03	2,154	1,817	84.4	1,651	76.6	1,645	76.4	90.5
OR-043	OR-013	21R	6/5/03	2,055	1,621	78.9	1,436	69.9	1,426	69.4	88.0
W-292	OR-013	22R	6/10/03	2,664	2,652	99.5	2,648	99.4	2,595	97.4	97.9
W-292	W-294	22S	6/10/03	2,613	2,603	99.6	2,561	98.0	2,578	98.7	99.0
W-299	OR-057	23Q	6/10/03	2,195	2,184	99.5	2,175	99.1	2,172	99.0	99.5
W-299	OR-047	23T	6/10/03	2,053	2,038	99.3	2,021	98.4	2,049	99.8	100.5 <sup>a</sup>
OR-011	OR-054	24M	6/10/03	2,756	1,335	48.4	1,270	46.1	1,239	45.0	92.8

Table 8—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green	Number Tanked	Percent Tanked from Green	Percent Tanked From Eyed
Female	Male							Eggs Hatched		Eggs	
OR-011	OR-009	24O	6/10/03	1,935	881	45.5	771	39.8	774	40.0	87.9
W-283	OR-051	25J	6/10/03	3,123	1	0.0	1	0.0	1	0.0	100.0
W-280	W-286	26N	6/12/03	2,784	2,776	99.7	2,755	99.0	2,758	99.1	99.4
W-280	OR-057	26Q	6/12/03	2,666	2,659	99.7	2,650	99.4	2,575	96.6	96.8
OR-041	W-294	27S	6/16/03	3,345	3,325	99.4	3,301	98.7	3,321	99.3	99.9
OR-041	OR-047	27T	6/16/03	3,263	3,240	99.3	3,237	99.2	3,147	96.4	97.1
W-278	W-294	28S	6/16/03	3,262	3,251	99.7	3,238	99.3	3,129	95.9	96.2
W-278	OR-047	28T	6/16/03	3,243	3,231	99.6	3,228	99.5	3,205	98.8	99.2
OR-065	OR-061	29U	6/19/03	2,858	2,826	98.9	2,796	97.8	2,661	93.1	94.2
OR-065	OR-052	29V	6/19/03	2,605	2,587	99.3	2,556	98.1	2,551	97.9	98.6
W-300	OR-061	30U	6/19/03	1,315	1,269	96.5	897	68.2	844	64.2	66.5
W-300	OR-064	30W	6/19/03	941	901	95.7	663	70.5	736	78.2	81.7
OR-066	OR-064	31W	6/19/03	2,086	2,077	99.6	2,073	99.4	2,076	99.5	100.0 <sup>a</sup>
OR-066	OR--063	31X	6/19/03	1,813	1,783	98.3	1,777	98.0	1,764	97.3	98.9
OR-002	OR-060	32Y	6/19/03	2,611	2,572	98.5	2,564	98.2	2,553	97.8	99.3
OR-002	W-279	32Z	6/19/03	2,148	2,114	98.4	2,103	97.9	2,084	97.0	98.6
OR-059	OR-060	33Y	6/19/03	1,633	1,621	99.3	1,604	98.2	1,604	98.2	99.0
OR-059	W-279	33Z	6/19/03	1,480	1,470	99.3	1,450	98.0	1,445	97.6	98.3
W-264	OR-070	34AA	6/24/03	2,835	2,823	99.6	2,817	99.4	2,810	99.1	99.5
W-264	OR-069	34BB	6/24/03	2,522	2,517	99.8	2,514	99.7	2,487	98.6	98.8
OR-005	OR-070	35AA	6/24/03	2,533	2,111	83.3	1,731	68.3	1,669	65.9	79.1
OR-005	OR-067	35CC	6/24/03	2,463	2,102	85.3	1,812	73.6	1,708	69.3	81.3
OR-030	OR-070	36AA	6/24/03	2,688	1,998	74.3	1,665	61.9	1,645	61.2	82.3
OR-030	OR-067	36CC	6/24/03	2,349	1,554	66.2	1,216	51.8	1,151	49.0	74.1

