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2004 Annual Report of Winter Chinook Propagation Activities

A U.S. Fish & Wildlife Service Report

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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 2004 marks the fourth 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 2004, 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 collected. In 2004, 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 Dam fish trap (river mile 302) 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 primary trap used in 2004 and was operated by Service personnel. In 2004, the Keswick Dam trap was fished only during daylight hours in response to nocturnal otter predation that began toward the latter part of broodyear 2003 collections. The Red Bluff Diversion Dam (RBDD) fish trap (river mile 243) was operated by the California Department of Fish and Game, and was a secondary source of broodstock. The RBDD trap can only be operated when the dam gates are lowered which typically occurs from May 15 – September 15.

Handling & 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 carbon dioxide 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.

Salmon trapped at the Red Bluff Diversion Dam trap were anesthetized with carbon dioxide and sorted to run type based on phenotypic characteristics. Phenotypic winter Chinook were netted from the trap and placed in a flow-through retention tube until transport to Livingston Stone NFH. Phenotypic non-winter Chinook were released on-site.

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 the Service's Abernathy Fish Technology Center. 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 the Abernathy Fish Technology Center .

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 the 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. Tricaine 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_a) 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_a 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 three males received LH-RH_a 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, 2004.

Tag Number	Date Captured	Fork Length (mm)	Weight (lbs)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-136	2/4/04	758	12.4	6/3/04	6/3/04	119	0.6	3	n/a	0	32
OR-196	2/18/04	658	8.44	PSM ^a	2/27/04	8	n/a ^b	0	n/a	0	2
OR-183	2/18/04	810	14.8	PSM ^a	3/3/04	13	n/a	0	n/a	0	4
OR-188	2/18/04	811	17.25	PSM ^a	3/3/04	13	n/a	0	n/a	0	4
OR-182	2/18/04	750	12.3	PSM ^a	3/8/04	18	n/a	0	n/a	0	5
OR-181	2/18/04	761	13.9	7/5/04	7/5/04	137	0.6	3	n/a	0	38
OR-208	3/23/04	849	18	5/19/04	5/19/04	56	0.7	1	150	2	15
OR-218	3/23/04	780	14.9	6/10/04	6/10/04	78	0.7	3	n/a	0	22
OR-210	3/23/04	794	14.75	6/24/04	6/24/04	92	0.6	3	150	1	26
OR-205	3/23/04	770	14.6	7/1/04	7/1/04	99	0.6	2	150	2	28
OR-271	3/31/04	840	18.8	PSM ^a	4/22/04	21	n/a	0	150	2	7
OR-265	3/31/04	748	15.3	6/17/04	6/17/04	77	0.6	3	150	1	22
OR-258	3/31/04	800	16.04	7/5/04	7/5/04	95	0.7	3	150	2	27
OR-411	4/13/04	848	17.8	5/19/04	5/19/04	35	0.7	1	n/a	0	9
OR-399	4/13/04	808	15.3	5/24/04	5/24/04	40	0.7	2	150	2	11
OR-366	4/13/04	810	15.7	5/24/04	5/24/04	40	0.7	2	150	2	11
OR-379	4/13/04	745	11.2	5/31/04	5/31/04	47	0.5	1	150	1	12
OR-394	4/13/04	775	12.8	6/14/04	6/14/04	61	0.6	3	150	4	17
OR-401	4/13/04	745	12.5	6/14/04	6/14/04	61	0.6	3	150	1	17
OR-393	4/13/04	881	23.3	6/14/04	6/14/04	61	0.7	3	150	4	17
OR-377	4/13/04	790	14.6	6/17/04	6/17/04	64	0.6	3	150	1	18
OR-381	4/13/04	785	14.3	6/17/04	6/17/04	64	0.6	3	150	1	18
OR-369	4/13/04	708	11.4	6/24/04	6/24/04	71	0.5	3	150	5	20
OR-373	4/13/04	781	12.9	6/24/04	6/24/04	71	0.6	3	150	1	20
OR-378	4/13/04	823	14.8	6/24/04	6/24/04	71	0.6	3	150	1	20
OR-407	4/13/04	758	11.4	6/28/04	6/28/04	75	0.5	3	150	1	21
OR-397	4/13/04	784	13.7	6/28/04	6/28/04	75	0.6	3	150	2	21
OR-382	4/13/04	810	14.1	7/1/04	7/1/04	78	0.6	3	n/a	0	11
OR-389	4/13/04	718	10.9	7/8/04	7/8/04	85	0.5	3	150	1	24

Table 2 (cont.)

Tag Number	Date Captured	Fork Length (mm)	Weight (lbs)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Number	
OR-384	4/13/04	767	12.6	7/8/04	7/8/04	85	0.6	3	150	2	24
OR-409	4/13/04	778	14.3	7/13/04	7/13/04	90	0.6	3	150	2	26
OR-433	4/27/04	774	14.1	7/5/04	7/5/04	68	0.6	2	150	2	19
OR-472	5/4/04	677	9.5	6/14/04	6/14/04	40	0.4	2	150	1	11
W-096	5/25/04	740	16.38	5/27/04	5/27/04	1	n/a	0	n/a	0	0
W-201	6/8/04	637	11.26	6/10/04	6/10/04	1	n/a	0	n/a	0	0
W-208	6/8/04	800	16.6	6/17/04	6/17/04	8	0.7	1	150	2	2
W-205	6/8/04	785	13.2	6/28/04	6/28/04	19	0.6	1	150	2	5
W-204	6/8/04	738	11.7	7/1/04	7/1/04	22	0.5	0	n/a	0	6
W-292	6/8/04	735	11.4	7/9/04	7/9/04	30	0.5	1	150	4	9
W-297	6/15/04	777	11.44	6/28/04	6/28/04	12	0.5	1	150	2	3
W-349	7/9/04	780	11.5	7/13/04	7/13/04	3	n/a	0	n/a	0	0
W-350	7/9/04	805	15.9	7/26/04	7/26/04	16	n/a	0	150	2	4

^a Pre-spawn mortality; ^b not applicable

Table 3. Spawning and drug treatment history of individual male Chinook salmon held at Livingston Stone National Fish Hatchery, 2004.

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-154	2/18/04	810	20.5	PSM ^a	3/8/04	18	n/a ^b	none	n/a	none	5
OR-171	2/18/04	800	16.88	PSM ^a	3/8/04	18	n/a	none	n/a	none	5
OR185,186	2/18/04	930	27.7	PSM ^a	3/10/04	20	n/a	none	n/a	none	6
OR-216	3/23/04	870	20.65	6/14/04	7/4/04	102	n/a	none	n/a	none	29
OR395	3/31/04	878	20	6/17/04 6/24/04 5/19/04	6/2/04	62	n/a	none	150	2	16
OR-273	3/31/04	853	18	5/24/04 5/31/04 6/10/04	6/14/04	74	n/a	none	150	1	21
OR-269	3/31/04	545	4.96	6/14/04 6/17/04	7/22/04	112	n/a	none	n/a	none	30
OR-320	4/6/04	562	6.24	6/24/04 PSM ^a	5/21/04	44	n/a	none	150	1	11
OR-314	4/6/04	571	5.24	6/17/04	7/21/04	105	n/a	none	n/a	none	29
OR-315	4/6/04	526	4.4	6/24/04 7/1/04	7/28/04	112	n/a	none	n/a	none	32
OR-400	4/13/04	578	5.1	7/5/04 6/28/04	7/25/04	102	n/a	none	n/a	none	29
OR-372	4/13/04	829	15.5	7/1/04 6/28/04	7/25/04	102	n/a	none	n/a	none	29
OR-469	5/4/04	921	19.75	6/28/04	7/23/04	79	n/a	none	n/a	none	23
OR-402	4/13/04	555	5.1	7/1/04	7/29/04	106	n/a	none	n/a	none	30
OR-370	4/13/04	788	15.3	7/5/04 7/9/04 7/1/04	7/23/04	100	n/a	none	n/a	none	29

Table 3 (cont.)

Tag Number	Date Captured	Fork Length (mm)	Weight (lbs)	Date Spawned	Date Died	Days in Captivity	Erythromycin		LH-RHa		No. of Malachite Green Treatments
							Dose (ml)	Injections	Dose (ml)	Injections	
OR-406	4/13/04	508	3.6	6/24/04 6/28/04	7/23/04	100	n/a	none	n/a	none	18
OR-386	4/13/04	580	5.6	6/24/04 6/24/04	7/15/04	92	n/a	none	n/a	none	26
OR-270	4/13/04	856	16.8	5/19/04	5/22/04	38	n/a	none	150	1	10
OR-398	4/13/04	830	15.4	5/24/04 6/3/04 6/24/04	7/2/04	79	n/a	none	n/a	none	21
OR-385	4/13/04	825	16.5	5/24/04 5/27/04	6/9/04	56	n/a	none	150	3	16
OR-391	4/13/04	561	4.92	5/31/04 6/3/04	6/14/04	61	n/a	none	n/a	none	16
OR-383	4/13/04	590	6.1	PSM ^a	4/30/04	16	n/a	none	150	1	11
OR-405	4/13/04	866	19.3	6/10/04 6/14/04	6/14/04	61	n/a	none	150	1	17
OR-418	4/20/04	630	7.4	6/10/04 6/14/04	7/4/04	74	n/a	none	150	1	20
OR-421	4/20/04	548	4.8	6/14/04 6/17/04	7/15/04	85	n/a	none	150	1	23
OR-376	4/13/04	850	18.2	7/5/04 7/10/04	7/29/04	106	n/a	none	150	1	30
OR-388	4/13/04	515	3.8	7/10/04 7/13/04 5/19/04	7/21/04	98	n/a	none	150	1	27
OR-455	4/27/04	578	4.8	6/14/04 6/14/04	7/4/04	67	n/a	none	n/a	none	19
OR-444	4/27/04	580	5.1	PSM ^a	5/24/04	26	n/a	none	150	1	7
OR-476	5/4/04	629	7.2	7/5/04	7/22/04	78	n/a	none	150	1	20
OR-475	5/4/04	637	7.3	7/5/04 7/10/04	7/23/04	79	n/a	none	150	1	23

Table 3 (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-471	5/4/04	575	5.3	6/10/04 6/14/04	7/8/04	64	n/a	none	n/a	none	18
W-005	5/5/04	608	6.4	6/17/04 6/17/04	6/20/04	45	n/a	none	150	1	13
W-044	5/11/04	758	11.1	5/19/04 5/27/04	6/8/04	27	n/a	none	n/a	none	8
W-100	5/25/04	621	7.26	PSM ^a	6/11/04	16	n/a	none	150	1	4
W-121	5/25/04	597	6.74	7/10/04 7/13/04	7/28/04	63	n/a	n/a	n/a	1	18
W-111	5/25/04	594	6.3	6/14/04	6/16/04	21	n/a	none	n/a	none	6
W-101	5/25/04	624	6.92	6/17/04 6/28/04	7/13/04	48	n/a	none	n/a	none	14
W-280	6/8/04	542	4.36	6/24/04 6/28/04	7/20/04	41	n/a	none	n/a	none	10
W-334	6/22/04	481	2.7	6/28/04 7/1/04	7/13/04	20	n/a	none	n/a	none	6
W-366	7/9/04	580	4.3	7/13/04	7/23/04	13	n/a	none	n/a	none	3
W-351	7/9/04	600	4.86	7/13/04 7/26/04	7/27/04	17	n/a	none	n/a	none	5
W-438	7/22/04	610	5.12	7/26/04	8/2/04	10	n/a	none	n/a	none	2

^a Pre-spawn mortality; ^b 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.

