1999 Annual Report of Winter Chinook Propagation Activities

USFWS Report

U.S. Fish and Wildlife Service
Red Bluff Fish and Wildlife Office
Red Bluff, California 96080
March 2003

Disclaimer

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the federal government.

TABLE OF CONTENTS

Tables and Figures

FIGURES

TABLES

Background

In 1989, due to drastic declines in adult returns, Sacramento River winter Chinook salmon were listed as a threatened species under the California Endangered Species Act. In November of 1990, the National Fisheries Service (NMFS) finalized an emergency rule that listed winter Chinook salmon as threatened under the federal Endangered Species Act (ESA). Despite continued restoration efforts, adult returns of winter Chinook salmon continued to decline, and in January of 1994 NMFS published its final rule reclassifying winter Chinook salmon as federally endangered. The NMFS cited the following reasons for the reclassification, 1) the continued decline and increased variability of run sizes since listing winter Chinook as a threatened species, 2) the expectation of weak returns in certain years as the result of two small year classes (1991 and 1993), and 3) continuing threats to the population.

In 1989, in order to supplement natural production and to protect against extinction, the US Fish and Wildlife Service (the Service) developed an artificial propagation program for winter Chinook salmon at Coleman National Fish Hatchery. Between 1991 and 1995, an average of approximately 30,600 (range: 11,582-51,267) juvenile winter Chinook salmon were released from Coleman NFH annually.

In 1996, a moratorium on hatchery winter Chinook releases was put into effect. One concern was the potential hybridization between spring Chinook and winter Chinook salmon due to the uncertainty surrounding the identification and selection of broodstock. Another concern was that despite releasing hatchery-origin juvenile winter Chinook into the mainstem Sacramento River, hatchery-origin adults were returning primarily to Battle Creek. Since the intent of the hatchery program was to supplement the natural-origin population on the Sacramento River, the return of adults to Battle Creek was not desired.

Because of these concerns, the winter Chinook salmon program was moved, in 1998, to a new facility at the base of Shasta Dam; the Livingston Stone NFH. It was felt that by incubating eggs and rearing juveniles in mainstem water rather than Battle Creek water, the hatchery fish would better imprint on mainstem water, and thus would be much more likely to return to upper mainstem spawning areas. Also, during broodstock collection, a tissue sample is collected and analyzed to ensure that only genetically identified winter Chinook salmon are spawned in the hatchery program. This will guard against any potential hybridization. 1998 marked the first year in which juvenile winter Chinook salmon produced at the new Livingston Stone NFH were released into the Sacramento River.

Broodstock Collection

Adult Collection Plan

Before the collection of winter Chinook broodstock began in 1999, the Service developed a broodstock collection plan that defined the timing and location of collection activities and the number of fish to be collected (attachment A). In 1999, the adult collection schedule was based on a pre-season run estimate of 1,400 adult winter Chinook salmon. Therefore based on the broodstock collection guidelines allowing capture of up to 15% of the run size up to a maximum of 120 fish, the service planned to collect 120 adult winter Chinook salmon, the maximum allowed. The scheduled timing of broodstock collection set out by the adult collection plan was as follows: December, 1.8% (2 fish); January, 5.1% (6 fish); February, 9.6% (12 fish); March, 36.0% (43 fish); April, 28.6% (34 fish); May, 8.9% (11 fish); June, 6.8% (8 fish); July, 3.4% (4 fish); and August, 0% (0 fish).

Adult Trapping

In 1999, broodstock for the winter Chinook propagation program were captured at both the Keswick Dam fish trap (RM 302) and the Red Bluff Diversion Dam (RBDD) fish trap (RM 243). Winter Chinook salmon broodstock were captured between April 7 and June 23 in 1999. The Service also conducted trapping efforts for adult winter Chinook salmon at the Coleman National Fish Hatchery (CNFH) trap on Battle Creek; however none of the 70 adult salmon collected at that location were genetically determined to be winter Chinook. A total of 157 Chinook salmon were captured at these sites, 83 at Keswick Dam, 4 at RBDD, and 70 at Battle Creek. Of these 157 fish, 25 were genetically determined to be winter Chinook salmon. Of the total winter Chinook salmon captured, females comprised 36% (9 fish) and males comprised 60% (15 fish) and 4% (1 fish) was a mortality of unknown sex. This was the first year that males outnumbered females in winter Chinook capture numbers.

Keswick Dam Fish Trap

The Keswick Dam fish trap was operated from March 16 through July 28, 1999. Winter Chinook salmon were captured between April 7 and June 23 in 1999 (Figure 1). During normal operation, the fish trap was in operation for at least two consecutive days every week and was checked once a week. The operation of the fish trap varied throughout the trapping season depending on the number of fish captured and water flows. When the fish trap was not in use, it was raised to prevent fish from collecting in the trap.

In 1999, trapping operations at Keswick Dam did not fulfill the Service's annual broodstock collection target, despite the fact that the pre-season run size estimate was 1,400 adult winter Chinook salmon, and the post-season escapement estimate was 3,288 (Doug Killam, CDFG Red Bluff Office; "GrandTab"). A possible cause for the deficiency of fish at Keswick Dam was poor passage at the Anderson-Cottonwood Irrigation District (ACID) diversion dam (RM 298.5). This is supported by data from aerial redd counts conducted by CDFG. In 1998 3.3% of winter Chinook redds were observed above ACID, and in 1999 only 0.1% were above ACID; but in 2000 5.8% were above ACID and in 2001 34% were above ACID (Doug Killam, CDFG, personal communication). The increase in 2001 coincides with the completion of new fish ladders at ACID in early 2001.

Red Bluff Diversion Dam Trap
The CDFG operates the fish trap at the Red Bluff Diversion Dam (RBDD) from May 15 through September 15, while the diversion gates are in place. The fish ladders and trap at RBDD are used to monitor passage of Chinook salmon during the "gates in" period. Counts of phenotypic winter Chinook have been used to generate run-size estimates since 1967. When the number of adults collected from the Keswick trap is not sufficient to meet hatchery broodstock goals, potential broodstock for the LSNFH propagation program are collected in conjunction with the monitoring program.

RBDD has three fish ladders; one on the west bank, one at the center of the dam, and one on the east bank. The fish trap at RBDD is located on the east fish ladder. When the trap is operating, fish ascending the east ladder are diverted (by a weir) into an examination area after navigating two false weirs. Captured fish are anaesthetized with CO_2 and adult Chinook salmon are phenotypically identified to run. Phenotypic winter Chinook salmon are sorted from non-winter Chinook salmon, netted from the trap, and placed in a flow-through retention tube located on the fish ladder where they are detained for approximately one hour prior to transport to Livingston Stone NFH.

Coleman National Fish Hatchery Barrier Weir Fish Trap
The fish trap at the CNFH barrier weir is not used for winter Chinook broodstock collection. It is used to monitor naturally-produced (unmarked) winter Chinook (and other salmonids) passage into upper Battle Creek, and to trap hatchery-origin (marked) winter Chinook salmon so that they could be relocated to the mainstem Sacramento River. Additionally, in 1999 phenotypic winter Chinook salmon trapped at Battle Creek were quarantined and fin-tissue sampled to identify possible hybrids produced while the winter Chinook supplementation program was located at Coleman NFH. Further description of the trapping activities conducted at the CNFH barrier weir fish trap can be found in the Research and Monitoring report and will not be discussed here.