Table 8—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green Eggs Hatched	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked From Eyed Eggs
Female	Male										
OR-037	OR-067	37CC	6/26/03	2,269	2,065	91.0	1,972	86.9	1,933	85.2	93.6
OR-068	W-279	38Z	6/26/03	1,926	1,901	98.7	1,889	98.1	1,789	92.9	94.1
OR-068	OR-069	38BB	6/26/03	1,691	1,677	99.2	1,673	98.9	1,666	98.5	99.3
OR-036	OR-064	39W	6/26/03	1,906	1,758	92.2	1,580	82.9	1,459	76.5	83.0
OR-036	OR-060	39Y	6/26/03	1,796	1,439	80.1	1,303	72.6	1,103	61.4	76.7
OR-024	OR-052	40V	6/30/03	3,542	3,491	98.6	3,454	97.5	3,447	97.3	98.7
OR-024	OR-071	40DD	6/30/03	3,065	3,027	98.8	2,991	97.6	2,971	96.9	98.1
OR-062	W-277	42FF	6/30/03	2,638	2,522	95.6	2,507	95.0	2,490	94.4	98.7
OR-062	OR-031	42GG	6/30/03	2,471	2,426	98.2	2,414	97.7	2,457	99.4	101.3 <sup>a</sup>
OR-072	OR-031	43EE	7/3/03	1,674	1,628	97.3	1,607	96.0	1,615	96.5	99.2
OR-072	OR-058	43GG	7/3/03	1,334	1,300	97.5	1,279	95.9	1,257	94.2	96.7
OR-038	OR--063	44X	7/7/03	2,435	2,311	94.9	2,282	93.7	1,622	66.6	70.2
OR-038	W-277	44FF	7/7/03	2,680	2,510	93.7	2,446	91.3	2,385	89.0	95.0
OR-073	W-279	45Z	7/9/03	2,996	2,955	98.6	2,934	97.9	2,968	99.1	100.4 <sup>a</sup>
OR-073	W-277	45FF	7/9/03	2,647	2,631	99.4	2,616	98.8	2,622	99.1	99.7
OR-082	OR-031	46GG	7/23/03	4,026	3,895	96.7	3,869	96.1	1,362	33.8	35.0
OR-082	02OR-271	46CR02G	7/23/03	1,202	804	66.9	780	64.9	250	20.8	31.1
OR-082	02OR-273	46CR02F	7/23/03	1,331	992	74.5	966	72.6	950	71.4	95.8
Totals				218,346	195,689	.	187,860	.	180,205	.	.
Averages				4,852 <sup>b</sup>	4,349 <sup>b</sup>	89.6	4,175 <sup>b</sup>	86.0	4,005 <sup>b</sup>	82.5	92.1

<sup>a</sup> Numbers of eggs, eggs hatched, and fish tanked are estimates. Error inherent in the estimates can result in anomalous results such as more fry tanked than there were eyed eggs. <sup>b</sup> Averages derived from the number of females spawned (n = 45), not the number of family groups.

### *Spawning & Production- Captive Broodstock*

Captive-origin females from BML were spawned with natural-origin males at Livingston Stone NFH June 23 through August 5 (Table 9, Figure 2). Spawn timing of captive-origin females was much more truncated than that observed in natural-origin females. A total of 99 captive-origin female and 21 natural-origin male winter Chinook salmon were spawned producing 99 family groups (Table 9). Females produced an average of 1,421 green eggs yielding a total of 140,641 green eggs with 70.0% of these developing into eyed eggs (Table 9). The percent of green eggs that hatched averaged 54.3%, and 50.2% of the green eggs resulted in juveniles that were transferred to rearing tanks (Table 9).

