2008 Annual Report of Winter Chinook Propagation Activities

A U.S. Fish & Wildlife Service Report

U.S. Fish and Wildlife Service
Red Bluff Fish and Wildlife Office
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TABLE OF CONTENTS

FIGURES

TABLES and APPENDIX

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 4 August 1989 (54 Federal Register 32085). Winter Chinook were formally added to the list of federally threatened species by final rule on 5 November 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 winter Chinook propagation program was initially 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 desired location of the Sacramento River. To alleviate this problem, a new hatchery facility, Livingston Stone NFH, was established in 1998 along the Sacramento River at the base of Shasta Dam.

METHODS

Broodstock

Collection

Prior to collecting winter Chinook broodstock in 2008, the Service developed a broodstock collection plan that established an annual collection goal and set forth monthly collection targets spread throughout the run (Attachment 1). Broodstock collection guidelines for winter Chinook allow the Service to capture up to 15% of the run size, with a maximum of 120 fish. Therefore, a run size of 800 or greater allows for the maximum of 120 fish to be retained as broodstock. In 2008, the pre-season run estimate was greater than 800; therefore, the Service established an annual collection goal of up to 120 adult winter Chinook salmon. The timing of broodstock collection was scheduled to mimic the historic migration timing past the Red Bluff Diversion Dam. Monthly collection targets were established, 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 occurs when monthly collection targets are not fulfilled. When this occurs, the Service may increase collection targets for subsequent months so that the annual collection goal for the winter Chinook propagation program is maintained. The Keswick Dam fish trap was the only trap used to collect winter Chinook broodstock in 2008. The alternate trap located at the Red Bluff Diversion Dam was operated in 2008, however, no winter Chinook were collected at that location.

Generally, no pre-assigned criteria are made for broodstock collection with the exception of percent fungus. Early in the season, fish with moderate to high amounts of fungus covering the body are selected against because these fish generally will not survive in captivity long enough to spawn. As the season progresses, the fish generally are riper when they enter the trap, the limit on fungus rates are relaxed.

Handling and Transportation

Fishes collected at the Keswick Dam fish trap were crowded into a 1,000 gallon brail-lift, from which they were transferred directly into an aerated and insulated 1,200 or 1,600-gallon transport tank and driven to Livingston Stone NFH. At Livingston Stone NFH the fish were anaesthetized with CO_2 to facilitate handling. All Chinook receive a Floy tag below the dorsal fin, are fin tissue sampled for genetic analysis, and are assigned a preliminary run (i.e., winter or non-winter) based on phenotypic characteristics (e.g., color, degree of ripeness, fish size, amount of fungus, and collection date). Fish classified as non-winter are either transported back to the Sacramento River and released or, alternatively, transported to Coleman NFH for use as broodstock in the late-fall Chinook propagation program. Fish classified as phenotypic winter are further divided based on hatchery broodstock needs. Fish desired for use as broodstock are quarantined in a 20-foot circular tank pending genetic confirmation of their run type and any fish not selected for broodstock being transported back to the Sacramento River and released. Of the quarantined fish, those genetically confirmed as winter are transferred from quarantine into a separate 20-foot circular adult holding tank until spawned. Those genetically identified as non-winter are transported back to the Sacramento River and released.

Final Run Identification

A genetic-based run assignment was used to classify fish as either winter or non-winter 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 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 or non-winter. A LOD score of one 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 72 hours of receipt of the tissue sample at 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 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	Target Dosage	Administered by	Use
Erythromycin	20 mg/kg	dorsal sinus injection	antibacterial
Iodophor	75 ppm	bath	antibacterial
Liquamycin	20 mg/kg	Intraperitoneal injection	antibacterial
Malachite green	1 ppm	bath	antifungal
Formalin	167 ppm	flow through	antifungal
MS-222	60 - 80 mg/L	bath	anesthetic
Poly Aqua	1 qt/1,200 gallons	bath/flow through	stress reducer
Salt	1% – 3% solution	bath/flow through	stress reducer
Chloramine-T	15 ppm	bath	antibacterial

Spawning

Winter Chinook 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_a) implants were administered to accelerate final gamete maturation in fish that had already undergone gametogenesis and to synchronize maturation of broodstock. 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 varied, 150 or 250 µg, depending on fish size (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.

When a female salmon was identified as being sexually mature, it was removed from the tank, euthanized, 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, sperm life and motility was extended using tris-glycine buffer (250-500 ml used proportionally to volume of eggs). 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 was spawned with at least two others thereby spreading the gametes over multiple family groups. This provided a buffer from loss of all gametes for any one fish from such circumstances as, one parent having unfit gametes (thereby resulting in loss of gametes from both fish) or losses due to equipment failure.

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 temperature 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 Nelson and Sons Silvercup Soft Moist Starter. *Artemia nauplii* (Cyclop-eeze™ from Argent Chemical Laboratories) were added to increase interest in the feed. The fish were subsequently fed Nelson and Sons Soft Moist Starter #1. Once they attained a size of approximately 300 to-the-pound, they were fed Nelson and Sons Soft Moist Starter #2 until release. Feeding rates were determined using Silvercup'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

Rearing units were cleaned daily to maintain a sanitary rearing environment. Juvenile winter Chinook were tested for the presence of pathogens by California-Nevada Fish Health Center personnel.

Marking and Tagging

All hatchery reared winter Chinook are adipose-fin clipped and coded-wire tagged prior to release. The adipose fin is removed from all fish so they can easily be identified as hatchery-origin fish upon return. The tagging is conducted by the Hatchery Evaluation program of the Red Bluff Fish & Wildlife Office using a manual tagging trailer (Northwest Marine Technology).

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 2008. 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 Chinook was captured on 19 February 2008 and the last was captured on 22 July 2008 (Figure 1, Appendix A). Most of the brood year 2008 winter Chinook were collected from late-March through April. Non-winter Chinook did not exhibit the same late-March pulse return and instead were more evenly distributed throughout the trapping period. A total of 387 Chinook salmon were captured at the Keswick Dam fish trap (Table 2). Of those, 51% (n = 198) were identified as winter based on genetic data or phenotypic characteristics. Females comprised 52% (n = 102) of the winter Chinook salmon captured, males comprised 48% (n = 96). Hatchery-origin fish comprised 28% (n = 56) of the winter Chinook captured and 18% (n = 70) of all Chinook captured.

Ninety-one winter Chinook, 159 non-winter Chinook, and 4 Chinook of undetermined run were collected and released without being quarantined (Table 2). Eleven Chinook were held in quarantine and later released back into the Sacramento River; 2 of these fish were winter, 8 were non-winter, and 1 was of undetermined run (Table 2). Quarantined fish were generally held for two days; one female was held four days. One hundred five winter Chinook salmon were retained for broodstock. Among these, 93 were spawned and 12 died before they could be spawned. Fifteen non-winter Chinook were euthanized. No non-winter Chinook were transferred for use as late-fall Chinook salmon broodstock due to construction at Coleman NFH blocking access to the holding area.

The winter Chinook broodstock collected at the Keswick Dam fish trap were sufficient to meet the Service's annual collection goal; therefore, the Service did not initiate broodstock collection at the alternate trapping facility, the Red Bluff Diversion Dam.

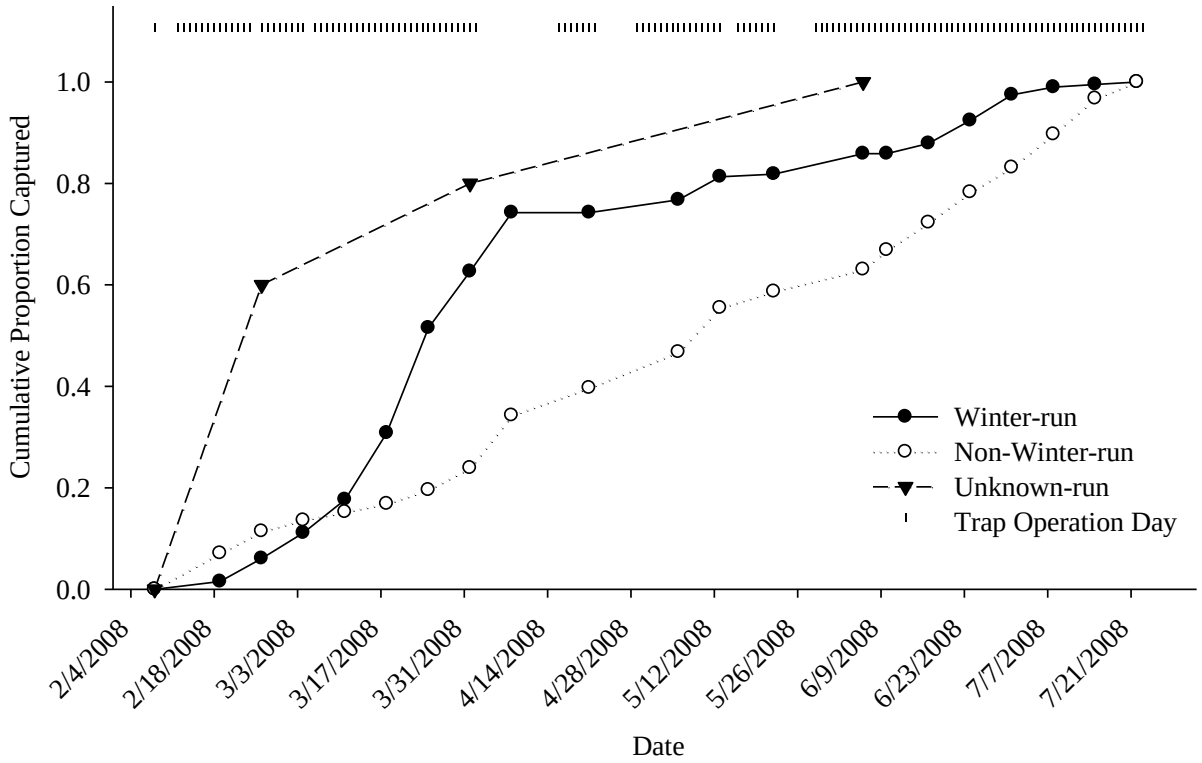

Figure 1.—Capture timing of brood year 2008 Chinook salmon from the Keswick Dam fish trap by run-type.

Table 2.—Disposition of Chinook salmon trapped at the Keswick Dam fish trap from 19 February 2008 – 22 July 2008; grouped 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	
Winter	Trapped and spawned	93	(7)	45	(5)	48	(2)	0	(0)
Winter	Pre-spawn mortality	12	(1)	7	(1)	5	(0)	0	(0)
Winter	Trapped, quarantined, and released back into river	2	(1)	0	(0)	2	(1)	0	(0)
Winter	Trapped and released back into river without quarantine	91	(47)	44	(29)	47	(18)	0	(0)
Winter	Trapped, and retained at LSNFH (unknown disposition)	0	(0)	0	(0)	0	(0)	0	(0)
Winter	Euthanized	0	(0)	0	(0)	0	(0)	0	(0)
	Subtotal	198	(56)	96	(35)	102	(21)	0	(0)
Non-winter	Pre-spawn mortality	2	(0)	2	(0)	0	(0)	0	(0)
Non-winter	Trapped, quarantined, and released back into river	8	(0)	8	(0)	0	(0)	0	(0)
Non-winter	Trapped and released back into river without quarantine	159	(0)	66	(0)	93	(0)	0	(0)
Non-winter	Transferred to Coleman National Fish Hatchery	0	(0)	0	(0)	0	(0)	0	(0)
Non-winter	Euthanized	15	(14)	5	(4)	10	(10)	0	(0)
	Subtotal	184	(14)	81	(4)	103	(10)	0	(0)
Undetermined	Pre-spawn mortality	0	(0)	0	(0)	0	(0)	0	(0)
Undetermined	Trapped, quarantined, and released back into river	1	(0)	1	(0)	0	(0)	0	(0)
Undetermined	Trapped and released back into river without quarantine	4	(0)	4	(0)	0	(0)	0	(0)
	Subtotal	5	(0)	5	(0)	0	(0)	0	(0)
	Grand Total	387	(70)	182	(39)	205	(31)	0	(0)

Health

Sacramento River broodstock tested positive for *Aeromonas salmonicida*, infectious hematopoietic necrosis virus, *Ceratomyxa shasta*, and *Parvicapsula minibicornis* (Table 3).

Table 3.—Test results (positive or negative) for fish pathogens in brood year 2008 winter Chinook salmon broodstock and juveniles, conducted by the U. S. Fish & Wildlife Service's California - Nevada Fish Health Center.

Pathogen	Adult	Juveniles[a]
Aeromonas salmonicida	positive	negative
Yersinia ruckeri	negative	negative
Renibacterium salmoninarum	negative	positive
Myxobolus cerebralis	no test	negative
Infectious hematopoietic necrosis virus	positive	negative
Viral hemorrhagic septicemia virus	negative	negative
Infectious pancreatic necrosis virus	negative	negative
*Oncorhynchus masou*virus	negative	no test
Ceratomyxa shasta	positive	no test
Parvicapsula minibicornis	positive	no test

[a] Juvenile progeny of the broodstock origin types were combined for the assay.

