FISHERY RESEARCH

CAPTIVE REARING PROGRAM FOR SALMON RIVER CHINOOK SALMON

PROJECT PROGRESS REPORT
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CAPTIVE REARING PROGRAM FOR SALMON RIVER CHINOOK SALMON

Project Progress Report

2008 Annual Report

By

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ABSTRACT

During 2008, 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 2007. Captive rearing groups were not collected in 2008; brood year 2005 (BY05) represented the final brood cohorts collected for full-term captive rearing studies in the EFSR and WFYF. During 2008, no captive Chinook remained in freshwater rearing at Eagle Fish Hatchery (FH). All remaining brood years (BY02, BY03, BY04, and BY05) were rearing to maturity in saltwater at the Manchester Research Station, Manchester, Washington (Manchester) during 2008. Maturing fish transfers from Manchester to Idaho for release to natal waters included 185 individuals from the WFYF and 157 from the EFSR. All maturing captive-reared Chinook salmon were released in 2008. 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. Thirteen redds were constructed by volitionally spawning captive-reared Chinook salmon females in the WFYF and 55 constructed in the EFSR. Fin samples from Chinook salmon parr were collected in the WFYF (n = 114) and the EFSR (n = 120) to assess production levels from volitional spawning events resulting from program releases conducted in 2007. 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.

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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 2007). Restoring currently depressed wild populations to historic levels is a prerequisite to this condition. Artificial propagation of spring and summer Chinook salmon in the Salmon River basin was initiated to mitigate for lost recruitment and productivity caused by the construction and operation of private and federal hydroelectric facilities in the Snake River basin. This was accomplished through the Lower Snake River Compensation Plan (LSRCP) and Idaho Power Company hatcheries. 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 meet both sportfishing harvest and continued hatchery production needs. It was also assumed that hatchery programs would not negatively affect the productivity or genetic viability of target or other populations, and that natural populations would remain self-sustaining even with hydropower projects in place. Estimated survival rates used in the hatchery program models appear to have been substantially overestimated, which led to hatchery programs that have not consistently mitigated for reductions in Chinook salmon production and productivity. Spring/summer Chinook salmon returns have historically been insufficient to meet artificial and natural smolt and adult production goals, much less provide a consistent harvestable number 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), and has contributed to the listing of Snake River Chinook salmon as threatened under the Endangered Species Act (ESA; National Marine Fisheries Service [NMFS] 1992). Marmorek et al. (1998) suggested a recovery strategy incorporating natural river function was most likely to increase the smolt-to-adult return rate and provide for recovery of these populations. However, our immediate 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 to initiate two programs: 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. Captive fish 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. Alternately, 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 was 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 develop 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 elusive (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 Chinook salmon parr from three study streams. Since then, naturally spawned Chinook salmon progeny from BY95-BY05 have been reared in captivity to continue the project. Hassemer et al. (1999, 2001), Venditti et al. (2002, 2003a, 2003b, 2005), and Baker et al. (2006, 2008) summarize project activities from inception through 2006. 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). 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 (Figure 1).

All three study streams were selected because of their water temperature and water quality. Water temperatures are ideal for juvenile Chinook salmon rearing in all three streams,

while water quality ranges from sufficient to ideal. Stream 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). 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 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. Stream habitat in the EFSR typically reflects “C” and “B” channel morphologies (Rosgen 1985). A B-type channel is defined as being moderately entrenched with a moderate width-to-depth ratio, moderate sinuosity, and a slope of 0.02 to 0.099%. 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 “C” and “B” channel morphologies (Rosgen 1985).

The goal of the captive rearing program is to evaluate the potential of captive rearing technology for the conservation of Snake River spring/summer Chinook salmon. There are two primary project objectives needed to accomplish this goal: 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 (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, 2008 through December 31, 2008. This project was coordinated with the Northwest Power and Conservation Council’s Fish and Wildlife Program (NPCC 2000), identified as project 2007-40-300. Funding was provided through the Bonneville Power Administration under contracts 35399 and 39364.

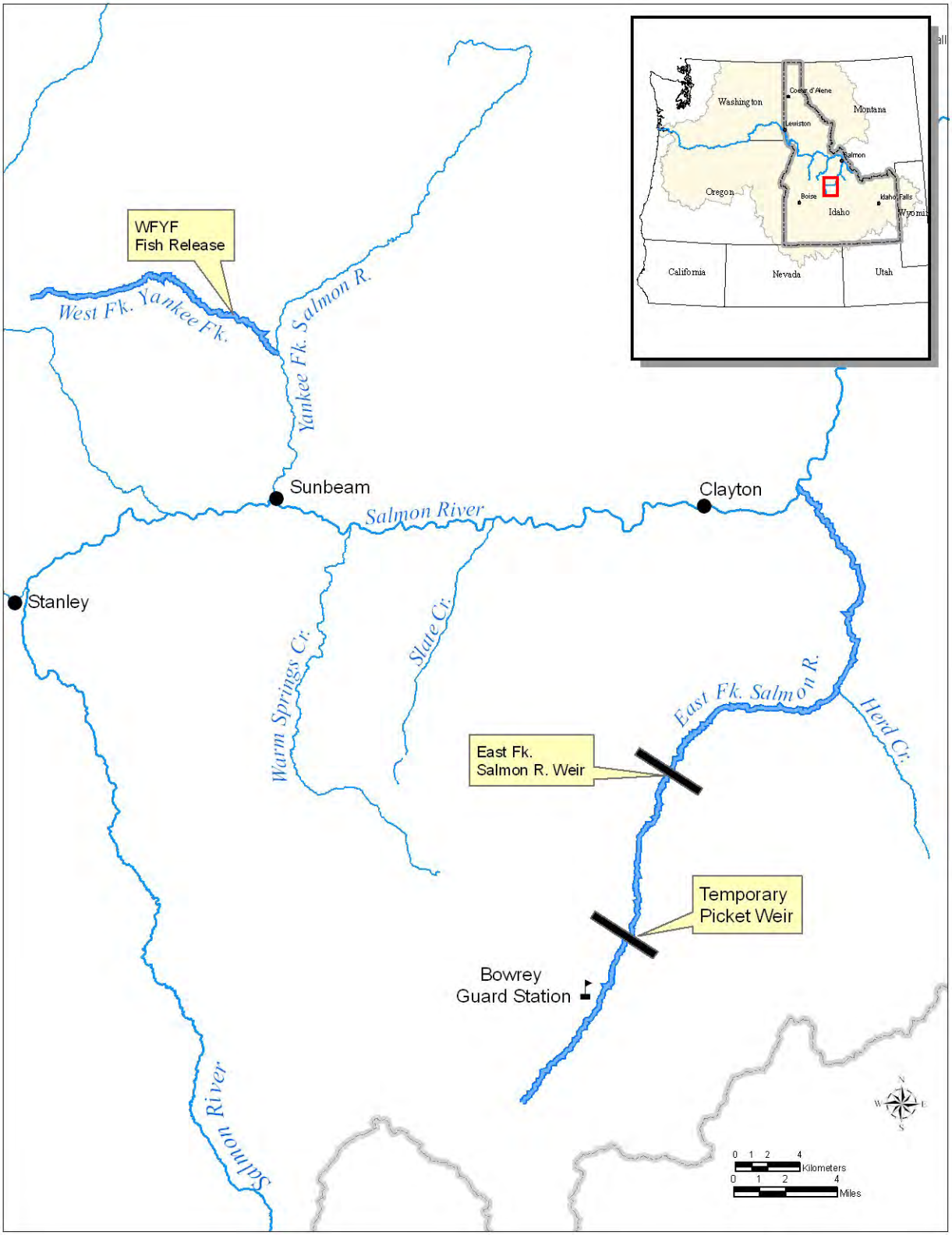


Figure 1. Location of study streams included in the Idaho Department of Fish and Game Captive Rearing Program for Salmon River Chinook salmon.

FACILITIES

Eagle Fish Hatchery

The IDFG Eagle Fish Hatchery (Eagle FH) in Eagle, Idaho 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 and between 8.0°C and 10.0°C from ponding through transfer of smolts to seawater. 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. Fish are segregated by brood year and stream origin throughout all rearing phases. 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 transferring 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) 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 following 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 μm, 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 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 attain 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 200740300.

Juvenile Rearing, Marking, and Transportation

No juvenile rearing was performed during 2008. The last remaining brood year (BY05) was transported to Manchester for saltwater rearing in 2007. Juvenile rearing, marking, and transportation methods are summarized in Baker et al. (2008). Brood years still rearing in saltwater at Manchester include BY02, BY03, BY04, and BY05.

Adult Rearing, Marking, and Transportation

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 (Aloka Co., Ltd., Tokyo, Japan).

Maturing Chinook salmon destined for release for natural spawning were fitted with spaghetti tags prior to release. Spaghetti tags were color-coded to identify the brood year to which the fish belonged. 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. Spaghetti tags were attached by passing a stainless steel needle through the musculature of the dorsal surface just ventral to the midline of the dorsal fin. The two ends of the spaghetti tag were then tied in a knot to secure. After marking, all fish were allowed to recover in coolers of temperature-appropriate water before being returned to the holding tanks.

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 natal waters were transferred from truck tanks to streamside release sites.

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) 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.

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) 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.

Fish health was monitored daily by observing feeding response, external condition, and behavior 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. Bacterial or viral pathogens were isolated to identify parasite etiology using American Fisheries Society Bluebook procedures (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, mortality by age, and maturation by age were summarized 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 calculated. 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 BY03 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

A fish weir was installed in the EFSR to assess captive reared mature Chinook salmon spawning success in a natural stream environment. The weir was assembled at the downstream end of the 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. Thermal records provided a means to accurately determine when redds should be sampled and ultimately to determine fertilization rates and survival to the eyed-egg stage of development. No weir was constructed on the WFYF during this reporting period, allowing fish released into the WFYF 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.