To estimate fecundity and gamete viability, and evaluate maturation rates of captive winter Chinook salmon reared entirely in fresh water, captive-origin females were spawned with captive-origin males July 10 through August 12 (Table 10). A total of 24 captive-origin female and 24 captive-origin male winter Chinook were spawned producing 24 family groups (Table 10). Females produced an average of 1,469 green eggs yielding a total of 35,259 green eggs and 30,688 eyed-eggs (Table 10). Percent eye-up ranged from 29.8% to 99.6% and averaged 87.0% (SD 19.2%) across family groups (Table 10). All eyed eggs resulting from captive-origin × captive-origin crosses were euthanized.

Table 9. Early survival of eggs and fry from winter Chinook salmon crosses of captive-brood females raised at Bodega Bay Marine Lab and natural-origin males, 2003.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled <sup>b</sup>	Number Hatched	Percent Green Eggs Hatched	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male											
425F7F080F	OR-047	B1T	6/23/03	1,981	1,893	95.6	0	1,250	63.1	1,033	52.1	54.6
42620C7354	OR-067	B2CC	7/1/03	1,186	1,051	88.6	0	659	55.6	505	42.6	48.0
4262017238	OR-069	B3BB	7/1/03	1,281	1,226	95.7	0	1,178	92.0	981	76.6	80.0
4262075A16	OR-069	B4BB	7/1/03	1,540	1,520	98.7	0	1,450	94.2	1,388	90.1	91.3
4259012164	OR-069	B5BB	7/1/03	1,428	1,357	95.0	0	1,155	80.9	1,125	78.8	82.9
4259123860	OR-057	B6Q	7/1/03	1,242	1,170	94.2	0	1,127	90.7	1,109	89.3	94.8
4262105243	OR-057	B7Q	7/1/03	1,570	1,542	98.2	0	1,446	92.1	1,325	84.4	85.9
4259155439	OR-047	B8T	7/1/03	1,804	1,748	96.9	0	1,705	94.5	1,605	89.0	91.8
4259292D78	OR-047	B9T	7/1/03	1,321	1,252	94.8	0	1,006	76.2	647	49.0	51.7
42594A4F33	W-294	B10S	7/1/03	1,815	1,742	96.0	0	1,663	91.6	1,586	87.4	91.0
4261797C0E	W-294	B11S	7/1/03	1,692	1,570	92.8	0	953	56.3	785	46.4	50.0
4259356049	W-294	B12S	7/1/03	1,569	1,549	98.7	0	1,509	96.2	1,492	95.1	96.3
42587E4F20	OR-009	B13O	7/1/03	1,950	1,709	87.6	0	1,561	80.1	1,523	78.1	89.1
NO TAG	OR-009	B14O	7/1/03	1,804	1,707	94.6	0	1,618	89.7	1,598	88.6	93.6
425F7FE5B	W-279	B15Z	7/1/03	1,388	1,333	96.0	0	1,275	91.9	1,135	81.8	85.1
4259153E31	W-279	B16Z	7/1/03	1,755	1,689	96.2	0	1,173	66.8	1,025	58.4	60.7
4259324035	W-279	B17Z	7/7/03	1,398	1,321	94.5	0	1,198	85.7	1,164	83.3	88.1
42590F0E10	W-279	B18Z	7/7/03	1,198	1,134	94.7	0	1,108	92.5	1,055	88.1	93.0
42617E1B06	W-279	B19Z	7/7/03	1,530	1,406	91.9	0	885	57.8	836	54.6	59.5
4260091341	W-279	B20Z	7/7/03	1,243	1,164	93.6	965	965	77.6	0	0.0	0.0
42617F7039	OR-054	B21M	7/7/03	1,597	1,525	95.5	0	1,446	90.5	1,463	91.6	95.9
4261572650	OR-054	B22M	7/7/03	1,319	1,298	98.4	0	1,219	92.4	1,183	89.7	91.1
426555545B	OR-054	B23M	7/7/03	1,232	1,145	92.9	0	1,031	83.7	995	80.8	86.9