Spawning & Production

Twenty-one females and seven males received LH-RH_a injections to accelerate final gamete maturation (Tables 4 and 5). Brood year 2008 winter Chinook salmon were spawned between 23 May 2008 and 23 July 2008 (Tables 4 and 5, Figure 2). A total of 48 female (Table 4) and 45 male (Table 5) winter Chinook salmon were spawned producing 95 family groups (Table 6). Fork length of spawned females ranged from 640 to 860 mm and averaged 790 mm (SD = 38; Table 4). Fork length of spawned males ranged from 450 to 930 mm and averaged 788 mm (SD = 137; Table 5). Females produced an average of 5,519 green eggs yielding a total of 260,370 green eggs, with 90% of these developing into eyed eggs (Table 6). The percent of green eggs that hatched averaged 88% with 77% of the green eggs resulted in juveniles that were transferred to rearing tanks (Table 6).

Table 4.—Spawning and drug treatment history of individual female Chinook salmon held at the Livingston Stone National Fish Hatchery, 2008 broodstock.

Floy Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned[1]	Date Died	Days in Captivity	Erythromycin		Liquamycin		LH-RHa		No. of Malachite Green Treatments
							Dose (mls)	Injections	Dose (mls)	Injections	Dose (mls)	Injections	
OR-112	2/26/2008	740	10.90	PSM	3/20	22	n/a	none	n/a	none	n/a	none	5
OR-117	2/26/2008	850	17.80	PSM	4/8	41	n/a	none	n/a	none	n/a	none	11
OR-200	3/18/2008	770	14.30	PSM	4/20	32	n/a	none	n/a	none	n/a	none	9
OR-345	4/8/2008	790	15.60	PSM	5/18	39	0.75	1	n/a	none	250	1	11
OR-361	4/8/2008	770	12.80	PSM	6/13	65	0.65	2	n/a	none	n/a	none	18
OR-099	2/26/2008	770	12.20	6/16	6/16	110	0.65	1	0.65	2	150	2	30
OR-100	2/26/2008	785	14.30	5/23	5/23	86	0.75	1	0.65	1	n/a	none	23
OR-141	3/4/2008	790	13.00	6/2	6/2	89	0.65	2	n/a	none	n/a	none	25
OR-144	3/4/2008	780	13.80	6/6	6/6	93	0.65	1	0.65	1	150	2	26
OR-147	3/4/2008	780	13.70	7/4	7/4	121	0.65	2	n/a	none	n/a	none	36
OR-150	3/11/2008	780	13.80	7/18	7/18	128	0.65	2	n/a	none	150	2	36
OR-155	3/11/2008	760	7.80	5/23	5/23	72	0.40	1	n/a	none	250	1	19
OR-171	3/11/2008	820	16.30	6/13	6/13	93	0.75	2	0.75	1	n/a	none	26
OR-175	3/18/2008	780	13.70	5/23	5/23	65	0.65	1	n/a	none	250	1	18
OR-176	3/18/2008	840	16.10	6/9	6/9	82	0.75	1	n/a	none	n/a	none	23
OR-202	3/18/2008	800	16.50	6/6	6/6	79	0.75	1	n/a	none	250	1	22
OR-205	3/18/2008	780	14.50	6/20	6/20	93	0.65	2	n/a	none	n/a	none	26
OR-208	3/18/2008	810	15.00	6/23	6/23	96	0.65	2	n/a	none	n/a	none	25
OR-212	3/18/2008	730	10.50	6/20	6/20	93	0.50	2	n/a	none	150	2	24
OR-213	3/18/2008	820	17.50	7/4	7/4	107	0.75	2	n/a	none	n/a	none	30
OR-215	3/18/2008	810	17.20	5/26	5/26	68	0.75	1	n/a	none	250	1	19
OR-218	3/25/2008	820	15.60	6/30	6/30	96	0.75	2	n/a	none	n/a	none	27
OR-219	3/25/2008	840	16.20	6/6	6/6	72	0.75	1	n/a	none	250	1	20
OR-223	3/25/2008	850	17.60	6/13	6/13	79	0.75	1	n/a	none	n/a	none	22
OR-230	3/25/2008	810	12.30	6/20	6/20	86	0.50	2	n/a	none	150	2	24
OR-242	3/25/2008	820	20.00	6/30	6/30	96	0.90	2	n/a	none	n/a	none	27
OR-246	3/25/2008	760	12.50	6/13	6/13	79	0.65	1	n/a	none	150	2	22
OR-249	3/25/2008	830	14.80	6/20	6/20	86	0.65	2	n/a	none	n/a	none	24
OR-250	3/25/2008	720	10.60	6/23	6/23	89	0.50	2	n/a	none	n/a	none	25
OR-253	3/25/2008	780	13.30	6/16	6/16	82	0.65	1	0.65	1	n/a	none	23
OR-255	3/25/2008	770	12.80	7/18	7/18	115	0.65	2	n/a	none	n/a	none	32
OR-262	3/25/2008	845	22.00	6/30	6/30	96	1.05	2	n/a	none	n/a	none	27

Table 4.—continued

Floy Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Erythromycin		Liquamycin		LH-RHa		No. of Malachite Green Treatments
							Dose (mls)	Injections	Dose (mls)	Injections	Dose (mls)	Injections	
OR-267	3/25/2008	780	14.30	6/9	6/9	75	0.65	1	0.65	1	150	2	21
OR-272	3/25/2008	790	13.50	7/11	7/11	107	0.65	2	n/a	none	n/a	none	30
OR-273	3/25/2008	770	13.60	6/9	6/9	75	0.65	1	0.65	0	150	2	21
OR-278	3/25/2008	760	11.25	7/18	7/18	114	0.50	2	n/a	none	150	2	32
OR-279	3/25/2008	820	14.80	6/30	6/30	96	0.65	2	n/a	none	n/a	none	27
OR-282	3/25/2008	760	12.90	7/23	7/23	119	0.50	2	n/a	none	n/a	none	32
OR-306	4/1/2008	780	15.00	5/23	5/23	51	0.75	1	0.75	1	250	1	14
OR-326	4/1/2008	790	13.50	6/20	6/20	79	0.65	2	n/a	none	n/a	none	22
OR-331	4/1/2008	640	6.80	6/13	6/13	72	0.30	1	0.3	1	150	1	18
OR-379	4/8/2008	770	10.80	7/7	7/7	89	0.50	2	n/a	none	n/a	none	25
OR-388	4/8/2008	780	12.50	5/26	5/26	47	0.65	1	n/a	none	250	1	12
OR-391	4/8/2008	800	13.80	6/27	6/27	79	0.65	2	n/a	none	n/a	none	22
OR-392	4/8/2008	860	18.40	5/30	5/30	51	0.90	1	n/a	none	250	1	14
W-002	5/13/2008	810	16.00	6/9	6/9	26	0.75	1	n/a	none	250	1	7
W-083	6/17/2008	810	15.20	6/27	6/27	9	0.75	1	n/a	none	n/a	none	2
W-135	6/24/2008	760	10.54	6/27	6/27	2	n/a	none	n/a	none	n/a	none	0
W-163	7/1/2008	760	11.40	7/4	7/4	2	n/a	none	n/a	none	n/a	none	0
W-174	7/1/2008	820	13.40	7/4	7/4	2	n/a	none	n/a	none	n/a	none	0
W-177	7/1/2008	790	11.50	7/14	7/14	12	n/a	none	n/a	none	150	1	0
W-206	7/8/2008	830	14.00	7/11	7/11	2	n/a	none	n/a	none	n/a	none	0
W-211	7/8/2008	780	14.38	7/11	7/11	2	n/a	none	n/a	none	n/a	none	0

[1] PSM = Pre-spawn mortality.

Table 5.—Spawning and drug treatment history of individual male Chinook salmon held at the Livingston Stone National Fish Hatchery, 2008 broodstock.

Floy Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Liquamycin		LH-RHa		No. of Malachite Green Treatments
							Dose (mls)	Injections	Dose (mls)	Injections	
OR-116	2/26/2008	850	12.8	PSM	3/23/2008	25	n/a	none	n/a	none	6
OR-140	3/4/2008	690	6.5	PSM	4/8/2008	34	n/a	none	n/a	none	10
OR-193	3/18/2008	910	20.7	PSM	4/10/2008	22	n/a	none	n/a	none	6
OR-235	3/25/2008	880	19.7	PSM	4/11/2008	16	0.9	1	250	1	5
OR-180	3/18/2008	870	20.6	PSM	5/2/2008	44	0.9	2	250	1	12
OR-318	4/1/2008	780	12	PSM	5/23/2008	51	0.65	1	250	1	14
OR-440	5/6/2008	840	16.9	6/9/2008 7/14/2008	5/15/2008	8	0.75	1	250	1	2
OR-214	3/18/2008	770	12.7	6/9/2008	5/20/2008	62	0.65	1	n/a	none	17
OR-259	3/25/2008	800	12.76	5/23/2008 5/23/2008 5/23/2008	5/26/2008	61	n/a	none	n/a	none	17
OR-350	4/8/2008	840	18.2	5/23/2008 5/23/2008	5/26/2008	12	n/a	none	n/a	none	2
OR-179	3/18/2008	890	17.15	5/23/2008 5/23/2008 5/26/2008	5/26/2008	68	0.75	1	250	1	19
OR-494 495	5/13/2008	850	17.3	5/23/2008 5/26/2008 5/26/2008	5/30/2008	16	n/a	none	n/a	none	4
OR-489	5/13/2008	800	12.66	5/26/2008 5/30/2008	6/1/2008	18	n/a	none	n/a	none	4
OR-383	4/8/2008	920	21.5	5/30/2008 6/2/2008	6/3/2008	55	n/a	none	n/a	none	16
OR-354 355	4/8/2008	900	19.8	6/2/2008 6/6/2008 6/6/2008	6/9/2008	61	n/a	none	250	1	17
OR-322	4/1/2008	890	27.2	6/6/2008 6/6/2008	6/9/2008	68	n/a	none	n/a	none	19
OR-297	4/1/2008	910	21	6/6/2008 6/13/2008	6/25/2008	84	n/a	none	n/a	none	22

Table 5.—continued

Floy Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Liquamycin		LH-RHa		No. of Malachite Green Treatments
							Dose (mls)	Injections	Dose (mls)	Injections	
OR-201	3/18/2008	910	20.5	6/6/2008 6/9/2008 6/13/2008	6/16/2008	89	n/a	none	n/a	none	25
OR-156	3/11/2008	860	19.8	6/9/2008 6/9/2008 6/13/2008	6/25/2008	105	n/a	none	n/a	none	28
OR-138	3/4/2008	790	14.2	6/9/2008 6/9/2008 6/13/2008	6/13/2008	100	n/a	none	n/a	none	26
OR-271	3/25/2008	880	19.1	6/9/2008 6/13/2008 6/20/2008	6/24/2008	90	n/a	none	n/a	none	24
W-039	6/6/2008	860	16.3	6/13/2008 6/16/2008 5/20/2008	6/30/2008	23	n/a	none	n/a	none	6
OR-143	3/4/2008	820	18.6	6/13/2008 6/13/2008	6/17/2008	104	n/a	none	n/a	none	29
W-022	5/22/2008	700	7.95	6/16/2008 6/16/2008	6/28/2008	36	n/a	none	n/a	none	8
OR-145	3/4/2008	830	15.7	6/16/2008 6/20/2008	6/28/2008	115	n/a	none	n/a	none	31
OR-222	3/25/2008	890	19.6	6/20/2008	6/20/2008	86	n/a	none	n/a	none	24
OR-453	5/6/2008	520	3.3	6/20/2008 6/23/2008	6/23/2008	40	n/a	none	n/a	none	9
OR-471	5/6/2008	450	2.88	6/20/2008 6/23/2008	6/30/2008	47	n/a	none	n/a	none	13
OR-245	3/25/2008	890	19.6	6/20/2008 6/23/2008	6/30/2008	96	n/a	none	n/a	none	25
OR-304	4/1/2008	840	17.7	6/20/2008 6/20/2008	6/30/2008	89	n/a	none	n/a	none	25
OR-174	3/11/2008	885	17.2	6/23/2008	6/25/2008	105	n/a	none	n/a	none	27
OR-439	5/6/2008	510	3.3	6/27/2008 6/30/2008	6/30/2008	47	n/a	none	n/a	none	13