Identification of Winter Chinook Broodstock

Chinook salmon collected at the Keswick Dam and RBDD fish traps were initially identified to race (i.e., winter Chinook or non-winter Chinook) based on phenotypic characteristics including: color, degree of ripeness (firmness), size, amount of fungus, and collection date. A color-coded alphanumeric floy tag was attached to each salmon just below the dorsal fin and a fin-tissue sample was collected from phenotypic winter Chinook. Phenotypic winter Chinook salmon were transported to the Livingston Stone NFH in an aerated and insulated 1,200 or 1,600-gallon transport tank where they were initially quarantined in one of two 20-foot circular tanks at Livingston Stone NFH. Phenotypic non-winter Chinook salmon were released into the Sacramento River.

A total of 42 Chinook salmon collected at the Keswick Dam and RBDD fish traps were tissue sampled for genetic run determination and quarantined at the Livingston Stone NFH. Forty five Chinook salmon collected at the Keswick Dam fish trap were returned to the Sacramento River without being tissue sampled, primarily because they were deemed to be phenotypic non-winter Chinook salmon. An unknown number of Chinook salmon were captured and released from the RBDD fish trap. Unsampled salmon from the Keswick trap were relocated to the Caldwell Park boat ramp (RM 299).

Genetic Stock Identification
A sample of fin tissue collected from phenotypic winter Chinook salmon was sent to the genetics laboratory at the Bodega Marine Laboratory (BML) within 24-hours of collection. Stock determination from genetic analysis (i.e., winter Chinook or non-winter Chinook) was usually available 24 to 48 hours after tissue samples arrived at Bodega Marine Laboratory. Floy tags enabled quarantined fish to be matched with the results of genetic run call determinations.

Twenty one of the 42 phenotypic winter Chinook salmon collected at the Keswick Dam and RBDD fish traps were genetically identified as winter Chinook salmon, including 14 males (66.6%), 6 females (28.6%), and 1 of unknown sex (4.8%) (Table 1). All four of the phenotypic winter Chinook salmon collected at the RBDD fish trap were genetically identified as winter Chinook salmon (1 male, 3 females). None of the winter Chinook collected at the Keswick Dam and RBDD fish traps were marked with an adipose fin-clip. The 17 Chinook salmon collected at the Keswick Dam fish trap genetically determined to be non-winter Chinook were subsequently returned to Caldwell Park boat ramp (11 males, 4 females, and 2 unknowns).

Disposition of Quarantined Fish

1999 marked the first year in which fish collected for broodstock were taken directly to Livingston Stone NFH[1].

Of the 42 Chinook salmon collected at the Keswick Dam and RBDD fish traps that were quarantined and sampled for genetic run determination in 1999 (Tables 1 and 2), 23 genetically identified winter Chinook salmon were spawned (19 from the Keswick trap [13 males and 6 females]; 4 from the RBDD trap [1 male and 3 females]); none were of hatchery origin. Eighteen of the quarantined salmon were returned to the Sacramento River at Caldwell Park, 17 of which were genetically identified non-winter Chinook (11 males, 4 females, and 2 of undetermined gender). One genetically identified winter Chinook (a male) held in quarantine was released into the Sacramento River because the spawning matrix was fully represented for males. One Chinook salmon (a male) captured at the Keswick Dam fish trap died during quarantine.

[1] In 1998, the fish collected for broodstock purposes were initially taken to CNFH as the construction/installation of the broodstock holding area at Livingston Stone NFH was incomplete.

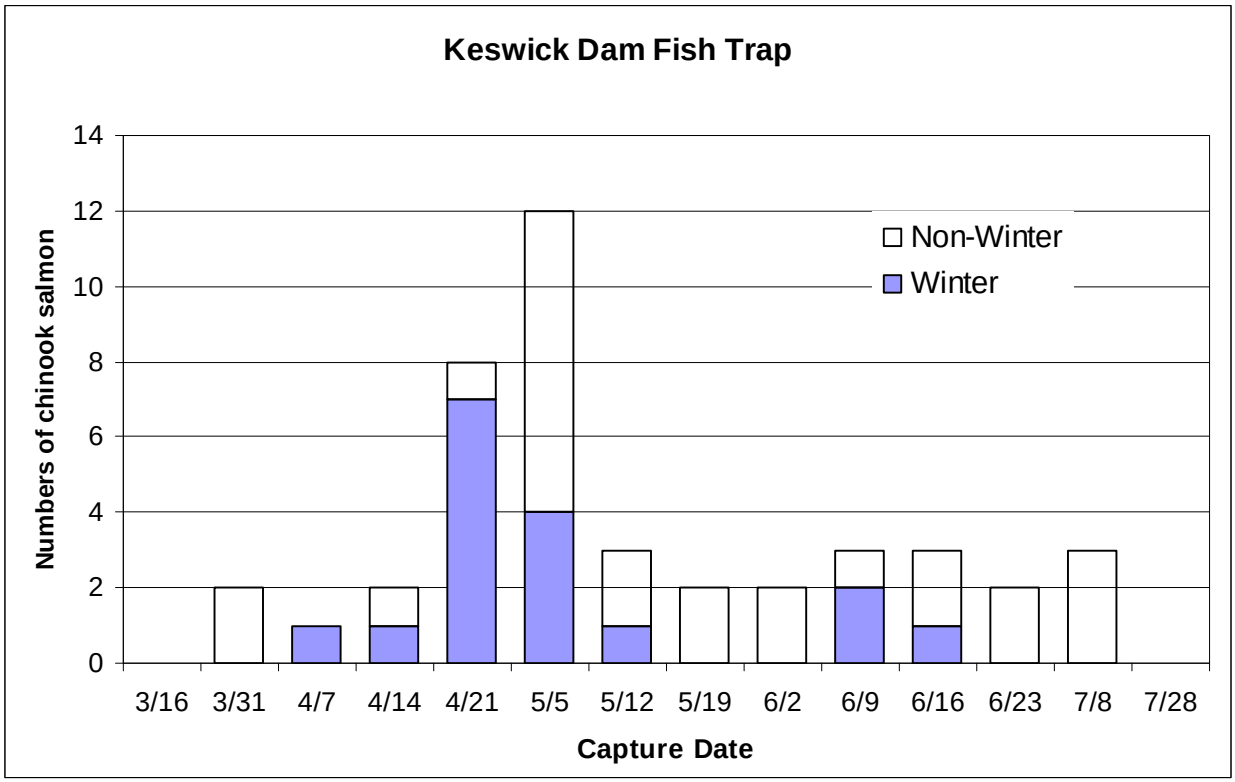

Figure 1 Numbers of winter and non-winter Chinook salmon captured at the Keswick Dam fish trap between March 16 and July 28, 1999.

Table 1 Disposition of Chinook salmon captured at the Keswick Dam fish trap (Keswick), and the Red Bluff Diversion Dam fish trap (RBDD) in 1999. Marked salmon were considered to be of hatchery origin. Unmarked salmon were considered to be of natural-origin.