Monitoring of Chinook spawning activity began approximately 24 h after captive-reared fish were released. Each field crew was assigned 3-4 stream reaches within a study section to monitor each day. Depending upon crew availability, the entire study section was monitored a minimum of three times per week. Technicians walked slowly upstream surveying for Chinook

salmon with the aid of polarized sunglasses. When fish were identified, technicians remained motionless and viewed each fish for a minimum of five minutes looking for spawning behaviors. During this time, the technician recorded the number of fish observed, fish origins (natural origin or captive-reared based on the presence of a spaghetti tag), and the gender of each fish when possible. For each female Chinook observed, its location was recorded on a handheld global positioning system receiver and the location marked with flagging. The observer noted the gender, origin (natural or captive), and spawn activities observed for each fish on the flagging (Table 1). Not all spawn activities listed in Table 1 were recorded, but were used as guidance for determining the likelihood of spawning and redd completion to occur. For each spaghetti-tagged study fish, the identification color was also recorded. For each female Chinook observed, a unique redd number was recorded along with the date and the observer initials. When multiple female Chinook were observed simultaneously, their activity and location information were recorded separately and each assigned their own redd number and GPS waypoint.

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

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

Production Estimation

Parr Collections—Fin clips from Chinook salmon parr were collected in previously supplemented study streams to determine if they were the progeny of captive-reared parents via genetic analysis. Parr were previously collected by snorkelers using aquarium dip nets (Bonneau et al. 1995) and angling, but during this reporting period only with rotary screw traps within the study area (operated by Shoshone-Bannock fisheries biologists). Once captured, parr were transferred to tubs filled with fresh stream water along the shore, 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. After recovering in a tub of fresh water, parr were released back into the stream 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. These samples will be used in future parental exclusion analyses through the use of microsatellite markers (parental exclusion analysis; Colbourne et al. 1996; Talbot et al. 1996; Estoup et al. 1998; Bernatchez and Duchesne 2000; Eldridge et al. 2002). These data will allow us 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. Eyed-egg to fry survival for captive-origin and natural origin Chinook salmon are equal.

This hypothesis was tested by estimating survival from eyed-egg to emergence for both captive-reared and natural fish that volitionally spawned within our study areas. Field investigations for this study began during the fall of 2006 and will continue thru the fall of 2009.

Eyed-eggs for this study were collected using hydraulic sampling methods described in Venditti et al. (2005) and Baker et al. (2008). This system consists of two main components. The first is a gasoline-powered pump attached to a 3.8 cm diameter aluminum probe using flexible tubing. Holes drilled near the top of the probe infuse air into the water-stream through venturi action. The second component is the collection net frame, which consists of a “D” shaped aluminum frame with expanded plastic mesh along its curved portion and netting around the bottom and sides of its straight portion. When the pump is operating, water and air are forced through the probe, which is worked into the substrate within the net frame. The air/water mixture lifts eggs out of the substrate, where they are swept downstream into the net. The expanded plastic screen confines eggs lifted out near the periphery and directs them into the net. In order to minimize disturbance to the redd, sampling is initiated downstream of estimated nest pocket locations and progresses upstream. This prevents fine materials lifted out of the substrate from settling back into the redd and possibly smothering the remaining eggs. Care is also taken to keep personnel below or to the side of the net frame to minimize redd disturbance.

Hydraulic sampling gear previously used for eyed-egg collections for captive rearing were 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.

Actual egg numbers collected per redd varied, but attempts were made to collect between 70 and 100 eggs per redd. We enumerated dead eggs, eggshells, and live eggs to estimate survival to the eyed-egg stage of development. Forty live eggs were placed into an egg capsule (treatment group) which was placed back in the redd. Another portion of up to 40 eggs was taken to the Eagle FH and raised to buttoned-up fry stage (genetics group) according to culture techniques described in Venditti et al. (2005) and Baker et al. (2008). If more than 80 live eggs were collected at sampling, surplus eggs were placed in an extra egg capsule and buried in the same redd (different location). This extra capsule could then be retrieved as a means of determining emergence timing for the redd without jeopardizing premature retrieval and subsequent loss of the treatment capsule results. In a few cases, the extra capsule was filled with lower or higher densities of eggs than the treatment capsules to see if loading density affected survival.

Egg transport tubes made of rigid plastic mesh, currently used at Eagle FH (Venditti et al. 2005; Baker et al. 2006), were modified and used as the egg capsules for eggs placed back into the redd (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).

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 receiving redd, thus representative of the habitat sought by naturally spawning fish. Eyed-eggs were then distributed throughout the capsule and around the gravel to minimize egg-to-egg contact, and the environment inside each egg capsule was made as similar to the natural conditions as possible. 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. 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).

Figure 2. Egg capsules used for emergence survival study.

Embryo development was then monitored through water temperatures. When estimated emergence timing was reached, the capsules were extracted from the gravel and hatched fish were enumerated. This method was thought to provide a reliable estimate of survival to emergence because a known number of eggs were placed into each capsule and a known number of fry were collected when a capsule was extracted.

Surviving fry from both hatchery and egg capsule study groups were sampled after depletion of yolk reserves, determined by tracking accumulated thermal units and using historic emergence timing estimates for similar stocks of Chinook salmon. Fry hatched from BY08 egg collections from egg capsules (treatment) were released into the stream after enumeration. Fry from the hatchery groups were lethally sampled after yolk-absorption in early 2009, and fin clips taken for parentage genetic analyses.

Captive-reared fish and natural fish were treated as the two different treatment groups and each redd was treated as a sample unit. Eyed-egg to emergence survival was averaged from all redds created by captive-reared fish and natural fish, respectively.

Differences in mean egg survival were compared between captive-reared and natural Chinook using a t-test (alpha level of 0.05). Data from both groups were transformed if survival rates of either group varied by more than 60%, since they could confound the ability to detect a relationship between study groups.

East Fork Salmon River Weir Operations

The EFSR adult weir was operated to collect genetic samples from returning natural Chinook salmon as well as to monitor the movement of resident species. The facility is located near Big Boulder Creek, approximately 29 river kilometers 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, measured to FL, genetic samples collected on salmonids, and released upstream of the weir. Additionally, bull trout *Salvelinus confluentus* received a PIT tag placed into the left operculum in order to assess recapture timing and distribution.

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 a coded-wire tag, 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 n-butyl cyanoacrylate (veterinary tissue adhesive) 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. Total Chinook salmon numbers were reported to the IDFG trapping database daily via internet.

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 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, 2008. During this reporting period, no brood years remained in culture at Eagle FH from either the WFYF or EFSR stocks. Thus, summaries of losses, transfers, and releases while in culture were not reported during 2008. However, one experimental brood year group (eyed-egg) was briefly in culture during this reporting period to facilitate emergence survival studies as described below in the Monitoring Programs.

Juvenile Rearing, Marking, and Transportation

No juvenile Chinook salmon remained in culture at Eagle FH during 2008; therefore, there were no results to report under this section.

Adult Rearing, Marking, and Transportation

Captive adult Chinook salmon from the WFYF and EFSR stocks identified as maturing were transferred from Manchester directly to the WFYF and to the EFSR satellite weir holding pond, respectively, in 2008. Mature adults were transported on July 10 and included fish from four brood years (BY02, BY03, BY04, BY05) for the WFYF stock and three brood years (BY03, BY04, BY05) for the EFSR stock (Appendix A). On July 21, EFSR Chinook were transported from the holding pond and released to the EFSR for volitional spawning.

On June 9, spaghetti tags were attached to EFSR and WFYF Chinook salmon destined for release to their natal streams. A total of 200 WFYF and 168 EFSR Chinook salmon were tagged during this event (Table 1). Post-tagging mortality occurred in 25 fish (WFYF-16 and EFSR-9). No mortalities were observed during transport of the WFYF and EFSR stocks in 2008.

On July 10, 185 and 159 Chinook salmon were released into the WFYF and EFSR satellite weir holding pond, respectively (Table 2). Subsequently, two mortalities were observed in the EFSR stock during holding at the satellite holding pond prior to release; therefore, 157 Chinook salmon were released into the EFSR for volitional spawning. In addition, radio transmitters were inserted into the stomach (oral insertion) of five WFYF captive-reared Chinook salmon prior to release. The radio transmitter numbers of these fish are listed along with PIT tag numbers in Appendix B.

Table 2. Number of captive-reared Chinook salmon tagged, transferred, and released into their natal waters (West Fork Yankee Fork Salmon River = WFYF and East Fork Salmon River = EFSR). Tagging mortalities, transfer mortalities, mean fork length (FL), and mean weight of adults are summarized by brood year (BY) and stock.

		Number of Captive Adult Chinook						
		Tagged		Transferred		Released		
Stock / Release Location	BY	Number Tagged	Tagging Mortalities	Number Transferred	Transfer Mortalities*	Number Released	Mean FL (mm)	Mean Weight (g)
EFSR	2003	13	0	13	0	13	497	1765
EFSR	2004	111	4	107	1	106	516	1998
EFSR	2005	44	5	39	1	38	398	985
Total EFSR		168	9	159	2	157		
WFYF	2002	1	0	1	0	1	515	1383
WFYF	2003	17	2	16	0	16	501	1513
WFYF	2004	100	12	88	0	88	493	1628
WFYF	2005	82	2	80	0	80	374	844
Total WFYF		200	16	185	0	185		
TOTAL ALL		**368**	**25**	**344**	**2**	**342**		

* Transfer mortalities listed for the EFSR stock were actually incurred during holding at the satellite weir holding pond prior to release into the EFSR.

Fish Health Monitoring

Pathogen Sampling and Detection

During calendar year 2008, no captive Chinook salmon stocks remained in culture in freshwater at Eagle FH. Thus, no pathogen sampling was performed from Chinook salmon at Eagle FH during this reporting period.

In 2008, 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 a separate cover.

Vaccine and Antibiotic Treatments

No vaccinations or antibiotic treatments were performed on captive Chinook salmon since no fish remained in culture at Eagle FH during 2008.