Marking and Tagging

All winter Chinook juveniles were coded-wire tagged between December 20, 2004 and January 10, 2005. Each of the 13 natural-origin by natural-origin family group combinations received a unique tag code as did three hatchery-origin by natural-origin family group combinations and the one captive-origin by natural-origin family group combination (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 2004 winter Chinook salmon released by coded-wire tag (CWT) code, family group, and parental origin.

Tag Code	Family Group	Parental Origin ^a	Number Tagged	Tagging Mortalities	Proportion	Tagged	Number Released	Avg. Fork Len. (mm)	Min. Fork Len. (mm)	Max. Fork Len. (mm)
					Tags Retained	Fish Released				
051681	4D, 7D, 7F, 8G	N x N	9,551	7	0.730	6,967	9,544	90.2	62	105
051683	6F, 10K, 9J, 12J	N x N	8,681	11	0.710	6,156	8,670	89.6	73	109
051684	13N, 20M, 14N, 21T	N x N	8,719	8	0.878	7,648	8,711	86.3	65	105
051685	17K, 19P, 25Y, 28BB	N x N	8,838	3	0.897	7,925	8,835	83.9	61	97
051686	19T, 26W, 35II, 27Z, 32FF	N x N	8,788	21	0.845	7,408	8,767	82.0		
051687	1A, 2A, 12G, 13M	N x N	10,012	4	0.733	7,339	10,008	89.7	68	107
051688	1B, 3B, 6B, 22U, 21U	N x N	9,075	6	0.908	8,238	9,069	85.2	46	103
051689	29CC, 35HH, 11L, 16Q	N x N	8,535	2	0.853	7,281	8,533	84.7	64	102
051690	25X, 26V, 15O, 17Q	N x N	8,591	7	0.840	7,211	8,584	87.4	63	113
051691	32DD, 29BB, 2C, 2E	N x N	9,042	7	0.905	8,177	9,035	86.1	67	110
051693	20O, 22V, 30AA, 30DD	N x N	8,781	17	0.933	8,180	8,764	80.9	67	98
051694	27AA, 28V, 36GG, 36FF	N x N	9,601	4	0.917	8,797	9,597	79.3	56	109
051696	16R, 15P, 33GG, 33EE	N x N	8,421	18	0.846	7,108	8,403	81.8	64	115
			Subtotal	115		98,435	116,520			
051692	31Z, 31EE, 23W, 24S	H x N	9,034	41	0.910	8,184	8,993	79.9	60	95
051695	23R, 24X, 37II, 37JJ	H x N	9,255	2	0.840	7,775	9,253	79.2	63	102
052476	5C, 5E, 8H, 9I, 10H, 11I	H x N	13,719	100	0.810	11,031	13,619	77.7	50	102
			Subtotal	143		26,990	31,865			
052477	LSNFH 1-4, LSNFH 6-45	C x N	19,914	38	0.938	18,650	19,876	70.7	51	89
			Subtotal	38		18,650	19,876			

^a "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 2004. 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 Chinook genetically identified as winter-run was captured on January 7 and the last on July 29 (Table 5, Figure 1). Winter-run Chinook were collected at a relatively constant rate during April and May (Table 5, Figure 1) and non-winter-run were collected at a relatively constant rate throughout the entire collection period (Table 5, Figure 1). A total of 706 Chinook salmon were captured from the Keswick Dam trap and one from the RBDD trap (Table 6). Just under half (49.0%) of the fish captured were identified as winter-run. Females comprised 19.7% ($n = 68$) of the winter Chinook salmon captured and males comprised 80.3% ($n = 278$). Hatchery-origin fish comprised 64.7% of the winter Chinook captured and 56.9% of all the Chinook captured.

Two-hundred and forty winter Chinook and 63 non-winter-run Chinook, were collected and released without being quarantined as were 199 Chinook of undetermined run (Table 6). All non-quarantined fish, except those of undetermined run, were tissue sampled. Fifty-nine Chinook were held in quarantine and later released back into the Sacramento River; 21 of these fish were winter-run and 38 were non-winter-run (Table 6). Quarantined fish were held for no more than 6 days. Eighty-five winter Chinook salmon were retained for broodstock. Among these, 73 were spawned and 12 died before they could be spawned. Among the non-winter Chinook captured, forty-three were transferred to Coleman NFH for use in the late-fall Chinook broodstock program, there was one pre-spawn mortality, and 16 were euthanized.

Late in the brood year 2004 trapping season, approximately 20 live Chinook salmon were observed in the Keswick trap. The next morning when the trap was emptied, no Chinook were present. Video surveillance equipment was subsequently installed and it was confirmed that river otters were entering the trap at night. It was not possible to provide a reasonable estimate of how many Chinook salmon may have been lost to otter predation. The trap was modified to include a gate that prevented entry of otters and fish into the trap. Because otters are primarily nocturnal predators, the gate was closed during the night but opened during the day so Chinook could be trapped. Based on direct observations and video surveillance following implementation of these measures, no otters were observed entering the trap and there was no further evidence of otter predation.

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
1/7/04	80001	R-04383	Present	Female	840	Non-Winter	Transferred CNFH
1/7/04	80002	OR-083	Absent	Male	920	Non-Winter	Sacrificed
1/7/04	80003	R-04384	Absent	Male	590	Non-Winter	Sacrificed
1/7/04	80004	R-04385	Absent	Male	728	Non-Winter	DIP
1/7/04	80005	R-04386	Present	Male	1000	Non-Winter	Transferred CNFH
1/7/04	80006	R-04387	Present	Female	840	Non-Winter	Transferred CNFH
1/7/04	80007	R-04388	Present	Female	900	Non-Winter	Released
1/7/04	80008	R-04389	Absent	Female	700	Non-Winter	Sacrificed
1/7/04	80009	R-04390	Present	Male	670	Non-Winter	Transferred CNFH
1/7/04	80010	R-04391	Absent	Male	708	Non-Winter	Sacrificed
1/7/04	80011	R-04392	Present	Male	470	Non-Winter	Transferred CNFH
1/7/04	80012	R-04393	Present	Female	940	Non-Winter	Transferred CNFH
1/14/04	80013	R-04394	Absent	Male	723	Non-Winter	Sacrificed
1/14/04	80014	R-04395	Absent	Male	843	Non-Winter	Sacrificed
1/14/04	80015	R-04403	Absent	Female	710	Non-Winter	Sacrificed
1/14/04	80016	R-04406	Absent	Male	590	Non-Winter	Sacrificed
1/14/04	80701	R-04396	Present	Male	820	Non-Winter	Transferred CNFH
1/14/04	80702	R-04397	Present	Male	980	Non-Winter	Transferred CNFH
1/14/04	80703	R-04398	Present	Female	878	Non-Winter	Transferred CNFH
1/14/04	80704	R-04399	Present	Male	1070	Non-Winter	Transferred CNFH
1/14/04	80705	R-04400	Present	Male	1010	Non-Winter	Transferred CNFH
1/14/04	80706	R-04402	Present	Male	1070	Non-Winter	Transferred CNFH
1/14/04	80707	R-04404	Present	Male	1060	Non-Winter	Transferred CNFH
1/14/04	80708	R-04405	Present	Male	1060	Non-Winter	Transferred CNFH
1/21/04	80017	OR-094	Absent	Female	NA	Winter	Released
1/21/04	80709	OR-084	Present	Female	999	Non-Winter	Transferred CNFH
1/21/04	80710	OR-085	Present	Male	1150	Non-Winter	Transferred CNFH
1/21/04	80711	OR-086	Present	Female	902	Non-Winter ^a	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
1/21/04	80712	OR-089	Present	Male	1100	Non-Winter	Transferred CNFH
1/21/04	80713	OR-090	Present	Female	855	Non-Winter ^a	Released
1/21/04	80714	OR-092	Present	Male	1100	Non-Winter	Transferred CNFH
1/21/04	80715	OR-093	Present	Male	1100	Non-Winter	Transferred CNFH
1/27/04	80018	OR-096	Absent	Male	665	Non-Winter	Sacrificed
1/27/04	80019	OR-103	Absent	Male	730	Non-Winter	Sacrificed
1/27/04	80020	OR-108	Absent	Female	NA	Winter	Released
1/27/04	80021	OR-111	Absent	Female	800	Winter	Released
1/27/04	80022	OR-118	Absent	Female	730	Winter	Released
1/27/04	80023	OR-115	Absent	Male	1000	Non-Winter	Sacrificed
1/27/04	80716	OR-101	Present	Female	890	Non-Winter	Transferred CNFH
1/27/04	80717	OR-102	Present	Male	950	Non-Winter	Transferred CNFH
1/27/04	80718	OR-116	Present	Male	1020	Non-Winter	Transferred CNFH
1/27/04	80719	OR-117	Present	Male	690	Non-Winter	Transferred CNFH
1/27/04	80720	OR-104	Present	Female	860	Non-Winter ^a	Released
1/27/04	80721	OR-106	Present	Female	950	Non-Winter ^a	Released
1/27/04	80722	OR-109	Present	Female	1000	Unknown, PH	Released
1/27/04	80723	OR-113	Present	Female	1000	Non-Winter ^a	Released
2/4/04	80024	OR-123	Absent	Female	765	Winter	Released
2/4/04	80025	OR-124	Absent	Female	750	Winter	Released
2/4/04	80026	OR-126	Absent	Female	728	Winter	Released
2/4/04	80027	OR-128	Absent	Female	705	Non-Winter	Sacrificed
2/4/04	80028	OR-129	Absent	Male	745	Winter	Released
2/4/04	80029	OR-134	Absent	Male	825	Non-Winter	Sacrificed
2/4/04	80030	OR-135	Absent	Female	784	Winter	Released
2/4/04	80031	OR-136	Present	Female	740	Winter	Spawned
2/4/04	80032	OR-139	Absent	Female	760	Winter	Released
2/4/04	80724	OR-122	Present	Male	970	Non-Winter	Transferred CNFH
2/4/04	80725	OR-125	Present	Female	830	Non-Winter	Transferred CNFH
2/4/04	80726	OR-127	Present	Male	980	Non-Winter	Transferred CNFH
2/4/04	80727	OR-130	Present	Female	910	Non-Winter	Transferred CNFH
2/4/04	80728	OR-131	Present	Female	990	Non-Winter	Transferred CNFH
2/4/04	80729	OR-132	Present	Female	890	Non-Winter	Transferred CNFH
2/4/04	80730	OR-133	Present	Male	860	Non-Winter	Transferred CNFH
2/4/04	80731	OR-137	Present	Male	1000	Non-Winter	Transferred CNFH
2/4/04	80732	OR-138	Present	Male	1060	Non-Winter	Transferred CNFH
2/4/04	80733	OR-140	Present	Male	1110	Non-Winter	Transferred CNFH
2/18/04	80033	OR-154	Present	Male	835	Winter	DIP
2/18/04	80034	OR-163	Absent	Male	670	Non-Winter	Sacrificed
2/18/04	80035	OR-171	Present	Male	777	Winter	DIP
2/18/04	80036	OR-181	Present	Female	750	Winter	Spawned