			Keswick	RBDD
Salmon returned without tissue samples (phenotypically non-winter)		=	45	unk
Tissue sampled salmon				
Unmarked		=	38	4
Adipose fin-clipped (ad-clip)		=	0	0
Total captured (not including recaptures)		=	83	unk
Recaptured salmon		=	1	unk
Salmon that escaped before data were collected		=	unk	unk
Disposition of tissue sampled salmon				
			Keswick	**RBDD**
Genetic non-winter salmon released/relocated	M	=	11	0
	F	=	4	0
	unk	=	2	0
Genetic winter chinook released/relocated	M	=	1	0
	F	=	0	0
	unk	=	0	0
Winter chinook salmon retained as broodstock and spawned	M	=	13	1
	F	=	6	3
	unk	=	0	0
Mortalities				
Non-winters found dead	M	=	0	0
	F	=	0	0
	unk	=	0	0
Non-winters sacrificed for CWT recovery	M	=	0	0
	F	=	0	0
	unk	=	0	0
Winters sacrificed for CWT recovery	M	=	0	0
	F	=	0	0
	unk	=	0	0
Winter mortalities	M	=	0	0
	F	=	0	0
	unk	=	1	0
TOTAL TISSUE SAMPLED			**38**	**4**

Table 2 Identification numbers, biological data, and floy-tag number for fin-tissue sampled Chinook salmon captured at the Keswick Dam fish trap, Sacramento River (RM 302) and the Red Bluff Diversion Dam fish trap (RM 243). Salmon were captured between April 7 and June 23, 1999. Salmon with adipose fin-clips (ad-clip) were considered to be of hatchery origin. Salmon without adipose fin-clips were considered to be of natural origin. Coded-wire tag data were not available (N/A) for all marked salmon.

Date Captured	Location	Genetic ID	Floy Tag Number	Mark Status	Sex	Fork Length (mm)	Genetic Run	Final Disposition	Comments
4/7/1999	Keswick	99-3001	Y-051	Unmarked	Male	543	WCS	Spawned	
4/14/1999	Keswick	99-3002	Y-052	Unmarked	Female	654	WCS	Spawned	
4/14/1999	Keswick	99-3003	Y-053	Unmarked	Unknown	816	NON-WCS	Relocated	
4/21/1999	Keswick	99-3004	Y-055	Unmarked	Male	682	WCS	Relocated	1st call=non-winter, 2nd call =winter
4/21/1999	Keswick	99-3005	Y-056	Unmarked	Male	743	NON-WCS	Relocated	
4/21/1999	Keswick	99-3006	Y-057	Unmarked	Female	710	WCS	Spawned	
4/21/1999	Keswick	99-3007	Y-058	Unmarked	Male	710	WCS	Spawned	
4/21/1999	Keswick	99-3008	Y-059	Unmarked	Female	678	WCS	Spawned	
4/21/1999	Keswick	99-3009	Y-060	Unmarked	Female	782	WCS	Spawned	
4/21/1999	Keswick	99-3010	Y-061	Unmarked	Male	535	WCS	Spawned	
4/21/1999	Keswick	99-3011	Y-062	Unmarked	Male	530	WCS	Spawned	
5/5/1999	Keswick	99-3012	Y-063	Unmarked	Male	772	WCS	Spawned	
5/5/1999	Keswick	99-3013	Y-064	Unmarked	Female	841	NON-WCS	Relocated	Recapture
5/5/1999	Keswick	99-3014	Y-065	Unmarked	Female	738	NON-WCS	Relocated	
5/5/1999	Keswick	99-3015	Y-066	Unmarked	Female	677	NON-WCS	Relocated	
5/5/1999	Keswick	99-3016	Y-067	Unmarked	Female	678	NON-WCS	Relocated	
5/5/1999	Keswick	99-3017	Y-068	Unmarked	Female	662	WCS	Spawned	
5/5/1999	Keswick	99-3018	Y-069	Unmarked	Female	695	WCS	Mortality	
5/5/1999	Keswick	99-3019	Y-070	Unmarked	Male	538	WCS	Spawned	
5/5/1999	Keswick	99-3020	Y-071	Unmarked	Female	612	WCS	Spawned	
5/5/1999	Keswick	99-3021	Y-072	Unmarked	Male	492	WCS	Spawned	
5/5/1999	Keswick	99-3022	Y-073	Unmarked	Male	562	WCS	Spawned	

Table 2 (cont.) Identification numbers, biological data, and floy-tag number for fin-tissue sampled Chinook salmon captured at the Keswick Dam fish trap, Sacramento River (RM 302) and the Red Bluff Diversion Dam fish trap (RM 243). Salmon were captured between April 7 and June 23, 1999. Salmon with adipose fin-clips (ad-clip) were considered to be of hatchery origin. Salmon without adipose fin-clips were considered to be of natural origin. Coded-wire tag data were not available (N/A) for all marked salmon.

Date Captured	Location	Genetic ID	Floy Tag Number	Mark Status	Sex	Fork Length (mm)	Genetic Run	Final Disposition	Comments
5/5/1999	Keswick	99-3023	Y-074	Unmarked	Male	527	WCS	Spawned	
5/12/1999	Keswick	99-3024	Y-075	Unmarked	Male	781	NON-WCS	Relocated	
5/12/1999	Keswick	99-3025	Y-076	Unmarked	Male	452	NON-WCS	Relocated	
5/12/1999	Keswick	99-3026	Y-077	Unmarked	Male	508	WCS	Spawned	
5/19/1999	Keswick	99-3027	Y-078	Unmarked	Male	668	NON-WCS	Relocated	
5/19/1999	Keswick	99-3028	Y-079	Unmarked	Male	682	NON-WCS	Relocated	
6/2/1999	Keswick	99-3029	Y-080	Unmarked	Male	461	NON-WCS	Relocated	
6/2/1999	Keswick	99-3030	Y-081	Unmarked	Unknown	469	NON-WCS	Relocated	
6/8/1999	RBDD	99-3031	Y-082	Unmarked	Female	699	WCS	Spawned	
6/9/1999	Keswick	99-3032	Y-083	Unmarked	Male	602	WCS	Spawned	
6/9/1999	Keswick	99-3033	Y-084	Unmarked	Male	497	WCS	Spawned	
6/9/1999	Keswick	99-3034	Y-085	Unmarked	Male	432	NON-WCS	Relocated	
6/15/1999	RBDD	99-3035	Y-086	Unmarked	Female	679	WCS	Spawned	
6/15/1999	RBDD	99-3036	Y-087	Unmarked	Male	564	WCS	Spawned	
6/16/1999	Keswick	99-3037	Y-088	Unmarked	Male	930	NON-WCS	Relocated	
6/16/1999	Keswick	99-3038	Y-089	Unmarked	Male	568	WCS	Spawned	
6/16/1999	Keswick	99-3039	Y-090	Unmarked	Male	474	NON-WCS	Relocated	
6/17/1999	RBDD	99-3040	Y-091	Unmarked	Female	610	WCS	Spawned	
6/23/1999	Keswick	99-3041	Y-092	Unmarked	Male	522	NON-WCS	Relocated	
6/23/1999	Keswick	99-3042	Y-093	Unmarked	Male	404	NON-WCS	Relocated	

Fish Health Maintenance and Monitoring

1999 marked the first year in which Chinook salmon collected at the Keswick Dam and RBDD fish traps were taken directly to Livingston Stone NFH. They were transported directly to Livingston Stone NFH via transport vehicles which were equipped with either a 1,200 or 1,600 gallon, aerated and insulated transport tank. Fish were initially held in one of the 20-foot circular tanks at Livingston Stone NFH.