Table 9—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled <sup>b</sup>	Number Hatched	Percent Green Eggs Hatched	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male											
4262044E01	OR-054	B24M	7/7/03	1,615	1,609	99.6	0	1,551	96.0	1,584	98.1	98.4
42587D7E0D	OR-054	B25M	7/7/03	1,928	1,562	81.0	0	1,195	62.0	1,130	58.6	72.3
425F766549	OR-054	B26M	7/7/03	1,018	771	75.7	0	599	58.8	582	57.2	75.5
4261637414	W-277	B27FF	7/7/03	1,474	1,227	83.2	0	1,000	67.8	803	54.5	65.4
NO TAG	W-277	B28FF	7/7/03	1,171	1,146	97.9	0	1,056	90.2	1,042	89.0	90.9
42645C2478	W-277	B29FF	7/7/03	1,304	1,287	98.7	0	1,246	95.6	1,188	91.1	92.3
4259416A2D	W-277	B30FF	7/7/03	1,574	1,531	97.3	0	1,404	89.2	1,400	88.9	91.4
4259584E1B	W-277	B31FF	7/7/03	1,157	1,043	90.1	0	748	64.6	724	62.6	69.4
42593F1C21	W-277	B32FF	7/7/03	1,160	1,113	95.9	0	1,034	89.1	1,035	89.2	93.0
4258762923	OR-031	B33GG	7/7/03	1,366	1,316	96.3	0	937	68.6	885	64.8	67.2
4259231F01	OR-031	B34GG	7/7/03	1,517	1,451	95.6	0	1,126	74.2	1,072	70.7	73.9
42620D267E	OR-031	B35GG	7/7/03	1,070	1,036	96.8	0	955	89.3	936	87.5	90.3
42592B7902	OR-031	B36GG	7/14/03	1,350	1,318	97.6	400	829	61.4	863	63.9	94.0
4262090819	OR-031	B37GG	7/14/03	1,057	926	87.6	0	638	60.4	659	62.3	71.2
4258714926	OR-031	B38GG	7/14/03	1,788	1,663	93.0	300	656	36.7	687	38.4	50.4
42600D0A56	OR-031	B39GG	7/14/03	1,069	897	83.9	0	421	39.4	396	37.0	44.1
425F71746B	OR-031	B40GG	7/14/03	1,334	1,266	94.9	400	644	48.3	602	45.1	69.5
42594E2C52	OR-031	B41GG	7/14/03	1,863	1,717	92.2	800	852	45.7	761	40.8	83.0
425820132E	OR-017	B42B cryo	7/14/03	1,822	1,493	81.9	500	903	49.6	763	41.9	76.8
4259396854	OR-017	B43B cryo	7/14/03	1,610	1,279	79.4	350	876	54.4	807	50.1	86.9
4261617C35	OR-017	B44B cryo	7/14/03	1,339	1,027	76.7	100	529	39.5	569	42.5	61.4
426003155F	OR-001	B45I cryo	7/14/03	1,281	775	60.5	0	386	30.1	362	28.3	46.7
42615F3811	OR-001	B46I cryo	7/14/03	1,983	1,543	77.8	600	865	43.6	744	37.5	78.9
42616E2D39	OR-001	B47I cryo	7/14/03	911	620	68.1	0	457	50.2	355	39.0	57.3