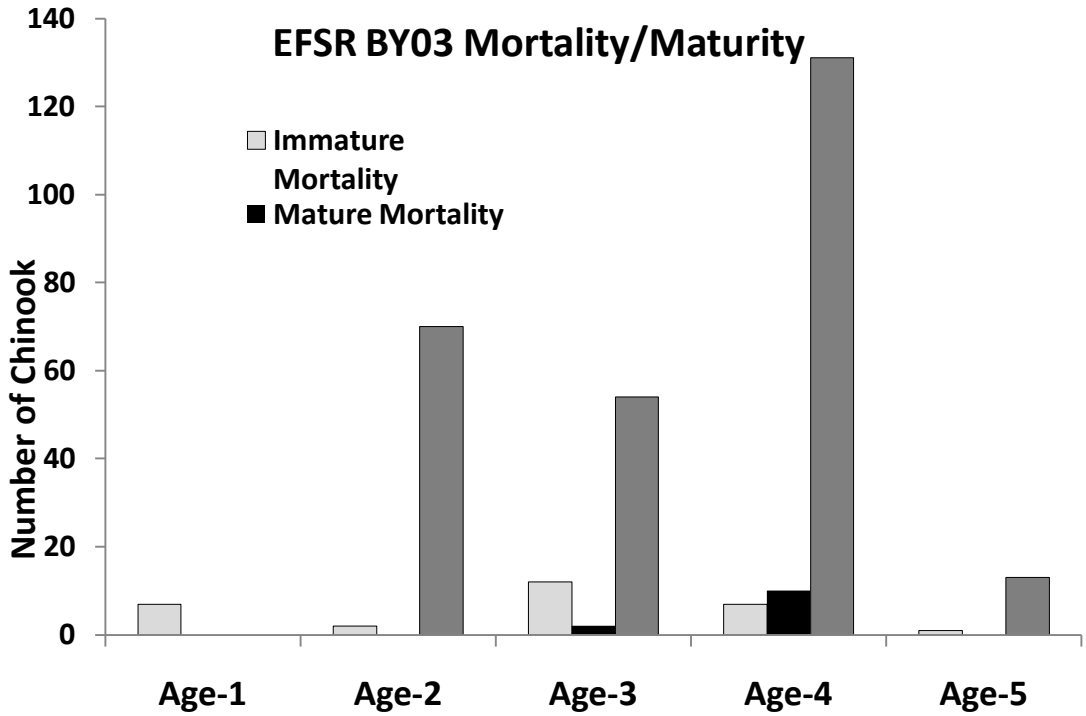
Growth and Survival of Brood Year 2003

Brood year 2003 captive-reared Chinook salmon were transferred as smolts to Manchester in May 2005. 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 early brood years (Venditti et al. 2003b). Primary sources of mortality in this group included mortality of immature fish during hatchery rearing, unproductive mature adults (includes mature hatchery mortality and mature culls), and productive mature adults (precocial culls at Manchester or released for volitional spawning). Of the 314 BY03 EFSR eyed-eggs collected, 268 fish (85.4%) survived to maturity (productive mature adult), 42 fish (13.4%) died as immature fish (n = 29) or unproductive mature fish (n = 12), and one undetermined mortality (0.3%). An additional four BY03 EFSR fish were unaccounted or missing (1.2%). Of the 338 BY03 WFYF eyed-eggs collected, 226 fish (66.9%) survived to maturity (productive mature adult), 107 fish (31.7%) died as immature fish (n = 92) or unproductive mature fish (n = 12), and the maturity of three fish mortalities was not determined (0.8%; Figure 3). An additional five BY03 WFYF fish were unaccounted or missing (1.4%).

Of the 268 fish that matured in the EFSR cohort, 70 fish (26.1%) matured as age-2 (precocial) adults, 54 fish (20.1%) matured as age-3 fish, 131 fish (48.9%) matured as age-4 fish, and 13 fish (4.9%) matured as age-5 fish. Of the 42 fish that died during culture of the EFSR cohort, seven fish (16.7%) died as age-1, three fish (7.1%) died as age-2, 14 fish (33.3%) died as age-3, 17 fish (40.5%) died as age-4, and one fish (2.4%) died as age-5 fish (Figure 3).

Of the 226 fish that matured in the WFYF cohort, 54 fish (23.9%) matured as age-2 (precocial) adults, 44 fish (19.5%) matured as age-3 fish, 112 fish (49.6%) matured as age-4, and 16 fish (7.1%) matured as age-5 fish. Of the 107 fish that died in culture from the WFYF cohort, 36 fish (33.6%) died as age-1, five fish (4.7%) died as age-2, 17 fish (15.9%) died as age-3, 41 fish (38.3%) died as age-4, and eight fish (7.5%) died as age-5 fish (Figure 3).

A total of 518 fish reached maturity from at total of 652 (including unproductive mature fish). Precocity rates (age-2 maturation), averaged 33.3% in the EFSR stock and 30.1% in the WFYF stock for BY03, compared to brood years 97-02 average rate of 35.7% (Hassemer et al. 2001; Venditti et al. 2002, 2003a, 2003b, 2005). The average maturation rate (productive mature adult) combined for both stocks of BY03 fish (75.8%) was greater than the average of the previous five brood years (BY98-02 = 55.4%). The mean length at maturity of BY03 EFSR and WFYF fish combined was greater than that of previous brood years for age 3 and 4, but was less than previous brood years for age 5 fish (Figure 4). The same pattern was also observed for BY03 fish mean weight at maturity (Figure 5).



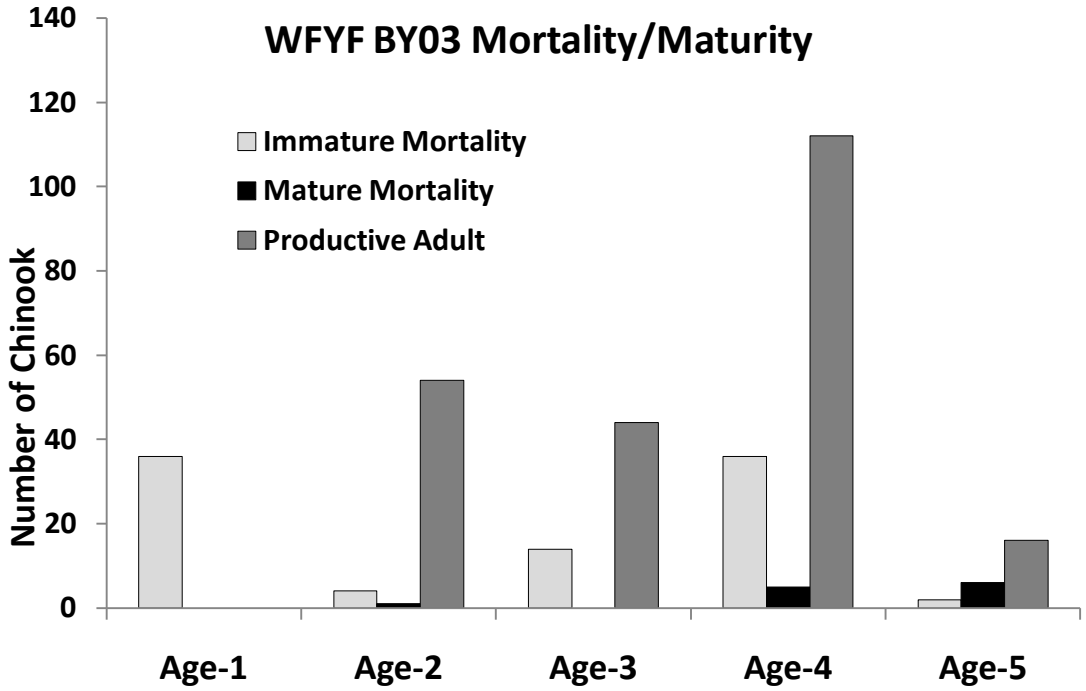


Figure 3. Mortality by age and age at maturation for East Fork Salmon River (EFSR) and West Fork Yankee Fork (WFYF) captive-reared brood year 2003 (BY03) stocks. Immature Mortality = fish that died prior to reaching sexual maturity; Mature Mortality = fish that reached sexual maturity but did not spawn; Productive Adults = fish that reached sexual maturity and were released to spawn.

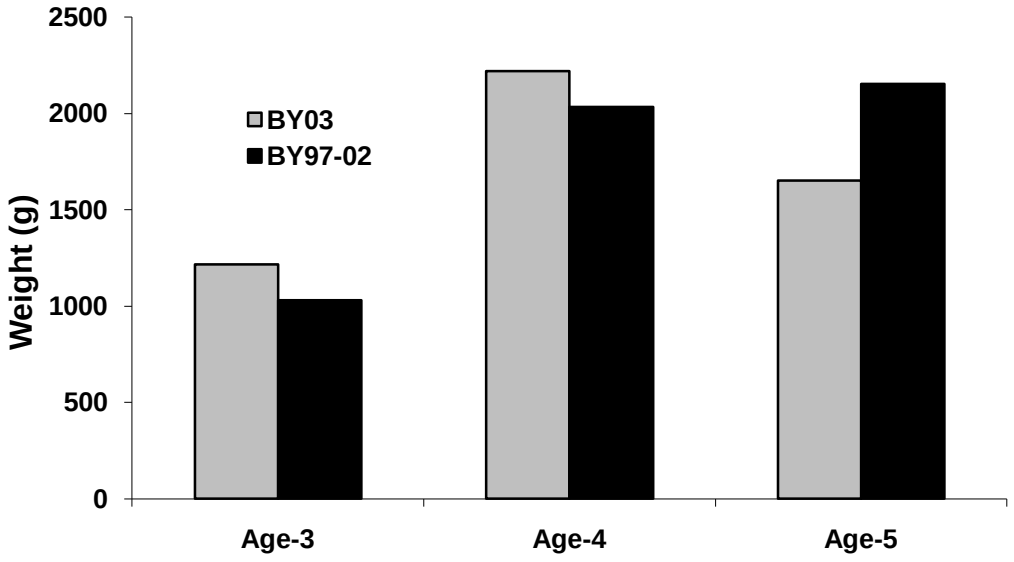


Figure 4. Weight at maturity by age for captive-reared Chinook salmon from brood year 2003 (BY03) and the average of BY97-BY02. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish.