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 3). Additionally, salt, Poly Aqua, and anesthetics were used to reduce effects of stress on broodstock. The application of drugs followed the "Unapproved Drugs for Use on Threatened and Endangered Fish Species" guidelines from the Food and Drug Administration (FDA 2696). Hatchery personnel and staff from the California-Nevada Fish Health Center closely monitored fish health.

In the adult holding tanks malachite green was used to treat all adult winter Chinook salmon that were captured to reduce or eliminate fungal infections. Based on previous mortality rates of winter Chinook in untreated holding ponds at Coleman NFH, treatments with malachite green appeared to be effective in reducing the number of fungus-related deaths (when fish did not arrive heavily infected). In 1999, no deaths were attributed to fungal infection. A total of 487.5 g of malachite green was used for 25 treatments in 1999.

Adults were given injections of erythromycin in the dorsal sinus at a target dosage of 20 mg/kg to help prevent vertical transmission of *Renibacterium salmoninarum* (the organism responsible for bacterial kidney disease). Females were targeted for treatment; however, salmon of unknown sex were treated as well. All 9 of the females spawned received one to four injections with at least fourteen days between injections (Table 4). Eight of 14 males spawned received erythromycin injections prior to sex determination; none received more than one injection (Table 5). The CA-NV FHC tested 44 winter Chinook adults for *R. salmoninarum* using an enzyme-linked immunosorbent assay (ELISA). These consisted of all 24 winter Chinook captured in the Sacramento River and 20 captive broodstock females. The results indicated suspected *R. salmoninarum* infection in 84% (37) of the salmon tested while the remaining 16% (7) tested negative for the bacteria.

Luteinizing Hormone - Releasing Hormone analogue (LH-RH_a) was administered in 1999 to accelerate final gamete maturation in fish that had already undergone gametogenesis. Similar to previous years, LH-RH_a was used to synchronize maturation of broodstock. These Ovaplant 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 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.

Six fish were given LH-RH_a therapy from May 3 through July 5, 1999 (2 males, 4 females). These fish took an average of 8.3 days post-injection (range 3 to 18 days) to reach maturity.

Prespawning Mortality

Prespawning mortality was 4.17% (1 of 24). Prespawning mortality for brood years 1995 and 1998 was 7.1% and 6.5%, respectively.

Table 3 Drugs and treatments that may be applied to maintain health of winter Chinook salmon at Livingston Stone National Fish Hatchery.

Type	Dosage	Method	Application
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
vibrio spp. vaccine		bath	vaccination against salt-water vibrio 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

Table 4 Spawning and drug treatment history for female winter Chinook salmon held for spawning at Livingston Stone National Fish Hatchery in 1999.

Genetic ID	Date Captured	Location	length (mm)	Weight (lbs)	Date Spawned	Date of death	Days in Captivity	Erythromycin[1]		LH-RHa[2]		Number of MG[3]	Comments
								Dose (mls)	Injections	Dose (μg)	Injections		
99-3002	04/14/99	Keswick	647	6.7	05/01/99	05/19/99	34	0.3	1			4	
99-3006	04/21/99	Keswick	711	11.0	05/06/99	05/06/99	14	0.5	1			4	
99-3008	04/21/99	Keswick	669	9.0	05/06/99	05/06/99	14	0.4	1			4	
99-3009	04/21/99	Keswick	718	11.5	05/13/99	05/13/99	21	0.5	1			5	
99-3017	05/05/99	Keswick	667	8.4	06/10/99	06/10/99	35	0.4	2			8	
99-3018	05/05/99	Keswick	697	9.2		05/11/99	14	0.5	1			3	Prespawn mortality
99-3020	05/05/99	Keswick	618	6.3	06/07/99	06/07/99	32	0.3	2	250.0	1	7	
99-3031	06/08/99	RBDD	692	11.1	07/01/99	07/01/99	22	0.5	1	250.0	1	5	
99-3035	06/15/99	RBDD	679	9.7	07/08/99	07/08/99	22	0.5	1	250.0	2	5	
99-3040	06/17/99	RBDD	617	7.0	07/05/99	07/05/99	17	0.4	1	250.0	2	3	

1 Erythromycin dose was based on 20 mg/kg.
2 LH-RHa = Luteinizing Hormone - Releasing Hormone analogue. Each capsule contained 250 μg.
3 MG = Malachite green. Fish were immersed in a 1 ppm bath.

Table 5 Spawning and drug treatment history for male winter Chinook salmon held for spawning at Livingston Stone National Fish Hatchery in 1999.

Genetic ID	Date Captured	Location	length (mm)	Weight (lbs)	Date Spawned	Date of death	Days in Captivity	Erythromycin[1]		LH-RHa[2]		Number of MG[3]	Comments
								Dose (mls)	Injections	Dose (µg)	Injections		
99-3001	04/07/99	Keswick	548	5.1	06/07/99	07/13/99	97	0.3	1			23	
99-3007	04/21/99	Keswick	723	10.7	05/01/99	05/13/99	22					5	
					05/06/99								
					05/13/99								
99-3010	04/21/99	Keswick	538	4.5	07/05/99	07/13/99	83					21	
99-3011	04/21/99	Keswick	532	4.5	05/06/99	05/13/99	22	0.2	1	125	1	8	
					05/10/99								
					05/13/99								
99-3012	05/05/99	Keswick	818	13.5	05/10/99	05/13/99	8					1	
99-3019	05/05/99	Keswick	539	4.5	07/08/99	07/13/99	69					17	
99-3021	05/05/99	Keswick	488	2.9	07/08/99	07/27/99	83					19	
99-3022	05/05/99	Keswick	560	4.9	06/10/99	07/13/99	69	0.2	1			17	
99-3023	05/05/99	Keswick	525	3.9	06/07/99	07/27/99	83	0.2	1			19	
99-3026	05/12/99	Keswick	508	3.2	06/10/99	07/13/99	62	0.2	1			12	
99-3032	06/09/99	Keswick	607	6.1	07/01/99	07/13/99	34					7	
99-3033	06/09/99	Keswick	499	3.4	07/05/99	07/13/99	34					7	
99-3036	06/15/99	RBDD	565	4.9	07/01/99	07/27/99	42					8	
*99-3038	06/16/99	Keswick	564	4.6	06/21/99	06/23/99	7					0	

1 Erythromycin dose was based on 20 mg/kg.
2 LH-RHa = Luteinizing Hormone - Releasing Hormone analogue. Each capsule contained 250 µg.
3 MG = Malachite green. Fish were immersed in a 1 ppm bath.
* Male 99-3038 was not spawned directly with females captured from the Sacramento River; semen was cryogenically preserved for spawning with captive females.