Table 9—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled <sup>b</sup>	Number Hatched	Percent Green Eggs Hatched	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male											
425F5E3203	W-277	B48FF	7/14/03	1,462	1,231	84.2	300	562	38.4	480	32.8	51.6
426176536E	W-277	B49FF	7/14/03	1,213	1,197	98.7	300	688	56.7	536	44.2	59.8
4262064537	W-277	B50FF	7/14/03	1,114	977	87.7	0	716	64.3	662	59.4	67.8
4256333A12	W-258	B51D cryo	7/14/03	1,569	1,013	64.6	100	711	45.3	482	30.7	52.8
425F5E6113	W-258	B52D cryo	7/14/03	1,188	723	60.9	0	434	36.5	425	35.8	58.8
42587A5637	W-258	B53D cryo	7/14/03	1,606	677	42.2	0	652	40.6	643	40.0	95.0
425F70076C	OR-018	B54C cryo	7/14/03	1,849	756	40.9	0	599	32.4	574	31.0	75.9
42616D427B	OR-018	B55C cryo	7/14/03	1,177	572	48.6	0	397	33.7	383	32.5	67.0
4259302028	OR-018	B56C cryo	7/14/03	1,556	341	21.9	0	300	19.3	372	23.9	109.1 <sup>a</sup>
4259251D5E	W-298	B57F cryo	7/21/03	1,476	0	0.0	0	0	0.0	0	0.0	0.0
42600D0941	W-298	B58F cryo	7/21/03	1,145	727	63.5	0	597	52.1	634	55.4	87.2
NO TAG	W-298	B59F cryo	7/21/03	1,636	1,180	72.1	300	597	36.5	545	33.3	61.9
425900386B	W-276	B60H cryo	7/21/03	1,584	805	50.8	0	515	32.5	400	25.3	49.7
426167562F	W-276	B61H cryo	7/21/03	1,447	966	66.8	0	912	63.0	887	61.3	91.8
4259184B43	W-276	B62H cryo	7/21/03	1,417	999	70.5	0	681	48.1	568	40.1	56.9
4261783A4D	OR-035	B63L cryo	7/21/03	911	384	42.2	0	340	37.3	305	33.5	79.4
4261675122	OR-035	B64L cryo	7/21/03	1,043	702	67.3	0	545	52.3	489	46.9	69.7
4259475C15	OR-035	B65L cryo	7/21/03	1,810	573	31.7	0	506	28.0	485	26.8	84.6
4259036E31	OR-050	B66K cryo	7/21/03	1,798	664	36.9	0	649	36.1	634	35.3	95.5
42591A2A7D	OR-050	B67K cryo	7/21/03	946	593	62.7	0	524	55.4	484	51.2	81.6
426157507A	OR-050	B68K cryo	7/21/03	1,290	357	27.7	0	344	26.7	339	26.3	95.0

Table 9—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled <sup>b</sup>	Number Hatched	Percent Green	Number Tanked	Percent Tanked from Green	Percent Tanked from Eyed
Female	Male								Eggs Hatched		Eggs	Eggs
4259274041	W-286	B69N cryo	7/21/03	1,444	12	0.8	0	11	0.8	10	0.7	83.3
42646A6625	W-286	B70N cryo	7/21/03	1,306	28	2.1	0	21	1.6	18	1.4	64.3
425932016F	W-286	B71N cryo	7/21/03	1,520	10	0.7	0	9	0.6	8	0.5	80.0
425879340A	OR-051	B72J cryo	7/21/03	1,199	907	75.6	0	776	64.7	662	55.2	73.0
4262044764	OR-051	B73J cryo	7/21/03	1,249	720	57.6	0	692	55.4	668	53.5	92.8
4259023B1B	OR-051	B74J cryo	7/21/03	1,542	1,099	71.3	200	876	56.8	864	56.0	96.1
4261752703	OR-009	B75O cryo	7/21/03	1,629	884	54.3	0	666	40.9	620	38.1	70.1
4259424D50	OR-009	B76O cryo	7/21/03	1,646	1,059	64.3	200	681	41.4	616	37.4	71.7
42600C2F78	OR-009	B77O cryo	7/21/03	1,369	1,113	81.3	250	656	47.9	589	43.0	68.3
4259463104	OR-054	B78M cryo	7/21/03	1,610	776	48.2	0	745	46.3	738	45.8	95.1
42586C030E	OR-054	B79M cryo	7/21/03	1,331	420	31.6	0	365	27.4	366	27.5	87.1
4258761421	OR-054	B80M cryo	7/21/03	1,456	1,032	70.9	100	859	59.0	837	57.5	89.8
4260144072	OR-057	B81Q cryo	7/21/03	1,974	1,362	69.0	500	835	42.3	737	37.3	85.5
4259074933	OR-057	B82Q cryo	7/21/03	1,030	382	37.1	0	198	19.2	164	15.9	42.9
4261762544	OR-057	B83Q cryo	7/21/03	1,628	944	58.0	0	927	56.9	928	57.0	98.3
425F5F2673	OR-067	B84CC cryo	7/21/03	1,612	676	41.9	0	532	33.0	501	31.1	74.1
4262110C38	OR-067	B85CC cryo	7/21/03	1,140	296	26.0	0	205	18.0	170	14.9	57.4
42600C3C11	OR-067	B86CC cryo	7/21/03	1,458	196	13.4	0	183	12.6	180	12.3	91.8
42633D2742	OR-067	B87CC cryo	7/21/03	1,301	561	43.1	0	472	36.3	437	33.6	77.9
4261612557	W-279	B88Z cryo	7/29/03	1,501	232	15.5	0	215	14.3	208	13.9	89.7
4259165A22	W-279	B89Z cryo	7/29/03	1,165	665	57.1	0	488	41.9	365	31.3	54.9
4259510570	W-279	B90Z cryo	7/29/03	1,119	611	54.6	0	554	49.5	540	48.3	88.4
425F64553F	OR-069	B91BB cryo	7/29/03	1,128	392	34.8	0	248	22.0	212	18.8	54.1