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
2/18/04	80037	OR-182	Present	Female	740	Winter	DIP
2/18/04	80038	OR-183	Present	Female	780	Winter	DIP
2/18/04	80039	OR-185	Present	Male	930	Winter	DIP
2/18/04	80040	OR-188	Present	Female	811	Winter	DIP
2/18/04	80041	OR-196	Present	Female	665	Winter	DIP
2/18/04	80042	OR-197	Absent	Female	765	Non-Winter	Sacrificed
2/18/04	80043	OR-152	Absent	Female	780	Winter	Released
2/18/04	80044	OR-160	Absent	Female	670	Winter	Released
2/18/04	80045	OR-172	Absent	Male	820	Winter	Released
2/18/04	80046	OR-177	Absent	Female	690	Winter	Released
2/18/04	80047	OR-179	Absent	Male	550	Winter	Released
2/18/04	80048	OR-187	Absent	Male	740	Winter	Released
2/18/04	80049	OR-189	Absent	Male	760	Winter	Released
2/18/04	80050	OR-191	Absent	Male	710	Winter	Released
2/18/04	80051	OR-193	Absent	Male	630	Winter	Released
2/18/04	80052	OR-198	Absent	Female	730	Winter	Released
2/18/04	80053	OR-200	Absent	Male	590	Winter	Released
2/18/04	80054	OR-202	Absent	Male	601	Winter	Released
2/18/04	80734	OR-148	Present	Male	1010	Non-Winter	Transferred CNFH
2/18/04	80735	OR-150	Present	Male	1000	Non-Winter ^a	Released
2/18/04	80736	OR-155	Present	Female	1000	Non-Winter ^a	Released
2/18/04	80737	OR-157	Present	Male	1090	Non-Winter	Transferred CNFH
2/18/04	80738	OR-158	Present	Female	950	Non-Winter ^a	Released
2/18/04	80739	OR-164	Present	Female	990	Non-Winter ^a	Released
2/18/04	80740	OR-166	Present	Male	990	Non-Winter	Transferred CNFH
2/18/04	80741	OR-167	Present	Male	940	Non-Winter	Transferred CNFH
2/18/04	80742	OR-168	Present	Male	960	Non-Winter	Transferred CNFH
2/18/04	80743	OR-169	Present	Female	920	Non-Winter	Transferred CNFH
2/18/04	80744	OR-170	Present	Male	NA	Non-Winter	Transferred CNFH
2/18/04	80745	OR-174	Present	Female	980	Non-Winter ^a	Released
2/18/04	80746	OR-176	Present	Male	800	Non-Winter	Transferred CNFH
2/18/04	80747	OR-184	Present	Male	1010	Non-Winter	Transferred CNFH
2/18/04	80748	OR-195	Present	Male	990	Non-Winter	Transferred CNFH
3/23/04	80055	OR-205	Present	Female	850	Winter	Spawned
3/23/04	80056	OR-206	Present	Female	790	Non-Winter	Released
3/23/04	80057	OR-207	Present	Female	820	Non-Winter	Released
3/23/04	80058	OR-208	Present	Female	820	Winter	Spawned
3/23/04	80059	OR-209	Present	Male	730	Non-Winter	Released
3/23/04	80060	OR-210	Present	Female	775	Winter	Spawned
3/23/04	80061	OR-212	Present	Female	743	Winter	Released
3/23/04	80062	OR-214	Present	Female	780	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
3/23/04	80063	OR-215	Present	Female	710	Non-Winter	Released
3/23/04	80064	OR-216	Present	Male	880	Winter	Spawned
3/23/04	80065	OR-217	Present	Female	810	Non-Winter	Released
3/23/04	80066	OR-218	Present	Female	780	Winter	Spawned
3/23/04	80067	OR-219	Absent	Male	440	Winter	Released
3/23/04	80068	OR-221	Absent	Male	450	Winter	Released
3/23/04	80069	OR-223	Absent	Male	771	Winter	Released
3/23/04	80070	OR-225	Absent	Male	570	Winter	Released
3/23/04	80071	OR-227	Absent	Male	810	Winter	Released
3/23/04	80072	OR-229	Absent	Male	490	Winter	Released
3/23/04	80073	OR-231	Absent	Male	520	Winter	Released
3/23/04	80074	OR-233	Absent	Female	740	Winter	Released
3/23/04	80075	OR-235	Absent	Male	NA	Winter	Released
3/23/04	80076	OR-238	Absent	Female	640	Winter	Released
3/23/04	80077	OR-240	Absent	Male	530	Winter	Released
3/23/04	80078	OR-242	Absent	Male	770	Winter	Released
3/23/04	80079	OR-244	Present	Female	880	Non-Winter	Released
3/23/04	80080	OR-246	Present	Male	920	Non-Winter	Released
3/23/04	80081	OR-248	Absent	Male	430	Winter	Released
3/23/04	80082	OR-250	Absent	Male	510	Winter	Released
3/31/04	80083	OR-258	Present	Female	780	Winter	Spawned
3/31/04	80084	OR-259	Present	Female	840	Non-Winter	Released
3/31/04	80085	OR-260	Present	Female	870	Non-Winter	Released
3/31/04	80086	OR-261	Present	Male	810	Non-Winter	Released
3/31/04	80087	OR-262	Present	Female	706	Non-Winter	Released
3/31/04	80088	OR-263	Present	Male	740	Non-Winter	Released
3/31/04	80089	OR-264	Present	Male	850	Non-Winter	Released
3/31/04	80090	OR-265	Present	Female	780	Winter	Spawned
3/31/04	80091	OR-266	Present	Female	750	Non-Winter	Released
3/31/04	80092	OR-268	Present	Female	860	Non-Winter	Released
3/31/04	80093	OR-269	Present	Male	520	Winter	Spawned
3/31/04	80094	OR-270	Present	Male	880	Winter	Spawned
3/31/04	80095	OR-271	Present	Male	870	Winter	DIP
3/31/04	80096	OR-272	Present	Male	780	Non-Winter	Released
3/31/04	80097	OR-273	Absent	Male	890	Winter	Spawned
3/31/04	80098	OR-274	Present	Female	770	Non-Winter	Released
3/31/04	80099	OR-275	Present	Female	710	Non-Winter	Released
3/31/04	80100	OR-276	Present	Male	710	Non-Winter	Released
3/31/04	80101	OR-277	Present	Female	820	Non-Winter	Released
3/31/04	80102	OR-279	Absent	Male	820	Winter	Released
3/31/04	80103	OR-281	Absent	Male	570	Winter	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
3/31/04	80104	OR-283	Absent	Male	600	Winter	Released
3/31/04	80105	OR-285	Absent	Female	770	Winter	Released
3/31/04	80106	OR-287	Absent	Male	710	Winter	Released
3/31/04	80107	OR-289	Absent	Male	570	Winter	Released
3/31/04	80108	OR-291	Absent	Male	560	Winter	Released
3/31/04	80109	OR-293	Absent	Male	510	Winter	Released
3/31/04	80110	OR-295	Present	Male	760	Non-Winter	Released
3/31/04	80111	OR-296	Absent	Male	420	Winter	Released
3/31/04	80112	OR-298	Absent	Male	510	Winter	Released
4/6/04	80113	OR-312	Present	Male	640	Non-Winter	Released
4/6/04	80114	OR-313	Present	Female	810	Non-Winter	Released
4/6/04	80115	OR-314	Present	Male	570	Winter	Spawned
4/6/04	80116	OR-315	Present	Male	530	Winter	Spawned
4/6/04	80117	OR-316	Absent	Male	560	Winter	Released
4/6/04	80118	OR-318	Absent	Female	730	Winter	Released
4/6/04	80119	OR-320	Present	Male	580	Winter	DIP
4/6/04	80120	OR-321	Absent	Male	760	Winter	Released
4/6/04	80121	OR-323	Absent	Male	490	Winter	Released
4/6/04	80122	OR-325	Absent	Male	540	Winter	Released
4/6/04	80123	OR-327	Absent	Male	510	Winter	Released
4/6/04	80124	OR-329	Absent	Male	490	Winter	Released
4/13/04	80125	OR-351	Present	Female	NA	Non-Winter	Released
4/13/04	80126	OR-352	Absent	Male	NA	Winter	Released
4/13/04	80127	OR-354	Absent	Male	NA	Winter	Released
4/13/04	80128	OR-356	Absent	Male	NA	Winter	Released
4/13/04	80129	OR-358	Absent	Male	NA	Winter	Released
4/13/04	80130	OR-360	Present	Male	NA	Winter	Released
4/13/04	80131	OR-362	Present	Male	NA	Winter	Released
4/13/04	80132	OR-364	Present	Male	NA	Winter	Released
4/13/04	80133	OR-366	Present	Female	810	Winter	Spawned
4/13/04	80134	OR-367	Present	Female	NA	Non-Winter	Released
4/13/04	80135	OR-369	Present	Female	708	Winter	Spawned
4/13/04	80136	OR-370	Present	Male	788	Winter	Spawned
4/13/04	80137	OR-371	Present	Male	NA	Winter	Released
4/13/04	80138	OR-372	Present	Male	829	Winter	Spawned
4/13/04	80139	OR-373	Present	Female	781	Winter	Spawned
4/13/04	80140	OR-374	Absent	Female	NA	Winter	Released
4/13/04	80141	OR-375	Present	Female	NA	Non-Winter	Released
4/13/04	80142	OR-376	Present	Male	850	Winter	Spawned
4/13/04	80143	OR-377	Present	Female	790	Winter	Spawned
4/13/04	80144	OR-378	Present	Female	823	Winter	Spawned