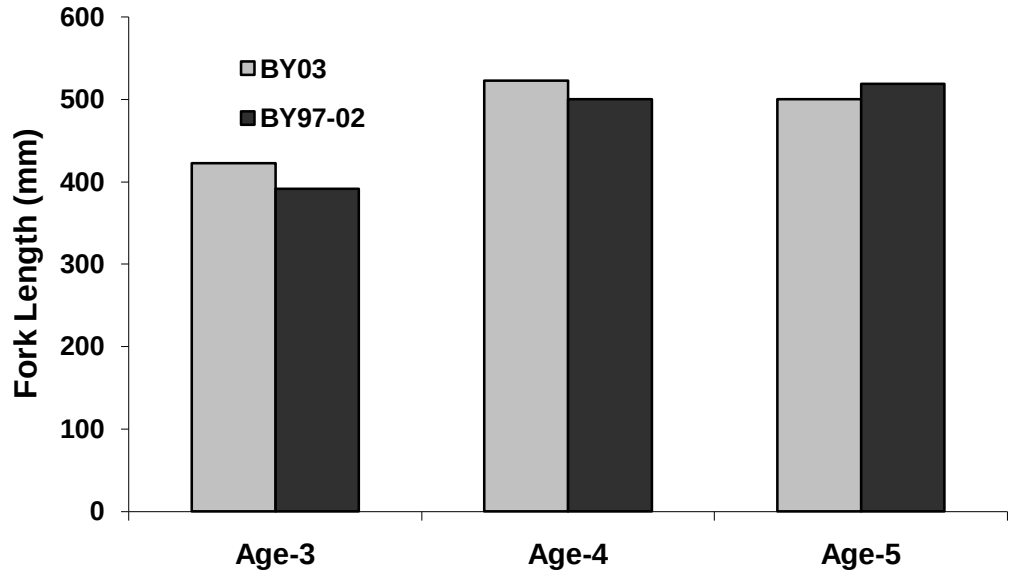


Figure 5. Length at maturity by age for captive-reared Chinook salmon from brood year 2003 (BY03) and the average of BY97-BY02. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish.

Volitional Spawning

In 2008, maturing adults were released into their natal streams for natural spawning and spawning observation studies on July 10 in the WFYF and July 21 on the EFSR (Appendix B). Fish destined for the EFSR upstream study section were held at the EFSR satellite weir holding ponds July 10-20 until the unusually high flows subsided enough to complete the temporary picket weir and were subsequently released on July 21. No transportation mortalities occurred in the WFYF stock while two mortalities occurred in the EFSR stock while being held at the EFSR satellite weir. At the time of release, the fish appeared to be in good condition. Only general spawning activity of captive-reared adults released into their natal streams was documented during 2008; habitat associations were not recorded as was done in previous years.

Radio tags were implanted in five of the 185 adults released into the WFYF for natural spawning. Radio-tagged fish were tracked one to two times weekly from July 14 through August 5, 2008. Tracking of radio-tagged fish revealed behavior consistent with previous years findings, including prolonged holding in one or two pools, downstream migration out of the WFYF, and upstream migration. However, all five radio-tagged fish either fell out of the WFYF drainage or were found dead by August 5, 2009. Despite the loss of radio-tagged fish, overall mortality of mature captive reared adult Chinook salmon released into both the WFYF and EFSR was less than previously observed.

Between August 27 and September 14, 2008, thirteen redds constructed by captive-reared adults were identified within the WFYF study area. The number of redds per captive female was greater than in 2007 but lower than all previous years except 2003 (Table 3). Between August 15 and September 17, 2008, eight redds constructed by natural adult Chinook salmon were identified in the WFYF by ground observers compared to the previous five-year average of 5.6. Annual Chinook salmon aerial redd counts conducted by IDFG Region 7 staff in WFYF trend sites identified 1 redd in 2008, compared to the previous five-year average of 9.2 (Table 4).

Between September 5 and September 24, 2008, 55 redds constructed by captive-reared adults were identified within the EFSR study area by ground counts. The number of redds per captive female was slightly lower than 2007 but higher than all previous years (Table 3). Between August 12 and September 3, 2007, 13 redds constructed by natural adults were identified within the EFSR study area by ground observers. Annual Chinook salmon aerial redd counts conducted by IDFG Region 7 staff in EFSR trend sites (NS-1a and NS-1b) identified 77 redds in 2008, compared to the previous five-year average of 70 (Table 4).

Table 3. Number of captive-reared female Chinook salmon released and redds produced by these fish, 2001-2008 in the West Fork Yankee Fork Salmon River (WFYF) and East Fork Salmon River (EFSR). Captive redds were enumerated via ground counts.

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
WFYF	2007	113	7	0.06
WFYF	2008	99	13	0.13
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
EFSR	2007	124	63	0.51
EFSR	2008	112	55	0.49

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

Table 4. Number of redds observed from aerial counts, 2000-2008 on the West Fork Yankee Fork Salmon River (WFYF) and East Fork Salmon River (EFSR).

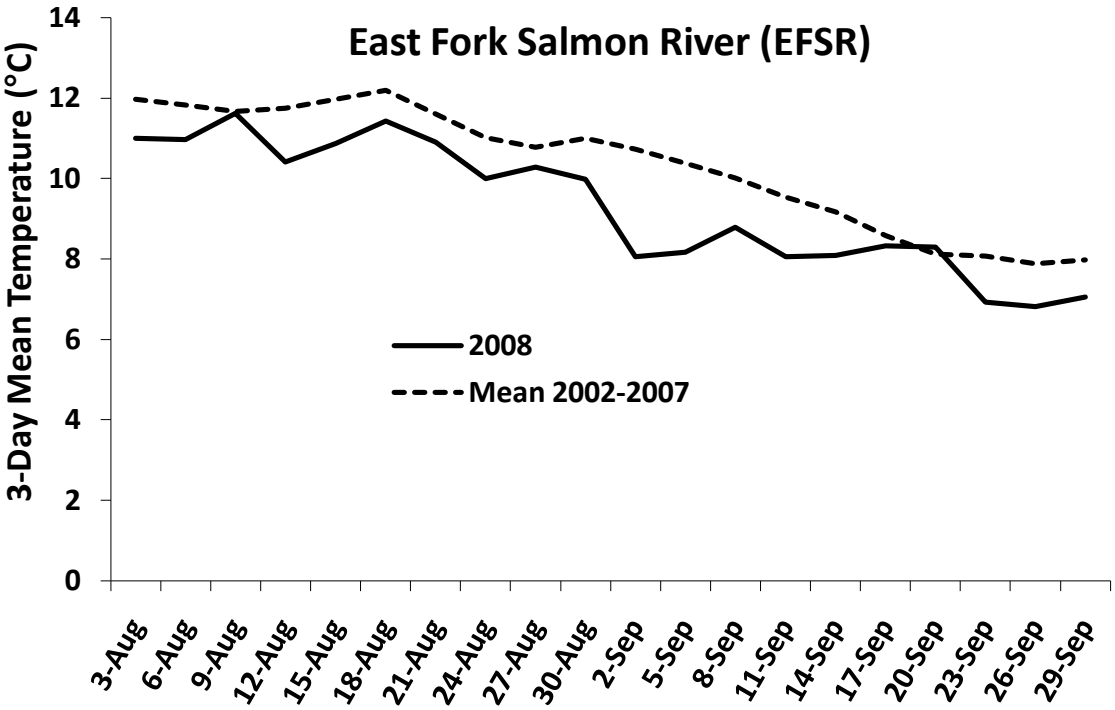
		Number of Redds								
Stream	**Section Description**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
WFYF	WFYF mouth to Lightning Cr[5]	4	10	10	18	5	1	0	7	1
	Lightning Cr to Cabin Cr[6]	0	3	1	7	0	0	0	0	0
	Total	**4**	**13**	**11**	**25**	**5**	**1**	**0**	**7**	**1**
EFSR	Mouth of East Fork to Herd Cr (NS-2a)[1]	12	17	56	15	38	12	7	3	34
	Herd Cr to 3.5 mi downstream of EF Weir (NS-2b)[2]	20	59	79	60	37	18	19	31	40
	3.5 mi downstream of EF Weir to EF Weir (NS-1a)[3]	18	48	100	93	55	32		21	50
	EF Weir to Bowrey Guard Station (NS-1b)[4]	9	12	44	59	24	16	2	25	27
	Total	**59**	**136**	**279**	**227**	**154**	**78**	**28**	**80**	**151**

Section Start Waypoint - Section End Waypoint (WGS-84 datum; Zone 11):

[1]713337mE 4905174mN - 715846mE 4892489mN
[2]715846mE 4892489mN - 709618mE 4891548mN
[3]709618mE 4891548mN - 705656mE 4887911mN
[4]705656mE 4887911mN - 700640mE 4872303mN
[5]681207mE 4913151mN - 675543mE 4917302mN
[6]675543mE 4917302mN - 672961mE 4918255mN

During 2008, water temperatures during August and September in the EFSR were cooler than the average of the previous six years, while those in the WFYF were similar to the six-year average (Figure 6). Water temperatures during August and September averaged 9.3°C in the EFSR (minimum 6.3°C / maximum 12.1°C) and 9.5°C in the WFYF (minimum 6.1°C / maximum 12.7°C).

Discharge (flow) of the EFSR during 2008 was slightly below average during the first two weeks of June, but higher than average from mid-June through the end of September (Figure 7). Discharge was especially high from mid-June through mid-July. Early summer low discharge and high discharge during mid-summer was likely the result of a cold spring and above-average winter snowpack. This delayed runoff and likely resulted in cooler than average (previous six years) August and September stream temperatures. Discharge data are not available on the WFYF, so we were not able to examine the relationship between discharge and stream temperatures there.