Table 5.—continued

Floy Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Liquamycin		LH-RHa		No. of Malachite Green Treatments
							Dose (mls)	Injections	Dose (mls)	Injections	
W-107	6/17/2008	550	4.46	6/27/2008 5/30/2008	7/23/2008	35	n/a	none	n/a	none	5
OR-305	4/1/2008	900	20.6	6/27/2008 6/30/2008	7/23/2008	112	n/a	none	n/a	none	30
OR-146	3/4/2008	860	17.6	6/27/2008 6/30/2008	7/18/2008	135	n/a	none	n/a	none	38
OR-139	3/4/2008	880	22.5	6/27/2008 6/30/2008	7/7/2008	124	n/a	none	n/a	none	35
OR-380	4/8/2008	870	18	6/27/2008 6/30/2008	7/19/2008	101	n/a	none	n/a	none	28
W-102	6/17/2008	540	4.56	6/30/2008	7/7/2008	19	n/a	none	n/a	none	5
W-136	6/24/2008	560	4.54	6/30/2008 7/4/2008	7/13/2008	18	n/a	none	n/a	none	5
W-184	7/1/2008	830	13.2	7/4/2008 7/4/2008	7/4/2008	2	n/a	none	n/a	none	0
W-181	7/1/2008	780	12.4	7/4/2008 7/4/2008	7/4/2008	2	n/a	none	n/a	none	0
W-180	7/1/2008	610	5	7/4/2008 7/4/2008	7/4/2008	2	n/a	none	n/a	none	0
OR-462	5/6/2008	520	3.33	7/4/2008 7/23/2008	7/23/2008	70	n/a	none	150	1	18
OR-225	3/25/2008	870	19.32	7/7/2008 7/11/2008	7/19/2008	115	n/a	none	n/a	none	30
OR-209	3/18/2008	860	17	7/7/2008 7/11/2008	7/23/2008	126	n/a	none	n/a	none	34
W-215	7/8/2008	540	3.1	7/11/2008 7/11/2008	7/11/2008	2	n/a	none	n/a	none	0
OR-292	4/1/2008	870	25.8	7/11/2008 7/11/2008	7/18/2008	114	n/a	none	n/a	none	32
OR-300	4/1/2008	930	21.4	7/14/2008 7/18/2008	7/19/2008	108	n/a	none	n/a	none	28
OR-254	3/25/2008	780	12.9	7/18/2008 7/23/2008	7/23/2008	119	n/a	none	n/a	none	32

Table 5.—continued

Floy Tag Number	Date Captured	Fork Length (mm)	Weight (lb)	Date Spawned	Date Died	Days in Captivity	Liquamycin		LH-RHa		No. of Malachite Green Treatments
							Dose (mls)	Injections	Dose (mls)	Injections	
OR-190	3/18/2008	820	16.4	7/18/2008 7/18/2008	7/23/2008	126	0.75	1	n/a	none	34
OR-224	3/25/2008	860	18.38	7/18/2008 7/18/2008	7/23/2008	119	n/a	none	n/a	none	32

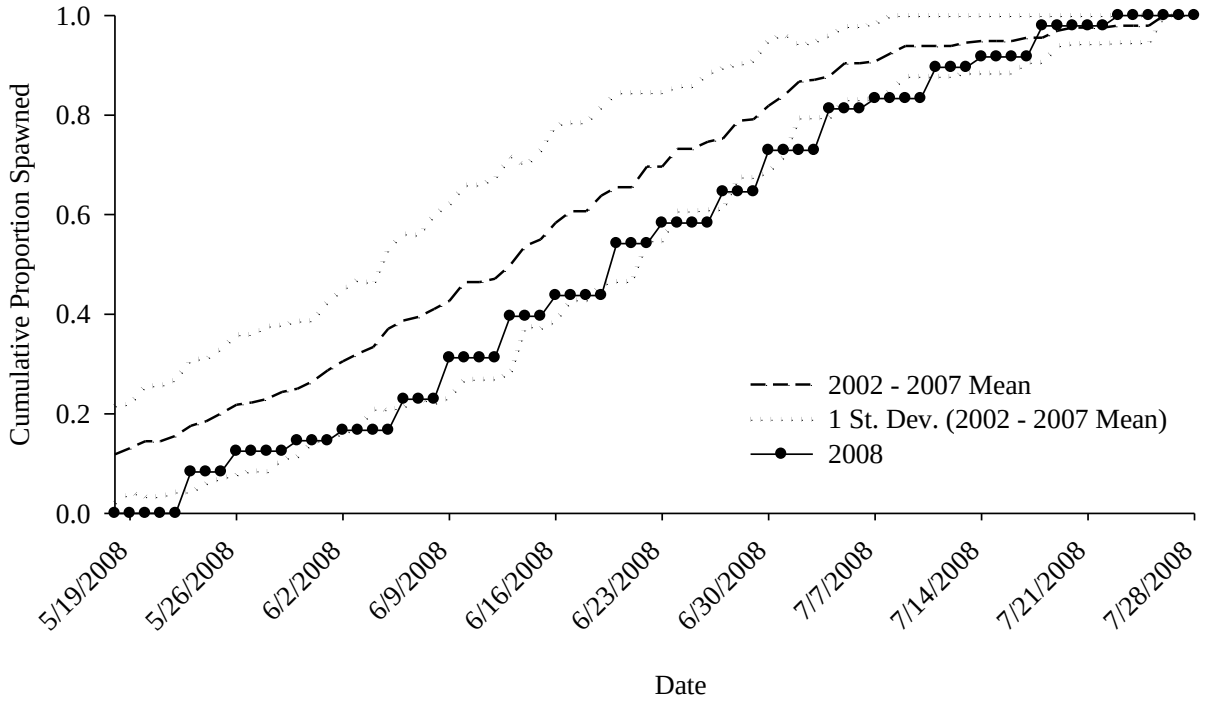

Figure 2.—Spawn timing of winter Chinook salmon at the Livingston Stone National Fish Hatchery, 2008 broodstock.

Table 6.—Early survival of eggs and fry from winter Chinook salmon captured from the wild and spawned at the Livingston Stone National Fish Hatchery, brood year 2008.

Crosses by floy tag		Family	Date	Green	Eyed	Percent	Number	Percent Green	Number	Percent Green	Percent Eyed
Female	Male	Group	Spawned	Eggs	Eggs	Eyed	Hatched	Eggs Hatched	Tanked	Eggs Tanked	Eggs Tanked
OR-155	OR-259	1C	5/23/2008	2,638	2,486	94.2%	2,469	93.6%	2,412	91.4%	97.0%
OR-155	OR-350	1D	5/23/2008	2,240	2,217	99.0%	2,198	98.1%	2,179	97.3%	98.3%
OR-175	OR-259	2C	5/23/2008	2,907	2,819	97.0%	2,804	96.5%	2,767	95.2%	98.2%
OR-175	OR-350	2D	5/23/2008	2,552	2,534	99.3%	2,514	98.5%	2,494	97.7%	98.4%
OR-306	OR-259	3C	5/23/2008	3,090	2,509	81.2%	2,316	75.0%	2,287	74.0%	91.2%
OR-306	OR-179	3E	5/23/2008	2,464	2,067	83.9%	1,968	79.9%	1,947	79.0%	94.2%
OR-100	OR-179	4E	5/23/2008	3,459	3,360	97.1%	3,315	95.8%	3,223	93.2%	95.9%
OR-100	OR-494	4F	5/23/2008	2,426	2,355	97.1%	2,330	96.0%	2,156	88.9%	91.5%
OR-215	OR-179	5E	5/26/2008	3,539	3,453	97.6%	3,408	96.3%	3,245	91.7%	94.0%
OR-215	OR-494	5F	5/26/2008	2,814	2,762	98.2%	2,744	97.5%	2,602	92.5%	94.2%
OR-388	OR-494	6F	5/26/2008	2,423	2,393	98.8%	2,391	98.7%	1,992	82.2%	83.2%
OR-388	OR-489	6G	5/26/2008	2,688	2,636	98.1%	2,634	98.0%	2,391	89.0%	90.7%
OR-392	OR-489	7G	5/30/2008	3,482	2,752	79.0%	2,637	75.7%	2,621	75.3%	95.2%
OR-392	OR-383	7H	5/30/2008	3,456	2,338	67.7%	2,260	65.4%	2,228	64.5%	95.3%
OR-141	OR-383	8H	6/2/2008	2,714	2,684	98.9%	2,664	98.2%	2,642	97.3%	98.4%
OR-141	OR-354	8I	6/2/2008	2,186	2,162	98.9%	2,154	98.5%	2,088	95.5%	96.6%
OR-202	OR-354	9I	6/6/2008	3,014	3,006	99.7%	2,998	99.5%	2,982	98.9%	99.2%
OR-202	OR-322	9J	6/6/2008	3,044	3,006	98.8%	2,995	98.4%	2,998	98.5%	99.7%
OR-144	OR-354	10I	6/6/2008	3,190	2,267	71.1%	1,889	59.2%	1,866	58.5%	82.3%
OR-144	OR-322	10J	6/6/2008	2,537	1,791	70.6%	1,524	60.1%	1,518	59.8%	84.8%
OR-219	OR-297	11K	6/6/2008	3,257	2,653	81.5%	2,379	73.0%	2,365	72.6%	89.1%
OR-219	OR-201	11L	6/6/2008	3,161	2,279	72.1%	1,955	61.8%	1,946	61.6%	85.4%
OR-267	OR-156	12M	6/9/2008	3,199	2,515	78.6%	2,353	73.6%	2,139	66.9%	85.0%
OR-267	OR-138	12N	6/9/2008	3,177	2,750	86.6%	2,479	78.0%	2,205	69.4%	80.2%
OR-273	OR-156	13M	6/9/2008	2,667	2,432	91.2%	2,318	86.9%	2,073	77.7%	85.2%
OR-273	OR-138	13N	6/9/2008	2,887	2,743	95.0%	2,566	88.9%	2,321	80.4%	84.6%
W-002	OR-214	14B[1]	6/9/2008	2,367	609	25.7%	568	24.0%	555	23.4%	91.1%
W-002	OR-271	14O	6/9/2008	3,345	3,237	96.8%	3,216	96.1%	3,177	95.0%	98.1%
OR-176	OR-440	15A[1]	6/9/2008	2,172	583	26.8%	554	25.5%	517	23.8%	88.7%
OR-176	OR-201	15L	6/9/2008	3,444	2,318	67.3%	2,255	65.5%	2,161	62.7%	93.2%
OR-171	OR-271	16O	6/13/2008	3,812	3,782	99.2%	3,757	98.6%	3,691	96.8%	97.6%
OR-171	W-039	16P	6/13/2008	3,150	3,122	99.1%	3,112	98.8%	3,056	97.0%	97.9%
OR-331	OR-297	17K	6/13/2008	1,308	226	17.3%	110	8.4%	107	8.2%	47.3%
OR-331	OR-138	17N	6/13/2008	1,164	213	18.3%	119	10.2%	93	8.0%	43.7%

Table 6.—continued

Crosses by floy tag		Family	Date	Green	Eyed	Percent	Number	Percent Green	Number	Percent Green	Percent Eyed
Female	Male	Group	Spawned	Eggs	Eggs	Eyed	Hatched	Eggs Hatched	Tanked	Eggs Tanked	Eggs Tanked
OR-246	OR-201	18L	6/13/2008	2,780	2,756	99.1%	2,412	86.8%	2,142	77.1%	77.7%
OR-246	OR-143	18Q	6/13/2008	2,949	2,816	95.5%	2,560	86.8%	2,152	73.0%	76.4%
OR-223	OR-156	19M	6/13/2008	3,148	2,933	93.2%	2,528	80.3%	2,087	66.3%	71.2%
OR-223	OR-143	19Q	6/13/2008	2,804	1,323	47.2%	932	33.2%	649	23.1%	49.1%
OR-253	W-039	20P	6/16/2008	2,904	2,876	99.0%	2,855	98.3%	7	0.2%	0.2%
OR-253	W-022	20R	6/16/2008	2,959	2,896	97.9%	2,869	97.0%	4	0.1%	0.1%
OR-099	W-022	21R	6/16/2008	2,297	2,085	90.8%	1,937	84.3%	482	21.0%	23.1%
OR-099	OR-145	21S	6/16/2008	2,277	2,090	91.8%	1,949	85.6%	659	28.9%	31.5%
OR-230	OR-222	22T	6/20/2008	3,162	5	0.2%	5	0.2%	5	0.2%	100.0%
OR-230	OR-453	22U	6/20/2008	2,416	2,315	95.8%	2,260	93.5%	2,268	93.9%	98.0%
OR-212	OR-145	23S	6/20/2008	2,210	2,169	98.1%	2,116	95.7%	2,126	96.2%	98.0%
OR-212	OR-471	23V	6/20/2008	2,621	2,532	96.6%	2,462	93.9%	2,420	92.3%	95.6%
OR-326	OR-245	24X[2]	6/20/2008	2,702	2,227	82.4%	2,163	80.1%	2,093	77.5%	94.0%
OR-249	W-039	25P	6/20/2008	3,012	3,001	99.6%	2,968	98.5%	2,933	97.4%	97.7%
OR-249	OR-304	25W	6/20/2008	3,450	3,422	99.2%	3,395	98.4%	3,410	98.8%	99.6%
OR-205	OR-271	26O	6/20/2008	2,977	2,966	99.6%	2,956	99.3%	2,959	99.4%	99.8%
OR-205	OR-304	26W	6/20/2008	2,845	2,833	99.6%	2,827	99.4%	2,816	99.0%	99.4%
OR-208	OR-245	27X[2]	6/23/2008	2,182	1,986	91.0%	1,877	86.0%	1,817	83.3%	91.5%
OR-208	OR-174	27Y[2]	6/23/2008	1,604	1,546	96.4%	1,458	90.9%	1,388	86.5%	89.8%
OR-250	OR-453	28U	6/23/2008	2,253	2,237	99.3%	2,231	99.0%	2,244	99.6%	100.3%
OR-250	OR-471	28V	6/23/2008	2,240	2,216	98.9%	2,209	98.6%	2,212	98.8%	99.8%
W-083	OR-439	29Z	6/27/2008	3,352	3,268	97.5%	3,238	96.6%	3,261	97.3%	99.8%
W-083	W-107	29AA	6/27/2008	2,746	2,717	98.9%	2,709	98.7%	2,330	84.9%	85.8%
OR-391	OR-305	30BB	6/27/2008	2,868	2,739	95.5%	2,701	94.2%	2,716	94.7%	99.2%
OR-391	OR-146	30CC	6/27/2008	2,884	2,660	92.2%	2,645	91.7%	2,659	92.2%	100.0%
W-135	OR-139	31DD	6/27/2008	1,931	1,914	99.1%	1,892	98.0%	1,866	96.6%	97.5%
W-135	OR-380	31EE	6/27/2008	1,913	1,884	98.5%	1,872	97.9%	1,868	97.6%	99.2%
OR-262	OR-380	32EE	6/30/2008	2,798	2,777	99.2%	2,767	98.9%	2,743	98.0%	98.8%
OR-262	W-102	32FF	6/30/2008	2,920	2,907	99.6%	2,896	99.2%	2,870	98.3%	98.7%
OR-279	OR-439	33Z	6/30/2008	3,119	3,092	99.1%	2,965	95.1%	2,918	93.6%	94.4%
OR-279	OR-305	33BB	6/30/2008	2,975	2,937	98.7%	2,821	94.8%	2,772	93.2%	94.4%
OR-242	W-107	34AA	6/30/2008	2,710	2,670	98.5%	2,658	98.1%	2,592	95.6%	97.1%
OR-242	W-136	34GG	6/30/2008	2,361	2,347	99.4%	2,341	99.2%	2,203	93.3%	93.9%
OR-218	OR-146	35CC	6/30/2008	2,986	2,959	99.1%	2,951	98.8%	2,934	98.3%	99.2%
OR-218	OR-139	35DD	6/30/2008	2,879	2,838	98.6%	2,828	98.2%	2,811	97.6%	99.0%