Table 9—cont.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Eyed Eggs Culled <sup>b</sup>	Number Hatched	Percent Green	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked From Eyed Eggs
Female	Male								Eggs Hatched		Eggs	
4261574004	OR-069	B92BB cryo	7/29/03	921	294	31.9	0	257	27.9	251	27.3	85.4
426159757C	OR-069	B93AA cryo	7/29/03	1,176	1,005	85.5	0	573	48.7	537	45.7	53.4
4262031528	OR-070	B94AA cryo	7/29/03	1,801	1,523	84.6	523	882	49.0	865	48.0	86.5
4259091060	OR-070	B95AA cryo	7/29/03	1,534	608	39.6	0	481	31.4	465	30.3	76.5
4259135452	W-294	B96S cryo	8/5/03	360	0	0.0	0	0	0.0	0	0.0	0.0
NO TAG	W-294	B97S cryo	8/5/03	1,848	939	50.8	0	790	42.7	765	41.4	81.5
4261670D79	not ripe	B98 green	8/5/03	0	0	0.0	0	0	0.0	0	0.0	0.0
4261696274	OR-047	B99T cryo	8/5/03	1,727	820	47.5	0	798	46.2	793	45.9	96.7
4258793010	OR-047	B100T cryo	8/5/03	1,076	762	70.8	0	643	59.8	599	55.7	78.6
Totals				140,641	98,432	.	7,188	76,394	.	70,547	.	.
Averages				1,421 <sup>c</sup>	994 <sup>c</sup>	70.0	.	772 <sup>c</sup>	54.3	713 <sup>c</sup>	50.2	71.7

<sup>a</sup> Numbers of eggs, eggs hatched, and fish tanked are estimated. Error inherent in the estimates can result in anomalous results such as more fry tanked than there were eyed eggs. <sup>b</sup> Eggs were culled to attain a desired production number from certain experimental crosses; <sup>c</sup> Averages derived from the number of females spawned (n = 99), not the number of family groups.

