FISHERY RESEARCH

CAPTIVE REARING PROGRAM FOR SALMON RIVER CHINOOK SALMON

PROJECT PROGRESS REPORT
January 1, 2006—December 31, 2006

Prepared by:

Dan Baker, Hatchery Manager II
Jeff Heindel, Assistant Hatchery Manager
Dmitri Vidergar, Senior Fisheries Research Biologist
Eric Stark, Senior Fisheries Research Biologist
Joshua Gable, Senior Fisheries Technician
Kurtis Plaster, Senior Fisheries Technician

and

Paul A. Kline, Principal Fisheries Research Biologist

IDFG Report Number 07-33
April 2007

Captive Rearing Program for Salmon River Chinook Salmon

Project Progress Report

2006 Annual Report

By

Dan Baker
Jeff Heindel
Dmitri Vidergar
Eric Stark
Joshua Gable
Kurtis Plaster

and

Paul A. Kline

Idaho Department of Fish and Game
600 South Walnut Street
P.O. Box 25
Boise, ID 83707

To

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-3621

Project Number 199700100
Contract Number 00024657 & 00029463

IDFG Report Number 07-33
April 2007

TABLE OF CONTENTS

Page

ABSTRACT 1
INTRODUCTION 2
FACILITIES 6
  Eagle Fish Hatchery 6
  Manchester Research Station 6
METHODS 7
  Fish Culture 7
  Juvenile Rearing, Marking, and Transportation 7
  Adult Rearing, Transportation, and Marking 8
  Monitoring Programs 9
    Fish Health Monitoring 9
    Growth and Survival of Completed Brood Years 10
    Volitional Spawning 10
    Production Estimation 12
      Parr Collections 12
      Emergence Survival Study 12
    East Fork Salmon River Weir Operations 14
RESULTS AND DISCUSSION 15
  Brood Year Report Outline 15
    Brood Year 2004 Culture Groups 15
    Brood Year 2005 Culture Groups 15
  Juvenile Rearing, Marking, and Transportation 16
  Adult Rearing, Marking, and Transportation 19
  Monitoring Programs 19
    Fish Health Monitoring 19
    Growth and Survival of Brood Year 2001 20
    Volitional Spawning 23
    Production Estimation 25
      Parr Collections 25
      Emergence Survival Study 26
    East Fork Salmon River Weir Operations 27
LITERATURE CITED 28
APPENDICES 32

LIST OF TABLES

Page

Table 1. Habitat and behavior variables recorded during observations of captive-reared Chinook salmon. 11

Table 2. Summary of losses and magnitude of mortality for two West Fork Yankee Fork (WFYF) captive-reared Chinook salmon culture groups reared at Idaho Department of Fish and Game facilities in 2006. Culture groups are designated by brood year (BY) and by the method in which the groups are sourced (NE = natural egg). 17

Table 3. Summary of losses and magnitude of mortality for two East Fork Salmon River (EFSR) captive-reared Chinook salmon culture groups reared at Idaho Department of Fish and Game facilities in 2006. Culture groups are designated by brood year (BY) and by the method in which the groups are sourced (NE = natural egg). 18

Table 4. Mean weight and length of captive-reared Chinook salmon marked for release in 2006. All fish were released into their natal waters (West Fork Yankee Fork Salmon River = WFYF and East Fork Salmon River = EFSR). 19

Table 5. Number of captive-reared female Chinook salmon released and redds produced by these fish, 2001-2006. West Fork Yankee Fork Salmon River (WFYF), East Fork Salmon River (EFSR). 24

Table 6. Summary of eyed egg collections in the East Fork Salmon River (EFSR) and West Fork Yankee Fork (WFYF) as part of the emergence survival study. Celsius Temperature Units (CTUs) are reported for the time of collection. Some redds received a second experimental egg capsule, those capsules are labeled as 2nd capsule. 26

Table 7. Natural adult Chinook salmon distributions trapped at the East Fork Salmon River weir facility during 2006. 27

Table 8. Summary of additional fish trapped at the East Fork Salmon River weir and genetic samples collected from these fish during 2006. 27

LIST OF FIGURES

Page

Figure 1. Location of study streams included in the Idaho Department of Fish and Game Captive Rearing Program for Salmon River Chinook salmon. 5

Figure 2. Egg capsules used for emergence survival study. 13

Figure 3. Mortality by age and age at maturation for East Fork Salmon River and West Fork Yankee Fork captive-reared brood year 2001 stocks. Immature Mortality = fish that died prior to reaching sexual maturity; Mature Mortality = fish that reached sexual maturity but did not spawn; Productive Adults = fish that reached sexual maturity and spawned. 21

Figure 4. Weight at maturity by age for captive-reared Chinook salmon from BY01 and the average of BY97 through BY00. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish. 22

Figure 5. Length at maturity by age for captive-reared Chinook salmon from BY01 and the average of BY97-BY00. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish. 22

Figure 6. Average 2006 three-day moving average temperatures for the East Fork Salmon River (EFSR) and the West Fork Yankee Fork (WFYF) compared to the 2001-2005 and 2002-2005 averages, respectively. 25

LIST OF APPENDICES

Appendix A. Summary of fish transfers conducted by the Chinook Salmon Captive Rearing Project during 2006. MAN = Manchester Research Station, WFYF = West Fork Yankee Fork River, EFSR = East Fork Salmon River, EAG = Eagle Fish Hatchery, Brood Year = BY. NP, NE, and SN refer to natural parr, natural egg, and safety net groups, respectively. 33

Appendix B. Tag and identification summary for captive-reared Chinook salmon released for volitional spawning in the West Fork Yankee Fork Salmon River (WFYF) and the East Fork Salmon River (EFSR). Fish were jaw-tagged (WFYF) or Petersen disc tagged (EFSR) for visual identification. A portable ultrasound unit was used on maturing fish reared at the Manchester Research Station (MAN) to determine sex, and classified as undetermined = UN, female = FEM, or male = MAL. 34

ABSTRACT

During 2006, the Idaho Department of Fish and Game (IDFG) continued to develop techniques to rear Chinook salmon *Oncorhynchus tshawytscha* to sexual maturity in captivity and to monitor their reproductive performance under natural conditions. Eyed eggs were collected from the East Fork Salmon River (EFSR) and the West Fork Yankee Fork Salmon River (WFYF) to establish study groups for an emergence survival study initiated in 2006. Captive rearing groups were not collected in 2006; brood year 2005 (BY05) represents the final brood cohorts collected for full-term captive rearing studies in the EFSR and WFYF. Brood year 2005 presmolts were passive integrated transponder and elastomer tagged, and then vaccinated against *Vibrio* spp. and bacterial kidney disease (causative agent *Renibacterium salmoninarum*) prior to being transferred to the National Oceanic & Atmospheric Administration Fisheries, Manchester Research Station, Manchester, Washington (Manchester) for seawater rearing through maturity. Smolt transfers included 264 individuals from the WFYF and 426 from the EFSR. Maturing fish transfers from Manchester to Idaho for release to natal waters included 179 individuals from the WFYF and 141 from the EFSR. All maturing captive-reared Chinook salmon were released in 2006. No maturing adults were spawned at Eagle FH for gamete evaluations, precluding the availability of eggs for in-stream incubators. Mature adults were released to evaluate reproductive performance of captive-reared adults as well as behavioral interactions of captive x captive and captive x natural adults. Eight captive-reared Chinook salmon females volitionally spawned in the WFYF and 13 in the EFSR. Fin samples from Chinook salmon parr were collected in the WFYF (n = 46) and the EFSR (n = 100) to assess production levels from volitional spawning events resulting from program releases conducted in 2005. Genetic material from these juveniles will be analyzed with samples taken from all program adults and natural carcasses collected within the study area. This information will be used in future parental exclusion analyses.

Authors:

Dan Baker
Hatchery Manager II

Jeff Heindel
Assistant Hatchery Manager

Dmitri Vidergar
Senior Fisheries Research Biologist

Eric Stark
Senior Fisheries Research Biologist

Joshua Gable
Senior Fisheries Technician

Kurtis Plaster
Senior Fisheries Technician

Paul A. Kline
Principal Fisheries Research Biologist

INTRODUCTION

Idaho Department of Fish and Game's (IDFG) long-term management objective for Chinook salmon *Oncorhynchus tshawytscha* is to maintain Snake River salmon populations at levels that will provide sustainable harvest (IDFG 2001). Restoring currently depressed populations to historic levels is a prerequisite to this condition. Artificial propagation of spring and summer Chinook salmon in the Salmon River basin, through Lower Snake River Compensation Plan (LSRCP) and Idaho Power Company hatcheries, was initiated to compensate for lost recruitment and productivity caused by the construction and operation of private and federal hydroelectric facilities in the Snake River basin. The mitigation approach was to trap, spawn, and rear a portion of the historically productive local broodstock to produce a large number of smolts (Bowles 1993). When Chinook salmon trapping began in 1981 as part of the LSRCP, it was assumed that enough Chinook salmon adults would return to provide for harvest and continued hatchery production needs. It was also assumed hatchery programs would not negatively affect the productivity or genetic viability of target or other populations, and natural populations would remain self-sustaining even with hydropower projects in place. In reality, smolt-to-adult survival in natural Snake River Chinook salmon declined abruptly with completion of the federal hydroelectric system by the mid-1970s (Petrosky and Schaller 1994; Petrosky et al. 1999), and numbers of naturally produced salmon declined at various rates throughout the Snake River basin. It now appears the survival rate estimates used in the hatchery mitigation program models were substantially overestimated, which has led to hatchery programs that have not consistently mitigated for reductions in Chinook salmon production and productivity. Spring/summer Chinook salmon returns have been insufficient to meet artificial and natural smolt and adult production goals, much less provide a consistent harvestable surplus of adults (Hassemer 1998).

Development of the Snake River hydrosystem has substantially influenced the decline of local spring/summer Chinook salmon stocks by reducing productivity and survival (Raymond 1979; Schaller et al. 1999) and has contributed to the listing of Snake River Chinook salmon under the Endangered Species Act (ESA; National Marine Fisheries Service [NMFS] 1992). A recovery strategy incorporating natural river function is most likely to increase the smolt-to-adult return rate and provide for recovery of these populations (Marmorek et al. 1998). However, until smolt-to-adult survival increases, our challenge is to preserve the existing metapopulation structure (by preventing local or demographic extinctions) of these stocks to ensure they remain extant to benefit from future recovery actions. This project is developing technology that may be used in the recovery of the listed Snake River spring/summer Chinook salmon evolutionarily significant unit (ESU), which consists of 31 subpopulations (i.e. breeding units or stocks; McClure et al. 2003). Preserving the metapopulation structure of this ESU is consistent with the various Snake River Salmon Recovery Plans (NMFS 1995; Schmitten et al. 1997; McClure et al. 2003), and supports the Northwest Power and Conservation Council's (NPCC) goal of maintaining biological diversity while doubling salmon and steelhead runs (NPCC 1994).

Idaho and Oregon state, tribal, and federal fish managers met during 1993 and 1994 to discuss captive culture research and implementation in the Snake River basin. The outcome of those meetings was an agreement that two programs would be initiated: 1) the Oregon Department of Fish and Wildlife (ODFW) would initiate a captive broodstock program using selected Grande Ronde River Chinook salmon populations, and 2) the IDFG would initiate captive rearing research using selected Salmon River Chinook salmon populations. Both captive culture techniques begin by bringing naturally produced juveniles (eggs, parr, or smolts) into captivity and rearing them to sexual maturity in a hatchery. At this point, the two programs

use different techniques. The F_1 generation in a captive rearing program (IDFG) is returned to their natal streams and allowed to spawn naturally. The F_1 generation from a captive broodstock program (ODFW) is spawned in the hatchery, where the resulting F_2 progeny are held until smoltification. The F_2 generation is then released as smolts to their natal streams to emigrate volitionally. The primary focus of these programs is to evaluate the effectiveness of the two forms of captive culture to meet population conservation objectives. Implicit within each research project is the objective to develop and test appropriate facilities and fish culture protocols specific to the captive culture of Chinook salmon for conservation management of depressed populations.

Little scientific information regarding captive culture techniques for Pacific salmonids was available at the inception of these programs, but a substantial amount of new literature has been published in the ensuing years. The Chinook Salmon Captive Propagation Technical Oversight Committee (CSCPTOC) was formed to convey this new information between the various state, federal, and tribal entities involved in the captive culture of Chinook salmon. The CSCPTOC meets approximately every two months, which allows an adaptive management approach to all phases of the program and provides a forum of peer review and discussion for all activities and culture protocols associated with this program. Flagg and Mahnken (1995) provided an initial literature review of captive rearing and captive broodstock technology, which provided the knowledge base upon which the program was designed. Using this work, the IDFG captive rearing program for Salmon River Chinook salmon was initiated to further the development of this technology by monitoring and evaluating captive-reared fish during rearing and post-release spawning phases. Since the program's inception, studies documenting the spawning behavior of captive-reared Chinook salmon (Berejikian et al. 2001b), coho salmon *O. kisutch* (Berejikian et al. 1997), and Atlantic salmon *Salmo salar* (Fleming et al. 1996) have been published. Other studies have also compared the competitive behavior of male captive-reared and natural coho salmon during spawning (Berejikian et al. 2001a) and the competitive differences between newly emerged fry produced by captive-reared and natural coho salmon (Berejikian et al. 1999). Finally, Hendry et al. (2000) reported on the reproductive development of sockeye salmon *O. nerka* reared in captivity.

The IDFG captive rearing program was developed as a way to increase the number of naturally spawning adults and maintain metapopulation structure in selected populations at high risk of extinction while avoiding the impacts of multigenerational hatchery culture described in Reisenbichler and Rubin (1999). The strategy of captive rearing is to prevent cohort collapse in the target populations by returning captive-reared adults to natural spawning areas to augment depressed natural escapement (or replace it in years when no natural escapement occurs). This maintains the continuum of generation-to-generation smolt production and provides the opportunity for population maintenance or increase should environmental conditions prove favorable for that cohort. However, the success of the captive rearing approach to produce adults with the desired morphological, physiological, and behavioral attributes to spawn successfully in the wild remains somewhat speculative (Fleming and Gross 1992, 1993; Joyce et al. 1993; Flagg and Mahnken 1995).