Table 6.—continued

Crosses by floy tag		Family	Date	Green	Eyed	Percent	Number	Percent Green	Number	Percent Green	Percent Eyed
Female	Male	Group	Spawned	Eggs	Eggs	Eyed	Hatched	Eggs Hatched	Tanked	Eggs Tanked	Eggs Tanked
W-174	W-184	36HH	7/4/2008	2,661	2,563	96.3%	2,549	95.8%	2,522	94.8%	98.4%
W-174	W-181	36II	7/4/2008	2,652	2,622	98.9%	2,609	98.4%	2,589	97.6%	98.7%
W-163	W-184	37HH	7/4/2008	2,334	2,319	99.4%	2,307	98.8%	2,275	97.5%	98.1%
W-163	W-181	37II	7/4/2008	2,080	2,067	99.4%	2,050	98.6%	2,025	97.4%	98.0%
OR-213	W-180	38JJ	7/4/2008	3,888	3,875	99.7%	3,857	99.2%	3,846	98.9%	99.3%
OR-213	OR-462	38KK	7/4/2008	2,778	2,761	99.4%	2,740	98.6%	2,747	98.9%	99.5%
OR-147	W-136	39GG	7/4/2008	2,772	2,741	98.9%	2,664	96.1%	2,607	94.0%	95.1%
OR-147	W-180	39JJ	7/4/2008	2,682	2,644	98.6%	2,575	96.0%	2,549	95.0%	96.4%
OR-379	OR-225	40LL	7/7/2008	2,943	2,924	99.4%	2,905	98.7%	2,856	97.0%	97.7%
OR-379	OR-209	40MM	7/7/2008	2,671	2,651	99.3%	2,629	98.4%	2,605	97.5%	98.3%
W-206	W-215	41NN	7/11/2008	3,149	3,129	99.4%	3,117	99.0%	2,794	88.7%	89.3%
W-206	OR-292	41OO	7/11/2008	2,816	2,783	98.8%	2,787	99.0%	2,464	87.5%	88.5%
W-211	W-215	42NN	7/11/2008	2,203	2,171	98.5%	2,147	97.5%	102	4.6%	4.7%
W-211	OR-292	42OO	7/11/2008	2,070	2,032	98.2%	2,060	99.5%	113	5.5%	5.6%
OR-272	OR-225	43LL	7/11/2008	2,870	2,850	99.3%	2,821	98.3%	1,047	36.5%	36.7%
OR-272	OR-209	43MM	7/11/2008	2,694	2,681	99.5%	2,666	99.0%	2,680	99.5%	100.0%
W-177	OR-440	44A[1]	7/14/2008	2,359	884	37.5%	854	36.2%	779	33.0%	88.1%
W-177	OR-300	44PP	7/14/2008	2,734	2,695	98.6%	2,638	96.5%	2,595	94.9%	96.3%
OR-278	OR-300	45PP	7/18/2008	2,972	2,927	98.5%	2,806	94.4%	781	26.3%	26.7%
OR-278	OR-254	45QQ	7/18/2008	2,334	2,296	98.4%	2,239	95.9%	573	24.6%	25.0%
OR-150	OR-190	46RR	7/18/2008	2,660	2,627	98.8%	2,619	98.5%	2,200	82.7%	83.7%
OR-150	OR-224	46SS	7/18/2008	3,020	2,950	97.7%	2,938	97.3%	1,823	60.4%	61.8%
OR-255	OR-190	47RR	7/18/2008	2,942	2,522	85.7%	2,272	77.2%	1,224	41.6%	48.5%
OR-255	OR-224	47SS	7/18/2008	2,419	2,203	91.1%	2,114	87.4%	2,158	89.2%	98.0%
OR-282	OR-462	48KK	7/23/2008	2,591	2,554	98.6%	2,535	97.8%	1,845	71.2%	72.2%
OR-282	OR-254	48QQ	7/23/2008	2,869	2,810	97.9%	2,791	97.3%	2,437	84.9%	86.7%
			Totals	260,370	235,279	90.4%	228,495	87.8%	200,696	77.1%	85.3%
			Average[3]	5,519	4,990		4,848		4,248		

[1] Family Group was created using cryo-preserved sperm.

[2] Female was considered not fully ripe at time of spawning.

[3] Average derived from the number of females spawned and not the number of family groups. Although females #24 (Floy # OR-326) and #27 (Floy # OR-208) were deemed partially ripe and not used in averages.

Progeny

Rearing

Between the dates of initial feeding (1 August 2008) and release (29 January 2009), progeny were fed a total of 2,150 pounds of dry fish feed, resulting in a total wet weight gain of 2,457 pounds with a food conversion rate of 0.88. The average length increase of the fish from time of initial feeding to release was 61 mm.

Marking and Tagging

Coded-wire tagging of juvenile winter Chinook occurred between 16 December 2008 and 6 January 2009. The 95 family groups were combined into thirteen coded-wire tag groups (Table 7). Juveniles tagged and marked included: 122,462 natural-origin × natural-origin, 22,248 natural-origin × hatchery-origin, 887 natural-origin cryopreserved sperm × natural-origin, and 614 natural-origin cryopreserved sperm × hatchery-origin progeny. The marking and tagging mortality rate for all groups combined was less than 0.1%.

Health

Juvenile progeny were tested for seven different pathogens. The only positive test result was for *Renibacterium salmoninarum* (Table 3). Previously, in brood year 2006 progeny, much of the early life stage mortality that occurred was attributed to a combination of coagulated yolk (in incubators and early rearing stages) and bacterial gill disease (early rearing stage). It was later theorized that fine silt within the supply water may have damaged the juvenile gill membranes leading to the high mortality. Since then, mortalities in the incubator trays were slightly reduced by the addition of a 50 ug mesh screen to remove the fine silt from the supply water.

Released

A total of 146,211 juvenile winter Chinook were released at Caldwell Park (river mile 298) on 29 January 2009. Accounting for mortality after tagging and tag retention, an estimated 133,760 marked and tagged winter Chinook were released (Table 7). Most (84%) of the fish released were from natural-origin × natural-origin crosses with the rest from natural-origin × hatchery-origin crosses.

Assessment of Potential Genetic Impacts

When brood year 2008 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 2). Under the scenario that 10% of the naturally-spawning population was successful at producing progeny, the hatchery program increased the effective population size from 279 to 312 spawners. Under the scenario that 33% of the population was successful at producing progeny, the hatchery program increased the effective population size from 930 to 1,019 individuals.

Table 7.—Brood year 2008 winter Chinook salmon release length (mm) and number by coded-wire tag (CWT) code, family group, and parental origin.

Tag Code	Family Group	Parental Origin[1]	Number Tagged	Tagging Mortalities	Proportion Tags Retained	Tagged Fish Released	Release Number	Fork Length (mm)		
								Avg.	Min.	Max.
053464	28U, 31DD, 32FF, 22U, 29Z	NxH	9,138	8	0.98	8,902	9,130	90	46	111
053465	32EE, 33BB, 34AA, 46SS, 46RR, 45QQ	NxN	7,868	31	0.95	7,426	7,837	87	46	111
053474	11L, 15L, 16O, 26O, 26W	NxN	10,737	6	0.93	10,007	10,731	89	65	108
054024	35DD, 34GG, 37II, 39JJ, 39GG, 40LL, 19Q, 22T, 18Q, 19M, 23S	NxN	13,549	19	0.98	13,327	13,530	89	50	126
054025	36II, 37HH, 43MM, 48QQ, 47SS, 47RR, 35CC, 40MM	NxN	12,890	4	0.96	12,371	12,886	87	51	107
054026	14B, 15A, 12M, 13M, 20P, 20R, 21R, 21S, 23B, 24X, 25P, 25W	NxN,NxC	14,318	9	0.89	12,783	14,309	91	55	117
054028	30BB, 30CC, 29AA, 36HH, 41OO, 42OO, 42NN, 43LL, 45PP, 8I, 10I, 10J	NxN	14,006	8	0.91	12,738	13,998	90	42	117
054029	31EE, 33Z, 38KK, 44A, 44PP, 48KK, 1D, 2D	NxH, HxC	13,744	12	0.97	13,303	13,732	94	65	114
054167	38JJ, 41NN, 9I, 11K	NxN	9,021	7	0.94	8,518	9,014	92	65	118
054171	14O, 13N, 27X, 27Y, 28V	NxN	8,751	3	0.72	6,255	8,748	94	59	115
054172	8H, 9J, 17K, 17N, 12N, 16P, 18L	NxN	9,871	3	0.82	8,067	9,868	90	54	114
054173	1C, 2C, 3C, 6G, 7G, 7H	NxN	10,756	10	0.88	9,403	10,746	94	60	123
054174	3E, 4E, 4F, 5E, 5F, 6F	NxN	11,688	6	0.91	10,660	11,682	90	60	115
		Total	146,337	126		133,760	146,211			

[1] N = natural-origin, H = hatchery-origin, and C = natural-origin cryopreserved sperm.

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Appendix A.—Brood year 2008 Chinook salmon captured and tissue sampled for genetic run assignment and their final disposition. The adipose fin was used to determine origin: fin present were natural-origin and fin absent were hatchery-origin.

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
2/19/2008	80001	OR-069	Present	Male	950	Non-Winter	Released@Caldwell
2/19/2008	80002	OR-071	Present	Male	1000	Non-Winter	Released@Caldwell
2/19/2008	80003	OR-073	Present	Male	1000	Non-Winter	DIP
2/19/2008	80004	OR-075	Absent	Female	800	Winter	Released@Caldwell
2/19/2008	80005	OR-077	Present	Female	860	Non-Winter	Released@Caldwell
2/19/2008	80006	OR-079	Present	Male	820	Non-Winter	DIP
2/19/2008	80007	OR-081	Present	Female	760	Winter	Released@Caldwell
2/19/2008	80008	OR-083	Present	Female	900	Non-Winter	Released@Caldwell
2/19/2008	80009	OR-085	Present	Female	710	Non-Winter	Released@Caldwell
2/19/2008	80010	OR-087	Present	Female	760	Winter	Released@Caldwell
2/19/2008	80011	OR-089	Present	Female	900	Non-Winter	Released@Caldwell
2/19/2008	80012	OR-091	Absent	Female	740	Non-Winter	Sacrificed
2/19/2008	80013	OR-092	Absent	Female	720	Non-Winter	Sacrificed
2/19/2008	80014	OR-093	Absent	Female	770	Non-Winter	Sacrificed
2/19/2008	80015	OR-094	Absent	Female	690	Non-Winter	Sacrificed
2/19/2008	80016	OR-095	Absent	Male	895	Non-Winter	Sacrificed
2/26/2008	80017	OR-096	Present	Female	810	Winter	Released@Posse
2/26/2008	80018	OR-099	Present	Female	770	Winter	Spawned
2/26/2008	80019	OR-100	Present	Female	785	Winter	Spawned
2/26/2008	80020	OR-112	Present	Female	740	Winter	Prespawn
2/26/2008	80021	OR-116	Present	Male	850	Winter	Prespawn
2/26/2008	80022	OR-117	Present	Female	850	Winter	Prespawn
2/26/2008	80023	OR-097	Present	Male	950	No Call	Released@Posse
2/26/2008	80024	OR-102	Present	Male	710	No Call	Released@Posse
2/26/2008	80025	OR-104	Present	Male	750	Winter	Released@Posse
2/26/2008	80026	OR-106	Present	Male	900	No Call	Released@Posse
2/26/2008	80027	OR-108	Present	Male	830	Non-Winter	Released@Posse
2/26/2008	80028	OR-110	Present	Female	870	Non-Winter	Released@Posse
2/26/2008	80029	OR-114	Present	Female	780	Winter	Released@Posse
2/26/2008	80030	OR-118	Present	Male	1000	Non-Winter	Released@Posse
2/26/2008	80031	OR-120	Present	Female	870	Non-Winter	Released@Posse
2/26/2008	80032	OR-122	Present	Female	900	Non-Winter	Released@Posse
2/26/2008	80033	OR-124	Present	Female	N/A	Winter	Released@Posse
2/26/2008	80034	OR-126	Absent	Male	825	Non-Winter	Sacrificed
2/26/2008	80035	OR-127	Absent	Female	715	Non-Winter	Sacrificed
2/26/2008	80036	OR-128	Absent	Female	693	Non-Winter	Sacrificed
3/4/2008	80037	OR-130	Absent	Male	830	Winter	Released@Posse
3/4/2008	80038	OR-132	Present	Male	1000	Non-Winter	Released@Posse
3/4/2008	80039	OR-134	Present	Female	890	Non-Winter	Released@Posse