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
4/13/04	80145	OR-379	Present	Female	745	Winter	Spawned
4/13/04	80146	OR-380	Present	Female	NA	Non-Winter	Released
4/13/04	80147	OR-381	Present	Female	785	Winter	Spawned
4/13/04	80148	OR-382	Present	Female	810	Winter	Spawned
4/13/04	80149	OR-383	Present	Male	590	Winter	DIP
4/13/04	80150	OR-384	Present	Female	767	Winter	Spawned
4/13/04	80151	OR-385	Present	Male	825	Winter	Spawned
4/13/04	80152	OR-386	Present	Male	580	Winter	Spawned
4/13/04	80153	OR-387	Present	Female	NA	Non-Winter	Released
4/13/04	80154	OR-388	Present	Male	515	Winter	Spawned
4/13/04	80155	OR-389	Present	Female	718	Winter	Spawned
4/13/04	80156	OR-390	Present	Male	NA	Winter	Released
4/13/04	80157	OR-391	Present	Male	561	Winter	Spawned
4/13/04	80158	OR-392	Present	Female	NA	Non-Winter	Released
4/13/04	80159	OR-393	Present	Female	881	Winter	Spawned
4/13/04	80160	OR-394	Present	Female	775	Winter	Spawned
4/13/04	80161	OR-395	Present	Male	878	Winter	Spawned
4/13/04	80162	OR-397	Present	Female	784	Winter	Spawned
4/13/04	80163	OR-398	Present	Male	830	Winter	Spawned
4/13/04	80164	OR-399	Present	Female	808	Winter	Spawned
4/13/04	80165	OR-400	Present	Male	578	Winter	Spawned
4/13/04	80166	OR-401	Present	Female	745	Winter	Spawned
4/13/04	80167	OR-402	Present	Male	555	Winter	Spawned
4/13/04	80168	OR-403	Absent	Male	NA	Winter	Released
4/13/04	80169	OR-405	Absent	Male	866	Winter	Spawned
4/13/04	80170	OR-406	Present	Male	508	Winter	Spawned
4/13/04	80171	OR-407	Present	Female	758	Winter	Spawned
4/13/04	80172	OR-408	Present	Male	NA	Winter	Released
4/13/04	80173	OR-409	Present	Female	778	Winter	Spawned
4/13/04	80174	OR-410	Present	Male	NA	Non-Winter	Released
4/13/04	80175	OR-411	Present	Female	848	Winter	Spawned
4/20/04	80176	OR-412	Present	Male	713	Non-Winter	Released
4/20/04	80177	OR-414	Present	Female	742	Non-Winter	Released
4/20/04	80178	OR-416	Absent	Male	820	Winter	Released
4/20/04	80179	OR-418	Present	Male	620	Winter	Spawned
4/20/04	80180	OR-419	Absent	Male	545	Winter	Released
4/20/04	80181	OR-421	Present	Male	547	Winter	Spawned
4/27/04	80182	OR-422	Present	Male	812	Non-Winter	Released
4/27/04	80183	OR-424	Present	Male	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
4/27/04	80184	OR-426	Absent	Female	775	Winter	Released
4/27/04	80185	OR-428	Present	Male	695	Non-Winter	Released
4/27/04	80186	OR-429	Present	Male	720	Non-Winter	Released
4/27/04	80187	OR-431	Absent	Male	591	Winter	Released
4/27/04	80188	OR-433	Absent	Female	777	Winter	Spawned
4/27/04	80189	OR-434	Absent	Female	712	Winter	Released
4/27/04	80190	OR-436	Absent	Male	546	Winter	Released
4/27/04	80191	OR-438	Absent	Male	530	Winter	Released
4/27/04	80192	OR-440	Absent	Male	522	Winter	Released
4/27/04	80193	OR-442	Absent	Male	625	Winter	Released
4/27/04	80194	OR-444	Present	Male	580	Winter	DIP
4/27/04	80195	OR-445	Absent	Male	557	Winter	Released
4/27/04	80196	OR-447	Absent	Male	507	Winter	Released
4/27/04	80197	OR-449	Absent	Male	590	Winter	Released
4/27/04	80198	OR-451	Absent	Male	570	Winter	Released
4/27/04	80199	OR-453	Absent	Male	525	Winter	Released
4/27/04	80200	OR-455	Present	Male	550	Winter	Spawned
4/27/04	80201	OR-456	Absent	Male	560	Winter	Released
4/27/04	80202	OR-458	Absent	Male	NA	Winter	Released
4/27/04	80203	OR-460	Absent	Male	490	Winter	Released
4/27/04	80204	OR-462	Absent	Male	490	Winter	Released
5/6/04	80205	OR-464	Present	Male	905	Winter	Released
5/6/04	80206	OR-466	Present	Female	689	Non-Winter	Released
5/6/04	80207	OR-467	Absent	Male	650	Winter	Released
5/6/04	80208	OR-469	Present	Male	920	Winter	Spawned
5/6/04	80209	OR-470	Present	Female	680	Non-Winter	Released
5/6/04	80210	OR-471	Present	Male	580	Winter	Spawned
5/6/04	80211	OR-472	Present	Female	685	Winter	Spawned
5/6/04	80212	OR-473	Present	Female	735	Non-Winter	Released
5/6/04	80213	OR-475	Present	Male	628	Winter	Spawned
5/6/04	80214	OR-476	Present	Male	628	Winter	Spawned
5/6/04	80215	OR-477	Present	Male	480	Winter	Released
5/6/04	80216	OR-479	Present	Male	597	Winter	Released
5/6/04	80217	OR-480	Present	Male	590	Winter	Released
5/6/04	80218	OR-481	Present	Female	760	Non-Winter	Released
5/6/04	80219	OR-482	Present	Male	550	Winter	Released
5/6/04	80220	OR-483	Absent	Female	658	Winter	Released
5/6/04	80221	OR-485	Absent	Male	570	Winter	Released
5/6/04	80222	OR-487	Absent	Male	505	Winter	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
5/6/04	80223	OR-489	Absent	Male	568	Winter	Released
5/6/04	80224	OR-491	Absent	Male	485	Winter	Released
5/6/04	80225	OR-493	Absent	Male	520	Non-Winter	Released
5/6/04	80226	OR-495	Absent	Male	520	Winter	Released
5/6/04	80227	OR-497	Absent	Male	570	Winter	Released
5/6/04	80228	OR-499	Absent	Male	500	Winter	Released
5/6/04	80229	OR-344	Absent	Male	490	Winter	Released
5/6/04	80230	OR-347	Absent	Male	510	Winter	Released
5/6/04	80231	OR-349	Absent	Male	520	Winter	Released
5/6/04	80232	W-001	Absent	Male	520	Winter	Released
5/6/04	80233	W-003	Absent	Male	550	Winter	Released
5/6/04	80234	W-005	Present	Male	600	Winter	Spawned
5/6/04	80235	W-006	Absent	Male	548	Winter	Released
5/6/04	80236	W-008	Absent	Male	530	Winter	Released
5/6/04	80237	W-010	Absent	Male	550	Winter	Released
5/6/04	80238	W-012	Absent	Male	628	Non-Winter	Released
5/6/04	80239	W-014	Absent	Male	528	Winter	Released
5/6/04	80240	W-016	Absent	Male	540	Winter	Released
5/6/04	80241	W-018	Absent	Male	560	Winter	Released
5/6/04	80242	W-022	Absent	Male	490	Winter	Released
5/6/04	80243	W-024	Absent	Male	550	Winter	Released
5/6/04	80244	W-026	Present	Male	550	Winter	Released
5/6/04	80245	W-027	Present	Female	580	Non-Winter	Released
5/11/04	80246	W-036	Present	Female	850	Non-Winter	Released
5/11/04	80247	W-038	Absent	Male	830	Winter	Released
5/11/04	80248	W-040	Present	Female	750	Non-Winter	Released
5/11/04	80249	W-042	Absent	Female	720	Winter	Released
5/11/04	80250	W-044	Present	Male	758	Winter	Spawned
5/11/04	80251	W-045	Present	Unknown	695	Non-Winter	Released
5/11/04	80252	W-046	Present	Female	685	Non-Winter	Released
5/11/04	80253	W-048	Present	Female	710	Non-Winter	Released
5/11/04	80254	W-050	Absent	Male	560	Winter	Released
5/11/04	80255	W-052	Absent	Male	550	Winter	Released
5/11/04	80256	W-054	Present	Male	685	Winter	Released
5/11/04	80257	W-056	Present	Male	552	Winter	Released
5/11/04	80258	W-058	Absent	Male	540	Winter	Released
5/11/04	80259	W-060	Absent	Male	490	Winter	Released
5/11/04	80260	W-062	Absent	Male	560	Winter	Released
5/11/04	80261	W-064	Absent	Male	NA	Winter	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
5/11/04	80262	W-066	Absent	Male	540	Winter	Released
5/11/04	80263	W-068	Absent	Male	540	Winter	Released
5/11/04	80264	W-070	Absent	Male	520	Winter	Released
5/11/04	80265	W-072	Absent	Male	490	Winter	Released
5/18/04	80266	W-075	Absent	Male	442	Winter	Released
5/18/04	80267	W-077	Absent	Male	490	Winter	Released
5/25/04	80268	W-079	Present	Male	935	Winter	Released
5/25/04	80269	W-080	Present	Male	925	Winter	Released
5/25/04	80270	W-082	Partial	Female	722	Winter	Released
5/25/04	80271	W-084	Absent	Male	635	Winter	Released
5/25/04	80272	W-086	Present	Male	895	Winter	Released
5/25/04	80273	W-088	Present	Female	695	Non-Winter	Released
5/25/04	80274	W-090	Absent	Male	660	Winter	Released
5/25/04	80275	W-092	Present	Female	690	Non-Winter	Released
5/25/04	80276	W-094	Present	Female	615	Non-Winter	Released
5/25/04	80277	W-096	Absent	Female	735	Winter	Spawned
5/25/04	80278	W-097	Present	Female	702	Non-Winter	Released
5/25/04	80279	W-099	Present	Male	780	Non-Winter	Released
5/25/04	80280	W-100	Present	Male	650	Winter	DIP
5/25/04	80281	W-101	Present	Male	620	Winter	Spawned
5/25/04	80282	W-102	Absent	Male	625	Winter	Released
5/25/04	80283	W-104	Absent	Male	560	Winter	Released
5/25/04	80284	W-106	Absent	Male	612	Winter	Released
5/25/04	80285	W-107	Absent	Male	570	Winter	Released
5/25/04	80286	W-109	Present	Female	650	Non-Winter	Released
5/25/04	80287	W-111	Present	Male	600	Winter	Spawned
5/25/04	80288	W-112	Present	Male	595	Non-Winter	Released
5/25/04	80289	W-113	Absent	Male	490	Winter	Released
5/25/04	80290	W-115	Absent	Male	560	Winter	Released
5/25/04	80291	W-117	Absent	Male	480	Winter	Released
5/25/04	80292	W-119	Partial	Male	520	Winter	Released
5/25/04	80293	W-121	Present	Male	600	Winter	Spawned
5/25/04	80294	W-122	Absent	Male	440	Winter	Released
5/25/04	80295	W-124	Absent	Male	550	Winter	Released
5/25/04	80296	W-126	Present	Male	NA	Winter	Released
5/25/04	80297	W-128	Absent	Male	535	Winter	Released
5/25/04	80298	W-130	Absent	Male	510	Winter	Released
5/25/04	80299	W-132	Absent	Male	505	Winter	Released
5/25/04	80300	W-145	Absent	Male	440	Winter	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
5/25/04	80301	W-135	Absent	Male	545	Winter	Released
5/25/04	80302	W-137	Absent	Male	590	Winter	Released
5/25/04	80303	W-139	Absent	Male	460	Winter	Released
5/25/04	80304	W-141	Absent	Male	520	Winter	Released
5/25/04	80305	W-143	Absent	Male	510	Winter	Released
5/25/04	80306	W-145	Absent	Male	490	Winter	Released
5/25/04	80307	W-149	Present	Male	NA	Winter	Released
5/25/04	80308	W-151	Absent	Male	610	Winter	Released
5/25/04	80309	W-153	Absent	Male	490	Winter	Released
5/25/04	80310	W-155	Absent	Male	440	Winter	Released
5/25/04	80311	W-157	Present	Male	540	Winter	Released
5/25/04	80312	W-159	Present	Male	540	Winter	Released
5/25/04	80313	W-161	Present	Male	560	Winter	Released
6/2/04	80314	W-168	Absent	Male	860	Winter	Released
6/2/04	80315	W-170	Present	Male	558	Winter	Released
6/2/04	80316	W-172	Absent	Male	562	Winter	Released
6/2/04	80317	W-174	Present	Female	700	Non-Winter	Released
6/2/04	80318	W-176	Present	Female	648	Non-Winter	Released
6/2/04	80319	W-178	Partial	Male	510	Winter	Released
6/2/04	80320	W-180	Absent	Male	590	Winter	Released
6/2/04	80321	W-184	Absent	Male	558	Winter	Released
6/2/04	80322	W-182	Absent	Male	603	Winter	Released
6/2/04	80323	W-186	Absent	Male	495	Winter	Released
6/2/04	80324	W-188	Present	Male	665	Winter	Released
6/2/04	80325	W-190	Absent	Male	520	Winter	Released
6/3/04	80326	W-193	Present	Female	690	Non-Winter	Released
6/8/04	80327	W-201	Present	Female	670	Winter	Spawned
6/8/04	80328	W-204	Present	Female	738	Winter	Spawned
6/8/04	80329	W-205	Absent	Female	780	Winter	Spawned
6/8/04	80330	W-208	Present	Female	820	Winter	Spawned
6/8/04	80331	W-209	Present	Female	712	Non-Winter	Released
6/8/04	80332	W-210	Present	Male	748	Non-Winter	Released
6/8/04	80333	W-219	Present	Female	700	Non-Winter	Released
6/8/04	80334	W-280	Present	Male	547	Winter	Spawned
6/8/04	80335	W-292	Absent	Female	740	Winter	Spawned
6/8/04	80336	W-195	Present	Female	830	Non-Winter	Released
6/8/04	80337	W-197	Present	Male	815	Non-Winter	Released
6/8/04	80338	W-199	Present	Male	780	Non-Winter	Released
6/8/04	80339	W-202	Present	Male	700	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
6/8/04	80340	W-206	Present	Male	440	Non-Winter	Released
6/8/04	80341	W-211	Absent	Male	570	Winter	Released
6/8/04	80342	W-213	Absent	Male	830	Winter	Released
6/8/04	80343	W-215	Present	Male	840	Winter	Released
6/8/04	80344	W-217	Absent	Male	660	Winter	Released
6/8/04	80345	W-220	Absent	Male	528	Winter	Released
6/8/04	80346	W-222	Present	Male	530	Winter	Released
6/8/04	80347	W-224	Absent	Male	600	Winter	Released
6/8/04	80348	W-226	Absent	Male	500	Winter	Released
6/8/04	80349	W-228	Present	Male	500	Winter	Released
6/8/04	80350	W-230	Absent	Male	480	Winter	Released
6/8/04	80351	W-232	Present	Male	570	Winter	Released
6/8/04	80352	W-234	Absent	Male	579	Winter	Released
6/8/04	80353	W-236	Absent	Male	560	Winter	Released
6/8/04	80354	W-238	Present	Male	460	Non-Winter	Released
6/8/04	80355	W-240	Absent	Male	575	Winter	Released
6/8/04	80356	W-242	Absent	Male	480	Winter	Released
6/8/04	80357	W-244	Present	Male	540	Winter	Released
6/8/04	80358	W-247	Absent	Male	490	Winter	Released
6/8/04	80359	W-249	Absent	Male	530	Winter	Released
6/8/04	80360	W-251	Absent	Male	560	Winter	Released
6/8/04	80361	W-253	Present	Male	490	Non-Winter	Released
6/8/04	80362	W-255	Present	Male	590	Winter	Released
6/8/04	80363	W-257	Absent	Male	580	Winter	Released
6/8/04	80364	W-259	Absent	Male	NA	Winter	Released
6/8/04	80365	W-261	Partial	Male	480	Winter	Released
6/8/04	80366	W-263	Present	Male	540	Winter	Released
6/8/04	80367	W-266	Absent	Male	NA	Winter	Released
6/8/04	80368	W-268	Absent	Male	500	Winter	Released
6/8/04	80369	W-270	Absent	Male	510	Winter	Released
6/8/04	80370	W-272	Present	Male	540	Winter	Released
6/8/04	80371	W-274	Absent	Male	530	Winter	Released
6/8/04	80372	W-276	Absent	Male	550	Winter	Released
6/8/04	80373	W-278	Present	Male	530	Winter	Released
6/8/04	80374	W-281	Absent	Male	480	Winter	Released
6/8/04	80375	W-283	Absent	Male	515	Winter	Released
6/8/04	80376	W-285	Absent	Male	530	Winter	Released
6/8/04	80377	W-287	Absent	Male	540	Winter	Released
6/8/04	80378	W-290	Absent	Male	528	Winter	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
6/15/04	80379	W-297	Absent	Female	780	Winter	Spawned
6/15/04	80380	W-298	Absent	Male	850	Winter	Released
6/15/04	80381	W-300	Present	Male	NA	Winter	Released
6/15/04	80382	W-302	Absent	Male	810	Winter	Released
6/15/04	80383	W-304	Absent	Male	640	Winter	Released
6/15/04	80384	W-306	Present	Male	815	Winter	Released
6/15/04	80385	W-308	Absent	Male	590	Winter	Released
6/15/04	80386	W-310	Absent	Male	575	Winter	Released
6/15/04	80387	W-312	Absent	Male	570	Winter	Released
6/15/04	80388	W-314	Present	Male	660	Winter	Released
6/15/04	80389	W-316	Present	Male	530	Winter	Released
6/15/04	80390	W-318	Present	Male	825	Winter	Released
6/15/04	80391	W-321	Absent	Male	540	Non-Winter	Released
6/15/04	80392	W-323	Present	Male	428	Non-Winter	Released
6/15/04	80393	W-325	Absent	Male	540	Winter	Released
6/15/04	80394	W-327	Absent	Male	590	Winter	Released
6/15/04	80395	W-329	Absent	Male	508	Winter	Released
6/15/04	80396	W-331	Present	Male	440	Non-Winter	Released
6/22/04	80397	W-334	Present	Male	481	Winter	Spawned
6/22/04	80398	W-335	Present	Male	708	Winter	Released
7/7/04	80399	W-337	Partial	Male	625	Winter	Released
7/7/04	80400	W-339	Absent	Male	595	Winter	Released
7/7/04	80401	W-341	Absent	Male	625	Winter	Released
7/7/04	80402	W-343	Absent	Male	474	Winter	Released
7/7/04	80403	W-345	Absent	Male	490	Winter	Released
7/7/04	80404	W-347	Present	Male	555	Winter	Released
7/9/04	80405	W-349	Present	Female	750	Winter	Spawned
7/9/04	80406	W-350	Absent	Female	800	Winter	Spawned
7/9/04	80407	W-351	Present	Male	580	Winter	Spawned
7/9/04	80408	W-366	Present	Male	560	Winter	Spawned
7/9/04	80409	W-352	Present	Female	680	Non-Winter	Released
7/9/04	80410	W-354	Present	Female	710	Non-Winter	Released
7/9/04	80411	W-356	Absent	Male	530	Winter	Released
7/9/04	80412	W-358	Absent	Male	480	Winter	Released
7/9/04	80413	W-360	Absent	Male	590	Winter	Released
7/9/04	80414	W-362	Absent	Male	500	Winter	Released
7/9/04	80415	W-364	Absent	Male	490	Winter	Released
7/9/04	80416	W-367	Absent	Male	530	Winter	Released
7/9/04	80417	W-369	Absent	Male	520	Winter	Released