Spawning

Adults Collected at Keswick and RBDD

When genetic analysis indicated that a quarantined fish was a winter Chinook salmon, the fish was transferred to a 20-foot diameter tank where it was held until ripe for spawning. Winter Chinook were examined twice a week to assess their state of sexual maturity. To assess sexual maturity of salmon in the 20-foot circular tank, several salmon 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. When a female salmon was identified as being sexually mature, it was sacrificed with a blow to the head, removed from the tank and rinsed in fresh water to remove any remaining MS-222. The caudal artery was severed to bleed out the females so that blood would not mix into the eggs. The eggs were removed by making an incision from the vent to the pectoral fin. Eggs from females were separated into two approximately equal groups, when possible, and each group was fertilized with semen from a different male. After mixing the sperm 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 sacrificed. Males were used a maximum of four times. After the fourth spawning event, males were sacrificed. Each fish, if possible, was spawned with at least two others for two reasons: 1) to increase genetic variability, and 2) to prevent losing all of the gametes from a spawner if the other spawner did not have viable gametes.

Each female was assigned a number and each male was assigned a letter. Thus each spawning cross resulted in a specific "family group". For example, when female 1 was spawned with male A, "family group" 1A was created.

Hatchery spawning of winter Chinook salmon occurred between May 1 and July 8, 1999 (Figure 2) roughly corresponding to the historical natural spawn timing. Naturally reproducing winter Chinook spawn between April and early August, peaking near the end of May and the beginning of June (Vogel and Marine 1991). A total of 9 female (Table 4) and 14 male (Table 5) winter Chinook salmon were spawned in 1999. Over 38,000 eggs were collected, producing 17 family groups (Table 7), giving an average of 4,256 green eggs per female. Lengths of spawned females ranged from 617 to 718 mm (fork length) and averaged 669 mm. Lengths of spawned males ranged from 488 to 818 mm and averaged 563 mm.

Captive Broodstock

Because of the low numbers of adult winter Chinook broodstock collected at the Keswick Dam and RBDD fish traps in 1999, captive broodstock were used to augment the propagation program. Captive broodstock spawning that produced juveniles intended for release occurred between June 18 and August 6, 1999 (Table 8). Twenty captive broodstock females, were spawned (1 from brood year 1994 and 19 from brood year 1995) with 15 natural-origin males, producing 40 total crosses. Over 30,500 eggs were collected, producing 26 family groups, giving an average of 1,530 eggs per female. Four crosses were created using fresh milt and 36 using cryo-preserved milt.

In 1999, there were 8 additional captive adults that ripened too late for incorporation into the production group (Table 8). From August 19 to August 26, 3 females (all from brood year 1995) were spawned with 5 males (1 from brood year 1994, 5 from brood year 1995) producing 6 crosses (all using fresh milt).

Table 6 Summary of captive broodstock spawning activities in 1999

Females Spawned	*For release*	*Late spawners*
BY 1994	1	0
BY 1995	19	3
Total	**20**	**3**
Males Spawned		
Natural-origin	15	0
Captive-origin	0	5
Total	**15**	**5**
Crosses		
using fresh milt	4	6
using cryo milt	36	0
Total	**40**	**6**
Green Eggs	30,589	4,996
Eyed Eggs	7,148	4,849
No. Hatched	4,831	est. 4,064
No. Tanked	4,508	3,391

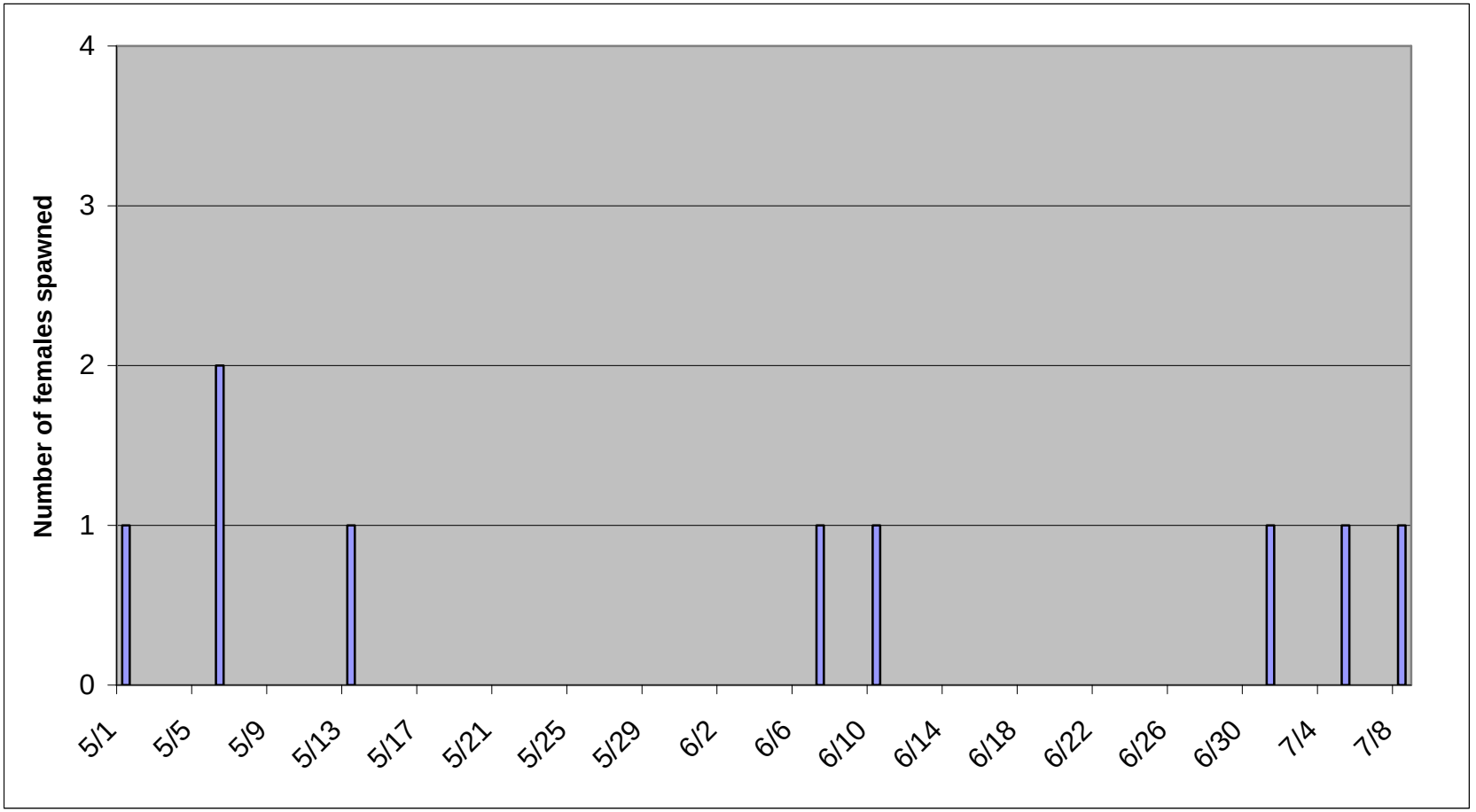

Figure 2 Spawning of winter Chinook salmon at Livingston Stone National Fish Hatchery, May 1 through July 8, 1999. Bars correspond to numbers of females spawned per day.

Incubation and Rearing

Progeny of Adults Collected at the Keswick Dam and RBDD fish traps
After fertilization, the winter Chinook eggs were placed in a Heath incubator tray and disinfected with 75 parts per million (ppm) iodophor bath for 15 minutes. To help prevent excessive fungus, incubating eggs were treated twice a week with 1,400 ppm formalin for 15 minutes as a flow-through treatment. This proved very successful as a prophylactic. Formalin treatments were discontinued once eggs had hatched. Initial water flow in the incubator trays was four gallons per minute (gpm) and later increased to six gpm at eye-up. Percent eye-up ranged from 73.6 to 99.4%, averaging 89.0%. After eye-up, eggs were shocked and non-viable eggs were removed. 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.