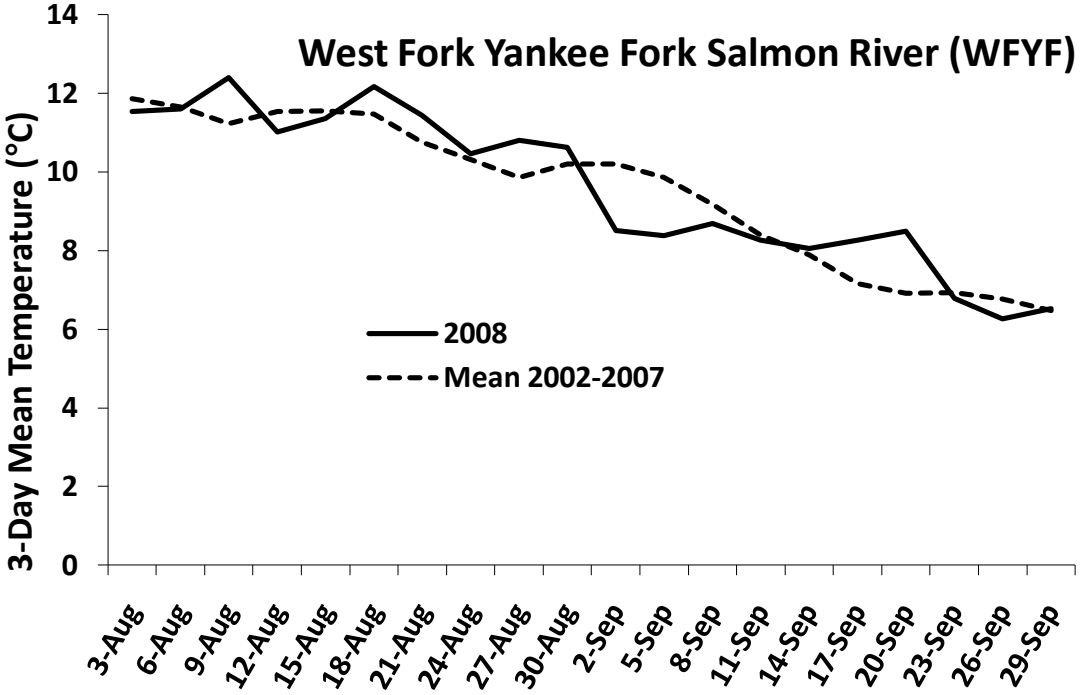


Figure 6. Three-day moving average temperatures in 2008 for the East Fork Salmon River (EFSR) and the West Fork Yankee Fork (WFYF) compared to the mean for 2002-2007.

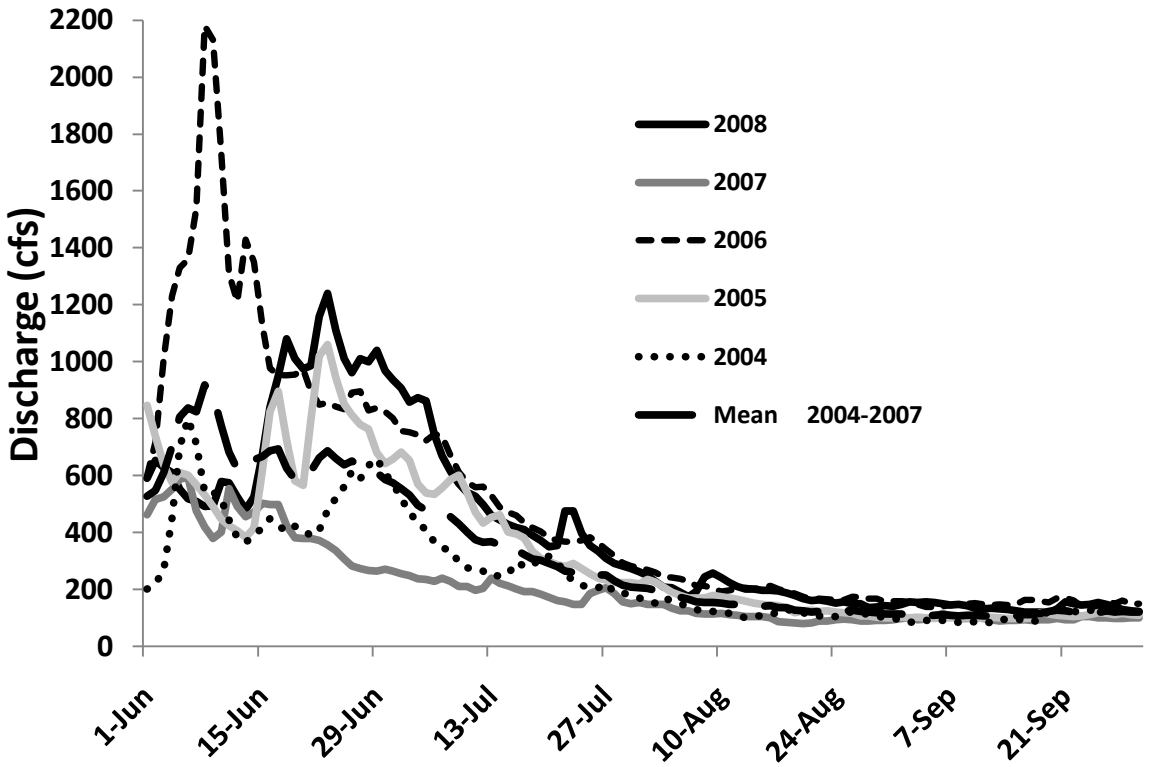


Figure 7. Discharge of the East Fork Salmon River (EFSR), June 1 – September 30, 2008.

Production Estimation

Juvenile Genetic Sampling

Genetic samples from 120 Chinook salmon juveniles were collected from the EFSR and 114 from the WFYF from June to September in 2008, with no reported mortalities. Samples collected in 2008 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 collected between October 4 and November 15, 2007 (BY07) included eggs from 15 redds constructed by captive-reared female adult Chinook salmon and 11 redds constructed by natural returning fish (Stark et. al. 2008). A portion of eyed-eggs collected from each redd (n = 40) were placed in egg capsules and into the substrate within their respective redd. These treatment egg capsules were then retrieved between April 9 and April 30, 2008, based upon accumulated Celsius Temperature Units (CTUs). From each egg capsule, all live fry were enumerated and released into the substrate in shallow low flow areas adjacent to their respective redd. All dead eggs, egg parts, and fry were also counted.

From the 430 BY07 natural origin eyed-eggs initially placed into capsules, 385 live fry were enumerated and released back into the stream (Table 5). Survival (± 95% CI) ranged from 72.5% to 100% and averaged 89.5% (± 0.06%); (Figure 8). Of the initial 600 captive eyed-eggs placed into capsules, 505 live fry were recovered and released. Survival ranged from 52.5% to 100% for all captive redds and averaged 84.2% (± 0.08%). Natural origin progeny demonstrated slightly better survival to emergence than captive-reared progeny from brood year 2007 studies. However, captive-reared survival was similar, and the difference in survival was statistically indistinguishable based on overlapping confidence intervals (Figure 8).

Primary sources of mortality in both groups appear to be from predatory invertebrates that move into the capsules, or from siltation events caused by localized disturbances. On occasion we experienced difficulty locating capsules again in the spring after flows altered stream channels. Another limitation to this method (egg capsule) is it does not account for post-hatch mortality that may occur as fry emigrate out of the natural gravel environment.

Table 5. Egg-to-fry survival of brood year 2007 (BY07) eyed-eggs collected in the East Fork Salmon River (EFSR). Eyed-eggs were collected during October and November 2007, counted into egg capsules, and returned to the redd. Capsules were then retrieved and live fry enumerated in April 2008.

Redd Number	Origin	Date Redd Completed	Eyed-eggs in Capsule	Date Retrieved	Dead (eggs, parts, fry)	Live Fry	Egg-to-fry Survival
1	natural	8/23/07	40	4/9/2008	0	40	1.00
2	natural	8/24/07	40	4/16/2008	0	40	1.00
4	natural	8/23/07	40	4/9/2008	0	32	0.80
5	natural	8/22/07	40	4/16/2008	2	40	1.00
6	natural	8/24/07	40	4/16/2008	0	40	1.00
7	natural	8/25/07	40	4/16/2008	2	34	0.85
8	natural	8/29/07	30	4/23/2008	1	26	0.87
11	natural	8/28/07	40	4/23/2008	1	29	0.73
15	natural	8/31/07	40	4/23/2008	1	33	0.83
18	natural	9/5/07	40	4/23/2008	0	34	0.85
19	natural	9/5/07	40	4/23/2008	0	37	0.93
20	captive	9/9/07	40	4/29/2008	0	40	1.00
21	captive	9/9/07	40	4/29/2008	5	31	0.78
22	captive	9/12/07	40	4/29/2008	0	36	0.90
24	captive	9/12/07	40	4/29/2008	0	40	1.00
27	captive	9/14/07	40	4/30/2008	6	21	0.53
28	captive	9/14/07	40	4/30/2008	10	24	0.60
29	captive	9/16/07	40	4/30/2008	3	34	0.85
30	captive	9/16/07	40	4/30/2008	11	26	0.65
31	captive	9/16/07	40	4/30/2008	2	33	0.83
32	captive	9/17/07	40	4/30/2008	0	33	0.83
33	captive	9/18/07	40	4/29/2008	1	31	0.78
34	captive	9/19/07	40	4/29/2008	0	33	0.83
36	captive	9/18/07	40	4/27/2008	0	40	1.00
37	captive	9/18/07	40	4/29/2008	0	40	1.00
38	captive	9/20/07	40	4/29/2008	1	38	0.95