Table 10. Early survival of eggs from winter Chinook salmon crosses of captive brood females by captive brood males crosses, 2003. All eggs resulting from these crosses were euthanized.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed
Female	Male					
4261583028	4260B011B	L1	7/10/03	1,432	1,032	72.1
NO TAG	42660B6527	L2	7/10/03	2,186	1,976	90.4
425F724B2E	42616C317C	L3	7/21/03	1,403	1,715	122.2 <sup>a</sup>
425F653646	42617C317C	L4	7/21/03	1,264	1,241	98.2
4263232859	4259444802	L5	7/21/03	1,448	946	65.3
42595E3D63	425F7E3B71	L6	7/21/03	1,372	1,095	79.8
42600C250A	4259456449	L7	7/21/03	1,473	1,400	95.0
426462634B	4260004305	L8	7/21/03	1,471	1,182	80.4
4260164D6A	4258774725	L9	7/21/03	1,687	1,585	94.0
4260044309	42620B011B	L10	7/21/03	1,125	1,053	93.6
4259436B69	42617E3E3C	L11	7/21/03	819	746	91.1
NO TAG	4261635623	L12	7/29/03	1,184	1,130	95.4
42591A7C54	425F772524	L13	7/29/03	1,970	1,835	93.1
425F3E0E54	42586B4A6D	L14	7/29/03	1,956	1,897	97.0
42620A0B7D	4266052F10	L15	7/29/03	1,970	1,889	95.9
4260011E69	4258774725	L16	7/29/03	1,388	1,278	92.1
42600B5D37	NO TAG	L17	7/29/03	1,212	864	71.3
42591D1B5C	42617E3E3C	L18	7/29/03	1,383	1,349	97.5
42620B3D3A	42617F457D	L19	7/29/03	1,334	432	32.4
NO TAG	4258774725	L20	8/5/03	1,868	1,725	92.3
4260137C2C	4258774725	L21	8/5/03	1,494	1,304	87.3
426204314E	42586B416D	L22	8/5/03	1,877	1,870	99.6
425917420E	4266052F10	L23	8/5/03	1,281	947	73.9
407F252239	4258774725	L24	8/12/03	662	197	29.8
Totals				35,259	30,688	
Averages				1,469	1,279	87.0

<sup>a</sup> Numbers of green and eyed eggs are estimated. Error inherent in the estimates can result in anomalous results such as more eyed-eggs than there were green eggs.

## **Progeny**

### *Rearing*

Between the dates of initial feeding (July 15, 2003) and release (February 5, 2004), progeny of non-captive parents were fed a total of 1,767 pounds of fish feed, resulting in a total weight gain by the fish of 1,932 pounds (food conversion rate of 0.91). The average length increase of the fish from time of initial feeding to release was 48 mm.

Between the dates of initial feeding (August 9, 2003) and release (February 5, 2004), progeny of captive-females were fed a total of 707 pounds of fish feed, resulting in a total weight gain by the fish of 763 pounds (food conversion rate of 0.93). The average length increase of the fish from time of initial feeding to release was 50 mm.

### *Marking and Tagging*

Coded-wire tagging of juvenile winter Chinook occurred between December 18, 2003 and January 9, 2004. At the time of tagging, adipose fins were removed from all fish so they could easily be identified as hatchery-origin fish upon return. Juveniles tagged and marked included: 125,186 natural-origin × natural-origin progeny, 25,892 natural-origin × hatchery-origin progeny, and 65,569 captive-origin × natural-origin progeny (Table 4). Mortality rates for all three groups were 0.2% or less. Juveniles retained for the Livingston Stone NFH captive broodstock program (n = 217) were tagged with passive integrated transponder (PIT) tags.

### *Health*

Juvenile progeny of all broodstock types (Sacramento River, Livingston Stone NFH, BML) were combined and tested for seven different pathogens. Results were negative for all (Table 7).

### *Released*

A total of 218,517 juvenile winter Chinook were released at Caldwell Park (river mile 299) on February 5, 2004. Most (58 %) of the fish released were from natural-origin × natural-origin parents, 12% were from natural-origin × hatchery-origin crosses and 30% were captive-origin × natural-origin crosses.

## **Assessment of Potential Genetic Impacts**

When brood year 2003 hatchery propagation data was applied to the population genetics model (Hedrick et al. 1995), the model indicated loss of genetic variation due to genetic drift was not likely to occur (Attachment A). Under the scenario that 10% of the naturally-spawning population was successful at producing progeny, the hatchery program increased the effective population size from 822 to 862 spawners. Under the scenario that 33% of the population was successful at producing progeny, the hatchery program increased the effective population size from 2,737 to 2,840 individuals.

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**Attachment A-- Brood Year 2003 Effective Population Size Methodology, Estimates, and Assumptions**

(Note: In the event of a data discrepancy, data presented in the Propagation Report supercedes data in the following attachment.)