The IDFG captive rearing program was initiated in 1995 with the collection of brood year (BY) 1994 (BY94) Chinook salmon parr from three study streams. Since then, naturally spawned Chinook salmon progeny from BY95-BY05 have been represented in captivity to continue the project. Hassemer et al. (1999, 2001), Venditti et al. (2002, 2003a, 2003b, 2005), and Baker et al. (2006) summarize project activities from inception through 2005. The streams selected for inclusion in the captive rearing program include the Lemhi River (LEM), the East Fork Salmon River (EFSR), and the West Fork Yankee Fork Salmon River (WFYF); the 2006

study area is depicted in Figure 1. Project activities were completed on the LEM in 2003 with the release of mature BY99 adult fish, enabling increased monitoring intensity on the EFSR and WFYF to the present day. Water temperatures are ideal for juvenile Chinook salmon rearing in all three streams, while water quality ranges from sufficient to ideal. Habitat quality ranges from relatively pristine to areas of riparian degradation caused by sedimentation, grazing, mining, logging, road building, and irrigation diversion. The LEM drains productive basaltic parent material resulting in rapid fish growth. The lower section of this river flows through private land developed extensively for agriculture and grazing and typically reflects C channel conditions (Rosgen 1985). The EFSR drains a relatively sterile watershed of granitic parent material associated with the Idaho batholith. The lower 30 km of the EFSR runs through ranch and grazing property developed during the last century, but the upper reaches reflect near pristine conditions with little historical disturbance from logging, mining, or agriculture. Stream habitat in the EFSR typically reflects B and C conditions (Rosgen 1985). The WFYF, which drains a sterile watershed similar to the EFSR, remains primarily roadless and nonimpacted by land use practices for nearly half a century. Stream habitat typically reflects B and C conditions (Rosgen 1985). A B type channel is defined as being moderately entrenched with a moderate width to depth ration, moderate sinuosity, and a slope of .02 to .099% while a C type channel is slightly entrenched with a moderate to high width to depth ratio moderate sinuosity, and a slope between 0.001 and 0.039% (Rosgen 1985).

The goal of the captive rearing program is to evaluate the potential usefulness of the captive rearing concept as applied to the conservation of Snake River spring/summer Chinook salmon. We have identified two primary project objectives needed to accomplish this goal. These are to: 1) develop and implement culture practices and facility modifications necessary to rear Chinook salmon to maturity in captivity having morphological, physiological, and behavioral characteristics similar to natural fish; and 2) evaluate the spawning behavior and success of captive-reared individuals under hatchery and natural conditions. These objectives divide the program into two functional units including fish culture and field evaluations, but the success of the program is dependent on the synchronous development of both. This report documents activities performed in both aspects of the evaluation from January 1, 2006 through December 31, 2006. This project is coordinated with the Northwest Power and Conservation Council's Fish and Wildlife Program (NPCC 2000) and is identified as project 199700100. Funding is provided through the Bonneville Power Administration under contracts 00024657 and 00029463.

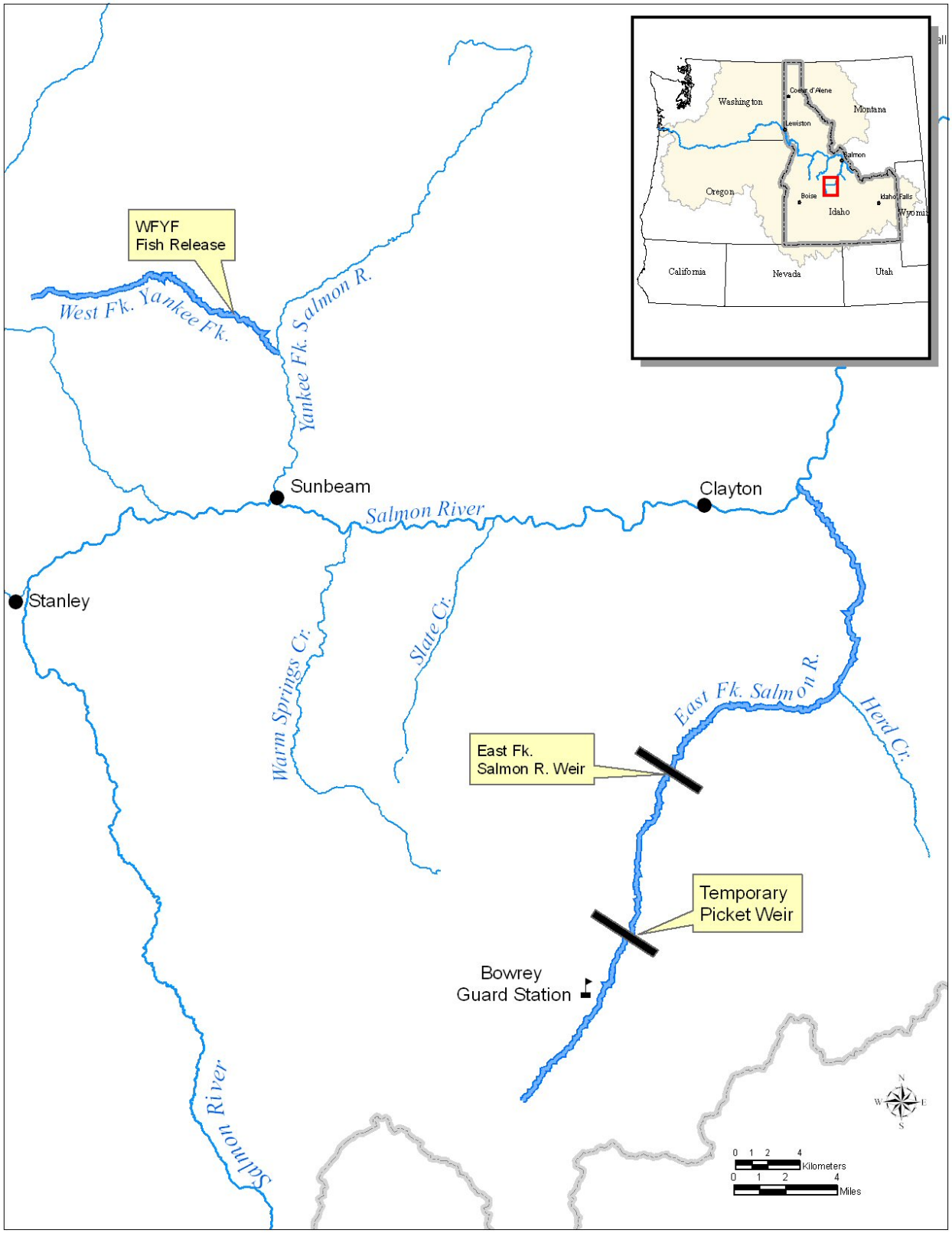


Figure 1. Location of study streams included in the Idaho Department of Fish and Game Captive Rearing Program for Salmon River Chinook salmon.

FACILITIES

Eagle Fish Hatchery

The IDFG Eagle Fish Hatchery, Eagle, Idaho (Eagle FH) is the primary Idaho site for the captive culture of program fish. The hatchery is supplied with pathogen-free artesian water from three wells, and artesian flow is augmented with three separate pump and motor systems. Ambient water temperature and total dissolved gas average 13.5°C and 100% respectively, after degassing. Water chilling capability was added in 1994 and expanded in 2001 for use during various stages of the captive rearing process. Water temperature is maintained between 7.0°C and 9.0°C during the egg incubation period of the rearing cycle. From ponding through transfer of smolts to seawater, water temperature is maintained between 8.0°C and 10.0°C. Chilled water is also used in holding tanks of maturing, adult Chinook salmon prior to in-hatchery spawning or release for natural spawning. Backup and system redundancy is maintained for degassing, pumping, and power generation. Ten water level alarms are linked through an emergency service operator. Additional security is provided by limiting public access and by the presence of three onsite residences occupied by IDFG hatchery personnel.

Tanks of various sizes and configurations are maintained at Eagle FH to accommodate the various life stages and sizes of Chinook salmon maintained on station. Plastic incubators and fiberglass tanks ranging in size from 0.7–3.0 m in diameter are used to culture Chinook salmon from eggs to maturity. Fertilized eggs are held in incubators until swim-up, transferred to 0.7 m semisquare tanks (0.09 m^3), then transferred to 1.0 m diameter semisquare tanks (0.30 m^3) where they remain until they reach approximately 10 g. Fish are then moved to 2.0 m semisquare tanks (1.42 m^3) where they remain until transfer to seawater at smoltification. At maturation, fish are transferred from seawater back to freshwater at Eagle FH or released directly to their natal waters. Maturing fish are held in 3.0 m circular tanks (6.50 m^3) separated by stream origin until they are released into their natal waters or spawned in the hatchery to monitor specific reproductive success variables.

Flow to all tanks at Eagle FH is maintained at a minimum of 1.5 exchanges per hour, with shade covering (70%) and jump screens used where appropriate. Tank discharge standpipes are external and assembled in two sections (“half-pipe” principle) to prevent tank dewatering when removed for tank cleaning.

Manchester Research Station

Seawater rearing is provided for all study animals post smoltification at the National Oceanic & Atmospheric Administration (NOAA) Manchester Research Station in Manchester, Washington (Manchester). This facility is located on Puget Sound near Seattle, Washington, and is supplied with approximately 5,000 L/min of seawater that ranges in temperature between 7°C and 14°C annually and averages 29‰ salinity. Raw seawater is passed through sand and cartridge filters to remove particles >5 μ, sanitized with ultraviolet light, and degassed prior to entering fish rearing tanks. Effluent from the rearing tanks is treated with ozone prior to being returned to Puget Sound (Frost et al. 2002).

METHODS

Fish Culture

Fish husbandry practices employed at Eagle FH ranged from traditional to experimental. Fish health issues were handled using only approved therapeutants, and standard fish culture practices were employed whenever possible (for an overview of standard methods see Leitritz and Lewis 1976; Piper et al. 1982; Erdahl 1994; Bromage and Roberts 1995; McDaniel et al. 1994; Pennell and Barton 1996). However, due to the experimental nature of the work conducted at Eagle FH, some aspects of the incubation, rearing, and feeding protocols differ from those used at production hatcheries. Eyed eggs were hatched in specially designed incubators (Heindel et al. 2005) that can allow siblings from individual spawn crosses or redds to be maintained separately until the juveniles are tagged with passive integrated transponder (PIT) tags (Prentice et al. 1990) to permit future familial identification. Rearing tank size, density, and food ration varied with fish age and were managed to promote optimum growth and the attainment of program objectives. Juveniles were periodically anesthetized, weighed to the nearest 0.1 g, and measured to the nearest 1 mm fork length (FL) to track growth and to ensure that projected weights tracked closely with actual weights.

Fish were fed standard commercial diets produced by Bio-Oregon (Warrenton, Oregon) and Skretting (Vancouver, British Columbia, Canada). Ration and water temperature were manipulated to simulate the ration and temperature profiles that would be experienced in the natural environment to modulate growth and reduce precocial male development. This feeding regimen was developed collaboratively with NOAA Fisheries Project Number 1996-067-00.

Juvenile Rearing, Marking, and Transportation

Swim-up fry were fed for one week while in their incubators prior to ponding to 0.7 m semisquare tanks, and individual family groups were maintained separately until PIT tagging. Fry were fed hourly during daylight hours, approximately eight times/day, until they reached a mean weight of 1.0 g. Growth projections were developed at this time, and feeding rates were reduced to four times/d. Ambient and chilled water was added to the tanks to maintain a temperature of approximately 8.5°C and 1.5 exchanges/hour. Fry were fed a commercial diet (Bio-Oregon Starter #2) at approximately 2% of their body weight/d. As fish grew, ration and pellet sizes were increased accordingly. Sample counts were conducted as needed to ensure actual growth closely tracked the projected growth rate, but fish were handled as infrequently as possible.

Age-1 juvenile Chinook salmon were marked during two separate events at Eagle FH. 1) PIT tagging involved injecting a PIT tag into the peritoneal cavity of age-1 juveniles. Age-1 juveniles were anesthetized in MS-222 (tricaine methanesulfonate; buffered to neutrality with sodium bicarbonate), weighed to the nearest 0.1 g, and measured to the nearest 1 mm FL. A modified 12-gauge hypodermic needle was used to inject the PIT tag into the body cavity slightly anterior to the pelvic girdle and just off the ventral midline. The PIT tag gave each individual a unique identity within the program and was used to track each fish through the remainder of its life. 2) Visual implant elastomer (VIE) marking was conducted shortly before they were transported to Manchester. Fish were anesthetized in buffered MS-222, weighed to the nearest 0.1 g, measured to the nearest 1 mm FL, and a color-coded VIE tag was injected into the clear tissue immediately posterior to the eye (Olsen and Vøllestad 2001; Close and Jones 2002), based on its stream of origin.

All age-1 juvenile Chinook salmon were transported to Manchester as smolts for seawater rearing. Smolts were transported between facilities in truck-mounted, insulated tanks (950 L capacity) with alarm and backup oxygen systems and "fresh flow" mechanical water aeration units on board. Loading volumes did not exceed 89 g/L (0.75 lb/gal). Prior to offloading, if necessary, transport water was tempered to within 2.0°C of the receiving water and fish were moved, by stock, to 6.0 m circular tanks filled with full strength freshwater for seawater acclimation. Once in the circular tanks, full strength seawater was introduced into the tanks until the freshwater was completely replaced (approximately 12 h, C. McAuley, NOAA Fisheries, personal communication).

Adult Rearing, Transportation, and Marking

Maturing Chinook salmon at Manchester were transported to Idaho (Eagle FH and/or stream of origin) to complete the freshwater phase of their maturation and for spawning performance evaluation. Maturation state was determined for all individuals at Manchester by ultrasound examination using an Aloka SSD-500V ultrasound unit with an Aloka Electronic Linear Probe UST-556L-7.5. A second maturation sort was also conducted at Manchester several weeks after the initial sort to identify any maturing fish not detected in the earlier ultrasound examination. Adults were transported using similar equipment and techniques as described above, and loading volumes did not exceed 89 g/L. Maturing fish from multiple brood years were pooled by stock for transport to Idaho, although stocks that may have posed a health risk to other program fish were transported in separate vehicles. Tanks were loaded with approximately ¼ seawater and ¾ freshwater (by volume) to begin freshwater acclimation during transport. Adults destined for return to Eagle FH were transferred from truck tanks to 3.0 m circular tanks filled with full strength freshwater at Eagle FH. Adults destined for return to natal waters were transferred from truck tanks to streamside release sites.