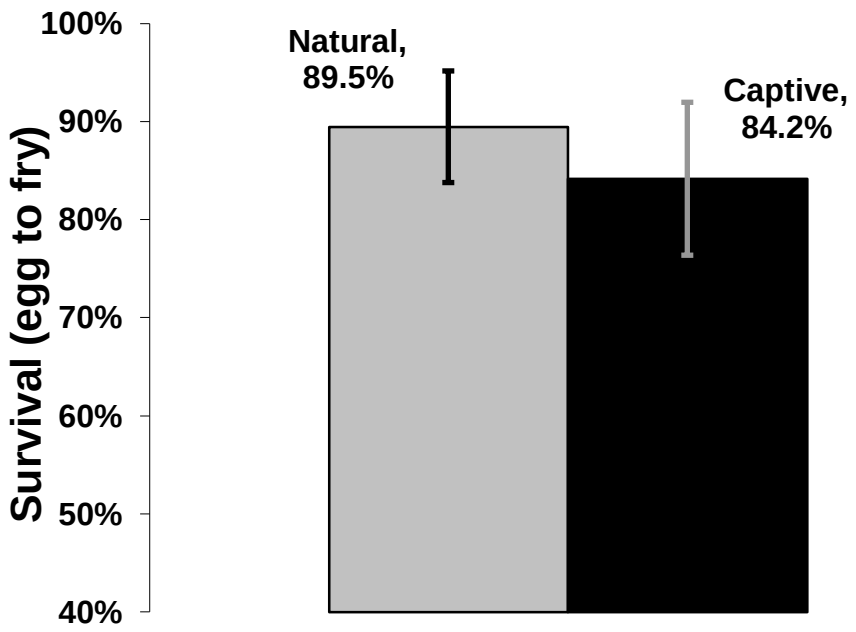


Figure 8. Comparison of egg-to-fry survival from brood year 2007 (BY07) eyed-egg collections from redds produced from natural versus captive reared Chinook salmon in the East Fork Salmon River (EFSR).

No eggs were collected for broodstock captive culture during this reporting period. All eyed-eggs collected during 2008 were used as research subjects for this study as described in the methods section. These BY08 eyed-eggs were used to establish either capsule (treatment) or hatchery (genetics) study groups.

Results from 2006 and 2007 emergence survival studies in the WFYF revealed very poor egg-to-fry survival of both natural and captive produced eggs. Low escapement and number of redds combined with very poor substrate from high sediment loads over the past several years created unfavorable conditions, which made it very difficult to evaluate emergence survival in the WFYF. Therefore, the WFYF was taken out of the study design, no redds (natural or captive) were pumped, and eyed-eggs were not collected from the WFYF in 2008.

Naturally spawned eyed-eggs were collected from September 29 to November 5, 2008 in EFSR study area. Collections totaled 2,832 eyed-eggs from the EFSR and included eggs from 15 redds constructed by captive-reared female adult Chinook salmon (n = 1,381) and 15 redds constructed by natural returning fish (n = 1,451; Table 6). Estimated survival to the eyed stage of development and CTUs at the time of collection are reported in Table 6. At the end of this reporting period, BY08 study groups were still developing (sac fry) in hatchery incubators and study redds. Emergence survival results from these fry will be covered in calendar year 2009 reporting.

Table 6. Summary of eyed-egg collections in the East Fork Salmon River (EFSR) as part of the emergence survival study during 2008. Celsius Temperature Units (CTUs) are reported for the time of collection. Redds which received additional egg capsules, when excess eyed-eggs were collected, are denoted as such with two or three sample sizes in the treatment capsule column.

Name	Origin	Collection Date	Treatment Capsule	Hatchery (genetics)	Survival To Eye	CTUs at Collection
JTG11EF	Natural	9/29/08	40	36	88.5%	382
JTG12EF	Natural	9/29/08	40 & 170	40	98.8%	382
KBK03EF	Natural	9/29/08	40	40	95.2%	437
JTG16EF	Natural	9/30/08	40	41	84.4%	390
JTG17EF	Natural	9/30/08	40	17	54.3%	390
KBK10EF	Natural	9/30/08	40 & 68	40	93.7%	366
KBK06EF	Natural	9/30/08	40	47	96.6%	366
KBK17EF	Natural	10/3/08	40	48	98.9%	368
JTG19EF	Natural	10/3/08	40	47	96.7%	357
KBK11EF	Natural	10/3/08	40	48	81.5%	378
EJS01EF	Natural	10/3/08	40 & 27	40	98.2%	348
EJS09EF	Natural	10/7/08	40 & 18	40	98.0%	356
EJS06EF	Natural	10/7/08	40	33	93.6%	356
EJS07EF	Natural	10/7/08	40	26	90.5%	356
KBK21EF	Natural	10/8/08	40	25	89.0%	332
KBK22EF	Captive	10/22/08	40	41	51.3%	357
KBK24EF	Captive	10/22/08	40 & 42	40	77.2%	357
KBK29EF	Captive	10/23/08	40	46	70.5%	341
KBK30EF	Captive	10/23/08	40	48	77.9%	341
KBK31EF	Captive	10/23/08	40	2	13.3%	341
DAB10EF	Captive	10/28/08	40 & 40	19	35.9%	337
DAB09EF	Captive	10/28/08	40	37	44.5%	337
KBK28EF	Captive	10/28/08	40 & 28	41	90.1%	366
DAB06EF	Captive	10/29/08	40	24	8.7%	343
KBK27EF	Captive	10/29/08	40	41	86.2%	372
JTG36EF	Captive	10/30/08	40	35	84.4%	326
JTG35EF	Captive	10/30/08	40, 40 & 63	91	98.7%	326
JTG32EF	Captive	10/30/08	40	34	39.4%	326
JTG37EF	Captive	11/5/08	40	32	97.3%	360
JTG31EF	Captive	11/5/08	40	37	41.0%	360
		Total:	**1381**	**1451**		

East Fork Salmon River Weir Operations

In 2008, the Sawtooth FH satellite weir on the EFSR was operated to collect genetic samples from returning natural Chinook salmon, as well as to monitor the movement of Chinook salmon and other resident species. During operation of the site from June 4 through September 24, two hundred seven adult Chinook salmon (64 females, 107 males, 36 jacks) were trapped at the facility and released upstream (Table 7). Caudal fin clips were collected from 206 of the 207 adult Chinook for genetic analyses. Two adipose-clipped Chinook salmon (hatchery origin) were trapped and subsequently relocated back to the mainstem Salmon R. (female) or expired in the trap (jack). Additional species trapped included bull trout *Salvelinus confluentus*, westslope cutthroat trout *O. clarkii lewisi*, rainbow trout *O. mykiss*, steelhead *O. mykiss*, mountain whitefish *Prosopium williamsoni*, sucker *Catostomus* spp. and one sockeye salmon *O. nerka* (Table 7).

Snorkeling surveys were conducted periodically in the pool immediately downstream of the weir to the confluence of Big Boulder Creek. No adult Chinook salmon were observed holding within the reach during the 2008 trapping season. Based on these observations, the weir did not appear to inhibit Chinook salmon from migrating upstream. Additional species observed during snorkeling included bull trout, rainbow trout, cutthroat trout, and mountain whitefish.

Table 7. Natural origin adult Chinook salmon distributions trapped at the East Fork Salmon River (EFSR) weir facility during 2008.

	Gender				
	Females	**Males**	**Jacks**		**Total**
June	2	0	0		2
July	36	35	12		83
August	26	68	21		115
Sept	0	4	3		7
Total	**62**	**109**	**36**		**207**
	Age				
Age (length)[a]	**3 (≤64 cm)**	**4 (64-82 cm)**	**5 (>82 cm)**		**Total**
Females	n/a	41	23		64
Males	n/a	73	34		107
Jacks	36	n/a	n/a		36
Total	**36**	**114**	**57**		**207**
	Recaptures				
Age (length)	**3 (≤64 cm)**	**4 (64-82 cm)**	**5 (>82 cm)**	**Unk[b]**	**Total**
Females	n/a	0	0	0	0
Males	n/a	14	3	2	19
Jacks	10	n/a	n/a	0	10
Total	**10**	**14**	**3**	**2**	**29**

[a] Fish were assigned ages based upon a previously established age-at-length relationship from natural origin EFSR Chinook salmon scale aging.
[b] Two recaptured male Chinook salmon jaw tags were unreadable and the lengths were not remeasured.

Table 8. Summary of additional fish trapped at the East Fork Salmon River weir and genetic samples collected from these fish during 2008.

Species	**Trapped [a]**	**Recaptured**	**Genetics Samples Collected**
Bull trout	170	25	101
Westslope cutthroat trout	5	0	5
Rainbow trout [b]	2	0	2
Mountain whitefish	128	1	36
Catostomus spp.	2	0	0
Steelhead (adult)	4	0	0
Sockeye salmon	1	0	0

[a] Including trapping mortality.
[b] Including one rainbow/cutthroat hybrid.

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APPENDICES

Appendix A. Summary of fish transfers conducted by the Chinook Salmon Captive Rearing Project during 2008. MAN = Manchester Research Station, WFYF = West Fork Yankee Fork River, POND = Sawtooth Hatchery - East Fork Salmon River satellite holding pond, EFSR = East Fork Salmon River, EAG = Eagle Fish Hatchery, Brood Year = BY, NE = natural egg.