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
7/9/04	80418	W-372	Absent	Male	570	Winter	Released
7/9/04	80419	W-374	Absent	Male	570	Winter	Released
7/9/04	80420	W-376	Absent	Male	530	Winter	Released
7/9/04	80421	W-378	Absent	Male	460	Winter	Released
7/9/04	80422	W-381	Present	Male	460	Non-Winter	Released
7/9/04	80423	W-383	Present	Male	438	Non-Winter	Released
7/9/04	80424	W-385	Absent	Male	NA	Winter	Released
7/9/04	80425	W-387	Present	Male	410	Non-Winter	Released
7/9/04	80426	W-389	Absent	Male	550	Winter	Released
7/9/04	80427	W-391	Present	Male	500	Non-Winter	Released
7/13/04	80428	W-395	Absent	Male	490	Winter	Released
7/13/04	80429	W-397	Absent	Male	540	Winter	Released
7/13/04	80430	W-399	Absent	Male	580	Winter	Released
7/13/04	80431	W-401	Absent	Male	575	Winter	Released
7/13/04	80432	W-403	Absent	Male	540	Winter	Released
7/13/04	80433	W-405	Present	Male	540	Winter	Released
7/13/04	80434	W-409	Present	Male	495	Winter	Released
7/13/04	80435	W-409	Present	Male	455	Winter	Released
7/15/04	80436	W-411	Absent	Male	490	Winter	Released
7/15/04	80437	W-413	Absent	Male	600	Winter	Released
7/15/04	80438	W-415	Absent	Female	660	Winter	Released
7/15/04	80439	W-417	Absent	Male	550	Winter	Released
7/15/04	80440	W-419	Absent	Male	470	Winter	Released
7/20/04	80441	W-421	Present	Female	775	Non-Winter	Released
7/20/04	80442	W-423	Absent	Male	NA	Winter	Released
7/20/04	80443	W-425	Absent	Male	540	Winter	Released
7/20/04	80444	W-427	Present	Male	450	Non-Winter	Released
7/20/04	80445	W-429	Absent	Male	490	Winter	Released
7/20/04	80446	W-431	Present	Male	460	Non-Winter	Released
7/20/04	80447	W-433	Present	Male	560	Non-Winter	Released
7/22/04	80448	W-436	Present	Male	510	Non-Winter	Released
7/22/04	80449	W-438	Present	Male	610	Winter	Spawned
7/22/04	80450	W-439	Absent	Female	690	Winter	Released
7/22/04	80451	W-441	Present	Male	480	Non-Winter	Released
7/27/04	80452	W-443	Absent	Female	780	Winter	Released
7/27/04	80453	W-445	Present	Female	750	Non-Winter	Released
7/27/04	80454	W-447	Present	Male	550	Winter	Released
7/29/04	80455	W-449	Present	Male	790	Non-Winter	Released
7/29/04	80456	W-451	Absent	Male	760	Non-Winter	Sacrificed