Maturing Chinook salmon destined for release for natural spawning were fitted with either disc tags, Floy tags, or jaw tags prior to release. Disc tags were color-coded to identify the brood year to which the fish belonged. Additionally, each disc tag had a unique number embossed upon it to identify the individual. Fish were anesthetized in buffered MS-222, weighed to the nearest 1.0 g, and measured to the nearest 1 mm FL. Water temperature in the anesthetic baths was determined by the tank temperature to which the fish were being exposed. Disc tags were attached to the fish by passing a stainless steel pin through a hole in the center of the tag and passing the pin through the musculature of the dorsal surface just ventral to the midline of the dorsal fin. Then a corresponding tag (same color code and number) was slipped onto the pin on the opposite side of the fish. The tag was secured by trimming the pin to length and forming a loop at the end with needle-nose pliers. When used, Floy tags were inserted into the left side of the dorsal musculature in a similar location as disc tags but did not protrude to the opposite side. Additionally, individually numbered jaw tags, when used, were attached to the lower left mandible of adults destined for release. Fish receiving Floy tags and jaw tags were anesthetized using the same protocol as outlined for disc tagging procedures. After marking, all fish were allowed to recover in coolers of temperature-appropriate water before being returned to the holding tanks.

Monitoring Programs

Fish Health Monitoring

When required, the captive rearing program has utilized various disinfectants, antibiotics, vaccinations, and antifungal treatments to control pathogens. When used, the dosage, purpose of use, and method of application were as follows:

1) Antibiotic therapies: Therapeutic erythromycin treatments are administered orally in Bio-Diet soft-moist feed obtained from Bio-Oregon (Warrenton, Oregon) to produce a dose of 100 mg/kg of body weight for up to 28 d. When oral administration is not feasible, as with maturing adults, an intraperitoneal injection of erythromycin is given to fish at a dose of 20 mg/kg of body weight. In addition, fingerlings may be fed oxytetracycline as needed to control outbreaks of pathogenic *myxobacteria*, *aeromonad*, and *pseudomonad* bacterial infections.

2) Vaccinations: age-1 Chinook salmon generally receive intraperitoneal injections of Renogen® (Aqua Health, Ltd., Charlottetown, Prince Edward Island, Canada) *Arthrobacter* spp. to vaccinate against bacterial kidney disease (BKD) and Vibrogen® (Aqua Health, Ltd.) to vaccinate against *Vibrio* spp. After each marking event, fish are allowed to recover in coolers of fresh water before being returned to the general population.

3) Egg disinfection: newly fertilized eggs are water hardened in 100 mg/L solution of Iodophor for 20 min. to inactivate viral and/or bacterial pathogens on the egg surface and in the perivitelline space. In addition, eyed eggs transferred to Eagle FH from field collections are disinfected in a 100 mg/L Iodophor solution for ten min. prior to incubator transfer.

Fish health was monitored daily by observing feeding response, external condition, and behavior of fish in each tank as initial indicators of developing problems. In particular, fish culturists looked for signs of lethargy, spiral swimming, side swimming, jumping, flashing, unusual respiratory activity, body surface abnormalities, and unusual coloration. Presence of any of these behaviors or conditions was immediately reported to the program fish pathologist. When a treatable pathogen was either detected or suspected, the program fish pathologist prescribed appropriate prophylactic and therapeutic drugs to control the problem.

Tissue samples were collected from dead program fish during necropsies to monitor for the presence of common bacterial and viral pathogens. American Fisheries Society Bluebook procedures were employed to isolate bacterial or viral pathogens and to identify parasite etiology (Thoesen 1994). All examinations were conducted under the direction of the program fish pathologist. Genetic samples were also collected from these fish in the event that they may be needed in future mitochondrial DNA and/or nuclear DNA evaluations for Chinook salmon populations held in the program. After necropsy, carcasses that were not vital to further analysis were disposed of as per language contained in the ESA Section 10 permit for the program.

Spawning adults were analyzed for common bacterial and viral pathogens. Tissue samples were collected from the kidney, spleen, and pyloric caeca of each fish, and ovarian fluid samples were collected from each female and analyzed at the Eagle Fish Health Laboratory. In addition, tissues from maturing Chinook salmon transferred to the State of Idaho from Manchester were screened for *Piscirickettsia salmonis*, and additional ovarian fluid was “blind passed” in a separate test for the North American strain of viral hemorrhagic septicemia.

These pathogens do not occur in Idaho but have been identified in fish reared at a seawater net pen location close to the Manchester site in prior years. Results of fish health analyses on spawned fish were used by IDFG and the CSCPTOC to determine the disposition of eggs and subsequent juveniles.

Growth and Survival of Completed Brood Years

Each program year, individual brood cohorts are terminated with respect to remaining live individuals of a certain age component (typically after year 5 of culture). In order to track the contribution of individual cohorts through time, measures such as growth and magnitudes of mortality for mature and immature losses, and maturation rates were evaluated for completed brood groups. Fish weights collected during routine sampling at both Eagle FH and Manchester were plotted over time, and both individual fish weight and group means were presented graphically. Finally, we determined the total number of brood year program fish from each study stream that reached sexual maturity and computed the percentage that matured at age-2, -3, -4, and -5. In this report, the growth and survival of BY01 Chinook salmon is summarized; however; this brood year was raised entirely at Manchester (no freshwater rearing after smoltification) precluding a comparison between fish raised at Eagle FH and Manchester.

Volitional Spawning

Fish weirs were utilized in study streams receiving mature Chinook salmon from the captive rearing program to assess spawning behavior and success in a natural environment. The components of a blocking weir were transported by truck or helicopter to a construction site and assembled at the downstream end of a given study section to ensure that project fish remained in the study area above the weir. Trap boxes built into the weir allowed natural Chinook salmon and other species to be trapped and passed in either direction; however, study fish attempting to move out of the study area were returned to the stream above the weir. Generally, study sections were divided into multiple reaches of varying length to permit systematic observations of Chinook salmon spawning above the weir. Thermographs were used to document the thermal histories of redds created by captive-reared individuals to provide a means to accurately determine when redds should be sampled to determine fertilization rates and survival to the eyed egg stage of development. During this reporting period, only the EFSR study site received a fish weir. Fish released into the WFYF were allowed to migrate unrestricted throughout the drainage.

Following weir construction, maturing captive-reared Chinook salmon were transported by truck to a streamside site in preparation for release into the study section. Water temperature in the transport tank varied with respect to the stream temperature into which they were released and represented a compromise temperature appropriate for the transport of both study groups. Fish were released at various sites after streamside transfer in insulated coolers and/or specially constructed, water-filled slings that were carried to the release site.

Behavioral data collection began approximately 24 h after fish were released. Field observers were assigned stream reaches within a study section, and the entire study section was monitored daily. Observers walked slowly upstream watching for Chinook salmon; when a fish was detected, the time of day was recorded and its habitat associations and behavior activities (Table 1) were observed and documented for 5 min. During this time, the observer used binoculars and polarized sunglasses to determine if it was a natural or a study fish based on the presence or absence of a disc or Floy tag. If it was a disc-tagged study fish, the

identification color combination and/or number of the tag was recorded. If the number was identified or a natural Chinook salmon was observed, its location was recorded on a global positioning system receiver. When multiple fish were observed simultaneously, their activity, habitat, and location information were recorded separately.

Table 1. Habitat and behavior variables recorded during observations of captive-reared Chinook salmon.

Habitat	**Definition**
Overhead vegetation	Associated with riparian vegetation overhanging the stream
Aquatic vegetation	Associated with aquatic vegetation
Cut bank	Under an overhanging bank
Pool	In a pool with no other structure
Riffle or run	In a riffle or run with no other structure
Riffle tail-out	In the tail-out section of a riffle with no other structure
Large woody debris	Within one body length of log(s)
General Behavior	**Definition**
Holding	Remaining in one position
Milling	Movement not resulting in displacement
Moving (A)	Movement in an upstream direction
Moving (B)	Movement in a downstream direction
Aggression	Aggression between Chinook of undetermined sex
Redd Holding	Maintaining position on or near a redd
Courting	Active male and receptive female
Spawn	Observed release of eggs and milt
Male Behavior	**Definition**
Quiver	Dart toward female ending with body vibrations
Crossover	Movement to opposite side, head passing over peduncle
Aggression (A)	Male on male aggression
Aggression (B)	Male on female aggression
Aggression (C)	Male on other species aggression
Following	Female present, no redd
Satellite	Holding away or downstream of a courting pair
Female Behavior	**Definition**
Aggression (A)	Female on female aggression
Aggression (B)	Female on male aggression
Aggression (C)	Female on other species aggression
Test dig	2–6 body flexures, not concentrated
Nest dig	5–8 body flexures in a concentrated area
Cover dig	8–12 body flexures along redd perimeter

When spawning related behaviors were observed during the first 5 min. of observation, additional time was spent recording the frequency of these behaviors to estimate how close the pair was to spawning. If, based on these frequencies, the observer believed that spawning would occur within 1-2 h, the person remained with that pair and recorded their behaviors until 30 min. after spawning. Behavioral observations were recorded in 10 min. blocks during this time to facilitate comparisons of courting, aggression, and digging frequencies as spawning approached.

Production Estimation

Parr Collections—Chinook salmon parr were collected in previously supplemented study streams to obtain fin clips for genetic analysis to determine if they were the product of program parents. Parr were collected by snorkelers using aquarium dip nets (Bonneau et al. 1995), angling, or collected with rotary screw traps within the study area (operated by Shoshone-Bannock fisheries biologists). Particular emphasis was given to areas near known spawning locations of captive-reared adults or egg-box incubators from supplementation efforts in the previous year. Once captured, parr were transferred to tubs located on the shore filled with fresh stream water, lightly anesthetized with MS-222, and measured to the nearest 1.0 mm FL. A small portion of the anal fin was removed and preserved in 95% ethanol. Scissors used to remove fin tissues were swabbed with isopropyl alcohol between specimens to reduce the possibility of DNA cross-contamination. Parr were then released back into the stream, after recovering in a tub of fresh water, near their point of collection. Genetic material from these juveniles will be analyzed with samples from all program adults and natural carcasses recovered from the study area; this information will be used in future parental exclusion analyses. Microsatellite markers will be utilized to conduct parentage analysis (parental exclusion analysis; Colbourne et al. 1996; Talbot et al. 1996; Estoup et al. 1998; Bernatchez and Duchesne 2000; Eldridge et al. 2002) to determine the reproductive success of captive-reared adults (released for volitional spawning in the previous year) as well as in-stream incubator production (eggs produced from hatchery spawning and planted in the previous year) from F_1 progeny (parr collections).

Emergence Survival Study—In this study, we adapted techniques described by Rubin (1995) to estimate eyed egg to emergence survival of progeny from captive-reared and natural Chinook salmon that spawned naturally in the EFSR and the WFYF. Our objective was to test the following hypothesis:

1. There is no difference in eyed egg to fry emergence survival for eggs produced by captive-origin or natural Chinook salmon that spawn naturally.

We will test this hypothesis by estimating survival to the eyed egg stage of development and survival from eyed egg to emergence for both captive-reared and natural fish that have volitionally spawned within our study areas. Field investigations for this study began during the fall of 2006 and are expected to continue through the fall of 2009.

Rubin's (1995) method of using egg capsules involved placing fertilized (eyed) eggs into a capsule made of rigid plastic mesh and then injecting the capsule into gravel that is representative of the habitat sought by naturally spawning fish. The mesh size of the capsule was large enough to allow water to flow through, but small enough to stop emigration of fry from the capsule and to exclude most predators from entering the capsule. Capsules were placed in the gravel, and embryo development was monitored through water temperatures. When emergence timing is estimated, based on existing data, the capsules are extracted from the gravel and hatched fish are enumerated. This method provides a reliable estimate of survival to emergence because a known number of eggs are placed into each capsule and a known number of fry are collected when a capsule is extracted. This method does not account, however, for mortality that may occur as fry emigrate from the natural gravel environment.

Eyed eggs were collected in study areas using hydraulic collection methods described in Venditti et al. (2002, 2003a, 2003b, 2005) and Baker et al. (2006). Hydraulic sampling gear was modified to allow eyed eggs to be inserted back into their natal redd after being enumerated and

carefully placed into an egg capsule. The only modification made to equipment already being used in this program was the addition of an aluminum sleeve that fits snuggly around the outside of the existing probe while the sampling gear is in use. Aluminum washers between the probe and the sleeve form a seal that blocks rocks or debris from becoming lodged between the probe and sleeve.

Egg transport tubes currently used at Eagle FH (Venditti et al. 2002, 2003a, 2003b, 2005; Baker et al. 2006) were modified and used as egg capsules for the treatment groups. Egg capsules were approximately 30 cm x 8 cm with mesh holes measuring 1 mm x 2 mm. A plastic-coated steel cable (extraction cord) was secured to the bottom of the capsule and extended through the middle of the capsule, with a 0.5 m “tail” protruding out the top of the capsule to facilitate future removal Figure 2.

Figure 2. Egg capsules used for emergence survival study.

Collection methods were simplified from Rubin’s original description. When an egg pocket was encountered while sampling a redd, the pump was shut off and the probe kept in place while eggs were collected. Egg capsules were filled with gravel collected from the redd and eyed eggs were distributed in the capsule around the gravel to minimize egg-to-egg contact and to mimic the natural environment. The probe, still in the gravel at the depth of the egg pocket, was then pulled out of the sleeve and the egg capsule dropped into the empty sleeve and pushed to the bottom. The sleeve was then lifted out of the gravel leaving the egg capsule in the same location from which the eggs were extracted. This method eliminates the additional step of using a spike and tube described by Dumas and Marty (2006).

Actual egg numbers collected per redd varied, but attempts were made to collect between 70 and 100 eggs per redd. Collected eggs were used in four ways. First, dead eggs, eggshells, and live eggs were enumerated to estimate survival to the eyed-egg stage of development. Second, a portion of the live eggs (generally 40) was placed into an egg capsule (treatment group). Third, a second portion of approximately 40 eggs was taken to the Eagle FH and raised to hatch (control group) as per culture techniques described in Venditti et al. (2002, 2003a, 2003b, 2005) and Baker et al. (2006). Fourth, if more than 100 live eggs were collected at sampling, surplus eggs were placed in an extra egg capsule and buried in the same redd (different location). (In a few cases, an extra capsule was filled with lower or higher densities of eggs than the treatment capsules to see if loading density affected survival.)

The environment inside each egg capsule was made as similar to the natural conditions as possible. Egg capsules were filled with gravel from the receiving redd and eggs distributed throughout the capsule. Eggs were not exposed to metal inside the capsule and only stainless steel was used for securing the extraction cord to the outside of each capsule.

Surviving fry from both hatchery and egg capsule study groups were sampled after depletion of yolk reserves, this was determined by tracking accumulated thermal units and using historic emergence timing estimates for similar stocks of Chinook salmon. Surviving fry from both treatment (egg capsule) and control (hatchery incubation) groups were lethally sampled and genetic samples collected for potential future analyses.

Captive-reared fish and natural fish will be treated as the two different study groups and each redd will be treated as a sample unit. The number of sample units per study group may not be equal, but will not exceed 2:1. Redds from both streams (WFYF & EFSR) will be pooled for each study group, and eyed-egg to emergence survival averaged from all redds created by captive-reared fish and natural fish, respectively.