Source Stream	BY	MAN to WFYF	Transfer Date	MAN to POND	Transfer Date	POND to EFSR	Transfer Date
WFYF-NE	02	1	7/10				
WFYF-NE	03	16	7/10				
WFYF-NE	04	88	7/10				
WFYF-NE	05	80	7/10				
EFSR-NE	03			13	7/10	13	7/21
EFSR-NE	04			107	7/10	106	7/21
EFSR-NE	05			39	7/10	38	7/21

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) in 2008. Fish were spaghetti-tagged for visual identification (Florescent = FL). A portable ultrasound unit was used on maturing fish reared at the Manchester Research Station to determine sex, and classified as female = FEM, or male = MAL.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF1F7E05E		EFSR	2003	MAL	GREEN
3D9.1BF1F72198		EFSR	2003	FEM	GREEN
3D9.1BF1A76FDD		EFSR	2003	FEM	GREEN
3D9.1BF1F78FA6		EFSR	2003	FEM	GREEN
3D9.1BF1F778E5		EFSR	2003	FEM	GREEN
3D9.1BF1F869AA		EFSR	2003	FEM	GREEN
3D9.1BF1A1CEC9		EFSR	2003	FEM	GREEN
3D9.1BF1A253BB		EFSR	2003	FEM	GREEN
3D9.1BF1A23916		EFSR	2003	MAL	GREEN
3D9.1BF1F8D034		EFSR	2003	FEM	GREEN
3D9.1BF1A23644		EFSR	2003	FEM	GREEN
3D9.1BF1F7EE2A		EFSR	2003	FEM	GREEN
3D9.1BF1A75BED		EFSR	2003	FEM	GREEN
3D9.1BF24314A9		EFSR	2004	FEM	FL PINK
3D9.1BF2433A29		EFSR	2004	FEM	FL PINK
3D9.1BF2433CEF		EFSR	2004	FEM	FL PINK
3D9.1BF24310E2		EFSR	2004	MAL	FL PINK
3D9.1BF2433D77		EFSR	2004	FEM	FL PINK
3D9.1BF242F7E2		EFSR	2004	FEM	FL PINK
3D9.1BF2433B2A		EFSR	2004	FEM	FL PINK
3D9.1BF242F9F7		EFSR	2004	MAL	FL PINK
3D9.1BF2433DBE		EFSR	2004	FEM	FL PINK
3D9.1BF2430C78		EFSR	2004	FEM	FL PINK
3D9.1BF2430FF0		EFSR	2004	FEM	FL PINK
3D9.1BF2433951		EFSR	2004	MAL	FL PINK
3D9.1BF24311A7		EFSR	2004	FEM	FL PINK
3D9.1BF24311B8		EFSR	2004	FEM	FL PINK
3D9.1BF2430E65		EFSR	2004	FEM	FL PINK
3D9.1BF242F4C7		EFSR	2004	FEM	FL PINK
3D9.1BF242FDA1		EFSR	2004	FEM	FL PINK
3D9.1BF2430D24		EFSR	2004	FEM	FL PINK
3D9.1BF2430FB4		EFSR	2004	FEM	FL PINK
3D9.1BF2433989		EFSR	2004	FEM	FL PINK
3D9.1BF2430C99		EFSR	2004	FEM	FL PINK
3D9.1BF242C437		EFSR	2004	FEM	FL PINK
3D9.1BF2430BB0		EFSR	2004	FEM	FL PINK
.....		EFSR	2004	FEM	FL PINK
3D9.1BF24339D7		EFSR	2004	FEM	FL PINK
3D9.1BF24312CE		EFSR	2004	FEM	FL PINK
3D9.1BF242F43A		EFSR	2004	MAL	FL PINK
3D9.1BF2431415		EFSR	2004	FEM	FL PINK
3D9.1BF243393F		EFSR	2004	FEM	FL PINK
3D9.1BF24312CF		EFSR	2004	FEM	FL PINK

Appendix B. Continued.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF242F338		EFSR	2004	FEM	FL PINK
3D9.1BF24310D6		EFSR	2004	FEM	FL PINK
3D9.1BF242C4E5		EFSR	2004	FEM	FL PINK
3D9.1BF2431267		EFSR	2004	FEM	FL PINK
3D9.1BF242C350		EFSR	2004	FEM	FL PINK
3D9.1BF243132D		EFSR	2004	FEM	FL PINK
3D9.1BF2431362		EFSR	2004	FEM	FL PINK
3D9.1BF24311C0		EFSR	2004	FEM	FL PINK
3D9.1BF242CAF6		EFSR	2004	FEM	FL PINK
3D9.1BF242FDB4		EFSR	2004	FEM	FL PINK
3D9.1BF2430C51		EFSR	2004	FEM	FL PINK
3D9.1BF242C47B		EFSR	2004	FEM	FL PINK
3D9.1BF242F768		EFSR	2004	FEM	FL PINK
3D9.1BF2430CBA		EFSR	2004	FEM	FL PINK
3D9.1BF242C39C		EFSR	2004	FEM	FL PINK
3D9.1BF2430FFB		EFSR	2004	FEM	FL PINK
3D9.1BF24309DA		EFSR	2004	FEM	FL PINK
3D9.1BF242F51A		EFSR	2004	FEM	FL PINK
3D9.1BF24311BD		EFSR	2004	FEM	FL PINK
3D9.1BF2430E0C		EFSR	2004	FEM	FL PINK
3D9.1BF242C386		EFSR	2004	FEM	FL PINK
3D9.1BF243122E		EFSR	2004	FEM	FL PINK
3D9.1BF2431028		EFSR	2004	FEM	FL PINK
3D9.1BF2433B5B		EFSR	2004	FEM	FL PINK
3D9.1BF2433A82		EFSR	2004	FEM	FL PINK
3D9.1BF242F838		EFSR	2004	FEM	FL PINK
3D9.1BF2431129		EFSR	2004	FEM	FL PINK
3D9.1BF242C44B		EFSR	2004	FEM	FL PINK
3D9.1BF242FDCA		EFSR	2004	FEM	FL PINK
3D9.1BF242C2C5		EFSR	2004	FEM	FL PINK
3D9.1BF2430F2B		EFSR	2004	FEM	FL PINK
3D9.1BF242FD63		EFSR	2004	FEM	FL PINK
3D9.1BF242FCB3		EFSR	2004	MAL	FL PINK
3D9.1BF2430AF9		EFSR	2004	FEM	FL PINK
3D9.1BF2430C4F		EFSR	2004	FEM	FL PINK
3D9.1BF2431466		EFSR	2004	FEM	FL PINK
3D9.1BF242F66A		EFSR	2004	FEM	FL PINK
3D9.1BF242FAD1		EFSR	2004	FEM	FL PINK
3D9.1BF24313AF		EFSR	2004	FEM	FL PINK
3D9.1BF242F72F		EFSR	2004	FEM	FL PINK
3D9.1BF24314E2		EFSR	2004	FEM	FL PINK
3D9.1BF2433DA4		EFSR	2004	FEM	FL PINK
3D9.1BF2430C97		EFSR	2004	FEM	FL PINK
3D9.1BF242F481		EFSR	2004	FEM	FL PINK
3D9.1BF242FA38		EFSR	2004	FEM	FL PINK
3D9.1BF242C591		EFSR	2004	FEM	FL PINK
3D9.1BF2433C55		EFSR	2004	FEM	FL PINK
3D9.1BF24339FC		EFSR	2004	FEM	FL PINK
3D9.1BF242F726		EFSR	2004	FEM	FL PINK

Appendix B. Continued.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF2431483		EFSR	2004	FEM	FL PINK
3D9.1BF2430ACD		EFSR	2004	FEM	FL PINK
3D9.1BF242F5E7		EFSR	2004	FEM	FL PINK
3D9.1BF2433C94		EFSR	2004	FEM	FL PINK
3D9.1BF242C3DA		EFSR	2004	FEM	FL PINK
3D9.1BF242F2F6		EFSR	2004	FEM	FL PINK
3D9.1BF2433B6C		EFSR	2004	FEM	FL PINK
3D9.1BF2430C72		EFSR	2004	FEM	FL PINK
3D9.1BF242FC0F		EFSR	2004	FEM	FL PINK
3D9.1BF242FE7C		EFSR	2004	FEM	FL PINK
3D9.1BF242C4EF		EFSR	2004	FEM	FL PINK
3D9.1BF2433998		EFSR	2004	FEM	FL PINK
3D9.1BF2433B41		EFSR	2004	FEM	FL PINK
3D9.1BF2433988		EFSR	2004	FEM	FL PINK
3D9.1BF2433C07		EFSR	2004	FEM	FL PINK
3D9.1BF243101F		EFSR	2004	FEM	FL PINK
3D9.1BF23E0D4D		EFSR	2004	FEM	FL PINK
3D9.1BF242FA1A		EFSR	2004	FEM	FL PINK
3D9.1BF24313D0		EFSR	2004	FEM	FL PINK
3D9.1BF24311E9		EFSR	2004	FEM	FL PINK
3D9.1BF242F3C5		EFSR	2004	MAL	FL PINK
3D9.1BF242F809		EFSR	2004	FEM	FL PINK
3D9.1BF242F7F9		EFSR	2004	FEM	FL PINK
3D9.1BF242FDA8		EFSR	2004	FEM	FL PINK
3D9.1BF242F7FB		EFSR	2004	FEM	FL PINK
3D9.1BF242FC9C		EFSR	2004	FEM	FL PINK
3D9.1BF242F83A		EFSR	2004	FEM	FL PINK
3D9.1BF2433E46		EFSR	2004	FEM	FL PINK
3D9.1BF25968EA		EFSR	2005	MAL	WHITE
3D9.1BF258492C		EFSR	2005	MAL	WHITE
3D9.1BF2591FC1		EFSR	2005	MAL	WHITE
3D9.1BF2596939		EFSR	2005	MAL	WHITE
3D9.1BF25946B5		EFSR	2005	MAL	WHITE
3D9.1BF258362C		EFSR	2005	MAL	WHITE
3D9.1BF2591EA7		EFSR	2005	MAL	WHITE
3D9.1BF259246D		EFSR	2005	MAL	WHITE
3D9.1BF2596434		EFSR	2005	MAL	WHITE
3D9.1BF25877A8		EFSR	2005	MAL	WHITE
3D9.1BF25968AE		EFSR	2005	MAL	WHITE
3D9.1BF2594F87		EFSR	2005	MAL	WHITE
3D9.1BF2586B5E		EFSR	2005	MAL	WHITE
3D9.1BF25860AF		EFSR	2005	MAL	WHITE
3D9.1BF25842DC		EFSR	2005	MAL	WHITE
3D9.1BF2594872		EFSR	2005	MAL	WHITE
3D9.1BF2584806		EFSR	2005	MAL	WHITE
3D9.1BF2590D65		EFSR	2005	MAL	WHITE
3D9.1BF2586A49		EFSR	2005	MAL	WHITE
3D9.1BF25843F7		EFSR	2005	MAL	WHITE
3D9.1BF258D091		EFSR	2005	MAL	WHITE