Table 5 (cont.)

Date Captured	Genetic Sample ID	Individual Tag Code	Adipose Fin Status	Sex	Fork Length (mm)	Run Assignment	Final Disposition
7/29/04	80457	W-453	Present	Female	820	Non-Winter	Released
7/29/04	80458	W-455	Present	Male	710	Non-Winter	Released
7/29/04	80459	W-457	Present	Male	470	Non-Winter	Released
7/29/04	80460	W-459	Present	Male	500	Non-Winter	Released

^a Run assignment based on phenotypic characteristics.

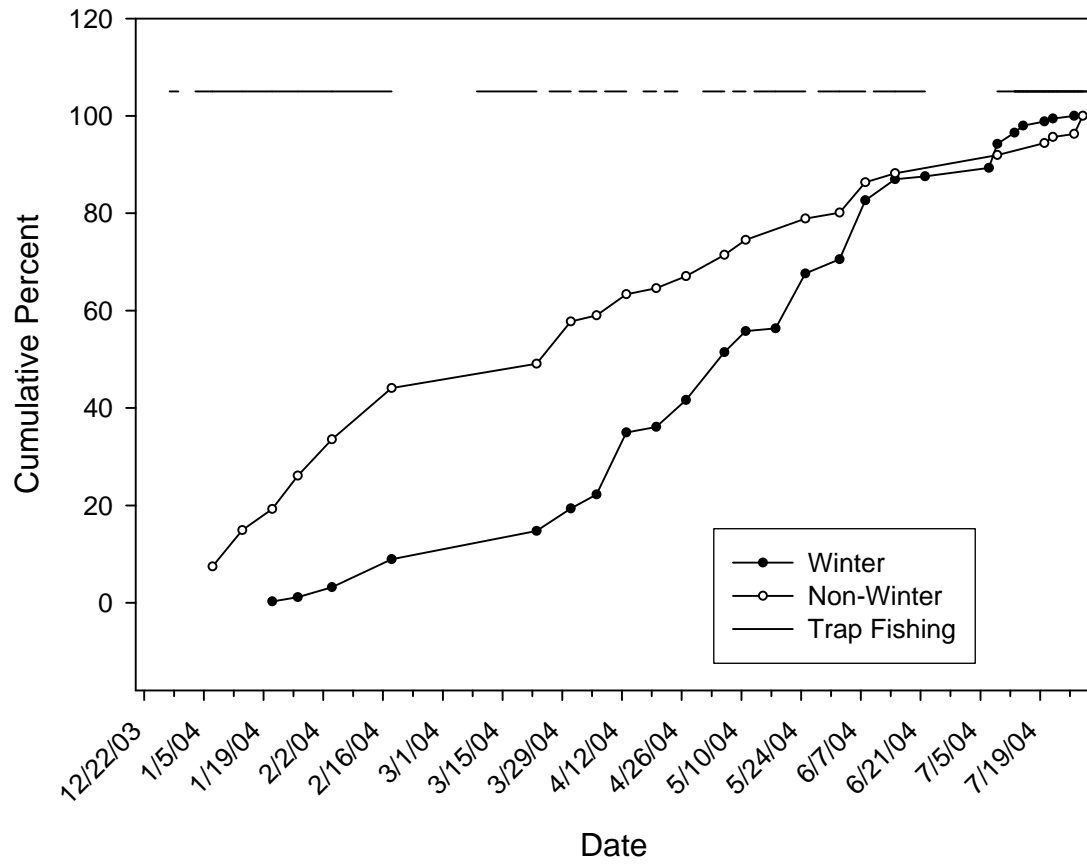


Figure 1. Capture timing of Chinook salmon from Keswick Dam trap by run-type, 2004.

Table 6. Disposition of Chinook salmon trapped at the Keswick Dam trap, January 7, 2004 – July 29, 2004, by run identity and gender. Numbers in parentheses indicate the number of hatchery-origin fish included in the category total. (One non-winter, natural-origin female Chinook was captured at the Red Bluff Diversion Dam trap, quarantined, and released back into the Sacramento River. This fish is included in the table.)

Run Identity	Disposition	Total	Males	Females	Unknown Gender
Winter	Trapped and spawned	73 (8)	36 (2)	37 (6)	0 (0)
Winter	Pre-spawn mortality	12 (0)	8 (0)	4 (0)	0 (0)
Winter	Trapped, quarantined, and released back into river	21 (12)	11 (2)	10 (10)	0 (0)
Winter	Trapped and released back into river without quarantine	240 (204)	223 (188)	17 (16)	0 (0)
	Total	346 (224)	278 (192)	68 (32)	0 (0)
Non-winter	Pre-spawn mortality	1 (1)	1 (1)	0 (0)	0 (0)
Non-winter	Trapped, quarantined, and released back into river	38 (0)	13 (0)	24 (0)	1 (0)
Non-winter	Trapped and released back into river without quarantine	63 (3)	30 (3)	33 (0)	0 (0)
Non-winter	Transferred to Coleman National Fish Hatchery	43 (0)	32 (0)	11 (0)	0 (0)
Non-winter	Euthanized	16 (16)	12 (12)	4 (4)	0 (0)
	Total	161 (20)	88 (16)	72 (4)	1 (0)
Undetermined	Pre-spawn mortality	0 (0)	0 (0)	0 (0)	0 (0)
Undetermined	Trapped, quarantined, and released back into river	0 (0)	0 (0)	0 (0)	0 (0)
Undetermined	Trapped and released back into river without quarantine	199 (158)	23 (13)	1 (0)	175 (145)
	Total	199 (158)	23 (13)	1 (0)	175 (145)
	Overall Total	706 (402)	389 (221)	141 (36)	176 (145)

Health

Broodstock captured from the Sacramento River tested positive for infectious hematopoietic necrosis virus and *Ceratomyxa shasta* (Table 7). Captive broodstock from Livingston Stone were tested for five pathogens and all tests were negative (Table 7).

Table 7. Test results (positive or negative) for fish pathogens in brood year 2004 winter Chinook salmon brood stock and juveniles, conducted by the USFWS California - Nevada Fish Health Center.

Pathogen	Brood stock origin		Juveniles by parental origin		
	Sacramento River	Livingston Stone Captive	Natural x Natural	Natural x Hatchery	Natural x Captive
	positive / negative	positive / negative	positive / negative	positive / negative	positive / negative
<i>Aeromonas salmonicida</i>	negative	no test	negative	negative	negative
<i>Yersinia ruckeri</i>	negative	no test	negative	negative	negative
<i>Renibacterium salmoninarum</i>	negative	negative	positive	positive	negative
<i>Myxobolous cerebralis</i>	no test	no test	negative	negative	negative
Infectious hematopoietic necrosis virus	positive	negative	negative	negative	negative
Viral hemorrhagic septicemia virus	negative	negative	negative	negative	negative
Infectious pancreatic necrosis virus	negative	negative	negative	negative	negative
<i>Oncorhynchus masou</i> virus	negative	negative	no test	no test	no test
<i>Ceratomyxa shasta</i>	positive	no test	no test	no test	no test
<i>Sphaerothecum destruens</i> (Rosette Agent)	negative	no test	no test	no test	no test

Spawning & Production- Non-captive Broodstock

In 2004, winter Chinook salmon were spawned between May 19 and July 26 (Tables 2 and 3, Figure 2). A total of 37 female (Table 2) and 36 male (Table 3) winter Chinook salmon were spawned in 2004 producing 72 family groups (Table 8). Fork length of spawned females ranged from 637 to 881 mm and averaged 774 mm (SD 48 mm) (Table 2). Fork length of spawned males ranged from 481 to 930 mm and averaged 664 mm (SD 135 mm) (Table 3). Females produced an average of 5,200 green eggs yielding a total of 192,387 green eggs with 92.3% of these developing into eyed eggs (Table 8). The percent of green eggs that hatched averaged 90.1%, and 86.2% of the green eggs resulted in juveniles that were transferred to rearing tanks (Table 8). Coagulated yolk disease was responsible for low survival in some family groups.