We will then statistically test for a difference in survival between study groups using a T-test (alpha level of 0.05). Survival rates varying by more than 60% may confound our ability to detect a relationship between study groups and may be transformed to allow a better measure of the relationship between groups. Survival is assumed similar between both study streams and all data will be combined for the analysis.

East Fork Salmon River Weir Operations

The Sawtooth Fish Hatchery (Sawtooth FH) satellite weir was operated to collect genetic samples from returning natural Chinook salmon and incidentally to monitor the movement of resident species. The facility is located near Big Boulder Creek, approximately 29 river kilometers (rkm) upstream from the confluence with the main Salmon River. The facility was checked regularly between 0700 and 2000 (every 2-3 hours) to assure proper trap settings and operation. The trap was emptied daily and fish were individually netted. Chinook salmon were placed in a separate holding tank for further data collection; all other fishes were identified by species, FL recorded, genetic samples collected on salmonids, and released upstream of the weir.

Procedures for examining trapped Chinook salmon included placing fish in an anesthetic bath containing MS-222 (50 mg/L) buffered with sodium bicarbonate. After each Chinook salmon was adequately sedated, it was checked for any visible marks, scanned for coded-wire tags, gender was determined, and FL recorded. If the Chinook salmon was not a recapture, it

received a numbered jaw tag (installed around the lower-left mandible), and a genetic sample was taken from the caudal fin with the aid of a hole punch. The genetic sample location on the caudal fin was subsequently treated with iodophor and sealed with ethyl cyanoacrylate ("super glue") in an effort to minimize the possibility of infection. The fish was then placed into a freshwater recovery bath until ready for release upstream of the weir. All information was recorded on data sheets, and total Chinook salmon numbers were reported to Sawtooth FH daily via telephone.

To determine if the weir was altering the movements of migrating adult Chinook salmon, the area downstream of the weir was monitored by snorkeling periodically from July through mid-September, and all observed fish were enumerated by species. Snorkeling efforts were concentrated in the river channel from the pool immediately below the weir to approximately 250 m downstream to the confluence with Big Boulder Creek.

RESULTS AND DISCUSSION

Brood Year Report Outline

The following information reflects culture history for the reporting period January 1 through December 31, 2006. During this reporting period, two brood year rearing groups were in culture at Eagle FH representing stocks from the WFYF and EFSR. Summaries of losses, transfers, and releases while in culture are presented in Tables 3 and 4. The following acronyms are used in the following section of the report to describe culture groups: NE refers to "natural egg" or fish generated from the collection of eyed eggs from redds constructed by natural adults; BY refers to brood year or the year of development of specific culture groups (e.g., BY02 refers to brood year 2002).

In addition to the rearing groups noted above, one brood year experimental group was in culture during this reporting period to facilitate emergence survival studies as described in the Monitoring Programs portion of this report (below).

Brood Year 2004 Culture Groups

At the beginning of the reporting period, 264 WFYF-NE and 426 EFSR-NE juveniles were in culture at Eagle FH. In May of 2006, all smolts (264 WFYF-NE and 426 EFSR-NE) were transferred to Manchester to complete maturation in seawater. Ending inventory for BY04 groups at Eagle FH totaled zero and zero, WFYF-NE and EFSR-NE juveniles, respectively (Tables 3 & 4).

Brood Year 2005 Culture Groups

Eyed-egg collections for BY05 cohorts were conducted in September and October of 2005 in both the WFYF and EFSR study areas. A total of 336 WFYF-NE and 327 EFSR-NE eyed-eggs were collected from redds of natural Chinook salmon in 2005. Starting inventory was 307 WFYF-NE and 305 EFSR-NE eyed-eggs/developing fry in culture. At the end of the reporting period, 304 WFYF-NE and 302 EFSR-NE juveniles remained in culture at Eagle FH (Tables 3 & 4).

Juvenile Rearing, Marking, and Transportation

Juvenile Chinook salmon from BY04 culture groups destined for transfer to Manchester for seawater rearing received intraperitoneal injections to provide a measure of protection from two common pathogens. Both vaccines were administered on March 22, 2006. Juveniles from the WFYF averaged 131.4 mm FL and 25.7 g (N = 264, range 104–169 mm FL and 11.4–57.3 g), and those from the EFSR averaged 134.0 mm FL and 27.5 g (N = 426, range 95–159 mm FL and 10.4–48.5 g). Juveniles from the WFYF cohort received VIE tags (orange, left eye); EFSR cohorts were not VIE tagged in 2006. Improved feed rationing and the availability of chilled water at Eagle FH during incubation and early rearing resulted in smolts of a more appropriate size (compared to their natural counterparts) than those produced in prior years (Venditti et al. 2002, 2003a, 2003b, 2005).

Brood year 2004 juvenile Chinook salmon were transferred from Eagle FH to Manchester as smolts on May 2, 2006. Smolts transferred between facilities included 426 fish from the EFSR-NE group and 264 fish from the WFYF-NE group.

Two culture groups of juvenile Chinook salmon representing BY05 (N = 606) were PIT tagged on December 19, 2006. Three hundred four WFYF and 302 EFSR fish were PIT tagged at that time. Fish from the WFYF averaged 110.75 mm FL and 14.82 g (range 87-130 mm FL, 8.2-23.0 g) while EFSR fish averaged 111.11 mm FL and 15.3 g (range 68-131 mm FL, 3.1-24.5 g).

Table 2. Summary of losses and magnitude of mortality for two West Fork Yankee Fork (WFYF) captive-reared Chinook salmon culture groups reared at Idaho Department of Fish and Game facilities in 2006. Culture groups are designated by brood year (BY) and by the method in which the groups are sourced (NE = natural egg).

	Culture Groups	
	BY04 NE	**BY05 NE**
Starting Inventory (January 1, 2006)	264	307
Eyed-egg to Fry		
Undetermined[a]	n/a	n/a
Mechanical Loss		
Handling	0	0
Jump-out	0	0
Transportation	0	0
Noninfectious		
Lymphosarcoma	0	0
Nephroblastoma	0	0
Other[b]	0	3
Infectious		
Bacterial	0	0
Viral	0	0
Other	0	0
Hatchery Spawning		
Male Spawners	0	0
Female Spawners	0	0
Cryopreservation	0	0
Relocation		
Transferred In	0	0
Transferred Out	264	0
Planted/Released	0	0
Ending Inventory (December 31, 2006)	0	304

[a] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.

[b] Includes mortality due to maturation, culling associated with cultural anomalies, and all undetermined, noninfectious mortality.

Table 3. Summary of losses and magnitude of mortality for two East Fork Salmon River (EFSR) captive-reared Chinook salmon culture groups reared at Idaho Department of Fish and Game facilities in 2006. Culture groups are designated by brood year (BY) and by the method in which the groups are sourced (NE = natural egg).

	Culture Groups	
	BY04 NE	**BY05 NE**
Starting Inventory (January 1, 2006)	426	305
Eyed-Egg to Fry		
Undetermined[a]	n/a	n/a
Mechanical Loss		
Handling	0	0
Jump-out	0	0
Transportation	0	0
Noninfectious		
Lymphosarcoma	0	0
Nephroblastoma	0	0
Other[b]	0	3
Infectious		
Bacterial	0	0
Viral	0	0
Other	0	0
Hatchery Spawning		
Male Spawners	0	0
Female Spawners	0	0
Cryopreservation	0	0
Relocation		
Transferred In	0	0
Transferred Out	426	0
Planted/Released	0	0
Ending Inventory (December 31, 2006)	0	302

[a] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.

[b] Includes mortality due to maturation, culling associated with cultural anomalies, and all undetermined, noninfectious mortality.

Adult Rearing, Marking, and Transportation

Adult Chinook salmon from the WFYF and EFSR stocks identified as maturing were transferred from Manchester directly to their natal streams on one occasion in 2006. Adults were transported on July 13 and included fish from BY02, BY03, and BY04. A total of 179 maturing adults were released to the WFYF and 141 to the EFSR (Appendix A).

On July 6, Petersen disc tags were attached to BY02 and BY03 EFSR groups, and jaw tags were attached to the lower left mandible of BY04 EFSR and all WFYF Chinook salmon (BY02, BY03, and BY04) groups destined for release to their natal streams. A total of 183 WFYF and 143 EFSR Chinook salmon were marked during this event (Table 5). Post-tagging mortality occurred in six fish between marking and release (WFYF-4 and EFSR-2).

On July 13, radio transmitters were inserted into the stomachs of seven WFYF and eight EFSR captive-reared Chinook salmon on the day they were released into their respective waters (Appendix B).

Table 4. Mean weight and length of captive-reared Chinook salmon marked for release in 2006. All fish were released into their natal waters (West Fork Yankee Fork Salmon River = WFYF and East Fork Salmon River = EFSR).

Stock	Brood Year	# Released	Mean Weight (g)	Mean Length (mm)
EFSR	02	79	1,602	480
EFSR	03	54	1,271	426
EFSR	04	8	118	197
WFYF	02	69	2,123	519
WFYF	03	43	1,153	419
WFYF	04	67	142	201

Monitoring Programs

Fish Health Monitoring

Pathogen Sampling and Detection—Calendar year 2006 captive Chinook salmon stocks rearing in freshwater at Eagle FH included progeny from BY04 and BY05 (WFYF, EFSR) natural-egg collections. Post-ponding mortality did not occur in either stock (WFYF, EFSR) of BY04 and BY05 Chinook salmon juveniles cultured at Eagle FH during 2006. As a result, no laboratory accessions were generated for BY04 and BY05 Chinook salmon during the 2006 reporting period.

In 2006, all maturing adults were transported and released directly to their natal streams and resulted in zero Eagle Fish Health Lab accessions for maturing adults. Pathogen sampling

and detection in Chinook salmon stocks reared in seawater at Manchester is the responsibility of NOAA Chinook salmon program staff and is reported under separate cover.

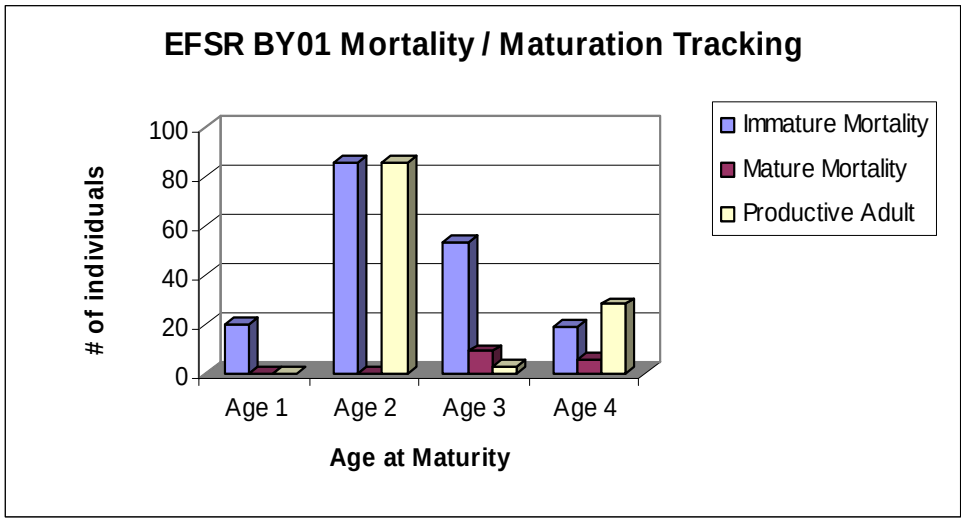
Vaccine and Antibiotic Treatments—Brood year 2004 cohorts from both the WFYF (n°= 264) and EFSR (n = 426) received a 21-day medicated erythromycin feed treatment (100 mg ERY/kg biomass) between January 14 and February 3, 2006. Additionally, on March 22, 2006, all BY04 cohorts received intraperitoneal injections of Renogen® and Vibrogen® vaccinations.

Growth and Survival of Brood Year 2001

Brood year 2001 captive-reared Chinook salmon were transferred as smolts to Manchester.

General sources of mortality in this cohort were similar to those observed previously (Hassemer et al. 2001; Venditti et al. 2002, 2003a, 2003b, 2005), although losses to BKD were lower than for some previous brood years (Venditti et al. 2003b). Primary sources of mortality in this group included immature mortality during hatchery rearing, unproductive mature adults (includes mature hatchery mortality and mature culls), and productive mature adults (spawned at Eagle FH, precocial culls at Manchester, or released for volitional spawning). Of the 311 BY01 EFSR eyed eggs collected, 117 fish (37.6%) survived to maturity (productive mature adult), 194 fish (62.4%) died as immature fish or unproductive mature fish. Of the 272 BY01 WFYF eyed eggs collected, 122 fish (44.9%) survived to maturity (productive mature adult), 150 fish (53.1%) died as immature fish or unproductive mature fish (Figure 2).

Of the 117 fish that matured in the EFSR cohort, 86 fish (73.5%) matured as age-2 (precocial) adults, three fish (2.6%) matured as age-3 fish, and 28 fish (23.9%) matured as age-4 fish. Of the 194 fish that died during culture of the EFSR cohort, 20 fish (10.3%) died as age-1, 86 fish (44.3%) died as age-2, 62 fish (32.0%) died as age-3, and 26 fish (13.4%) died as age-4 fish (Figure 2).



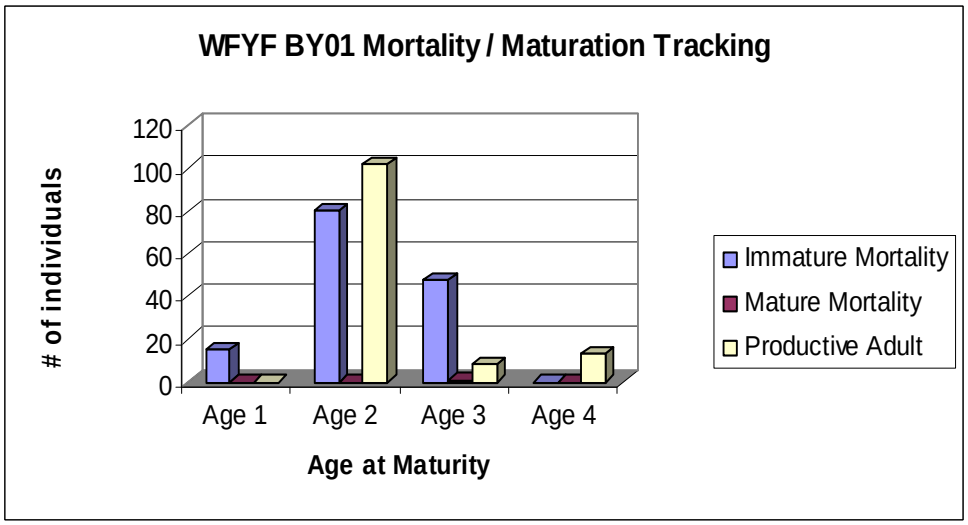


Figure 3. Mortality by age and age at maturation for East Fork Salmon River and West Fork Yankee Fork captive-reared brood year 2001 stocks. Immature Mortality = fish that died prior to reaching sexual maturity; Mature Mortality = fish that reached sexual maturity but did not spawn; Productive Adults = fish that reached sexual maturity and spawned.