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
3/4/2008	80040	OR-136	Present	Male	820	Non-Winter	Released@Posse
3/4/2008	80041	OR-138	Present	Male	790	Winter	Spawned
3/4/2008	80042	OR-139	Present	Male	880	Winter	Spawned
3/4/2008	80043	OR-140	Present	Male	690	Winter	Prespawn
3/4/2008	80044	OR-141	Present	Female	790	Winter	Spawned
3/4/2008	80045	OR-143	Present	Male	820	Winter	Spawned
3/4/2008	80046	OR-144	Present	Female	780	Winter	Spawned
3/4/2008	80047	OR-145	Present	Male	830	Winter	Spawned
3/4/2008	80048	OR-146	Present	Male	860	Winter	Spawned
3/4/2008	80049	OR-147	Present	Female	780	Winter	Spawned
3/4/2008	80050	OR-142	Absent	Male	725	Non-Winter	Sacrificed
3/11/2008	80051	OR-148	Present	Male	820	Non-Winter	Released@Posse
3/11/2008	80052	OR-150	Present	Female	780	Winter	Spawned
3/11/2008	80053	OR-151	Absent	Female	770	Winter	Released@Posse
3/11/2008	80054	OR-153	Absent	Female	775	Winter	Released@Posse
3/11/2008	80055	OR-155	Present	Female	760	Winter	Spawned
3/11/2008	80056	OR-156	Present	Male	860	Winter	Spawned
3/11/2008	80057	OR-157	Absent	Female	810	Winter	Released@Posse
3/11/2008	80058	OR-159	Present	Female	740	Winter	Released@Posse
3/11/2008	80059	OR-161	Present	Female	810	Winter	Released@Posse
3/11/2008	80060	OR-163	Present	Male	820	Non-Winter	Released@Posse
3/11/2008	80061	OR-165	Absent	Female	790	Winter	Released@Posse
3/11/2008	80062	OR-167	Absent	Male	860	Winter	Released@Posse
3/11/2008	80063	OR-169	Present	Female	1000	Non-Winter	Released@Posse
3/11/2008	80064	OR-171	Present	Female	820	Winter	Spawned
3/11/2008	80065	OR-172	Absent	Male	900	Winter	Released@Posse
3/11/2008	80066	OR-174	Present	Male	885	Winter	Spawned
3/18/2008	80067	OR-175	Present	Female	780	Winter	Spawned
3/18/2008	80068	OR-176	Present	Female	840	Winter	Spawned
3/18/2008	80069	OR-177	Present	Female	780	Winter	Released@Posse
3/18/2008	80070	OR-179	Present	Male	890	Winter	Spawned
3/18/2008	80071	OR-180	Present	Male	870	Winter	Prespawn
3/18/2008	80072	OR-181	Present	Female	740	Winter	Released@Posse
3/18/2008	80073	OR-183	Present	Female	N/A	Winter	Released@Caldwell
3/18/2008	80074	OR-184	Absent	Male	840	Winter	Released@Posse
3/18/2008	80075	OR-186	Absent	Male	810	Winter	Released@Posse
3/18/2008	80076	OR-188	Present	Female	810	Winter	Released@Posse
3/18/2008	80077	OR-190	Present	Male	820	Winter	Spawned
3/18/2008	80078	OR-191	Absent	Male	840	Winter	Released@Posse
3/18/2008	80079	OR-193	Present	Male	910	Winter	Prespawn
3/18/2008	80080	OR-194	Present	Female	740	Winter	Released@Posse

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
3/18/2008	80081	OR-196	Present	Female	N/A	Winter	Released@Posse
3/18/2008	80082	OR-198	Present	Male	720	Non-Winter	Released@Posse
3/18/2008	80083	OR-200	Present	Female	770	Winter	Prespawn
3/18/2008	80084	OR-201	Present	Male	910	Winter	Spawned
3/18/2008	80085	OR-202	Present	Female	800	Winter	Spawned
3/18/2008	80086	OR-204	Absent	Female	760	Non-Winter	Sacrificed
3/18/2008	80087	OR-205	Present	Female	780	Winter	Spawned
3/18/2008	80088	OR-206	Present	Female	760	Winter	Released@Posse
3/18/2008	80089	OR-208	Present	Female	810	Winter	Spawned
3/18/2008	80090	OR-209	Present	Male	860	Winter	Spawned
3/18/2008	80091	OR-210	Present	Female	680	Non-Winter	Released@Posse
3/18/2008	80092	OR-212	Present	Female	730	Winter	Spawned
3/18/2008	80093	OR-213	Present	Female	820	Winter	Spawned
3/18/2008	80094	OR-214	Present	Male	770	Winter	Spawned
3/18/2008	80095	OR-215	Present	Female	810	Winter	Spawned
3/25/2008	80096	OR-218	Present	Female	820	Winter	Spawned
3/25/2008	80097	OR-219	Present	Female	840	Winter	Spawned
3/25/2008	80098	OR-220	Present	Male	880	Winter	Released@Posse
3/25/2008	80099	OR-222	Present	Male	890	Winter	Spawned
3/25/2008	80100	OR-223	Present	Female	850	Winter	Spawned
3/25/2008	80101	OR-224	Present	Male	860	Winter	Spawned
3/25/2008	80102	OR-225	Present	Male	870	Winter	Spawned
3/25/2008	80103	OR-226	Present	Female	800	Winter	Released@Posse
3/25/2008	80104	OR-228	Present	Female	770	Winter	Released@Posse
3/25/2008	80105	OR-230	Present	Female	810	Winter	Spawned
3/25/2008	80106	OR-231	Present	Female	750	Winter	Released@Posse
3/25/2008	80107	OR-233	Present	Female	780	Winter	Released@Posse
3/25/2008	80108	OR-235	Present	Male	880	Winter	Prespawn
3/25/2008	80109	OR-236	Present	Female	700	Winter	Released@Posse
3/25/2008	80110	OR-238	Present	Female	820	Winter	Released@Posse
3/25/2008	80111	OR-240	Absent	Female	800	Winter	Released@Posse
3/25/2008	80112	OR-242	Present	Female	820	Winter	Spawned
3/25/2008	80113	OR-243	Present	Female	650	Non-Winter	Released@Posse
3/25/2008	80114	OR-245	Present	Male	890	Winter	Spawned
3/25/2008	80115	OR-246	Present	Female	760	Winter	Spawned
3/25/2008	80116	OR-247	Present	Male	900	Winter	Released@Posse
3/25/2008	80117	OR-249	Present	Female	830	Winter	Spawned
3/25/2008	80118	OR-250	Present	Female	720	Winter	Spawned
3/25/2008	80119	OR-251	Present	Female	780	Non-Winter	Released@Posse
3/25/2008	80120	OR-253	Present	Female	780	Winter	Spawned
3/25/2008	80121	OR-254	Present	Male	780	Winter	Spawned

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
3/25/2008	80122	OR-255	Present	Female	770	Winter	Spawned
3/25/2008	80123	OR-256	Present	Male	500	Winter	Released@Posse
3/25/2008	80124	OR-259	Present	Male	800	Winter	Spawned
3/25/2008	80125	OR-260	Present	Male	780	Winter	Released@Posse
3/25/2008	80126	OR-262	Present	Female	845	Winter	Spawned
3/25/2008	80127	OR-263	Present	Female	770	Winter	Released@Posse
3/25/2008	80128	OR-265	Absent	Female	730	Winter	Released@Posse
3/25/2008	80129	OR-267	Present	Female	780	Winter	Spawned
3/25/2008	80130	OR-268	Present	Female	N/A	Winter	Released@Posse
3/25/2008	80131	OR-270	Present	Male	900	Non-Winter	Released@Posse
3/25/2008	80132	OR-271	Present	Male	880	Winter	Spawned
3/25/2008	80133	OR-272	Present	Female	790	Winter	Spawned
3/25/2008	80134	OR-273	Present	Female	770	Winter	Spawned
3/25/2008	80135	OR-274	Present	Female	750	Non-Winter	Released@Posse
3/25/2008	80136	OR-276	Present	Male	750	Non-Winter	Released@Posse
3/25/2008	80137	OR-278	Present	Female	760	Winter	Spawned
3/25/2008	80138	OR-279	Present	Female	820	Winter	Spawned
3/25/2008	80139	OR-280	Present	Male	780	Winter	Released@Posse
3/25/2008	80140	OR-282	Present	Female	760	Winter	Spawned
3/25/2008	80141	OR-283	Absent	Male	800	Winter	Released@Posse
4/1/2008	80142	OR-288	Absent	Female	730	Winter	Released@Caldwell
4/1/2008	80143	OR-290	Present	Female	660	Non-Winter	Released@Caldwell
4/1/2008	80144	OR-292	Present	Male	870	Winter	Spawned
4/1/2008	80145	OR-293	Absent	Female	820	Winter	Released@Caldwell
4/1/2008	80146	OR-295	Present	Female	760	Non-Winter	Released@Caldwell
4/1/2008	80147	OR-297	Present	Male	910	Winter	Spawned
4/1/2008	80148	OR-298	Absent	Male	770	Winter	Released@Caldwell
4/1/2008	80149	OR-300	Present	Male	930	Winter	Spawned
4/1/2008	80150	OR-301	Present	Male	820	Non-Winter	Released@Caldwell
4/1/2008	80151	OR-302	Absent	Female	890	Winter	Released@Caldwell
4/1/2008	80152	OR-304	Present	Male	840	Winter	Spawned
4/1/2008	80153	OR-305	Present	Male	900	Winter	Spawned
4/1/2008	80154	OR-306	Present	Female	780	Winter	Spawned
4/1/2008	80155	OR-307	Absent	Female	780	Winter	Released@Caldwell
4/1/2008	80156	OR-309	Absent	Female	780	Winter	Released@Caldwell
4/1/2008	80157	OR-311	Present	Male	840	Winter	Released@Caldwell
4/1/2008	80158	OR-313	Present	Male	880	Winter	Released@Caldwell
4/1/2008	80159	OR-316	Absent	Male	870	Winter	Released@Caldwell
4/1/2008	80160	OR-318	Present	Male	780	Winter	Prespawn
4/1/2008	80161	OR-319	Present	Male	850	No Call	Released@Caldwell
4/1/2008	80162	OR-320	Present	Male	620	Non-Winter	Released@Caldwell