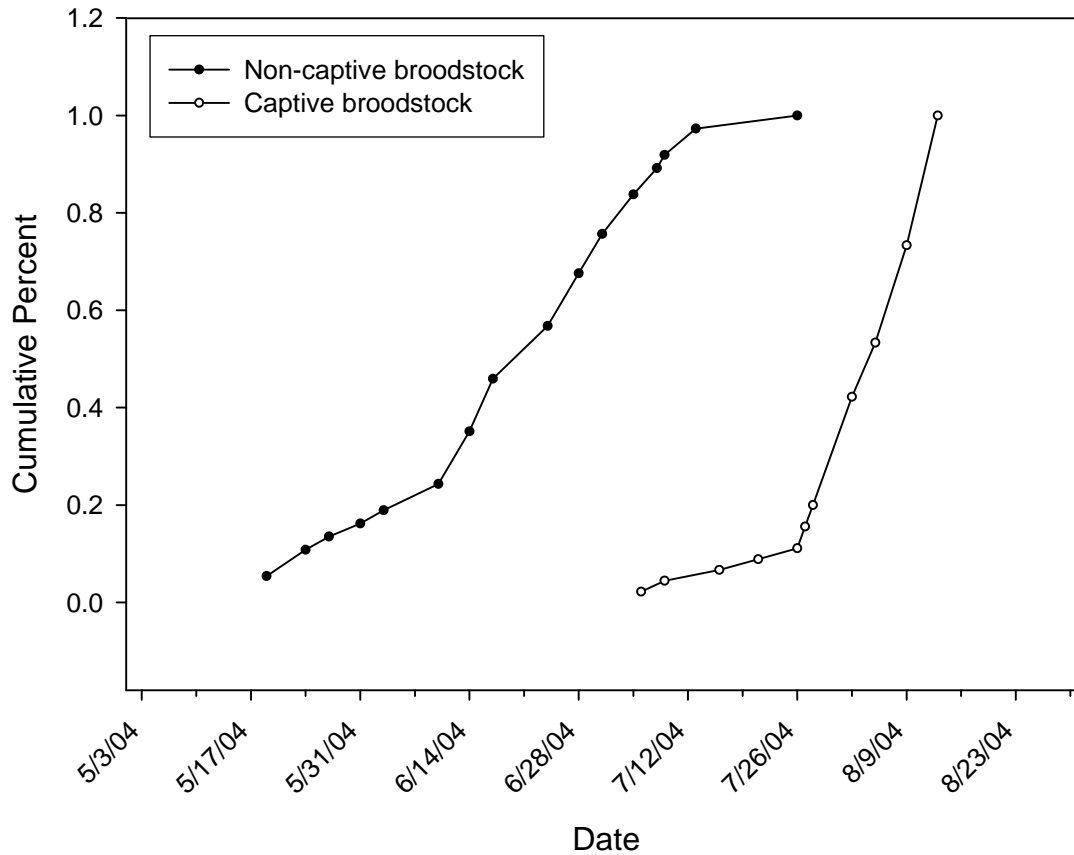


Figure 2. Spawning of winter Chinook salmon at Livingston Stone National Fish Hatchery, 2004.

Table 8. Early survival of eggs and fry from winter Chinook salmon captured from the wild and spawned at Livingston Stone National Fish Hatchery, 2004.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green	Number Tanked	Percent Tanked	Percent Tanked
Female	Male							Eggs Hatched		from Green Eggs	from Eyed Eggs
OR-208	OR-270	1A	5/19/04	3,403	3,333	97.9	3,328	97.8	3,321	97.6	99.6
OR-208	OR395	1B	5/19/04	3,377	3,328	98.5	3,320	98.3	3,284	97.2	98.7
OR-411	OR-270	2A	5/19/04	2,996	2,970	99.1	2,969	99.1	2,552	85.2	85.9
OR-411	B-035	2C	5/19/04	2,551	2,539	99.5	2,539	99.5	2,296	90.0	90.4
OR-399	OR-395	3B	5/24/04	972	345	35.5	195	20.1	155	15.9	44.9
OR-366	OR-398	4D	5/24/04	2,821	2,599	92.1	2,591	91.8	2,395	84.9	92.2
OR-366	OR-385	4E	5/24/04	2,514	2,393	95.2	2,378	94.6	2,205	87.7	92.1
W-096 AD	OR-385	5C	5/27/04	2,388	2,375	99.5	2,373	99.4	2,340	98.0	98.5
W-096 AD	B-035	5E	5/27/04	2,187	2,176	99.5	2,175	99.5	2,036	93.1	93.6
OR-379	OR-395	6B	5/31/04	2,338	2,308	98.7	2,300	98.4	2,299	98.3	99.6
OR-379	OR-391	6F	5/31/04	2,342	2,318	99.0	2,311	98.7	2,308	98.5	99.6
OR-136	OR-391	7D	6/3/04	2,525	2,479	98.2	2,453	97.1	2,442	96.7	98.5
OR-136	OR-398	7F	6/3/04	2,233	2,200	98.5	2,145	96.1	2,116	94.8	96.2
OR-218	B-031	8G	6/10/04	3,141	3,092	98.4	3,077	98.0	2,953	94.0	95.5
OR-218	OR-273 AD	8H	6/10/04	2,897	2,849	98.3	2,839	98.0	2,817	97.2	98.9
W-201	OR-405 AD	9I	6/10/04	2,863	2,782	97.2	2,777	97.0	2,768	96.7	99.5
W-201	OR-418	9J	6/10/04	2,351	2,329	99.1	2,328	99.0	2,323	98.8	99.7
OR-394	OR-273 AD	10H	6/14/04	3,269	3,223	98.6	3,200	97.9	3,129	95.7	97.1
OR-394	OR-421	10K	6/14/04	2,486	2,462	99.0	2,444	98.3	2,452	98.6	99.6
OR-472	OR-405 AD	11I	6/14/04	3,040	3,011	99.0	2,301	75.7	1,925	63.3	63.9
OR-472	B-036	11L	6/14/04	3,517	3,439	97.8	2,958	84.1	2,800	79.6	81.4
OR-401	B-031	12G	6/14/04	2,199	2,184	99.3	2,186	99.4	2,179	99.1	99.8
OR-401	OR-418	12J	6/14/04	2,624	2,607	99.4	2,605	99.3	2,557	97.4	98.1
OR-393	OR-216	13M	6/14/04	3,487	1,849	53.0	1,657	47.5	1,600	45.9	86.5
OR-393	OR-455	13N	6/14/04	3,641	2,015	55.3	1,852	50.9	1,704	46.8	84.6
OR-265	OR-216	14M	6/17/04	2,783	2,744	98.6	2,715	97.6	681	24.5	24.8
OR-265	OR-455	14N	6/17/04	2,722	2,620	96.3	2,591	95.2	2,591	95.2	98.9
OR-377	OR-269	15O	6/17/04	2,521	2,414	95.8	2,364	93.8	2,309	91.6	95.7
OR-377	OR-314	15P	6/17/04	2,539	2,503	98.6	2,487	98.0	2,354	92.7	94.0
W-208	W-005	16Q	6/17/04	3,433	3,401	99.1	3,388	98.7	3,307	96.3	97.2

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	Percent Tanked
Female	Male							Eggs Hatched		from Green Eggs	from Eyed Eggs
W-208	W-101	16R	6/17/04	2,511	2,471	98.4	2,460	98.0	2,427	96.7	98.2
OR-381	OR-421	17K	6/17/04	2,903	2,875	99.0	2,867	98.8	2,897	99.8	100.8 ^a
OR-381	W-005	17Q	6/17/04	2,933	2,835	96.7	2,828	96.4	2,826	96.4	99.7
OR-369	OR-391	18D	6/24/04	2,607	0	0.0	0	0.0	0	0.0	0.0
OR-369	OR-408	18S	6/24/04	1,589	0	0.0	0	0.0	0	0.0	0.0
OR-373	OR-314	19P	6/24/04	2,650	2,630	99.2	2,381	89.8	2,200	83.0	83.7
OR-373	OR-386	19T	6/24/04	2,443	2,433	99.6	2,428	99.4	2,375	97.2	97.6
OR-210	OR-216	20M	6/24/04	3,277	3,115	95.1	3,091	94.3	3,036	92.6	97.5
OR-210	OR-269	20O	6/24/04	2,483	2,356	94.9	2,335	94.0	2,309	93.0	98.0
OR-378	OR-386	21T	6/24/04	2,629	2,607	99.2	2,605	99.1	2,582	98.2	99.0
OR-378	W-280	21U	6/24/04	2,979	2,963	99.5	2,954	99.2	2,919	98.0	98.5
OR-407	W-280	22U	6/28/04	2,600	2,523	97.0	2,474	95.2	2,167	83.3	85.9
OR-407	W-334	22V	6/28/04	2,646	2,556	96.6	2,494	94.3	2,029	76.7	79.4
W-205 AD	W-101	23R	6/28/04	2,649	2,596	98.0	2,555	96.5	2,555	96.5	98.4
W-205 AD	OR-400	23W	6/28/04	2,638	2,537	96.2	2,495	94.6	2,410	91.4	95.0
W-297 AD	OR-408	24S	6/28/04	2,542	2,211	87.0	1,913	75.3	1,870	73.6	84.6
W-297 AD	OR-372	24X	6/28/04	2,874	2,456	85.5	2,135	74.3	2,070	72.0	84.3
OR-397	OR-372	25X	6/28/04	3,398	3,285	96.7	3,275	96.4	2,454	72.2	74.7
OR-397	OR-489	25Y	6/28/04	3,345	3,279	98.0	3,279	98.0	3,174	94.9	96.8
W-204	W-334	26V	7/1/04	2,794	2,780	99.5	2,778	99.4	2,739	98.0	98.5
W-204	OR-400	26W	7/1/04	2,216	2,186	98.6	2,168	97.8	2,147	96.9	98.2
OR-382	OR-402	27Z	7/1/04	2,925	2,899	99.1	2,860	97.8	2,808	96.0	96.9
OR-382	OR-370	27AA	7/1/04	2,502	2,465	98.5	2,420	96.7	2,417	96.6	98.1
OR-205	W-334	28V	7/1/04	2,480	2,302	92.8	2,277	91.8	2,253	90.8	97.9
OR-205	OR-315	28BB	7/1/04	1,932	1,849	95.7	1,799	93.1	1,805	93.4	97.6
OR-258	OR-315	29BB	7/5/04	2,951	2,889	97.9	2,875	97.4	2,825	95.7	97.8
OR-258	OR-476	29CC	7/5/04	2,993	2,929	97.9	2,905	97.1	2,906	97.1	99.2
OR-181	OR-370	30AA	7/5/04	2,847	2,796	98.2	2,785	97.8	2,783	97.8	99.5
OR-181	OR-475	30DD	7/5/04	2,952	2,931	99.3	2,918	98.8	2,922	99.0	99.7
OR-433 AD	OR-402	31Z	7/5/04	2,834	2,778	98.0	2,729	96.3	2,719	95.9	97.9

Table 8 (cont.)