Of the 122 fish that matured in the WFYF cohort, 101 fish (82.8%) matured as age-2 (precocial) adults, eight fish (6.6%) matured as age-3 fish, and 13 fish (10.6%) matured as age-4 fish. Of the 150 fish that died in culture from the WFYF cohort, 11 fish (7.3%) died as age-1, 88 fish (58.7%) died as age-2, 49 fish (32.7%) died as age-3, and two fish (1.3%) died as age-4 fish (Figure 2).

Precocity rates (age-2 and age-3 maturation), averaged 31.51% in the EFSR stock for BY01 and 40.44% in the WFYF stock, compared to brood years 97-00 average rate of 32.1% (Hassemer et al. 2001; Venditti et al. 2002, 2003a, 2003b, 2005). Maturation in BY01 (40.99%) was less than the average of the previous four brood years (60.0%). Length and weight at

maturity in BY01 was less than that of previous brood years (Figures 3 & 4). Both stocks incurred a large unexplained source of immature mortality at age-2. Twenty-nine percent of the total fish alive at that time died from the EFSR stock and 34% from the WFYF stock; program staff felt this might have affected the rearing performance (weight and length) of the remaining fish in culture.

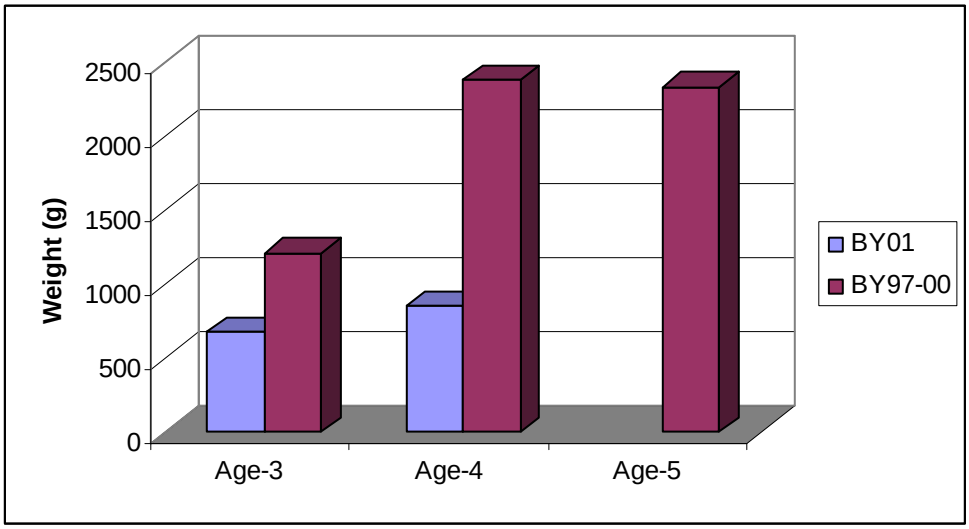


Figure 4. Weight at maturity by age for captive-reared Chinook salmon from BY01 and the average of BY97 through BY00. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish.

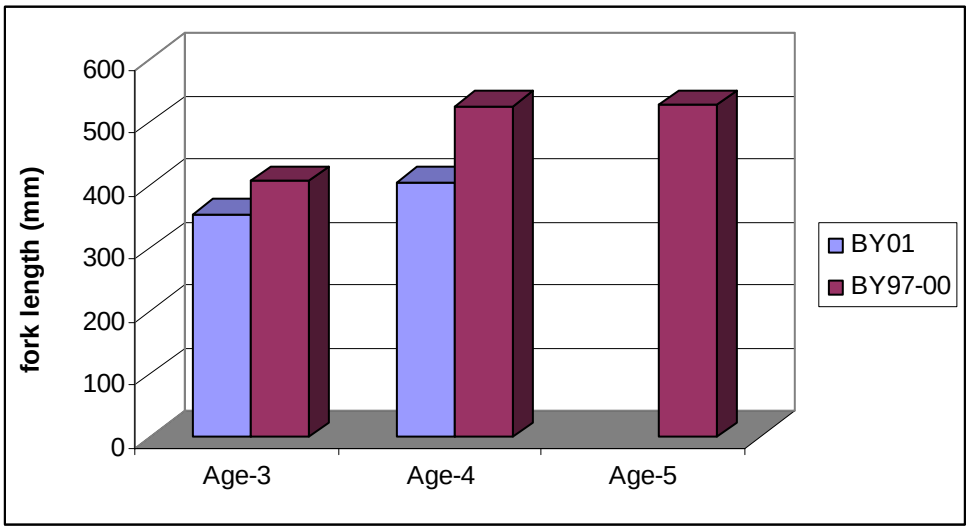


Figure 5. Length at maturity by age for captive-reared Chinook salmon from BY01 and the average of BY97-BY00. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish.

Volitional Spawning

In 2006, maturing adults were released into their natal streams for natural spawning and spawning observation studies on July 13 in both the EFSR and WFYF (Appendix B). No transportation mortalities occurred in the WFYF stock while two transportation mortalities occurred in the EFSR stock. At the time of release, the fish appeared to be in good condition.

Habitat associations of captive-reared Chinook salmon observed in the study streams were similar to observations recorded in previous years directly following release (Venditti et al. 2003a, 2003b, 2005). Initially, study fish were observed to be generally associated with pools, large woody debris, or runs and later moving into riffle tail-outs or runs as spawning behavior ensued. General behaviors observed were similar, initially, to observations recorded in previous years directly following release. Holding was the dominant behavior observed during August and September. These behaviors were also the dominant associations observed from August to September in study years 2001—2003 (Venditti et al. 2003a, 2003b, 2005). However, general behaviors observed later in the spawning season differed from observations recorded in previous years. Observed behavior in September and October was dominated by Male/Male aggression (30.8%), nest digging (18.9%), and redd holding (9.8%); these behaviors are more consistent with those of natural Chinook salmon that have been observed in the past (Baker et al. 2006). General behaviors of natural Chinook salmon were dominated by milling (20%), courting (19%), and redd holding (18%).

Prespawn behavior was more similar to that of natural Chinook salmon than in past years. Changes in behavior of captive-reared Chinook salmon may have been attributed to the release strategy in 2006; captive-reared fish were released without a fresh water acclimation period at the Eagle FH and were released a month earlier than in past years. Prespawn (recovered) mortality for age-3 and age-4 adult fish in 2006 was 51% compared to 20% in 2005. The difference in prespawn mortality is largely due to the fish being released into their natal waters earlier, thus increasing exposure to predators. Otters were regularly observed in the study area and partially consumed carcasses found near their dens.

Radio tags were implanted in seven of the 179 adults (five females, two males) released into the WFYF for natural spawning. Radio-tagged fish were tracked one to two times weekly from July 13 through September 19, 2006. Four radio-tagged fish moved downstream out of the WFYF within two weeks of release; two of those left the drainage. A forest fire in the YFSR drainage excluded access to our study area from August 01 through August 18. After August 18 only one radio-tagged fish was found; this fish was observed in a spawning event.

Between September 15 and September 25, 2006, eight redds constructed by captive-reared adults were identified within the WFYF study area. The ratio of redds/captive female falls within the range of previous years (Table 6). Between August 30 and September 9, 2006, four redds constructed by natural adult Chinook salmon were identified in the WFYF compared to the previous five-year average of 12.

Radio tags were implanted in eight of the 141 adults (eight females) released into the EFSR for natural spawning. Radio-tagged fish in the EFSR were tracked one to three times weekly from July 13 through September 15, 2006. Radio-tagged fish traveled less than 2 rkm downstream or 1.5 rkm upstream from their release site. No direct spawning events were observed in EFSR radio-tagged fish during the 2006 field season.

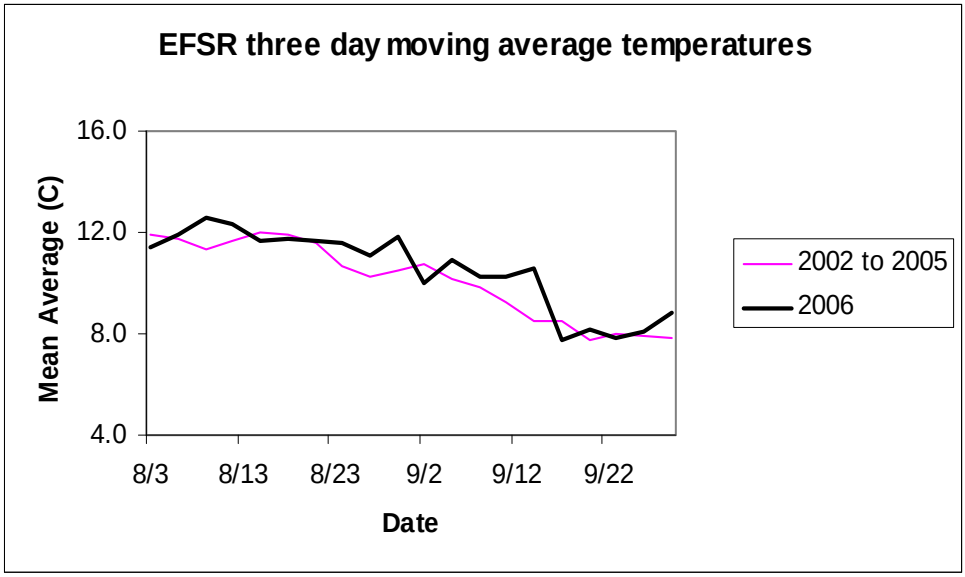
Between September 8 and September 20, 2006, thirteen redds constructed by captive-reared adults were identified within the EFSR study area. The ratio of redds/captive female falls within the range of previous years (Table 6). Between August 21 and August 29, 2006, four redds constructed by natural adults were identified within the EFSR study area. Annual natural Chinook salmon redd counts conducted by the Regional IDFG staff in EFSR trend sites identified six redds in 2006, compared to the previous five-year average of 97.

Water temperatures during August and September in both the EFSR and the WFYF were within the range of the previous five years (Figure 5). Water temperatures during August and September averaged 10.5°C in the EFSR (minimum 7.4°C / maximum 12.7°C) and 9.1°C in the WFYF (minimum 5.3°C / maximum 11.8°C).

Table 5. Number of captive-reared female Chinook salmon released and redds produced by these fish, 2001-2006. West Fork Yankee Fork Salmon River (WFYF), East Fork Salmon River (EFSR).

Study Stream	Year	Females Release	Captive Redds	Redds Per Captive Female
WFYF	2001	46	18	0.39
WFYF	2002	61	33	0.54
WFYF	2003[a]	62	0	0.00
WFYF	2004	59	11	0.19
WFYF	2005	10	2	0.20
WFYF	2006	48	8	0.17
EFSR	2001	6	1	0.17
EFSR	2002	30	0	0.00
EFSR	2003[a]	18	0	0.00
EFSR	2004	4	1	0.25
EFSR	2005	25	8	0.32
EFSR	2006	73	13	0.18

[a] No fish survived to spawn post release in 2003 due to unknown causes (Venditti et al. 2004).



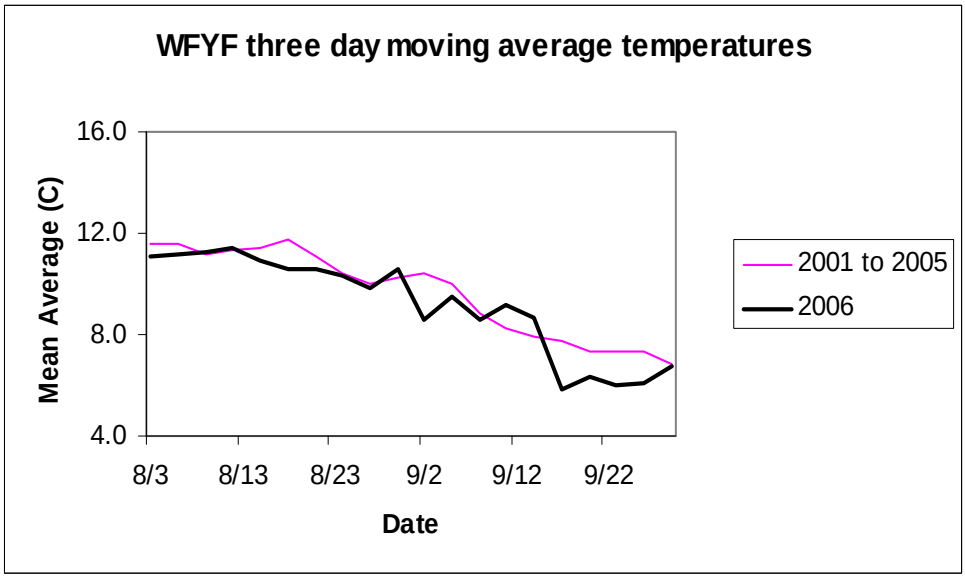


Figure 6. Average 2006 three-day moving average temperatures for the East Fork Salmon River (EFSR) and the West Fork Yankee Fork (WFYF) compared to the 2001-2005 and 2002-2005 averages, respectively.

Production Estimation

Parr Collections—One hundred Chinook salmon parr were collected from the EFSR and 46 from the WFYF during September and October in 2006. Genetic samples were collected from all captured parr, and no mortalities occurred during sampling. Samples collected in 2006 will be used for future parental exclusion analysis to determine relative production of program releases. Genetic analysis is currently ongoing and will be reported as results become available.

Emergence Survival Study—Naturally spawned eyed eggs were collected from the EFSR and the WFYF to establish study groups for an emergence survival study representing BY06; however, no broodstock were collected during this reporting period. Collections totaled 1346 eyed eggs from the EFSR (15 redds) and 219 eyed eggs from the WFYF (three redds; Table 7). Eggs were collected from 12 redds formed by captive-reared female adult Chinook salmon and three redds formed by natural returning fish on the EFSR. Eggs were collected from one redd formed by a captive-reared female adult Chinook salmon and two formed by natural returning fish on the WFYF. Survival to the eyed stage of development and CTUs at the time of collection is reported in Table 7. At the end of this reporting period, study groups were still developing (sac fry) in hatchery incubators and study redds; emergence survival results will be covered in calendar year 2007 reporting.