Progeny of Captive adults
Once the captive origin eggs reached the eyed stage at Bodega Marine Laboratory (BML), they were placed in jars filled with water and transported to Livingston Stone NFH for final incubation and rearing. Captive matings produced 7,148 eyed eggs (23.4% eye-up) of which 4,831 hatched (15.8% egg-to-hatch rate) and 4,508 were tanked (14.7% egg-to-tank rate). In 1999, all of these captive origin juveniles were combined prior to release, and were subsequently released as a single group. These relatively low percentages are likely due to the use of predominately cryo-preserved semen, which in other years have shown to have generally lower survival rates.

The later captive matings (August 19 to August 26) produced 4,996 green eggs resulting in 4,849 eyed eggs (97.1% eye up), of which an estimated 4,064 hatched (estimated 81.3% egg-to-hatch rate) and 3,391 were tanked (67.9% egg-to-tank rate).

Juvenile Rearing

The small circular tanks at Livingston Stone NFH and the Zeilger 12-hour belt feeders provided an excellent environment for starting and separating small groups of fish. A total of 643.6 pounds (lbs.) of feed was used resulting in a total weight gain of 584.0 pounds between July 12 and release on January 28. This provided a feed conversion of 1.10 (food fed/weight gain). This was the same conversion rate as seen in 1998. The total length increase was 2.662 inches (67.6 mm). Growth was at it highest in October with a length increase of 0.485 inches (12.3 mm), and at its lowest in September at 0.314 inches (8.0 mm). These numbers do not include any fish held for the captive broodstock program.

Captive-origin juveniles were fed a total of 47.4 pounds of feed resulting in a total weight gain of 32.3 pounds between July 12 and release on January 28. This provided a feed conversion of 1.47 (food fed/weight gain). The total length increase was 1.518 inches (38.6 mm). Growth was at its highest in November with a length increase of 0.493 inches (12.5 mm), and at its lowest in August at 0.028 inches (0.7 mm).

Initial feeding began on July 12, 1999 using Bio-Oregon's starter #1, then #2, and final #3. *Artemia nauplii* (Cyclop-eeze™ from Argent Chemical Laboratories) were added to increase interest in the feed. At approximately 500 fish to the pound the diet was changed to BioOregon's

Biodiet grower (BDG) 1.3 mm pellets and at 250 to the pound BDG 1.5 mm pellets. The fish remained on BDG 1.5 mm pellets until release.

Feeding rates were determined using the Bio-Oregon's feeding guidelines. This method uses average monthly water temperatures to determine the appropriate percent body weight to feed.

Because of the small number of naturally origin spawners available in 1999, each natural origin x natural origin family group was allowed to be kept in its own tank until release. Due to the relatively low number of juveniles produced from the captive propagation program, progeny from the captive broodstock females were combined into one tank.

Table 7 Family groups, date spawned, egg counts, and number tanked for brood year 1999 winter Chinook salmon spawned at Livingston Stone NFH.

Crosses (by floy tag number)			Family	Date	Number of		Percent eye-	Number	Percent	Number	Precent tanked
Female		Male	group	spawned	Green eggs	Eyed eggs	up	hatched	hatched	tanked	from eyed eggs
Y-052	X	Y-058	1A	5/1/99	3560	3387	95.14	3294	92.53	3169	93.56
Y-057	X	Y-058	2A	5/6/99	2174	2145	98.67	2140	98.44	2211	103.08
Y-057	X	Y-062	2B	5/6/99	2087	2065	98.95	2060	98.71	2044	98.98
Y-059	X	Y-062	3B	5/10/99	2009	1834	91.29	1826	90.89	1989	108.45
Y-059	X	Y-063	3C	5/10/99	1798	1787	99.39	1781	99.05	1755	98.21
Y-060	X	Y-058	4A	5/13/99	2479	1985	80.07	1968	79.39	1403	70.68
Y-060	X	Y-062	4B	5/13/99	2465	1859	75.42	1825	74.04	1772	95.32
Y-071	X	Y-051	5D	6/7/99	1893	1871	98.84	1853	97.89	1661	88.78
Y-071	X	Y-074	5E	6/7/99	1664	1652	99.28	1633	98.14	1398	84.62
Y-068	X	Y-073	6F	6/10/99	2304	2289	99.35	2279	98.91	2210	96.55
Y-068	X	Y-077	6G	6/10/99	1921	1910	99.43	1901	98.96	1878	98.32
Y-082	X	Y-083	7I	7/1/99	2375	2207	92.93	1534	64.59	1463	66.29
Y-082	X	Y-087	7J	7/1/99	2288	1819	79.50	1017	44.45	985	54.15
Y-091	X	Y-084	8K	7/5/99	2286	1734	75.85	1300	56.87	1050	60.55
Y-091	X	Y-061	8L	7/5/99	2370	2103	88.73	1667	70.34	1545	73.47
Y-086	X	Y-070	9M	7/8/99	2317	1706	73.63	1382	59.65	1365	80.01
Y-086	X	Y-072	9N	7/8/99	2313	1716	74.19	1317	56.94	1267	73.83
-											
TOTALS					**38303**	**34069**	**88.95**	**30777**	**80.35**	**29165**	**85.61**
Eggs per female					**4255.89**						

Table 8 Family groups, date spawned, egg counts, and number tanked for brood year 1999 captive winter Chinook salmon spawned at Bodega Marine Laboratory (BML).

MATING FEMALE		MALE	GROUP IDENITY	DATE SPAWNED	GREEN EGGS	EYED EGGS	% EYEUP	NO. HATCHED	% HATCH	NO. TANKED	TANKED FROM GREEN EGGS
011-289-853	X	CRYO I94	1A	6/18/99	967	0	0.00	0	0.00	0	0.00
011-289-853	X	CRYO D93	1B	6/18/99	1125	35	3.11	22	1.96	18	1.60
011-123-571	X	CRYO B	2A	6/29/99	519	155	29.87	129	24.86	123	23.70
011-123-571	X	CRYO D	2B	6/29/99	531	26	4.90	23	4.33	24	4.52
011-100-328	X	CRYO F	3A	6/30/99	1219	99	8.12	62	5.09	62	5.09
011-100-328	X	CRYO G	3B	6/30/99	1502	142	9.45	70	4.66	64	4.26
010-599-632	X	CRYO D	4A	7/7/99	636	164	25.79	97	15.25	91	14.31
010-599-632	X	CRYO B	4B	7/7/99	701	421	60.06	278	39.66	294	41.94
0N0IDF052	X	CRYO H	5A	7/7/99	1164	430	36.94	98	8.42	83	7.13
0N0IDF052	X	CRYO A	5B	7/7/99	1034	322	31.14	49	4.74	17	1.64
011-108-017	X	CRYO A	6A	7/9/99	679	14	2.06	7	1.03	7	1.03
011-108-017	X	CRYO B	6B	7/9/99	567	16	2.82	10	1.76	9	1.59
011-118-858	X	CRYO E	7A	7/9/99	924	187	20.24	143	15.48	144	15.58
011-118-858	X	CRYO F	7B	7/9/99	763	115	15.07	88	11.53	90	11.80
010-881-347	X	CRYO H	8A	7/9/99	448	124	27.68	84	18.75	75	16.74
010-881-347	X	CRYO A	8B	7/9/99	354	39	11.02	23	6.50	21	5.93
011-009-847	X	CRYO B	9A	7/9/99	1030	60	5.83	35	3.40	33	3.20
011-009-847	X	CRYO E	9B	7/9/99	1067	94	8.81	50	4.69	37	3.47
010-295-841	X	FRESH F	10A	7/13/99	326	56	17.18	40	12.27	28	8.59
010-295-841	X	FRESH D	10B	7/13/99	444	85	19.14	56	12.61	34	7.66
011-100-348	X	FRESH G	11A	7/13/99	574	241	41.99	116	20.21	103	17.94
011-100-348	X	FRESH I	11B	7/13/99	738	375	50.81	173	23.44	145	19.65
011-360-066	X	CRYO K	12A	7/28/99	1219	158	12.96	112	9.19	105	8.61
011-360-066	X	CRYO L	12B	7/28/99	1380	174	12.61	111	8.04	106	7.68
010-866-853	X	CRYO E	13A	7/30/99	1169	443	37.90	420	35.93	413	35.33
010-866-853	X	CRYO I	13B	7/30/99	864	356	41.20	304	35.19	296	34.26