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
4/1/2008	80163	OR-322	Present	Male	890	Winter	Spawned
4/1/2008	80164	OR-323	Present	Female	760	Winter	Released@Caldwell
4/1/2008	80165	OR-325	Present	Male	720	Non-Winter	Released@Caldwell
4/1/2008	80166	OR-326	Present	Female	790	Winter	Spawned
4/1/2008	80167	OR-327	Present	Male	860	Non-Winter	Released@Caldwell
4/1/2008	80168	OR-329	Present	Male	650	Non-Winter	Released@Caldwell
4/1/2008	80169	OR-331	Present	Female	640	Winter	Spawned
4/1/2008	80170	OR-332	Present	Female	840	Winter	Released@Caldwell
4/1/2008	80171	OR-334	Absent	Male	810	Winter	Released@Caldwell
4/1/2008	80172	OR-336	Present	Female	770	Non-Winter	Released@Caldwell
4/8/2008	80173	OR-341	Absent	Male	835	Winter	DIP
4/8/2008	80174	OR-342	Present	Male	N/A	Non-Winter	Sacrificed
4/8/2008	80175	OR-343	Present	Female	740	Non-Winter	Released@Caldwell
4/8/2008	80176	OR-345	Present	Female	790	Winter	Prespawn
4/8/2008	80177	OR-346	Present	Female	710	Non-Winter	Released@Caldwell
4/8/2008	80178	OR-348	Absent	Female	690	Winter	Released@Caldwell
4/8/2008	80179	OR-350	Absent	Male	840	Winter	Spawned
4/8/2008	80180	OR-352	Present	Male	740	Non-Winter	Released@Caldwell
4/8/2008	80181	OR-354	Present	Male	900	Winter	Spawned
4/8/2008	80182	OR-355	Absent	Male	820	Winter	Released@Caldwell
4/8/2008	80183	OR-357	Present	Male	870	Non-Winter	Released@Caldwell
4/8/2008	80184	OR-359	Absent	Female	810	Winter	Released@Caldwell
4/8/2008	80185	OR-361	Present	Female	770	Winter	Prespawn
4/8/2008	80186	OR-362	Absent	Female	790	Winter	Released@Caldwell
4/8/2008	80187	OR-364	Present	Female	810	Winter	Released@Caldwell
4/8/2008	80188	OR-366	Present	Female	610	Non-Winter	Released@Caldwell
4/8/2008	80189	OR-368	Absent	Female	780	Winter	Released@Caldwell
4/8/2008	80190	OR-370	Present	Female	780	Non-Winter	Released@Caldwell
4/8/2008	80191	OR-372	Present	Female	810	Non-Winter	Released@Caldwell
4/8/2008	80192	OR-375	Present	Female	740	Non-Winter	Released@Caldwell
4/8/2008	80193	OR-377	Present	Male	770	Non-Winter	Released@Caldwell
4/8/2008	80194	OR-379	Present	Female	770	Winter	Spawned
4/8/2008	80195	OR-380	Present	Male	870	Winter	Spawned
4/8/2008	80196	OR-381	Present	Female	700	Non-Winter	Released@Caldwell
4/8/2008	80197	OR-383	Present	Male	920	Winter	Spawned
4/8/2008	80198	OR-384	Present	Male	650	Non-Winter	Released@Caldwell
4/8/2008	80199	OR-386	Absent	Male	870	Winter	Released@Caldwell
4/8/2008	80200	OR-388	Present	Female	780	Winter	Spawned
4/8/2008	80201	OR-389	Present	Female	670	Non-Winter	Released@Caldwell
4/8/2008	80202	OR-391	Present	Female	800	Winter	Spawned
4/8/2008	80203	OR-392	Present	Female	860	Winter	Spawned

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
4/8/2008	80204	OR-393	Present	Male	770	Non-Winter	Released@Caldwell
4/8/2008	80205	OR-395	Present	Female	670	Non-Winter	Released@Caldwell
4/8/2008	80206	OR-397	Present	Male	0	Non-Winter	Released@Caldwell
4/8/2008	80207	OR-401	Present	Female	610	Winter	Released@Caldwell
4/8/2008	80208	OR-403	Present	Female	680	Winter	Released@Caldwell
4/8/2008	80209	OR-405	Present	Female	720	Winter	Released@Caldwell
4/8/2008	80210	OR-407	Present	Male	720	Non-Winter	Released@Caldwell
4/8/2008	80211	OR-409	Present	Female	820	Winter	Released@Caldwell
4/8/2008	80212	OR-411	Present	Female	740	Non-Winter	Released@Caldwell
4/8/2008	80213	OR-413	Present	Female	780	Winter	Released@Caldwell
4/8/2008	80214	OR-415	Present	Female	690	Non-Winter	Released@Caldwell
4/21/2008	80215	OR-417	Present	Female	740	Non-Winter	Released@Caldwell
4/21/2008	80216	OR-419	Present	Female	750	Non-Winter	Released@Caldwell
4/21/2008	80217	OR-421	Present	Male	790	Non-Winter	Released@Caldwell
4/21/2008	80218	OR-422	Present	Female	770	Non-Winter	Released@Caldwell
4/21/2008	80219	OR-424	Present	Male	810	Non-Winter	Released@Caldwell
4/21/2008	80220	OR-425	Present	Female	770	Non-Winter	Released@Caldwell
4/21/2008	80221	OR-436	Present	Male	730	Non-Winter	Released@Caldwell
4/21/2008	80222	OR-429	Present	Female	750	Non-Winter	Released@Caldwell
4/21/2008	80223	OR-431	Present	Male	720	Non-Winter	Released@Caldwell
4/21/2008	80224	OR-433	Present	Female	750	Non-Winter	Released@Caldwell
5/6/2008	80225	OR-439	Absent	Male	510	Winter	Spawned
5/6/2008	80226	OR-440	Present	Male	840	Winter	Spawned
5/6/2008	80227	OR-442	Present	Male	720	Non-Winter	Released@Caldwell
5/6/2008	80228	OR-444	Present	Female	670	Non-Winter	Released@Caldwell
5/6/2008	80229	OR-447	Present	Female	820	Non-Winter	Released@Caldwell
5/6/2008	80230	OR-449	Present	Female	650	Non-Winter	Released@Caldwell
5/6/2008	80231	OR-451	Present	Male	670	Non-Winter	Released@Caldwell
5/6/2008	80232	OR-453	Absent	Male	520	Winter	Spawned
5/6/2008	80233	OR-454	Present	Female	720	Non-Winter	Released@Caldwell
5/6/2008	80234	OR-456	Present	Female	810	Non-Winter	Released@Caldwell
5/6/2008	80235	OR-458	Present	Female	650	Non-Winter	Released@Caldwell
5/6/2008	80236	OR-460	Present	Male	690	Non-Winter	Released@Caldwell
5/6/2008	80237	OR-462	Absent	Male	520	Winter	Spawned
5/6/2008	80238	OR-463	Present	Male	720	Non-Winter	Released@Caldwell
5/6/2008	80239	OR-465	Present	Female	810	Non-Winter	Released@Caldwell
5/6/2008	80240	OR-467	Present	Male	720	Non-Winter	Released@Caldwell
5/6/2008	80241	OR-469	Present	Female	660	Non-Winter	Released@Caldwell
5/6/2008	80242	OR-471	Present	Male	450	Winter	Spawned
5/13/2008	80243	OR-472	Present	Female	690	Non-Winter	Released@Caldwell
5/13/2008	80244	OR-474	Present	Male	850	Non-Winter	Released@Caldwell

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
5/13/2008	80245	OR-476	Present	Female	710	Non-Winter	Released@Caldwell
5/13/2008	80246	OR-479	Present	Male	720	Non-Winter	Released@Caldwell
5/13/2008	80247	OR-481	Present	Male	660	Non-Winter	Released@Caldwell
5/13/2008	80248	OR-483	Absent	Male	500	Winter	Released@Caldwell
5/13/2008	80249	OR-485	Absent	Male	580	Winter	Released@Caldwell
5/13/2008	80250	OR-487	Present	Male	640	Non-Winter	Released@Caldwell
5/13/2008	80251	OR-489	Present	Male	800	Winter	Spawned
5/13/2008	80252	OR-490	Present	Male	590	Non-Winter	Released@Caldwell
5/13/2008	80253	OR-492	Present	Male	770	Non-Winter	Released@Caldwell
5/13/2008	80254	OR-494	Present	Male	850	Winter	Spawned
5/13/2008	80255	OR-496	Present	Female	720	Non-Winter	Released@Caldwell
5/13/2008	80256	OR-498	Present	Male	800	Winter	Released@Caldwell
5/13/2008	80257	OR-500	Present	Male	910	Non-Winter	Released@Caldwell
5/13/2008	80258	W-002	Present	Female	810	Winter	Spawned
5/13/2008	80259	W-004	Present	Male	520	Winter	Released@Caldwell
5/13/2008	80260	W-006	Absent	Male	870	Winter	Released@Caldwell
5/13/2008	80261	W-008	Present	Female	0	Non-Winter	Released@Caldwell
5/13/2008	80262	W-010	Absent	Male	500	Winter	Released@Caldwell
5/13/2008	80263	W-012	Present	Female	620	Non-Winter	Released@Caldwell
5/13/2008	80264	W-014	Present	Female	640	Non-Winter	Released@Caldwell
5/13/2008	80265	W-016	Present	Male	640	Non-Winter	Released@Caldwell
5/13/2008	80266	W-018	Present	Male	610	Non-Winter	Released@Caldwell
5/13/2008	80267	W-020	Present	Male	420	Non-Winter	Released@Caldwell
5/22/2008	80268	W-022	Present	Male	700	Winter	Spawned
5/22/2008	80269	W-023	Present	Female	680	Non-Winter	Released@Caldwell
5/22/2008	80270	W-025	Present	Male	710	Non-Winter	Released@Caldwell
5/22/2008	80271	W-027	Present	Female	740	Non-Winter	Released@Caldwell
5/22/2008	80272	W-029	Present	Female	720	Non-Winter	Released@Caldwell
5/22/2008	80273	W-031	Present	Female	730	Non-Winter	Released@Caldwell
5/22/2008	80274	W-034	Present	Female	690	Non-Winter	Released@Caldwell
6/6/2008	80275	W-037	Absent	Male	850	Winter	Released@Caldwell
6/6/2008	80276	W-039	Present	Male	860	Winter	Spawned
6/6/2008	80277	W-040	Present	Female	700	Non-Winter	Released@Caldwell
6/6/2008	80278	W-042	Present	Female	680	Non-Winter	Released@Caldwell
6/6/2008	80279	W-044	Present	Female	780	Non-Winter	Released@Caldwell
6/6/2008	80280	W-046	Present	Female	700	Non-Winter	Released@Caldwell
6/6/2008	80281	W-048	Present	Female	690	Non-Winter	Released@Caldwell
6/6/2008	80282	W-050	Present	Male	700		Released@Caldwell
6/6/2008	80283	W-052	Absent	Female	500	Winter	Released@Caldwell
6/6/2008	80284	W-054	Present	Female	680	Non-Winter	Released@Caldwell
6/6/2008	80285	W-056	Absent	Female	780	Winter	Released@Caldwell

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
6/6/2008	80286	W-057	Present	Female	700	Non-Winter	Released@Caldwell
6/6/2008	80287	W-059	Absent	Male	470	Winter	Released@Caldwell
6/6/2008	80288	W-061	Absent	Female	610	Winter	Released@Caldwell
6/6/2008	80289	W-063	Present	Female	630	Non-Winter	Released@Caldwell
6/6/2008	80290	W-065	Absent	Male	470	Winter	Released@Caldwell
6/6/2008	80291	W-067	Absent	Male	460	Winter	Released@Caldwell
6/10/2008	80292	W-070	Present	Female	700	Non-Winter	Released@Caldwell
6/10/2008	80293	W-072	Present	Male	870	Non-Winter	Released@Caldwell
6/10/2008	80294	W-074	Present	Female	720	Non-Winter	Released@Caldwell
6/10/2008	80295	W-076	Present	Male	690	Non-Winter	Released@Caldwell
6/10/2008	80296	W-078	Present	Female	770	Non-Winter	Released@Caldwell
6/10/2008	80297	W-080	Absent	Female	890	Non-Winter	Sacrificed
6/10/2008	80298	W-081	Present	Female	690	Non-Winter	Released@Caldwell
6/17/2008	80299	W-083	Present	Female	810	Winter	Spawned
6/17/2008	80300	W-084	Present	Female	790	Non-Winter	Released@Caldwell
6/17/2008	80301	W-086	Present	Female	630	Non-Winter	Released@Caldwell
6/17/2008	80302	W-088	Present	Male	730	Non-Winter	Released@Caldwell
6/17/2008	80303	W-090	Present	Male	750	Non-Winter	Released@Caldwell
6/17/2008	80304	W-092	Present	Female	680	Non-Winter	Released@Caldwell
6/17/2008	80305	W-094	Present	Female	720	Non-Winter	Released@Caldwell
6/17/2008	80306	W-096	Present	Female	760	Non-Winter	Released@Caldwell
6/17/2008	80307	W-098	Present	Male	790	Non-Winter	Released@Caldwell
6/17/2008	80308	W-100	Present	Female	720	Non-Winter	Released@Caldwell
6/17/2008	80309	W-102	Absent	Male	540	Winter	Spawned
6/17/2008	80310	W-103	Absent	Male	540	Winter	Released@Caldwell
6/17/2008	80311	W-105	Present	Male	640	Non-Winter	Released@Caldwell
6/17/2008	80312	W-107	Present	Male	550	Winter	Spawned
6/24/2008	80313	W-119	Present	Female	770	Non-Winter	Released@Caldwell
6/24/2008	80314	W-121	Present	Male	890	Non-Winter	Released@Caldwell
6/24/2008	80315	W-123	Present	Female	670	Non-Winter	Released@Caldwell
6/24/2008	80316	W-125	Present	Male	880	Winter	Released@Caldwell
6/24/2008	80317	W-127	Absent	Male	740	Winter	Released@Caldwell
6/24/2008	80318	W-129	Absent	Male	680	Winter	Released@Caldwell
6/24/2008	80319	W-131	Absent	Male	800	Winter	Released@Caldwell
6/24/2008	80320	W-133	Present	Female	870	Non-Winter	Released@Caldwell
6/24/2008	80321	W-135	Absent	Female	760	Winter	Spawned
6/24/2008	80322	W-136	Present	Male	560	Winter	Spawned
6/24/2008	80323	W-137	Present	Male	740	Non-Winter	Released@Caldwell
6/24/2008	80324	W-139	Present	Male	820	Non-Winter	Released@Caldwell
6/24/2008	80325	W-141	Present	Female	680	Non-Winter	Released@Caldwell
6/24/2008	80326	W-143	Present	Male	800	Non-Winter	Released@Caldwell