Table 6. Summary of eyed egg collections in the East Fork Salmon River (EFSR) and West Fork Yankee Fork (WFYF) as part of the emergence survival study. Celsius Temperature Units (CTUs) are reported for the time of collection. Some redds received a second experimental egg capsule, those capsules are labeled as 2nd capsule.

				Disposition (eyed-eggs)			
Stream	**Name**	**Captive or natural origin**	**Date of collection**	**Capsules**	**Control**	**Survival to eye**	**CTUs at collection**
WFYF	redd 1	natural	12-Oct	42	34	0.89	300
WFYF	redd 2	captive	25-Oct	40	31	0.7	256
WFYF	redd 3	natural	11-Oct	36	36	0.88	300
EFSR	redd 1	natural	13-Oct	41	41	0.84	411
EFSR	redd 2	natural	13-Oct	40	41	0.96	406
			2nd capsule	35			
EFSR	redd 3	natural	13-Oct	40	40	0.94	385
			2nd capsule	66			
EFSR	redd 4	captive	16-Oct	40	27	0.94	291
EFSR	redd 5	captive	18-Oct	40	29	0.91	300
EFSR	redd 6	captive	18-Oct	40	40	0.95	300
			2nd capsule	72			
EFSR	redd 7	captive	25-Oct	40	12	0.85	326
EFSR	redd 8	captive	18-Oct	40	27	0.92	290
EFSR	redd 9	captive	25-Oct	40	37	0.93	315
EFSR	redd 10	captive	16-Oct	40	30	0.94	310
			2nd capsule	30			
EFSR	redd 11	captive	16-Oct	40	31	0.44	310
EFSR	redd 12	captive	1-Nov	40	56	0.89	300
EFSR	redd 13	captive	1-Nov	40	39	0.72	293
EFSR	redd 14	captive	15-Nov	40	58	0.97	342
EFSR	redd 15	captive	15-Nov	40	34	0.91	342

East Fork Salmon River Weir Operations

The EFSR weir was operated from June 21 through September 25, 2006; during this time 81 adult Chinook salmon (21 females, 40 males, 20 jacks) were trapped at the facility (Table 8). None of the 81 Chinook salmon trapped in 2006 were adipose fin-clipped or coded-wire tagged, indicating Chinook salmon of natural origin. Additional species trapped included bull trout *Salvelinus confluentus*, westslope cutthroat trout *O. clarkii lewisi*, and mountain whitefish *Prosopium williamsoni* (Table 9).

Table 7. Natural adult Chinook salmon distributions trapped at the East Fork Salmon River weir facility during 2006.

	Gender			
	Females	**Males**	**Jacks**	**Total**
June	0	0	0	0
July	17	14	4	35
August	4	25	16	45
Sept	0	1	0	1
Total	**21**	**40**	**20**	**81**
	Age			
Age (length)	**3 (≤64 cm)**	**4 (64-82 cm)**	**5 (>82 cm)**	**Total**
Females	0	12	9	21
Males	n/a	37	3	40
Jacks	20	n/a	n/a	20
Total	**20**	**49**	**12**	**81**
	Recapture rates			
Age (length)	**3 (≤64 cm)**	**4 (64-82 cm)**	**5 (>82 cm)**	**Total**
Females	0	1	0	1
Males	n/a	7	1	8
Jacks	3	n/a	n/a	3
Total	**3**	**8**	**1**	**12**

Table 8. Summary of additional fish trapped at the East Fork Salmon River weir and genetic samples collected from these fish during 2006.

Species	**Trapped**	**Recaptured** [a]	**Unknown Recapture** [b]	**Genetics samples collected**
Bull trout	260	94	0	229
Westslope cutthroat trout	1	0	0	1
Mountain whitefish	147	2	0	58

[a] Not all mountain whitefish were marked allowing detection of recaptures.
[b] Some fish found with highly eroded upper caudal fin lobes or data not recorded.

Snorkeling surveys were conducted periodically from July 21 through August 22. One Chinook salmon adult was observed holding in the pool immediately below the weir on August 13. On August 14 and 15, one and three adult Chinook salmon, respectively, were captured in the trap. Based on these observations, the weir did not appear to inhibit Chinook salmon from migrating upstream. Additional species observed included bull trout, rainbow trout *O. mykiss*, cutthroat trout, mountain whitefish, and various *Catostomus* spp.

LITERATURE CITED

Baker, D. B., J. Heindel, D. Vidergar, J. Gable, K. Plaster, J. Redding, and P. Kline. 2006. Captive rearing program for Salmon River Chinook salmon, 2005. Project Progress Report to the Bonneville Power Administration, Contract Number 00004002. Portland, Oregon.

Berejikian, B. A., E. P. Tezak, S. L. Schroder, C. M. Knudsen, and J. J. Hard. 1997. Reproductive behavioral interactions between wild and captively reared coho salmon (*Oncorhynchus kisutch)*. ICES Journal of Marine Science 54:1040-1050.

Berejikian, B. A., E. P. Tezak, S. L. Schroder, T. A. Flagg, and C. M. Knudsen. 1999. Competitive differences between newly emerged offspring of captive-reared and wild coho salmon. Transactions of the American Fisheries Society 128:832-839.

Berejikian, B. A., E. P. Tezak, L. Park, E. LaHood, S. L. Schroder, and E. Beall. 2001a. Male competition and breeding success in captively reared and wild coho salmon (*Oncorhynchus kisutch)*. Canadian Journal of Fisheries and Aquatic Sciences 58:804-810.

Berejikian, B. A., E. P. Tezak, and S. L. Schroder. 2001b. Reproductive behavior and breeding success of captively reared Chinook salmon. North American Journal of Fisheries Management 21:255-260.

Bernatchez, L., and P. Duchesne. 2000. Individual-based genotype analysis in studies of parentage and population assignment: how many loci, how many alleles? Canadian Journal of Fisheries and Aquatic Sciences 57:1-12.

Bonneau, J. L., R. F. Thurow, and D. L. Scarnecchia. 1995. Capture, Marking, and Enumeration of Juvenile Bull Trout and Cutthroat Trout in Small, Low-Conductivity Streams. North American Journal of Fisheries Management 15:563-568.

Bowles, E. 1993. Operation of compensation hatcheries within a conservation framework, an issue paper. Idaho Department of Fish and Game. Boise, Idaho.

Bromage, N. R., and R. J. Roberts. 1995. Broodstock Management and Egg and Larval Quality. Blackwell Science Ltd. Cambridge, Massachusetts.

Close, T. L., and T. S. Jones. 2002. Detection of visible implant elastomer in fingerling and yearling rainbow trout. North American Journal of Fish Management 22:961-964.

Colbourne, J. K., B. D. Neff, J. M. Wright, and M. R. Gross. 1996. DNA fingerprinting of bluegill sunfish (*Lepomis macrochirus*) using $(GT)_n$ microsatellites and its potential for assessment of mating success. Canadian Journal of Fisheries and Aquatic Sciences 53:342-349.

Dumas, J. and S. Marty. 2006. A new method to evaluate egg-to-fry survival in salmonids, trials with Atlantic salmon. Journal of Fish Biology 68:284-304.

Eldridge, W. H., M. D. Bacigalupi, I. R. Adelman, L. M. Miller, and A. R. Kapuscinski. 2002. Determination of relative survival of two stocked walleye populations and resident natural-origin fish by microsatellite DNA parentage assignment. Canadian Journal of Fisheries and Aquatic Sciences 59:282-290.

Erdahl, D. A. 1994. Inland Salmonid Broodstock Management Handbook. United States Department of the Interior, Fish and Wildlife Service. 712 FW 1.

Estoup, A., K. Gharbi, M. SanCristobal, C Chevalet, P. Haffray, and R. Guyomard. 1998. Parentage assignment using microsatellites in turbot (*Scophthalmus maximus*) and rainbow trout (*Oncorhynchus mykiss*) hatchery populations. Canadian Journal of Fisheries and Aquatic Sciences 55:715-725.

Flagg, T. A., and C. V. W. Mahnken. 1995. An assessment of the status of captive broodstock technology for Pacific Salmon. Final report to the Bonneville Power Administration, Project No. 93-56, Contract No. DE-AI79-93BP55064. Portland, Oregon.

Fleming, I. A., and M. R. Gross. 1992. Reproductive behavior of hatchery and wild coho salmon (*Oncorhynchus kisutch*): does it differ? Aquaculture 103:101-121.

Fleming, I. A., and M. R. Gross. 1993. Breeding success of hatchery and wild coho salmon (*Oncorhynchus kisutch*) in competition. Ecological Applications 3(2):230-245.

Fleming, I. A., B. Jonsson, M. R. Gross, and A. Lamberg. 1996. An experimental study of the reproductive behaviour and success of farmed and wild Atlantic salmon (*Salmo salar*). Journal of Applied Ecology 33:893-905.

Frost, D. A., W. C. McAuley, D. J. Maynard, and T. A. Flagg. 2002. Redfish Lake sockeye salmon captive broodstock rearing and research. Project Progress Report to the Bonneville Power Administration, Contract 00004464. Portland, Oregon.

Hassemer, P. 1998. Upper Salmon River spring chinook salmon in Idaho. *In*: U.S. Fish and Wildlife Service. 1998. Proceedings of the Lower Snake River Compensation Plan Status Review Symposium. Compiled by USFWS-LSRCP. Boise, Idaho.

Hassemer, P. F., P. Kline, J. Heindel, and K. Plaster. 1999. Captive rearing initiative for Salmon River chinook salmon, 1998. Project Progress Report to the Bonneville Power Administration, Contracts 97-BI-97538 and 98-BI-63416, Portland, Oregon.

Hassemer, P. F., P. Kline, J. Heindel, K. Plaster, and D.A. Venditti. 2001. Captive rearing initiative for Salmon River chinook salmon, 1999. Project Progress Report to the Bonneville Power Administration, Contracts 97-BI-97538 and 98-BI-63416, Portland, Oregon.

Heindel, J. A., D. J. Baker, K. A. Johnson, P. A. Kline, and J. J. Redding. 2005. A Simple Isolation Incubator for Specialized Rearing of Salmonid Eggs and First-Feeding Fry. North American Journal of Aquaculture 67:13-17.

Hendry, A. P., A. H. Dittman, and R. W. Hardy. 2000. Proximate composition, reproductive development, and a test for trade-offs in captive sockeye salmon. Transactions of the American Fisheries Society 129:1082-1095.

Idaho Department of Fish and Game (IDFG). 2001. Fisheries Management Plan, 2001-2006. Idaho Department of Fish and Game. Boise, Idaho.

Joyce, J. E., R. M. Martin, and F. P. Thrower. 1993. Successful maturation of captive chinook salmon broodstock. Progressive Fish-Culturist 55:191-194.

Leitritz, E., and R. C. Lewis. 1976. Trout and salmon culture (hatchery methods). California Department of Fish and Game Fish Bulletin 164.

Marmorek, D., C. Peters, and I. Parnell, eds., and 32 contributors. 1998. PATH. Final Report for fiscal year 1998. ESSA Technologies Ltd., Vancouver, British Columbia, Canada.

McClure, M., and 11 co-authors. 2003. Independent Populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the interior Columbia River basin (Discussion Draft). Interior Columbia Basin Technical Recovery Team.

McDaniel, T. R., K. M. Prett, T. R. Meyers, T. D. Ellison, J. E. Follett, and J. A. Burke. 1994. Alaska Sockeye Salmon Culture Manual. Special Fisheries Report No. 6. Alaska Department of Fish and Game. Juneau, Alaska.

National Marine Fisheries Service (NMFS). 1992. Threatened status for Snake River spring/summer chinook salmon, threatened status for Snake River fall chinook salmon. Final Rule. Federal Register 57:78 (April 22, 1992):14563-14663.

National Marine Fisheries Service (NMFS). 1995. Proposed Recovery Plan for Snake River Salmon. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NMFS Protected Resources Division. Portland, Oregon.

Northwest Power and Conservation Council (NPCC). 1994. Columbia River Basin Fish and Wildlife Program. Portland, Oregon.

Northwest Power and Conservation Council (NPCC). 2000. Columbia River Basin Fish and Wildlife Program. Portland, Oregon.

Olsen, E. M., and L. A. Vøllestad. 2001. An evaluation of visible implant elastomer for marking age-0 brown trout. North American Journal of Fisheries Management 21:967-970.

Pennell, W., and B. A. Barton. 1996. Principles of Salmonid Aquaculture. Elsevier Science B. V. Amsterdam, The Netherlands.

Petrosky C. E., and H. A. Schaller. 1994. A comparison of productivities for Snake River and lower Columbia River spring and summer Chinook salmon stocks. *In* Salmon Management in the 21st Century: Recovering Stocks in Decline. Proceedings of the 1992 Northeast Pacific Chinook and Coho Workshop. Idaho Chapter of the American Fisheries Society. Boise, Idaho.

Petrosky, C. E., H. A. Schaller, and P. Budy. 1999. Productivity and survival rate trends in the freshwater spawning and rearing stage of Snake River Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 58:1196-1207.

Piper, G. R., I. B. McElwain, L. E. Orme, J. P. McCraren, L. G. Gowler, and J. R. Leonard. 1982. Fish Hatchery Management. U.S. Fish and Wildlife Service, Washington, D.C.

Prentice, E. F., T. A. Flagg, C. S. McCutcheon, and D. F. Brastow. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. Pages 317-322 *in* N. C. Parker, A. E. Giorgi, R. C. Heidinger, D. B. Jester, Fr., E. D. Prince, and G. A.

Winans, coeditors, Fish-marking techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

Raymond, H. L. 1979. Effects of dams and impoundments on migrations of juvenile Chinook salmon and steelhead from the Snake River, 1966 to 1975. Transactions of the American Fisheries Society 108:505-529.

Reisenbichler, R. R., and S. P. Rubin. 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. ICES Journal of Marine Science 56:459-466.

Rosgen, D. L. 1985. A stream classification system. Pages 91-95 *in* Riparian ecosystems and their management: reconciling conflicting uses. First North American Riparian Conference, Arizona.

Rubin, J. F. 1995. Estimating the success of natural spawning of salmonids in streams. Journal of Fish Biology 46:603-622.

Schaller, H. A., C. E. Petrosky, and O. P. Langness. 1999. Contrasting patterns of productivity and survival rates for stream-type Chinook salmon (*Oncorhynchus tshawytscha*) populations of the Snake and Columbia rivers. Canadian Journal of Fisheries and Aquatic Sciences 56:1,031-1,045.