Crosses by tag number								Percent Green Eggs Hatched	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male	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
OR-433 AD	OR-376	31EE	7/5/04	2,881	2,771	96.2	2,745	95.3	2,718	94.3	98.1
OR-389	OR-475	32DD	7/8/04	2,536	2,510	99.0	2,454	96.8	2,389	94.2	95.2
OR-389	OR-388	32FF	7/8/04	2,416	2,399	99.3	2,360	97.7	2,354	97.4	98.1
OR-384	OR-376	33EE	7/8/04	3,152	2,972	94.3	2,787	88.4	2,727	86.5	91.8
OR-384	W-121	33GG	7/8/04	2,343	2,206	94.2	2,061	88.0	1,987	84.8	90.1
W-292 AD	OR-402	34Z	7/9/04	2,086	0	0.0	0	0.0	0	0.0	0.0
W-349	W-366	35 HH	7/13/04	922	885	96.0	877	95.1	877	95.1	99.1
W-349	W-351	35 II	7/13/04	893	838	93.8	818	91.6	818	91.6	97.6
OR-409	OR-386	36FF	7/13/04	2,977	2,829	95.0	2,752	92.4	2,742	92.1	96.9
OR-409	W-121	36GG	7/13/04	2,934	2,861	97.5	2,785	94.9	2,781	94.8	97.2
W-350 AD	W-351	37 II	7/26/04	3,182	3,109	97.7	3,064	96.3	2,990	94.0	96.2
W-350 AD	W-438	37JJ	7/26/04	2,783	2,708	97.3	2,687	96.6	2,673	96.0	98.7
Totals				192,387	177,507	.	173,319	.	165,878	.	.
Averages				5,200 ^b	4,797 ^b	92.3	4,684 ^b	90.1	4,483 ^b	86.2	93.4

^a 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. ^b Averages derived from the number of females spawned (n = 37), not the number of family groups.

Spawning & Production- Captive Broodstock

Captive-origin females reared at Livingston Stone NFH were spawned with natural-origin males from July 6 through August 13 (Table 9, Figure 2). Spawn timing of captive-origin females was much more truncated than that observed in natural-origin females. A total of 45 captive-origin female and 23 natural-origin male winter Chinook salmon were spawned in 2004 producing 45 family groups (Table 9). Females produced an average of 1,066 green eggs yielding a total of 47,989 green eggs with 69.8% of these developing into eyed eggs (Table 9). The percent of green eggs that hatched averaged 65.7%, and 54.3% of the green eggs resulted in juveniles that were transferred to rearing tanks (Table 9).

Table 9. Early survival of eggs and fry from winter Chinook salmon crosses of captive-brood females and natural-origin males, 2004.

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green Eggs	Number Tanked	Percent Tanked from Green Eggs	Percent Tanked from Eyed Eggs
Female	Male							Hatched		Green Eggs	Green Eggs
4322692130	OR-471	L1G	7/6/04	1,190	1,127	94.7	1,061	89.2	1,072	90.1	95.1
434B5C3F01	OR-388	L2FF	7/9/04	789	179	22.7	60	7.6	58	7.4	32.4
4321781D7A	OR-376	L3EE	7/16/04	751	45	6.0	12	1.6	12	1.6	26.7
4350063B19	OR-315	L4BB	7/21/04	835	726	86.9	715	85.6	708	84.8	97.5
4322701803	OR-376	L5EE	7/26/04	931	0	0.0	0	0.0	0	0.0	0.0
43230D1070	W-351	L6II	7/27/04	1,115	950	85.2	922	82.7	903	81.0	95.1
434A795756	W-351	L7II	7/27/04	1,037	839	80.9	628	60.6	578	55.7	68.9
435029454A	OR-376	L8EE	7/28/04	889	839	94.4	833	93.7	795	89.4	94.8
434A154F43	OR-402	L9Z	7/28/04	1,016	1,000	98.4	992	97.6	987	97.1	98.7
NO TAG	W-438	L1OJJ	8/2/04	1,720	1,602	93.1	1,573	91.5	1,495	86.9	93.3
434A650471	W-438	L11JJ	8/2/04	1,174	1,158	98.6	1,141	97.2	1,125	95.8	97.2
43336C280F	W-438	L12JJ	8/2/04	1,093	1,019	93.2	985	90.1	942	86.2	92.4
4350305C7F	W-438	L13JJ	8/2/04	1,625	1,589	97.8	1,580	97.2	1,563	96.2	98.4
4349534D6E	OR-270	L14A cryo	8/2/04	1,082	592	54.7	569	52.6	555	51.3	93.8
434A5E6E26	OR-270	L15A cryo	8/2/04	1,324	860	65.0	851	64.3	850	64.2	98.8
4349495110	OR-391	L16F cryo	8/2/04	739	409	55.3	378	51.2	350	47.4	85.6
434E1E7A7F	OR-391	L17F cryo	8/2/04	1,202	971	80.8	901	75.0	882	73.4	90.8
434D712A35	W-044	L18C cryo	8/2/04	990	688	69.5	539	54.4	495	50.0	71.9
43500C3656	W-044	L19C cryo	8/2/04	759	579	76.3	496	65.3	466	61.4	80.5
4323002161	OR-314	L20P cryo	8/5/04	858	733	85.4	624	72.7	549	64.0	74.9
NO TAG	OR-314	L21P cryo	8/5/04	1,349	1,128	83.6	1,117	82.8	974	72.2	86.3
4348007538	OR-386	L22T cryo	8/5/04	1,104	914	82.8	894	81.0	903	81.8	98.8
43500C062B	OR-386	L23T cryo	8/5/04	810	624	77.0	619	76.4	618	76.3	99.0
4351596414	W-101	L24R cryo	8/5/04	1,210	813	67.2	787	65.0	754	62.3	92.7
4323200C0A	OR-216	L25M cryo	8/9/04	824	372	45.1	352	42.7	328	39.8	88.2
434C760020	OR-216	L26M cryo	8/9/04	1,068	585	54.8	489	45.8	372	34.8	63.6
43500D1641	OR-398	L27D cryo	8/9/04	927	620	66.9	585	63.1	313	33.8	50.5
434E12321B	OR-398	L28D cryo	8/9/04	781	583	74.6	569	72.9	247	31.6	42.4
434A48392B	OR-471	L29G cryo	8/9/04	1,186	699	58.9	664	56.0	125	10.5	17.9

Table 9 (cont.)

Crosses by tag number		Family Group	Date Spawned	Green Eggs	Eyed Eggs	Percent Eyed	Number Hatched	Percent Green	Number Tanked	Percent Tanked	Percent Tanked
Female	Male							Eggs Hatched		from Green Eggs	from Eyed Eggs
434B706122	OR-471	L30G cryo	8/9/04	1,401	969	69.2	924	66.0	283	20.2	29.2
434B795B6E	OR-418	L31J cryo	8/9/04	1,472	1,300	88.3	1,248	84.8	167	11.3	12.8
434A49126D	OR-418	L32J cryo	8/9/04	1,248	793	63.5	609	48.8	183	14.7	23.1
NO TAG	OR-385	L33E cryo	8/9/04	1,598	639	40.0	528	33.0	192	12.0	30.0
434B7D3744	OR-455	L34N cryo	8/13/04	1,409	593	42.1	584	41.4	586	41.6	98.8
434B744620	OR-455	L35N cryo	8/13/04	1,306	940	72.0	918	70.3	910	69.7	96.8
434A726E6A	OR-421	L36K cryo	8/13/04	880	599	68.1	532	60.5	518	58.9	86.5
434B59586E	OR-421	L37K cryo	8/13/04	856	659	77.0	597	69.7	581	67.9	88.2
434B562D7B	OR-370	L38AA cryo	8/13/04	819	538	65.7	384	46.9	344	42.0	63.9
4351316B7E	OR-370	L39AA cryo	8/13/04	897	737	82.2	691	77.0	661	73.7	89.7
4351344D4B	OR-489	L40Y cryo	8/13/04	1,227	922	75.1	823	67.1	144	11.7	15.6
43227A7C57	OR-489	L41Y cryo	8/13/04	768	226	29.4	110	14.3	97	12.6	42.9
434A594874	OR-400	L42W cryo	8/13/04	983	500	50.9	477	48.5	436	44.4	87.2
NO TAG	OR-400	L43W cryo	8/13/04	1,349	704	52.2	639	47.4	612	45.4	86.9
432016694A	W-121	L44GG cryo	8/13/04	1,398	1,123	80.3	1,074	76.8	1,010	72.2	89.9
431A742829	W-121	L45GG cryo	8/13/04	1,140	796	69.8	432	37.9	332	29.1	41.7
Totals				47,989	33,485	.	31,506	.	26,075	.	.
Averages				1,066 ^a	744 ^a	69.8	700 ^a	65.7	579 ^a	54.3	77.9

^a Averages derived from the number of females spawned (n = 45), not the number of family groups.

Progeny

Rearing

Between the dates of initial feeding (August 1, 2004) and release (February 3, 2005), progeny of non-captive parents were fed a total of 1,945 pounds of fish feed, resulting in a total weight gain by the fish of 2,166 pounds (food conversion rate of 0.90). The average length increase of the fish from time of initial feeding to release was 56.6 mm.

Between the dates of initial feeding (September 14, 2004) and release (February 5, 2004), progeny of captive-females were fed a total of 168 pounds of fish feed, resulting in a total weight gain by the fish of 162 pounds (food conversion rate of 1.04). The average length increase of the fish from time of initial feeding to release was 42.9 mm.

Marking and Tagging

Coded-wire tagging of juvenile winter Chinook occurred between December 20, 2004 and January 10, 2005. 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: 98,435 natural-origin × natural-origin progeny, 26,990 natural-origin × hatchery-origin progeny, and 18,650 captive-origin × natural-origin progeny (Table 4). Mortality rates for all three groups were 0.5% or less.

Health

Juvenile progeny were tested for seven different pathogens (Table 7). Progeny from parents collected from the Sacramento River tested positive for *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease.

Released

A total of 168,261 juvenile winter Chinook were released at Caldwell Park on February 3, 2005. Most (88.2%) of the fish released were from non-captive parents (Table 4). Of the progeny from non-captive parents, 78.5% were from natural-origin × natural-origin parents and the remaining 21.5% were from natural-origin × hatchery-origin parents. Progeny from captive-origin × natural-origin parents accounted for 11.8% of the total release.

Assessment of Potential Genetic Impacts

When brood year 2004 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 864 to 905 spawners. Under the scenario that 33% of the population was successful at producing progeny, the hatchery program increased the effective population size from 2,875 to 2,975 individuals.

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Attachment A-- Brood Year 2004 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.)