Table 8 (cont.) Family groups, date spawned, egg counts, and number tanked for brood year 1999 captive winter Chinook salmon spawned at Bodega Marine Laboratory (BML).

MATING FEMALE		MALE	GROUP IDENITY	DATE SPAWNED	GREEN EGGS	EYED EGGS	% EYEUP	NO. HATCHED	% HATCH	NO. TANKED	TANKED FROM GREEN EGGS
011-112-366	X	CRYO J	14A	7/30/99	871	221	25.37	120	13.78	101	11.60
011-112-366	X	CRYO N	14B	7/30/99	879	228	25.94	118	13.42	110	12.51
011-558-516	X	CRYO J	15A	7/30/99	376	186	49.47	158	42.02	149	39.63
011-558-516	X	CRYO N	15B	7/30/99	388	106	27.32	28	7.22	28	7.22
020-367-594	X	CRYO I	16A	7/30/99	436	252	57.80	170	38.99	183	41.97
020-367-594	X	CRYO K	16B	7/30/99	435	285	65.52	235	54.02	203	46.67
0N01DF028	X	CRYO M	17A	8/2/99	320	74	23.13	67	20.94	62	19.38
0N01DF028	X	CRYO L	17B	8/2/99	389	117	30.08	99	25.45	93	23.91
010-291-057	X	CRYO M	18A	8/4/99	818	79	9.66	50	6.11	50	6.11
010-291-057	X	CRYO K	18B	8/4/99	692	77	11.13	57	8.24	45	6.50
010-596-532	X	CRYO H	19A	8/6/99	972	546	56.17	518	53.29	481	49.49
010-596-532	X	CRYO E	19B	8/6/99	1035	392	37.87	370	35.75	358	34.59
010-322-515	X	CRYO A	20A	8/6/99	461	80	17.35	72	15.62	67	14.53
010-322-515	X	CRYO F	20B	8/6/99	573	174	30.37	169	29.49	156	27.23
Totals					**30589**	**7148**	**23.37**	**4831**	**15.79**	**4508**	**14.74**
Eggs per Female					**1529**						

Juvenile Fish Health Maintenance and Treatments

Brood year 1999 juveniles held for the captive broodstock program were vaccinated against *Vibrio* on March 4, 2000. Vaccinations were performed by mixing the formalin inactivated bacteria solution with the appropriate amount of water (one to ten ratio), then dipping the fish in this solution for 20 seconds. After the 20 second dip, fish were returned to their tanks.

Juvenile Releases

Tagging

All hatchery origin winter Chinook juveniles were coded-wire tagged between December 16, and December 21, 1999. Each of the 18 final family groups received a unique tag code (Table 9). A total of 1,204 juveniles retained for the captive broodstock program were also tagged with passive integrated transponder (PIT) tags. Of these fish, 204 were reared at Livingston Stone NFH and the remaining fish were transferred to BML and Steinhart Aquarium for rearing. Five fish lost their PIT tags before being transferred (2 destined for Steinhart, 2 destined for BML, and 1 slated to remain at Livingston Stone NFH). Tagging with PIT tags occurred on January 19 and 20, 2000. Fish ranged in length from 69 mm to 116 mm at the time of tagging.

Table 9 Coded-wire tag (CWT) codes, associated family groups, number that were tagged with passive integrated transponders (PIT), mean fork length, and distribution for juvenile winter Chinook salmon retained for the captive broodstock program, brood year 1999.

CWT Code	Family Group	Number PIT Tagged	Mean fork Length (mm)	Retained for Captive Broodstock Program
0501021205	9N	70	80	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021206	9M	70	78	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021207	8L	70	77	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021208	8K	70	79	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021209	7J	70	85	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021210	7I	70	81	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021211	3C	70	105	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021212	4A	70	106	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021213	6G	70	89	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021214	5D	70	92	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021215	5E	70	99	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021301	4B	70	101	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH

Table 9(cont) Coded-wire tag (CWT) codes, associated family groups, number that were tagged with passive integrated transponders (PIT), mean fork length, and distribution for juvenile winter Chinook salmon retained for the captive broodstock program, brood year 1999.

CWT Code	Family Group	Number PIT Tagged	Mean fork Length (mm)	Retained for Captive Broodstock Program
0501021302	2A	70	99	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021303	2B	70	102	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021304	3B	70	99	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021305	6F	70	88	29 Steinhart Aquarium 29 Bodega Marine Lab 12 Livingston Stone NFH
0501021306	1A	84	100	36 Steinhart Aquarium 36 Bodega Marine Lab 12 Livingston Stone NFH
0501021307	all captive broodstock crosses	0	69	all released, none retained

Distribution

Normally, before and after hatchery juvenile winter Chinook are released into the Sacramento River, the Service estimates 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 provides an assessment of potential genetic risk to the natural population as a result of the release of the juveniles from the production program. However, because of the small number of brood year 1999 hatchery juvenile winter Chinook relative to the natural production in the Sacramento River, genetic risk of the release was considered unlikely and an effective population size calculation was deemed to be unnecessary.