Schmitten, R., W. Stelle, and M. Brentwood. 1997. Draft Snake River Salmon Recovery Plan. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Talbot, J., J. Haigh, and Y. Plante. 1996. A parentage evaluation test in North American elk (wapiti) using microsatellites of ovine and bovine origin. Animal Genetics 27:117-119.

Thoesen, J. C. (editor). 1994. Blue book, version 1. Suggested procedures for the detection and identification of certain finfish and shellfish pathogens. Fish Health Section, American Fisheries Society. Bethesda, Maryland.

Venditti, D. A., C. Willard, C. Looney, P. Kline, and P. Hassemer. 2002. Captive rearing program for Salmon River chinook salmon, 2000. Project Progress Report to the Bonneville Power Administration, Contract Number 00000167-00001, Portland, Oregon.

Venditti, D. A., C. Willard, T. Giambra, D. Baker, and P. Kline. 2003a. Captive rearing program for Salmon River chinook salmon, 2001. Project Progress Report to the Bonneville Power Administration, Contract Number 00004002. Portland, Oregon.

Venditti, D. A., C. Willard, C. James, D. Baker, and P. Kline. 2003b. Captive rearing program for Salmon River Chinook salmon, 2002. Project Progress Report to the Bonneville Power Administration, Contract Number 00004002. Portland, Oregon.

Venditti, D. A., D. Baker, J. Heindel, C. James, and P. Kline. 2005. Captive rearing program for Salmon River Chinook salmon, 2003. Project Progress Report to the Bonneville Power Administration, Contract Number 00004002. Portland, Oregon.

APPENDICES

Appendix A. Summary of fish transfers conducted by the Chinook Salmon Captive Rearing Project during 2006. MAN = Manchester Research Station, WFYF = West Fork Yankee Fork River, EFSR = East Fork Salmon River, EAG = Eagle Fish Hatchery, Brood Year = BY. NP, NE, and SN refer to natural parr, natural egg, and safety net groups, respectively.

Source Stream	BY	EAG to MAN	Transfer Date	MAN to EAG	Transfer Date	MAN to WFYF	Transfer Date	MAN to EFSR	Transfer Date
WFYF-NE	02			0	NA	69	7/13		
WFYF-NE	03			0	NA	43	7/13		
WFYF-NE	04	264	5/2	0	NA	67	7/13		
EFSR-NE	02			0	NA			79	7/13
EFSR-NE	03			0	NA			54	7/13
EFSR-NE	04	426	5/2	0	NA			8	7/13

Appendix B. Tag and identification summary for captive-reared Chinook salmon released for volitional spawning in the West Fork Yankee Fork Salmon River (WFYF) and the East Fork Salmon River (EFSR). Fish were jaw-tagged (WFYF) or Petersen disc tagged (EFSR) for visual identification. A portable ultrasound unit was used on maturing fish reared at the Manchester Research Station (MAN) to determine sex, and classified as undetermined = UN, female = FEM, or male = MAL.

PIT Code	BY	Sex	Radio #	Number	Stock	Rearing
3D9.1BF1BBFB15	2002	FEM		JT144	WFYF	MAN
3D9.1BF1BBA8BE	2002	FEM		JT145	WFYF	MAN
3D9.1BF1BC8339	2002	FEM		JT146	WFYF	MAN
3D9.1BF1BD7247	2002	FEM		JT147	WFYF	MAN
3D9.1BF1BC12BD	2002	MAL		JT148	WFYF	MAN
3D9.1BF1BBBD09	2002	FEM		JT149	WFYF	MAN
3D9.1BF1BBB887	2002	FEM		JT150	WFYF	MAN
3D9.1BF1BDDF9D	2002	MAL		JT151	WFYF	MAN
3D9.1BF1BBA096	2002	FEM		JT152	WFYF	MAN
3D9.1BF1BCB462	2002	FEM		JT153	WFYF	MAN
3D9.1BF1BEDF26	2002	FEM		JT154	WFYF	MAN
3D9.1BF1BDD4C3	2002	FEM		JT155	WFYF	MAN
3D9.1BF1BC1C89	2002	FEM		JT156	WFYF	MAN
3D9.1BF1BBBF9D	2002	FEM		JT157	WFYF	MAN
3D9.1BF1BD96AD	2002	FEM		JT158	WFYF	MAN
3D9.1BF1BDE221	2002	FEM	151.085	JT159	WFYF	MAN
3D9.1BF1BDF19D	2002	FEM		JT160	WFYF	MAN
3D9.1BF1BB8FD2	2002	FEM		JT162	WFYF	MAN
3D9.1BF1BD895A	2002	FEM		JT163	WFYF	MAN
3D9.1BF1BC8485	2002	MAL		JT164	WFYF	MAN
3D9.1BF1BBDA35	2002	MAL		JT165	WFYF	MAN
3D9.1BF1BBB452	2002	FEM		JT166	WFYF	MAN
3D9.1BF1BBEB0C	2002	FEM		JT168	WFYF	MAN
3D9.1BF1BDE0F2	2002	MAL		JT169	WFYF	MAN
3D9.1BF1BC1148	2002	FEM	151.023	JT171	WFYF	MAN
3D9.1BF1BC21BB	2002	FEM		JT172	WFYF	MAN
3D9.1BF1BCD2E9	2002	MAL		JT173	WFYF	MAN
3D9.1BF1BBFB78	2002	MAL		JT174	WFYF	MAN
3D9.1BF1BBF38D	2002	FEM		JT176	WFYF	MAN
3D9.1BF1BEE8FB	2002	FEM		JT177	WFYF	MAN
3D9.1BF1BD77B5	2002	FEM		JT178	WFYF	MAN
3D9.1BF1BCE45B	2002	FEM		JT179	WFYF	MAN
3D9.1BF1BC8903	2002	MAL		JT180	WFYF	MAN
3D9.1BF1B85829	2002	FEM		JT181	WFYF	MAN
3D9.1BF1BCFB3A	2002	FEM		JT182	WFYF	MAN
3D9.1BF1BC1B22	2002	MAL		JT183	WFYF	MAN
3D9.1BF1BD6756	2002	FEM		JT184	WFYF	MAN
3D9.1BF1BCB738	2002	MAL		JT185	WFYF	MAN
3D9.1BF1BC196A	2002	FEM		JT186	WFYF	MAN
3D9.1BF1BDD804	2002	MAL		JT187	WFYF	MAN
3D9.1BF1BBB2B8	2002	MAL		JT188	WFYF	MAN
3D9.1BF1BBA5AE	2002	MAL		JT189	WFYF	MAN
3D9.1BF1BEF60B	2002	MAL	150.214	JT190	WFYF	MAN
3D9.1BF1BBB9A1	2002	MAL		JT191	WFYF	MAN
3D9.1BF1BBAC8F	2002	FEM		JT192	WFYF	MAN
3D9.1BF1BCB614	2002	FEM		JT193	WFYF	MAN
3D9.1BF1BCEA6C	2002	FEM		JT194	WFYF	MAN
3D9.1BF1BCF97F	2002	FEM		JT195	WFYF	MAN
3D9.1BF1BB4F85	2002	FEM		JT196	WFYF	MAN
3D9.1BF1BBD4F2	2002	MAL		JT197	WFYF	MAN

Appendix B. Continued.

PIT Code	BY	Sex	Radio #	Number	Stock	Rearing
3D9.1BF1BD6E44	2002	MAL		JT19	WFYF	MAN
3D9.1BF1BD836D	2002	FEM		JT199	WFYF	MAN
3D9.1BF1BEEEF0	2002	FEM		JT200	WFYF	MAN
3D9.1BF1BEDEFB	2002	FEM	151.045	JT100	WFYF	MAN
3D9.1BF1BD765C	2002	FEM		JT099	WFYF	MAN
3D9.1BF1BBFEDE	2002	MAL		JT098	WFYF	MAN
3D9.1BF1BD9E87	2002	MAL		JT097	WFYF	MAN
3D9.1BF1BCFB48	2002	FEM		JT096	WFYF	MAN
3D9.1BF1BD76C2	2002	FEM		JT095	WFYF	MAN
3D9.1BF1BEE268	2002	FEM		JT094	WFYF	MAN
3D9.1BF1BEF1AA	2002	FEM		JT093	WFYF	MAN
3D9.1BF1BD8953	2002	MAL		JT092	WFYF	MAN
3D9.1BF1BBFC6F	2002	FEM	150.214	JT091	WFYF	MAN
3D9.1BF1BD7FE0	2002	FEM		JT090	WFYF	MAN
3D9.1BF1BCED0C	2002	FEM		JT089	WFYF	MAN
3D9.1BF1BB8FE7	2002	FEM		JT088	WFYF	MAN
3D9.1BF1BCBC59	2002	MAL		JT087	WFYF	MAN
3D9.1BF1BBF43E	2002	FEM		JT086	WFYF	MAN
3D9.1BF1BC1AF0	2002	FEM		JT085	WFYF	MAN
3D9.1BF1F7D7B9	2003	MAL		JT101	WFYF	MAN
3D9.1BF1F75552	2003	MAL		JT102	WFYF	MAN
3D9.1BF1A73BC8	2003	MAL		JT103	WFYF	MAN
3D9.1BF1F789A9	2003	MAL		JT104	WFYF	MAN
3D9.1BF1F7F76A	2003	MAL		JT105	WFYF	MAN
3D9.1BF1F8851F	2003	MAL		JT106	WFYF	MAN
3D9.1BF1A77411	2003	MAL		JT107	WFYF	MAN
3D9.1BF1A71FDF	2003	MAL		JT108	WFYF	MAN
3D9.1BF1F7F0D5	2003	MAL		JT109	WFYF	MAN
3D9.1BF1F772A5	2003	MAL		JT110	WFYF	MAN
3D9.1BF1F7E4A8	2003	MAL		JT111	WFYF	MAN
3D9.1BF1F7FC75	2003	MAL		JT112	WFYF	MAN
3D9.1BF1F88A2B	2003	MAL		JT113	WFYF	MAN
3D9.1BF1A77054	2003	MAL		JT114	WFYF	MAN
3D9.1BF1F722FE	2003	MAL		JT115	WFYF	MAN
3D9.1BF1F7D564	2003	MAL		JT116	WFYF	MAN
3D9.1BF1F79937	2003	MAL		JT117	WFYF	MAN
3D9.1BF1A77EE8	2003	MAL		JT118	WFYF	MAN
3D9.1BF11B405B	2003	MAL		JT119	WFYF	MAN
3D9.1BF1F7D894	2003	MAL		JT120	WFYF	MAN
3D9.1BF1A1D467	2003	MAL		JT121	WFYF	MAN
3D9.1BF1F7E28F	2003	MAL		JT122	WFYF	MAN
3D9.1BF1A76668	2003	MAL		JT123	WFYF	MAN
3D9.1BF1A1DF89	2003	MAL	151.245	JT124	WFYF	MAN
3D9.1BF1F7C7FF	2003	MAL		JT125	WFYF	MAN
3D9.1BF1F80176	2003	MAL		JT126	WFYF	MAN
3D9.1BF1A1DA89	2003	MAL		JT127	WFYF	MAN
3D9.1BF1F7E2D1	2003	MAL		JT128	WFYF	MAN
3D9.1BF1F88643	2003	MAL		JT129	WFYF	MAN
3D9.1BF1A1CDAE	2003	MAL		JT130	WFYF	MAN
3D9.1BF1F88BC2	2003	MAL		JT131	WFYF	MAN
3D9.1BF1F7B44A	2003	MAL		JT132	WFYF	MAN
3D9.1BF1A75AB6	2003	MAL		JT133	WFYF	MAN
3D9.1BF1F8706D	2003	MAL	151.104	JT134	WFYF	MAN
3D9.1BF11B4D19	2003	MAL		JT135	WFYF	MAN
3D9.1BF1F7928D	2003	MAL		JT136	WFYF	MAN
3D9.1BF1A7268D	2003	MAL		JT137	WFYF	MAN
3D9.1BF1F71FE0	2003	MAL		JT138	WFYF	MAN

Appendix B. Continued.

PIT Code	BY	Sex	Radio #	Number	Stock	Rearing
3D9.1BF1F891FE	2003	MAL		JT139	WFYF	MAN
3D9.1BF1F88C40	2003	MAL		JT140	WFYF	MAN
3D9.1BF1F7D164	2003	MAL		JT141	WFYF	MAN
3D9.1BF11B6106	2003	MAL		JT142	WFYF	MAN
3D9.1BF1A1E011	2003	MAL		JT143	WFYF	MAN
3D9.1BF2430F99	2004	MAL			WFYF	MAN
3D9.1BF2433B98	2004	MAL			WFYF	MAN
3D9.1BF2431441	2004	MAL			WFYF	MAN
3D9.1BF2431130	2004	MAL			WFYF	MAN
3D9.1BF2433BEB	2004	MAL			WFYF	MAN
3D9.1BF2433AD2	2004	MAL			WFYF	MAN
3D9.1BF2430EC5	2004	MAL			WFYF	MAN
3D9.1BF242FB5F	2004	MAL			WFYF	MAN
3D9.1BF2433B55	2004	MAL			WFYF	MAN
3D9.1BF242C1CA	2004	MAL			WFYF	MAN
3D9.1BF2433C38	2004	MAL			WFYF	MAN
3D9.1BF2431252	2004	MAL			WFYF	MAN
3D9.1BF243392D	2004	MAL			WFYF	MAN
3D9.1BF243111F	2004	MAL			WFYF	MAN
3D9.1BF24312D6	2004	MAL			WFYF	MAN
3D9.1BF2431015	2004	MAL			WFYF	MAN
3D9.1BF2430D61	2004	MAL			WFYF	MAN
3D9.1BF2433B3D	2004	MAL			WFYF	MAN
3D9.1BF242FC7D	2004	MAL			WFYF	MAN
3D9.1BF242F8B0	2004	MAL			WFYF	MAN
3D9.1BF242F7A2	2004	MAL			WFYF	MAN
3D9.1BF2433A53	2004	MAL			WFYF	MAN
3D9.1BF2433C08	2004	MAL			WFYF	MAN
3D9.1BF24309FB	2004	MAL			WFYF	MAN
3D9.1BF242FAAF	2004	MAL			WFYF	MAN
3D9.1BF242CCA9	2004	MAL			WFYF	MAN
3D9.1BF24310D1	2004	MAL			WFYF	MAN
3D9.1BF242CB78	2004	MAL			WFYF	MAN
3D9.1BF24339DC	2004	MAL			WFYF	MAN
3D9.1BF2430E6E	2004	MAL			WFYF	MAN
3D9.1BF2433C02	2004	MAL			WFYF	MAN
3D9.1BF2431253	2004	MAL			WFYF	MAN
3D9.1BF2433902	2004	MAL			WFYF	MAN
3D9.1BF2431364	2004	MAL			WFYF	MAN
3D9.1BF242FBFC	2004	MAL			WFYF	MAN
3D9.1BF2431136	2004	MAL			WFYF	MAN
3D9.1BF24313B3	2004	MAL			WFYF	MAN
3D9.1BF2433B90	2004	MAL			WFYF	MAN
3D9.1BF2433A97	2004	MAL			WFYF	MAN
3D9.1BF24310B0	2004	MAL			WFYF	MAN
3D9.1BF242FD7B	2004	MAL			WFYF	MAN
3D9.1BF242FAEF	2004	MAL			WFYF	MAN
3D9.1BF242CB26	2004	MAL			WFYF	MAN
3D9.1BF24311B0	2004	MAL			WFYF	MAN
3D9.1BF242C4EA	2004	MAL			WFYF	MAN
3D9.1BF242F956	2004	MAL			WFYF	MAN
3D9.1BF2433DDC	2004	MAL			WFYF	MAN
3D9.1BF2433CAF	2004	MAL			WFYF	MAN
3D9.1BF24338FA	2004	MAL			WFYF	MAN
3D9.1BF24314E1	2004	MAL			WFYF	MAN
3D9.1BF2433CA4	2004	MAL			WFYF	MAN
3D9.1BF24312C4	2004	MAL			WFYF	MAN

Appendix B. Continued.