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
6/24/2008	80327	W-145	Present	Female	740	Non-Winter	Released@Caldwell
6/24/2008	80328	W-147	Absent	Male	820	Winter	Released@Caldwell
6/24/2008	80329	W-149	Present	Male	770	Non-Winter	Released@Caldwell
6/24/2008	80330	W-151	Present	Male	720	Non-Winter	Released@Caldwell
6/24/2008	80331	W-153	Absent	Male	460	Winter	Released@Caldwell
6/24/2008	80332	W-155	Absent	Male	480	Winter	Released@Caldwell
7/1/2008	80333	W-159	Present	Female	750	Non-Winter	Released@Caldwell
7/1/2008	80334	W-161	Present	Female	770	Non-Winter	Released@Caldwell
7/1/2008	80335	W-163	Present	Female	760	Winter	Spawned
7/1/2008	80336	W-164	Present	Male	730	Non-Winter	Released@Caldwell
7/1/2008	80337	W-166	Present	Male	810	Non-Winter	Released@Caldwell
7/1/2008	80338	W-168	Absent	Male	850	Winter	Released@Caldwell
7/1/2008	80339	W-170	Present	Female	700	Non-Winter	Released@Caldwell
7/1/2008	80340	W-172	Present	Male	830	Non-Winter	Released@Caldwell
7/1/2008	80341	W-174	Present	Female	820	Winter	Spawned
7/1/2008	80342	W-175	Present	Female	710	Non-Winter	Released@Caldwell
7/1/2008	80343	W-177	Absent	Female	790	Winter	Spawned
7/1/2008	80344	W-178	Present	Female	590	Non-Winter	Released@Caldwell
7/1/2008	80345	W-180	Present	Male	610	Winter	Spawned
7/1/2008	80346	W-181	Present	Male	780	Winter	Spawned
7/1/2008	80347	W-182	Present	Male	900	Winter	Released@Caldwell
7/1/2008	80348	W-184	Present	Male	830	Winter	Spawned
7/1/2008	80349	W-185	Present	Male	720	Winter	Released@Caldwell
7/1/2008	80350	W-187	Absent	Male	670	Winter	Released@Caldwell
7/1/2008	80351	W-189	Present	Female	660	Non-Winter	Released@Caldwell
7/8/2008	80352	W-192	Present	Male	680	Non-Winter	Released@Caldwell
7/8/2008	80353	W-194	Present	Male	630	Non-Winter	Released@Caldwell
7/8/2008	80354	W-196	Present	Female	690	Non-Winter	Released@Caldwell
7/8/2008	80355	W-198	Present	Male	790	Non-Winter	Released@Caldwell
7/8/2008	80356	W-200	Present	Male	780	Non-Winter	Released@Caldwell
7/8/2008	80357	W-202	Present	Female	630	Non-Winter	Released@Caldwell
7/8/2008	80358	W-204	Present	Female	700	Non-Winter	Released@Caldwell
7/8/2008	80359	W-206	Present	Female	830	Winter	Spawned
7/8/2008	80360	W-207	Present	Male	670	Non-Winter	Released@Caldwell
7/8/2008	80361	W-209	Present	Female	740	Non-Winter	Released@Caldwell
7/8/2008	80362	W-211	Present	Female	780	Winter	Spawned
7/8/2008	80363	W-212	Present	Male	640	Non-Winter	Released@Caldwell
7/8/2008	80364	W-213	Absent	Female	915	Non-Winter	Sacrificed
7/8/2008	80365	W-214	Present	Male	540	Non-Winter	Released@Caldwell
7/8/2008	80366	W-215	Present	Male	540	Winter	Spawned
7/15/2008	80367	W-218	Present	Male	940	Non-Winter	Released@Caldwell

Appendix A.—continued

Date Captured	Sample ID	Tag Code	Adipose Fin	Gender	Fork Length (mm)	Run Assignment	Final Disposition[a]
7/15/2008	80368	W-220	Present	Male	880	Non-Winter	Released@Caldwell
7/15/2008	80369	W-222	Present	Female	910	Non-Winter	Released@Caldwell
7/15/2008	80370	W-224	Present	Female	860	Non-Winter	Released@Caldwell
7/15/2008	80371	W-229	Present	Female	680	Non-Winter	Released@Caldwell
7/15/2008	80372	W-231	Absent	Male	760	Non-Winter	Sacrificed
7/15/2008	80373	W-232	Present	Male	650	Non-Winter	Released@Caldwell
7/15/2008	80374	W-234	Present	Female	710	Non-Winter	Released@Caldwell
7/15/2008	80375	W-236	Present	Male	0	Non-Winter	Released@Caldwell
7/15/2008	80376	W-238	Present	Male	670	Non-Winter	Released@Caldwell
7/15/2008	80377	W-240	Present	Male	480	Winter	Released@Caldwell
7/15/2008	80378	W-242	Present	Female	710	Non-Winter	Released@Caldwell
7/15/2008	80379	W-244	Absent	Female	940	Non-Winter	Sacrificed
7/15/2008	80380	W-245	Present	Male	480	Non-Winter	Released@Caldwell
7/22/2008	80381	W-248	Present	Female	710	Non-Winter	Released@Caldwell
7/22/2008	80382	W-250	Present	Male	740	Non-Winter	Released@Caldwell
7/22/2008	80383	W-252	Present	Female	720	Non-Winter	Released@Caldwell
7/22/2008	80384	W-254	Present	Male	780	Non-Winter	Released@Caldwell
7/22/2008	80385	W-256	Present	Male	870	Non-Winter	Released@Caldwell
7/22/2008	80386	W-258	Present	Female	780	Non-Winter	Released@Caldwell
7/22/2008	80387	W-260	Present	Male	550	Winter	Released@Caldwell

[a] DIP = fish that died in the Keswick Dam fish trap or transport truck; Prespawn = fish that died in the hatchery holding pond; Released@Caldwell – fish released at Caldwell Park, ~river mile 298.5; Released@Posse = fish released at Posse Grounds, ~river mile298; Sacrificed = hatchery Chinook euthanized for coded-wire tag analysis; Spawned = 2008 winter Chinook brood stock.

Attachment 1.—Return Year 2008 Winter Chinook Salmon Broodstock Trapping Plan and Schedule

In 2008, the U.S. Fish and Wildlife Service (Service) plans to capture up to 120 winter Chinook salmon broodstock for the propagation program at Livingston Stone National Fish Hatchery. Trapping for winter Chinook salmon broodstock is anticipated to begin in early February, 2008. Similar to previous years, all or nearly all of the winter Chinook salmon broodstock will be captured at the Keswick Dam fish trap. If numbers of adult Chinook salmon collected at the Keswick Dam fish trap are not sufficient to meet broodstock goals, the fish trap at the Red Bluff Diversion Dam (RBDD) may be used.

Provisions of the Service's section 10 permit (#1027) from the National Marine Fisheries Service allow the Service to collect up to 15% of the winter Chinook salmon run size, or a maximum of 120 fish (the broodstock holding capacity of Livingston Stone National Fish Hatchery), for use as broodstock in the winter Chinook propagation program. Based on the 15% collection limit criteria, a run size of 800 fish or greater would allow for the 120 fish maximum to be targeted for collection. To determine if more than 800 winter Chinook salmon are expected to return in 2008, a pre-season run size estimate has been calculated. The estimated number of winter Chinook returning in 2008 was calculated by multiplying the average cohort replacement rate (brood years 1992-2004) by the 2005 run size estimate. This methodology is similar to that used by the Service to generate pre-season estimates of winter Chinook run size since the early 1990's. Cohort replacement rates were calculated using counts at the Red Bluff Diversion Dam (RBDD; Table 1). Although populations estimate based on the carcass survey are recognized as being more accurate than RBDD counts, they lack the time series necessary to calculate cohort replacement rates for this analysis. Sacramento River winter Chinook return predominantly at age three years, therefore, the estimated 2008 return was based on the average cohort replacement rate multiplied by the run size estimate for return year 2005. The 2005 population estimate used was generated from the winter Chinook carcass survey and is the "officially recognized" estimate of the Department of Fish and Game, (CDFG, GrandTab file). Using this methodology, the 2008 Sacramento River winter Chinook salmon return estimate is 37,369.

Predicting the abundance of winter Chinook salmon based on cohort replacement rates is highly speculative, and actual levels of abundance may differ substantially from pre-season run size predictions. For example, the preceding run size predictions are based on average cohort replacement rates since broodyear 1992. During this period, the average cohort replacement rate for winter Chinook has been buoyed by particularly strong returns during the period 1996-2003. However, since 2005 cohort replacement rates based on this methodology have been less than 1.0, suggesting a recent period of decreased survival, which could result in the average cohort replacement rate used in this analysis being high. However, even considering the lowest replacement rate during this period of record (0.6 for return year 2005), we estimate that approximately 9,091 winter Chinook will return in 2008, which is substantially more than the return of 800 fish where the collection target for Livingston Stone NFH would be impacted. In fact, for the 2008 return to be less than 800 fish would require a cohort replacement rate of less than 0.05, which is less than one tenth the lowest rate observed since 1992. Therefore, based on recent trends of abundance and this simple mathematical model, we consider it unlikely that the

2008 run size will be less than 800 adults, thus allowing for the maximum of up to 120 winter Chinook salmon to be targeted for collection for brood stock at the Livingston Stone National Fish Hatchery.

The trapping schedule for winter Chinook salmon broodstock establishes monthly collection targets throughout the duration of the run (Table 2). However, if a monthly target is not met, efforts will be made to attain the cumulative trapping goal the following month. For example, because broodstock collection will commence in February, the monthly collection goals of two fish for December and eight fish for January will be added to February's target of twenty fish to attain the cumulative collection target of thirty fish through the month of February.

As described in the Service's 1998 Section 10 permit application supplement and addendum, at the time of capture, a fin tissue sample will be collected and a floy tag will be affixed to all Chinook salmon collected at the Keswick Dam fish trap. As in previous years, we will affix a second floy tag to all Chinook salmon released into the upper Sacramento River to assess the loss rate of floy tags from released fish. Phenotypic winter Chinook salmon retained for broodstock will be subjected to a quarantine/detention period (usually 2-3 days) while awaiting verification of run assignment, based on genetic analysis of fin tissue samples conducted by Service's Conservation Genetics Laboratory at the Abernathy Fish Technology Center in Longview, Washington. If the results indicate a high probability that the fish is a winter Chinook salmon (a LOD score $\geq$ 2), the fish will be retained for the propagation program. If the LOD score is < 2, or catch at the Keswick Dam fish trap exceeds the collection target, fish will be returned to the Sacramento River.

Table 1. Estimated run sizes and cohort replacement rates for Sacramento River winter Chinook salmon by return year.

Return Year	Estimated Run Size[1]	Cohort Replacemnt Rate[2]
1992	1,240	.
1993	387	.
1994	186	.
1995	1,297	1.0
1996	1,337	3.5
1997	880	4.7
1998	3,002	2.3
1999	3,288	2.5
2000	1,352	1.5
2001	5,523	1.8
2002	9,169	2.8
2003	9,757	7.2
2004	7,192	1.3
2005	5,299	0.6
2006	7,436	0.8
2007	6,144	0.9
2008	Average	2.4

[1] Based on passage at Red Bluff Diversion Dam

[2] Calculated by dividing the run size in year "x+3" by the run size in year "x". The predominant age at return for winter Chinook salmon is three years.

Table 2. Monthly and cumulative collection goals for Sacramento River winter Chinook Broodstock in 2008.

Month	Monthly Distribution (%)[1]	Estimated No. of Fish Available[2]	Monthly Collection Goal[3]	Cumulative Collection Goal
December	2	654	2	2
January	5	1,906	6	8
February	10	3,569	11	20
March	36	13,449	43	63
April	29	10,673	34	97
May	9	3,322	11	108
June	7	2,530	8	116
July	3	1,263	4	120
August	0	4	0	120

[1] Historic temporal distribution of winter Chinook salmon passing Red Bluff Diversion Dam.

[2] Calculated by multiplying the monthly proportional distribution by the preseason run estimate (37,369).

[3] Calculated by multiplying the proportional distribution by the total collection goal (120).

Attachment 2.—Brood Year 2008 Effective Population Size Methodology, Estimates, and Assumptions

The U.S. Fish and Wildlife Service (Service) released endangered winter Chinook salmon from the Livingston Stone National Fish Hatchery (NFH) on January 29, 2009. The number to be released was 146,211. Consistent with the Special Conditions in the Service's Section 10 Permit (# 1,027), the fish will be transported to the release site (Sacramento River at Caldwell Park) in two vehicles and released at dusk. Based on estimates of effective population size, loss of genetic variation due to genetic drift or inbreeding is unlikely to occur as a consequence of releasing brood year 2008 hatchery-origin winter Chinook salmon.

Brood stock Collection

During the months of January through July 2008, 104 Chinook salmon were collected from the fish trap at the Keswick Dam (Table 1). All fish collected were assessed for phenotypic indicators of run classification (e.g. run timing, general condition of fish). A sample of fin tissue was collected and transferred to the Service's Conservation Genetics Laboratory in Longview, Washington for genetic analysis and genetic run assignment (e.g. winter or non-winter). Run assignments were made based on a log-of-the-odds (LOD) score (Hedgecock et. al. 2002). LOD scores greater than 0 are classified as winter Chinook salmon. However, brood stock used for the artificial propagation program are selected only after meeting a more stringent genetic selection criterion (LOD>1). Information on all fish collected and retained for brood stock is displayed in Table 1.