Table 10 Tagging information for BY 1999 winter Chinook salmon

Tag Code	Number Tagged	Mortalities	Number held for Captive program	Tag Retention	Length			Number Released
					Min	Max	Mean	
501021205	943	4	70	0.99	62	90	75	860
501021206	1276	2	70	0.98	49	85	74	1180
501021207	1383	4	70	0.98	48	92	74	1283
501021208	894	3	70	0.99	48	94	76	813
501021209	1105	4	70	0.97	67	97	84	1000
501021210	1375	1	70	0.97	55	87	79	1265
501021211	1629	2	70	1.00	84	114	98	1557
501021212	1220	5	70	1.00	55	121	103	1145
501021213	1826	0	70	0.99	80	103	89	1738
501021214	1611	4	70	1.00	80	105	92	1545
501021215	1280	5	70	1.00	83	112	96	1205
501021301	1695	2	70	0.97	79	116	101	1574
501021302	2253	3	70	0.97	87	110	98	2115
501021303	2073	0	70	1.00	89	116	100	2003
501021304	1790	4	70	1.00	84	119	101	1716
501021305	2221	4	70	0.99	75	101	89	2125
501021306	3187	3	84	0.99	86	113	98	3069
501021307	4334	15	0	0.98	49	90	69	4232

A total of 26,522 fish (46.3 per pound) from natural origin by natural origin crosses and 4,318 fish (122.7 per pound) from captive by natural origin crosses were released into the Sacramento River at the Caldwell Park on January 28, 2000. The salmon were released at dusk thus allowing them to acclimate through the night to reduce possible losses from predation. Average survival from egg to release was 69.6% for natural origin matings crosses (range: 36.0-96.3%), and 14.1% for captive matings (range was unavailable). The majority of juvenile mortality occurred during the egg stage and the sac fry stage. Of the juveniles held for the captive broodstock program, 1,000 fish (25.7 per pound) were transferred to Bodega Bay Marine Lab for smolting on April 4, 2000 (half of these were later transferred to Steinhart Aquarium for maintenance) and 204 fish were retained at Livingston Stone NFH. At the time of tagging, a small piece of fin was removed from these fish allowing genetic determination of sex. This was done so that males and females can be reared separately, to reduce precocious maturation in the males. Hopefully this can be accomplished by reducing feed, and thus reducing growth and fat deposition in males.

Of the 3,391 juveniles produced by the later captive x captive matings, 30 were sent to Steinhart Aquarium for display (10 on 2/8/01 and 20 on 6/27/01), and 10 were sent to Pier 39 Underwater World for display (on 3/15/01). The remaining fish were held at BML until they died or were euthanized.

Fish Health Maintenance and Monitoring

At the time of release, CA-NV FHC personnel tested 40 juvenile Chinook salmon for *R. salmoninarum* using ELISA. Thirty two percent (13) were negative (optical density value ≤ 0.083); the remaining 68% (27) were in the low positive range (with the highest optical density value = 0.384). Because of the occurrence of false positive readings, optical density values that are within two standard deviations of the negative reference tissue are considered negative.

References

Vogel, D.A. and K.R.Marine. 1991. Guide to upper Sacramento River Chinook salmon life history. Prepared for the U.S. Bureau of Reclamation, Central Valley Project. 55 pp.

Attachment A

1999 Winter Chinook
Adult Trapping Plan

1999 Adult winter-run Chinook salmon trapping plan/schedule

In 1999 the Service intends to capture 120 adult winter-run Chinook salmon for the propagation program. A preseason run-size estimate of approximately 1,400 has been generated using an average replacement rate of 1.5:1 and a three year maturation schedule (Table 7). Run sizes over 800 allow the Service to collect the maximum number of adults requested (120) based on the 15% capture limit. The schedule for monthly collection targets is presented in Table 7. Due to construction projects no trapping will occur prior to mid-February 1999.

The preseason run-size estimate generated last year was relatively accurate when compared to the post season estimate. The preseason run-size estimate generated by the U.S. Fish and Wildlife Service in 1998 was 2,000. The preliminary post season run-size estimate generated by the California Department of Fish and Game was 2,612. As seen, the run size estimate generated by the Service was conservative when compared to the post season estimate, indicating fewer fish would have been collected for the program. However, the Service has placed an upper limit on broodstock collection at 120*. This means that if the run size estimate exceeds 800 only 120 fish will be collected regardless of the actual run size.

The trapping schedule has monthly collection targets throughout the trapping season. However, consistent with past operations, if monthly targets are not met, efforts will be made to attain the cumulative trapping number during the following month. For example, assume 50 adults are collected through March. This year's trap schedule (Table 7) calls for a cumulative target value of 63 through March (5th column, March entry). Although only 34 adults are targeted for collection in April (4th column, April entry), the target will be adjusted to 47 to attempt to hit the cumulative value of 97 (5th column, April entry) at the end of April.

As described in the Service's 1998 Section 10 permit application supplement and addendum, all collected fish will be subjected to a 3-5 day quarantine/detention period. At the time of capture at the Keswick Dam fish trap, a tissue sample will be collected and a floy tag affixed to the specific individual. The tissue sample will be shipped to the Bodega Marine Laboratory for genetic analysis. If the results of the analysis are favorable (i.e., high probability of being a winter-run Chinook salmon), the fish will be maintained for the propagation program. If the results are not favorable, the individual fish will be transported back to the mainstem Sacramento River at Caldwell Park and released. In 1998, a LOD score >= 2 was the genetic criteria to retain an individual for the spawning program (see amendment of ESA section 10 permit supplement dated June 30, 1998 for a complete description of LOD scores and genetic and phenotypic selection criteria). In 1999, a LOD score of >=1 may be adopted. Refinement of baseline genetic data suggests this reduction in the LOD will not result in selection of "non" winter-run Chinook salmon for the propagation program, while, at the same time, reducing the unnecessary rejection of actual winter-run Chinook salmon adults. Thorough discussion of this topic will occur on February 26, 1999 at a meeting of the Genetics Subcommittee of the Winter-run Chinook Salmon Captive Broodstock Committee.

*The Livingston Stone National Fish Hatchery was designed to have an adult holding capacity of approximately 120 winter-run Chinook salmon adults.

Table 7.—Livingston Stone National Fish Hatchery winter-run Chinook salmon adult collection strategy and actual adult collection activities for brood year **1999** based on a pre-season run-size estimate of 1,400 and a target collection of 120 fish.

Month	Percent Distribution[a]	Estimated Number[b]	Target Capture[c]		Actual Capture[e]		
			Number[d]	Cumulative Number	Number	Cumulative Number	Cumulative Percent of Total Estimated Run
Dec	1.8	25	2	2			
Jan	5.1	71	6	8			
Feb	9.6	134	12	20			
Mar	36.0	504	43	63			
Apr	28.6	400	34	97			
May	8.9	125	11	108			
Jun	6.8	95	8	116			
Jul	3.4	48	4	120			
Aug	0.0	0	0	120			
Total	100	1400	120				

[a]-Historic percent distribution timing from December through July (displayed) base on fish counts at Red Bluff Diversion Dam.

[b]-The estimated run-size of 1,400 for 1999 is initially predicted based on:

1) an estimated population of 940 in 1996 (most salmon return at age three);
2) an expected replacement level of 1.5 to 1 (recent replacement levels include: 1.2 to 1 [1992 - 1995]; 2.8 to 1 [1993 - 1996]; 4.6 to 1 [1994 - 1997]; and 1.9 to 1 [1995 to 1998]. Estimated run-size values will be updated with actual in-season predictions based on counts at the Red Bluff Diversion Dam, aerial redd surveys, and trapping success at the Keswick Dam fish trap.

[c]-The target capture rate is 15% of the estimated run-size. However, to maintain genetic diversity, no less than 20 will be taken regardless of the run-size (i.e., run-size<135). Additionally, due to spatial constrains, no more than 120 will be collected regardless of the run-size estimate (i.e., > 800)

[d]-Monthly target numbers are generated by multiplying the total target capture (see footnote c) by the percent distribution value (see footnote [a]).

[e]-Actual capture data for 1999 can be found in figure 1 on page 5 of this report