PIT Code	BY	Sex	Radio #	Number	Stock	Rearing
3D9.1BF2433D01	2004	MAL			WFYF	MAN
3D9.1BF2433AFF	2004	MAL			WFYF	MAN
3D9.1BF242F9DE	2004	MAL			WFYF	MAN
3D9.1BF2430E31	2004	MAL			WFYF	MAN
3D9.1BF242FE03	2004	MAL			WFYF	MAN
3D9.1BF243137D	2004	MAL			WFYF	MAN
3D9.1BF242C3C7	2004	MAL			WFYF	MAN
3D9.1BF242F736	2004	MAL			WFYF	MAN
3D9.1BF2430FEE	2004	MAL			WFYF	MAN
3D9.1BF2430F9B	2004	MAL			WFYF	MAN
3D9.1BF2433A15	2004	MAL			WFYF	MAN
3D9.1BF242FC5F	2004	MAL			WFYF	MAN
3D9.1BF24310C2	2004	MAL			WFYF	MAN
3D9.1BF2433943	2004	MAL			WFYF	MAN
3D9.1BF2433B4D	2004	MAL			WFYF	MAN
3D9.1BF1BEDE69	2002	FEM		GW01	EFSR	MAN
3D9.1BF1BC10CB	2002	FEM		GW02	EFSR	MAN
3D9.1BF1BBFF3B	2002	FEM	150.133	GW04	EFSR	MAN
3D9.1BF1BDE5A1	2002	MAL		GW05	EFSR	MAN
3D9.1BF1BBFC12	2002	FEM		GW07	EFSR	MAN
3D9.1BF1BBB18C	2002	FEM		GW11	EFSR	MAN
3D9.1BF1BCF734	2002	FEM	150.014	GW12	EFSR	MAN
3D9.1BF1BDE078	2002	FEM		GW13	EFSR	MAN
3D9.1BF1BEDEFA	2002	FEM		GW16	EFSR	MAN
3D9.1BF1BC06C7	2002	FEM		GW14	EFSR	MAN
3D9.1BF1BDDAD9	2002	MAL		GW15	EFSR	MAN
3D9.1BF1BC1AF2	2002	FEM		GW17	EFSR	MAN
3D9.1BF1BD8F45	2002	FEM		GW18	EFSR	MAN
3D9.1BF1BBA833	2002	FEM	150.193	GW19	EFSR	MAN
3D9.1BF1BBEC8F	2002	FEM	150.095	GW20	EFSR	MAN
3D9.1BF1BDD90E	2002	MAL		GW21	EFSR	MAN
3D9.1BF1BC887F	2002	FEM		GW22	EFSR	MAN
3D9.1BF1BCE925	2002	FEM		GW23	EFSR	MAN
3D9.1BF1BCF75E	2002	FEM		GW24	EFSR	MAN
3D9.1BF1BB923D	2002	FEM		GW25	EFSR	MAN
3D9.1BF1BBE33B	2002	FEM		GW26	EFSR	MAN
3D9.1BF1BBDEF2	2002	FEM		GW27	EFSR	MAN
3D9.1BF1BC108A	2002	FEM	151.163	GW28	EFSR	MAN
3D9.1BF1BD8478	2002	FEM		GW29	EFSR	MAN
3D9.1BF1BEDF35	2002	FEM		GW31	EFSR	MAN
3D9.1BF1BCAFE7	2002	FEM		GW32	EFSR	MAN
3D9.1BF1BD6EC5	2002	FEM		GW34	EFSR	MAN
3D9.1BF1BD6C0B	2002	FEM		GW35	EFSR	MAN
3D9.1BF1BCC0DF	2002	FEM		GW37	EFSR	MAN
3D9.1BF1BD73E7	2002	FEM		GW40	EFSR	MAN
3D9.1BF1BC8CC1	2002	FEM		GW41	EFSR	MAN
3D9.1BF1BCECCF	2002	FEM		GW42	EFSR	MAN
3D9.1BF1BBFC8A	2002	FEM		GW43	EFSR	MAN
3D9.1BF1BB4F29	2002	FEM		GW45	EFSR	MAN
3D9.1BF1BC10C9	2002	FEM		GW46	EFSR	MAN
3D9.1BF1BDE0B7	2002	FEM		GW47	EFSR	MAN
3D9.1BF1BC1AC6	2002	MAL		GW48	EFSR	MAN
3D9.1BF1BD8036	2002	FEM	151.145	GW49	EFSR	MAN
3D9.1BF1BC7F76	2002	FEM		GW50	EFSR	MAN
3D9.1BF1BD6C2C	2002	FEM		GW51	EFSR	MAN
3D9.1BF1BCAEAC	2002	MAL		GW52	EFSR	MAN
3D9.1BF1BDD9C6	2002	FEM		GW53	EFSR	MAN

Appendix B. Continued.

PIT Code	BY	Sex	Radio #	Number	Stock	Rearing
3D9.1BF1BCEC53	2002	FEM		GW54	EFSR	MAN
3D9.1BF1BC03C4	2002	FEM		GW55	EFSR	MAN
3D9.1BF1BBBB06	2002	FEM		GW56	EFSR	MAN
3D9.1BF1BBC77D	2002	FEM		GW57	EFSR	MAN
3D9.1BF1BCBF9A	2002	FEM		GW58	EFSR	MAN
3D9.1BF1BBEBA3	2002	FEM		GW59	EFSR	MAN
3D9.1BF1BC8080	2002	FEM		GW62	EFSR	MAN
3D9.1BF1BBC070	2002	FEM		GW61	EFSR	MAN
3D9.1BF1BB9E7C	2002	FEM		GW64	EFSR	MAN
3D9.1BF1BC848D	2002	FEM		GW65	EFSR	MAN
3D9.1BF1BD6FFB	2002	FEM		GW67	EFSR	MAN
3D9.1BF1BC1E29	2002	FEM		GW70	EFSR	MAN
3D9.1BF1BBA8AF	2002	FEM		GW71	EFSR	MAN
3D9.1BF1BCF50F	2002	FEM	150.074	GW72	EFSR	MAN
3D9.1BF1BEEF7F	2002	FEM		GW73	EFSR	MAN
3D9.1BF1BDE218	2002	FEM		GW74	EFSR	MAN
3D9.1BF1BD986F	2002	FEM		GW75	EFSR	MAN
3D9.1BF1BD7DBA	2002	FEM	150.113	GW76	EFSR	MAN
3D9.1BF1BD93B7	2002	FEM		GW77	EFSR	MAN
3D9.1BF1BD6ADA	2002	FEM		GW79	EFSR	MAN
3D9.1BF1BDD810	2002	FEM		GW81	EFSR	MAN
3D9.1BF1BB93ED	2002	FEM		GW82	EFSR	MAN
3D9.1BF1BC068F	2002	FEM		GW84	EFSR	MAN
3D9.1BF1BCAF41	2002	FEM		GW85	EFSR	MAN
3D9.1BF1BC1821	2002	FEM		GW87	EFSR	MAN
3D9.1BF1BD93C3	2002	FEM		GW91	EFSR	MAN
3D9.1BF1BCAEFE	2002	FEM		GW92	EFSR	MAN
3D9.1BF1BDD5F2	2002	FEM		GW94	EFSR	MAN
3D9.1BF1BE0608	2002	FEM		GW95	EFSR	MAN
3D9.1BF1BB4F61	2002	FEM		GW97	EFSR	MAN
3D9.1BF1BCB5C9	2002	FEM		YW95	EFSR	MAN
3D9.1BF1BD81A9	2002	FEM		YW94	EFSR	MAN
3D9.1BF1BDE0C4	2002	FEM		YW97	EFSR	MAN
3D9.1BF1BC1EA3	2002	FEM		YW92	EFSR	MAN
3D9.1BF1BDDA43	2002	FEM		YW91	EFSR	MAN
3D9.1BF1BCBECB	2002	MAL		YW87	EFSR	MAN
3D9.1BF1BBFF2B	2002	FEM		YW85	EFSR	MAN
3D9.1BF1A1E912	2003	MAL		RW17	EFSR	MAN
3D9.1BF1F88689	2003	MAL		RW50	EFSR	MAN
3D9.1BF1A73B22	2003	MAL		RW31	EFSR	MAN
3D9.1BF1F8B7EF	2003	MAL		RW51	EFSR	MAN
3D9.1BF1A7790B	2003	MAL		RW29	EFSR	MAN
3D9.1BF1F7CCD8	2003	MAL		RW52	EFSR	MAN
3D9.1BF1A257F8	2003	MAL		RW32	EFSR	MAN
3D9.1BF1A7405E	2003	MAL		RW53	EFSR	MAN
3D9.1BF1A1EA5E	2003	MAL		RW28	EFSR	MAN
3D9.1BF1A74426	2003	MAL		RW54	EFSR	MAN
3D9.1BF1A776EE	2003	MAL		RW26	EFSR	MAN
3D9.1BF1F7655F	2003	MAL		RW55	EFSR	MAN
3D9.1BF1F7FBB3	2003	MAL		RW25	EFSR	MAN
.....	2003	MAL		RW24	EFSR	MAN
3D9.1BF1F753AA	2003	MAL		RW56	EFSR	MAN
3D9.1BF1A241D4	2003	MAL		RW34	EFSR	MAN
3D9.1BF1A77222	2003	MAL		RW57	EFSR	MAN
3D9.1BF1F7C90B	2003	MAL		RW37	EFSR	MAN
3D9.1BF1F88F06	2003	MAL		RW58	EFSR	MAN
3D9.1BF1F88062	2003	MAL		RW35	EFSR	MAN

Appendix B. Continued.

PIT Code	BY	Sex	Radio #	Number	Stock	Rearing
3D9.1BF1F720E8	2003	MAL		RW61	EFSR	MAN
3D9.1BF1F76A1D	2003	MAL		RW17	EFSR	MAN
3D9.1BF1F81B31	2003	MAL		RW62	EFSR	MAN
3D9.1BF1F78459	2003	MAL		RW40	EFSR	MAN
3D9.1BF1F8146A	2003	MAL		RW64	EFSR	MAN
3D9.1BF1F7F6CA	2003	MAL		RW18	EFSR	MAN
3D9.1BF1F7D26E	2003	MAL		RW65	EFSR	MAN
3D9.1BF1A784ED	2003	MAL		RW19	EFSR	MAN
3D9.1BF1F7C72A	2003	MAL		RW67	EFSR	MAN
3D9.1BF1F7FB10	2003	MAL		RW41	EFSR	MAN
3D9.1BF1F85BA3	2003	MAL		RW70	EFSR	MAN
3D9.1BF1F76BCE	2003	MAL		RW42	EFSR	MAN
3D9.1BF1A25474	2003	MAL		RW71	EFSR	MAN
3D9.1BF1F81BC8	2003	MAL		RW20	EFSR	MAN
3D9.1BF1F7E690	2003	MAL		RW72	EFSR	MAN
3D9.1BF1F7E72A	2003	MAL		RW21	EFSR	MAN
3D9.1BF1F88ED4	2003	MAL		RW73	EFSR	MAN
3D9.1BF1F85DB8	2003	MAL		RW43	EFSR	MAN
3D9.1BF1A232BF	2003	MAL		RW74	EFSR	MAN
3D9.1BF1A771D2	2003	MAL		RW44	EFSR	MAN
3D9.1BF1A71D34	2003	MAL		RW75	EFSR	MAN
3D9.1BF1F88D8B	2003	MAL		RW45	EFSR	MAN
3D9.1BF1A22730	2003	MAL		RW22	EFSR	MAN
3D9.1BF1F77F3B	2003	MAL		RW77	EFSR	MAN
3D9.1BF1F72074	2003	MAL		RW23	EFSR	MAN
3D9.1BF1F71E2E	2003	MAL		RW78	EFSR	MAN
3D9.1BF1A77718	2003	MAL		RW16	EFSR	MAN
3D9.1BF1F7BEA1	2003	MAL		RW79	EFSR	MAN
3D9.1BF1F7C4CB	2003	MAL		RW01	EFSR	MAN
3D9.1BF1A1CBEC	2003	MAL		RW81	EFSR	MAN
3D9.1BF1A1D350	2003	MAL		RW02	EFSR	MAN
3D9.1BF1F82F2D	2003	MAL		RW82	EFSR	MAN
3D9.1BF1F878BE	2003	MAL		RW04	EFSR	MAN
3D9.1BF242C424	2004	MAL			EFSR	MAN
3D9.1BF2433BDF	2004	MAL			EFSR	MAN
3D9.1BF2433CFD	2004	MAL			EFSR	MAN
3D9.1BF24314E0	2004	MAL			EFSR	MAN
3D9.1BF2431134	2004	MAL			EFSR	MAN
3D9.1BF242F8E0	2004	MAL			EFSR	MAN
3D9.1BF2433BF3	2004	MAL			EFSR	MAN
3D9.1BF243113A	2004	MAL			EFSR	MAN

Prepared by:

Dan Baker
Hatchery Manager II

Jeff Heindel
Assistant Hatchery Manager

Dmitri Vidergar
Senior Fisheries Research Biologist

Eric Stark
Senior Fisheries Research Biologist

Joshua Gable
Senior Fisheries Technician

Kurtis Plaster
Senior Fisheries Technician

Paul A. Kline
Principal Fisheries Research Biologist

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

_____
Edward B. Schriever, Chief
Bureau of Fisheries

_____
Daniel J. Schill
Fisheries Research Manager