Spawning

Ninety-three adults (48 females and 45 males) captured from the Sacramento River (Table 2) contributed to brood year 2008 progeny. Twelve of the 105 fish captured from the Sacramento River died in the hatchery holding tanks prior to spawning. Eight of the fish collected from the Sacramento River had adipose fin-clips, indicating they were of hatchery origin (Table 1). Matings of adults collected from the Sacramento River were executed in a manner consistent with past efforts. Matings of naturally-reared adults were conducted by splitting the eggs collected from individual females into two or more lots and combining those lots with milt from different males. This mating protocol generated 95 family groups (Table 2).

Incubation, Rearing and Tagging

A total of 260,370 eggs were collected. Survival from green-egg to release is currently estimated to be 56.2%. All juveniles were coded-wire tagged from December 16 through January 6. Progeny were combined into 9 groups and a unique tag code was applied to each of these groups (Table 3).

Effective Population Size Calculation

The effective population size (N_e) is a measure of the rate of genetic drift within a population. 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. We used a bipartite model to estimate the effective population size. This model incorporates the joint effects of finite population size of wild and hatchery-reared individuals on the overall effective population size (Hedrick et al 1995; Hedrick et al 2000).

Our approximation of N_e for winter Chinook salmon is based on the estimated total run size to the Upper Sacramento River. The winter Chinook run size estimate was derived from carcass survey data using the Jolly-Seber formula (Manji 2007). Two estimates of natural-origin winter Chinook N_e were generated: one using 10% of the run size estimate and one using 33% of the run size estimate. Each value is an estimate of the proportion of the total spawning population that contributed to the effective population of natural spawners. The lower value ($0.10N_s$) was estimated by Bartley et al. (1992), while the upper value was estimated from an analysis of Snake River, Idaho data (Robin Waples, NMFS, Northwest Fisheries Center, Seattle, WA, personal communication). The effective population sizes bounded by these two values is consistent with that presented by Hedrick et al. (1995 and 2000) and decisions reached at the February 27, 1998 meeting of the winter Chinook salmon captive brood stock genetics subcommittee.

The brood year 2008 release group, consisting of 146,211 juveniles, was the progeny of 48 females and 45 males. A final release number for each mating was derived by apportioning mortality between all family groups within a rearing unit. For example, when two family groups were combined into a single rearing unit mortality was allocated proportionally, relative to the number of salmon from each family group. This method assumes equal rates of survival for all family groups combined in a common rearing unit.

The hatchery component of the effective population is an estimated 123 (Tables 4 & 5; Figure 1). The model indicates the overall effective population size would increase from 279 to 312 ($N_{ew} = 0.10 \times N_s$) or 930 to 1019 ($N_{ew} = 0.33 \times N_s$) as a result of the hatchery supplementation program (Tables 4 & 5; Figure 1). This suggests the effect of the brood year 2008 release on the winter Chinook salmon population will be negligible from genetic drift. Model assumptions for these calculations are presented in Appendix I.

Table A1. Estimated genetic impact of the release of brood year 2008 juvenile winter Chinook salmon propagated at Livingston Stone National Fish Hatchery on the effective population size (N_e). The calculation assumes N_e(wild) = 0.10 multiplied by the estimated run size.

2008 Run Size 2,850[1]

	Captured Adults	Natural Spawners
Available Adults	105	2,850
Pre-Spawn Mortality Rate	0.11	0.02
Est. Effective Population Size	123	279
Number of Females	48	1,466
Eggs per Female	5,519[2]	5,119[2]
Total Eggs	264,912	8,090,854
Survival to Fry		2,022,714
Survival to Pre-Smolt, Release	146,211	
Survival to Smolt, Post-Release	73,106	1,193,401
Total Smolt Production		1,266,506
Percentage of Production	5.8%	94.2%

Effective Population Size	312	(WITH HATCHERY INFLUENCE)
	279	(WITHOUT HATCHERY INFLUENCE)

[1] Year 2008 run-size estimate of winter Chinook salmon generated by the California Department of Fish and Game and includes hatchery-origin winter Chinook salmon. This value was adjusted by the California Department of Fish and Game to 2,830 after estimation of the effective population.

[2] Number of eggs per female was calculated based on data collected at Livingston Stone NFH.

Table A2. Estimated genetic impact of the release of brood year 2008 juvenile winter Chinook salmon propagated at Livingston Stone National Fish Hatchery on the effective population size (N_e). The calculation assumes N_e(wild) = 0.333 multiplied by the estimated run size.

2008 Run Size 2,850[1]

	Captured Adults	Natural Spawners
Available Adults	105	2,850
Pre-Spawn Mortality Rate	0.11	0.02
Est. Effective Population Size	123	930
Number of Females	48	1,466
Eggs per Female	5,519[2]	5,119[3]
Total Eggs	264,912	8,090,854
Survival to Fry		2,022,714
Survival to Pre-Smolt, Release	146,211	
Survival to Smolt, Post-Release	73,106	1,193,401
Total Smolt Production		1,266,506
Percentage of Production	5.8%	94.2%

Effective Population Size	1019	(WITH HATCHERY INFLUENCE)
	930	(WITHOUT HATCHERY INFLUENCE)

[1] Year 2008 run-size estimate of winter Chinook salmon generated by the California Department of Fish and Game and includes hatchery-origin winter Chinook salmon. This value was adjusted by the California Department of Fish and Game to 2,830 after estimation of the effective population.

[2] Number of eggs per female was calculated based on data collected at Livingston Stone NFH.

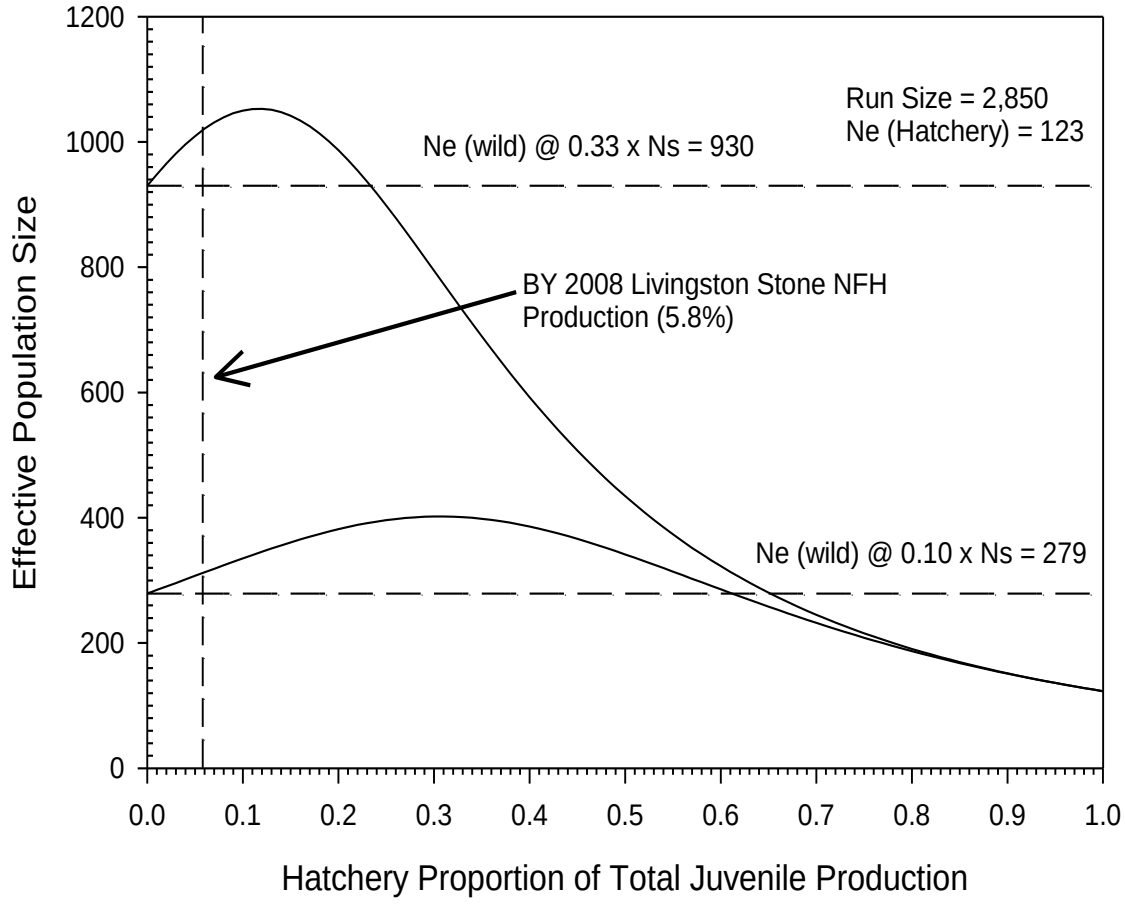

Figure 1. Estimated effect of brood year 2008 juvenile production of winter Chinook salmon at Livingston Stone National Fish Hatchery on the overall effective population size. The top curve depicts $N_e(wild) = 0.33 \times N_s$ where N_s is the total number of spawners, and the bottom curve displays $N_e(wild) = 0.10 \times N_s$. The proportion of brood year 2008 hatchery production, in terms of all estimated juvenile production (i.e., hatchery and natural), is represented by the vertical dashed line. The intersection of the vertical dashed line with the two curved lines are estimates of the combined hatchery and natural effective population size. The horizontal dashed lines indicate expected effective population size of the natural population in the absence of the hatchery program at the $N_e(wild) = 0.33 \times N_s$ level (top dashed line) and at the $N_e(wild) = 0.10 \times N_s$ level (bottom dashed line).

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Appendix I

Assumptions for the population genetics model used to determine effective population size with and without hatchery influence.

Assumptions for the population genetics model are based on the following best available information:

- Estimated run size for 2008 (2,850) was based on data collected in the Upper Sacramento River Winter-run Escapement Survey (Manji, 2008).

- Two estimates of the effective population size were generated: one using 10% of the run size estimate and one using 33% of the run size estimate. The lower value ($0.10N_s$) was estimated by Bartley et al. (1992), while the upper value was estimated from Snake River data (Robin Waples, NMFS, Northwest Fisheries Center, Seattle, WA, personal communication). Presentation of the effective population sizes bounded by these two values is consistent with that presented by Hedrick et al. (1995) and decisions reached at the February 27, 1998 meeting of the winter Chinook salmon captive brood stock genetics subcommittee. This value takes into consideration factors reducing N_{ew} such as unequal sex ratios, differential fecundity rates, and the inability of some individuals to spawn.

- Number of females spawning naturally in the upper Sacramento River (1,466) was based on data collected in the Upper Sacramento River Winter-run Escapement Survey (Manji, 2008).

- The proportion of male and females was assumed to be 0.466 and 0.534, respectively, was based on data collected in the Upper Sacramento River Winter-run Escapement Survey (Pers. Comm. Doug Killam, CDFG)

- Number of eggs per female is consistent with measures of fecundity noted at the Livingston Stone National Fish Hatchery in 2008.

- 25% survival from egg to fry stage for the wild population.

- 59% survival from fry to smolt stage for the wild population (Hallock, undated[1]).

Assumptions for hatchery production which differ from wild production include:

- 50% survival from pre-smolt to smolt stage for the hatchery population.
- Effective population sizes for the hatchery (N_{eh}) and captive broodstock (N_{eb}) portions of the run are calculated using:

[1] Hallock, R.J. Undated. The Status of Inland Habitat and Factors Adversely Impacting Salmon Resources.

Appendix I (continued)

$$N_{ec} = \frac{4N_f N_m}{xN_f + yN_m}$$

where

$$x = f + m\frac{\sigma^2_{km}}{k_m}$$

and

$$y = m + f\frac{\sigma^2_{kf}}{k_f}$$

where N_f and N_m are the actual numbers of breeding females and males in the captive program, k_f and σ^2_{kf} are the mean and variance of the number of progeny produced by females and k_m and σ^2_{km} are the mean and variance of progeny numbers for the males, and m and f are the proportion of male (m) to female (f) spawners, where $m + f = 1$.

Information from wild and hatchery production is then incorporated into the following formula to calculate N_e:

$$N_e = \frac{N_{ew} N_{ec}}{x_w^2 N_{ec} + x_c^2 N_{ew}}$$

where N_{ec} and N_{ew} are the effective population sizes in the captive (hatchery) adults and the wild-run adults, respectively, and x_c and x_w are the proportions of progeny coming from the captive and wild adults, respectively ($x_c + x_w = 1$).

Further assumptions for this formula include:

(1) N_{ec} and N_{ew} are known;

(2) x_c and x_w, the proportions of spawners from wild and hatchery production are known;

(3) if (2) is not known, the hatchery and wild fish have equal survival to spawning and the initial proportion from each source is known;

(4) hatchery and wild fish mate at random; and,

(5) hatchery and wild females have equal egg numbers and survival of the next generation is the same in both groups.