Appendix B. Continued.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF258CAFA		EFSR	2005	MAL	WHITE
3D9.1BF25845B0		EFSR	2005	MAL	WHITE
3D9.1BF25875F7		EFSR	2005	MAL	WHITE
3D9.1BF25869D3		EFSR	2005	MAL	WHITE
3D9.1BF25920BB		EFSR	2005	MAL	WHITE
3D9.1BF2587A22		EFSR	2005	MAL	WHITE
3D9.1BF25960C5		EFSR	2005	MAL	WHITE
3D9.1BF2587521		EFSR	2005	MAL	WHITE
3D9.1BF258467A		EFSR	2005	MAL	WHITE
3D9.1BF2590C1B		EFSR	2005	MAL	WHITE
3D9.1BF2584A1D		EFSR	2005	MAL	WHITE
3D9.1BF25921CC		EFSR	2005	MAL	WHITE
3D9.1BF2591006		EFSR	2005	MAL	WHITE
3D9.1BF258D318		EFSR	2005	MAL	WHITE
.....		EFSR	2005	MAL	WHITE
3D9.1BF2591D31		EFSR	2005	MAL	WHITE
3D9.1BF258C9D5		EFSR	2005	MAL	WHITE
3D9.1BF2590EE2		EFSR	2005	MAL	WHITE
3D9.1BF1BB41D5		WFYF	2002	FEM	WHITE
3D9.1BF1F7C466		WFYF	2003	FEM	YELLOW
3D9.1BF1F801C4		WFYF	2003	MAL	YELLOW
3D9.1BF1F7EF49		WFYF	2003	MAL	YELLOW
3D9.1BF1F7FE75		WFYF	2003	FEM	YELLOW
3D9.1BF1F821C8		WFYF	2003	FEM	YELLOW
3D9.1BF11B7435		WFYF	2003	FEM	YELLOW
3D9.1BF11B48D8		WFYF	2003	FEM	YELLOW
3D9.1BF1BB41D5		WFYF	2003	FEM	WHITE
3D9.1BF1A76172		WFYF	2003	FEM	YELLOW
3D9.1BF1F8577A		WFYF	2003	FEM	YELLOW
3D9.1BF1F7A161		WFYF	2003	FEM	YELLOW
3D9.1BF1F77326		WFYF	2003	FEM	YELLOW
3D9.1BF1F8B103		WFYF	2003	MAL	YELLOW
3D9.1BF1F78FC1		WFYF	2003	FEM	YELLOW
3D9.1BF1F7D2C2		WFYF	2003	FEM	YELLOW
.....		WFYF	2003	FEM	YELLOW
3D9.1BF2431059		WFYF	2004	FEM	FL GREEN
3D9.1BF24314DF		WFYF	2004	FEM	FL GREEN
3D9.1BF24310D9		WFYF	2004	FEM	FL GREEN
3D9.1BF243100C		WFYF	2004	FEM	FL GREEN
3D9.1BF242C35F		WFYF	2004	FEM	FL GREEN
3D9.1BF242FCCF		WFYF	2004	FEM	FL GREEN
3D9.1BF2431311	150.224	WFYF	2004	FEM	FL GREEN
3D9.1BF242FD1A		WFYF	2004	FEM	FL GREEN
3D9.1BF242F382		WFYF	2004	FEM	FL GREEN
3D9.1BF242F386		WFYF	2004	FEM	FL GREEN
3D9.1BF24310B7		WFYF	2004	FEM	FL GREEN
3D9.1BF242F64A		WFYF	2004	FEM	FL GREEN
3D9.1BF242F7EF		WFYF	2004	FEM	FL GREEN
3D9.1BF2433CDF		WFYF	2004	FEM	FL GREEN

Appendix B. Continued.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF2433AD5		WFYF	2004	FEM	FL GREEN
3D9.1BF242C19D		WFYF	2004	FEM	FL GREEN
3D9.1BF2433910		WFYF	2004	FEM	FL GREEN
3D9.1BF242C240		WFYF	2004	FEM	FL GREEN
3D9.1BF2433E43		WFYF	2004	FEM	FL GREEN
3D9.1BF242F750		WFYF	2004	FEM	FL GREEN
3D9.1BF2433CF0		WFYF	2004	FEM	FL GREEN
3D9.1BF2431158		WFYF	2004	FEM	FL GREEN
3D9.1BF242B7A6		WFYF	2004	FEM	FL GREEN
3D9.1BF24312F1		WFYF	2004	FEM	FL GREEN
3D9.1BF2431034		WFYF	2004	FEM	FL GREEN
3D9.1BF242F59D		WFYF	2004	FEM	FL GREEN
3D9.1BF242C47F		WFYF	2004	FEM	FL GREEN
3D9.1BF242CAAF		WFYF	2004	FEM	FL GREEN
3D9.1BF2430EEC		WFYF	2004	FEM	FL GREEN
3D9.1BF2433D27		WFYF	2004	FEM	FL GREEN
3D9.1BF242C49F		WFYF	2004	FEM	FL GREEN
3D9.1BF242F8B1		WFYF	2004	FEM	FL GREEN
3D9.1BF242C3D6		WFYF	2004	FEM	FL GREEN
3D9.1BF2431326		WFYF	2004	FEM	FL GREEN
3D9.1BF2433E48		WFYF	2004	FEM	FL GREEN
3D9.1BF242C40C		WFYF	2004	FEM	FL GREEN
3D9.1BF242C7EC		WFYF	2004	FEM	FL GREEN
3D9.1BF24314EC		WFYF	2004	FEM	FL GREEN
3D9.1BF242F940		WFYF	2004	FEM	FL GREEN
3D9.1BF2433D21		WFYF	2004	FEM	FL GREEN
3D9.1BF2430FC6		WFYF	2004	FEM	FL GREEN
3D9.1BF2431085		WFYF	2004	FEM	FL GREEN
3D9.1BF242FD6E		WFYF	2004	FEM	FL GREEN
3D9.1BF2433B9F		WFYF	2004	FEM	FL GREEN
3D9.1BF242C42F		WFYF	2004	FEM	FL GREEN
3D9.1BF2430FD7		WFYF	2004	FEM	FL GREEN
3D9.1BF242FA30	150.245	WFYF	2004	FEM	FL GREEN
3D9.1BF2430DE8		WFYF	2004	FEM	FL GREEN
3D9.1BF2433C8F		WFYF	2004	FEM	FL GREEN
3D9.1BF242FBA9		WFYF	2004	FEM	FL GREEN
3D9.1BF242C4AE		WFYF	2004	FEM	FL GREEN
3D9.1BF24312A9		WFYF	2004	FEM	FL GREEN
3D9.1BF2430CDA		WFYF	2004	FEM	FL GREEN
3D9.1BF2430E3C		WFYF	2004	FEM	FL GREEN
3D9.1BF2431232		WFYF	2004	FEM	FL GREEN
3D9.1BF242C439	150.203	WFYF	2004	FEM	FL GREEN
3D9.1BF242FCE5		WFYF	2004	FEM	FL GREEN
3D9.1BF2431007	151.012	WFYF	2004	FEM	FL GREEN
3D9.1BF2431463		WFYF	2004	FEM	FL GREEN
3D9.1BF2430CEC		WFYF	2004	FEM	FL GREEN
3D9.1BF2433963		WFYF	2004	FEM	FL GREEN
3D9.1BF2433B20		WFYF	2004	FEM	FL GREEN
3D9.1BF24310C0		WFYF	2004	FEM	FL GREEN

Appendix B. Continued.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF242F6E9		WFYF	2004	FEM	FL GREEN
3D9.1BF242F782		WFYF	2004	FEM	FL GREEN
3D9.1BF242F4E6		WFYF	2004	FEM	FL GREEN
3D9.1BF242F7DC		WFYF	2004	FEM	FL GREEN
3D9.1BF2433961		WFYF	2004	FEM	FL GREEN
3D9.1BF2433A8A		WFYF	2004	FEM	FL GREEN
3D9.1BF2430AD3		WFYF	2004	FEM	FL GREEN
3D9.1BF242F9D2		WFYF	2004	FEM	FL GREEN
3D9.1BF242FD17		WFYF	2004	FEM	FL GREEN
3D9.1BF242F7DB		WFYF	2004	MAL	FL GREEN
3D9.1BF243395F		WFYF	2004	FEM	FL GREEN
3D9.1BF24313A8		WFYF	2004	FEM	FL GREEN
3D9.1BF2430F7E		WFYF	2004	FEM	FL GREEN
3D9.1BF2433D02		WFYF	2004	MAL	FL GREEN
3D9.1BF2433D71		WFYF	2004	FEM	FL GREEN
3D9.1BF242F505	151.035	WFYF	2004	FEM	FL GREEN
3D9.1BF243127A		WFYF	2004	FEM	FL GREEN
3D9.1BF242FA24		WFYF	2004	FEM	FL GREEN
3D9.1BF242C34E		WFYF	2004	FEM	FL GREEN
3D9.1BF243111C		WFYF	2004	FEM	FL GREEN
3D9.1BF242F5D5		WFYF	2004	FEM	FL GREEN
3D9.1BF242FD8D		WFYF	2004	FEM	FL GREEN
3D9.1BF242C4D8		WFYF	2004	FEM	FL GREEN
3D9.1BF242C455		WFYF	2004	MAL	FL GREEN
3D9.1BF242F445		WFYF	2004	FEM	FL GREEN
3D9.1BF258CB1A		WFYF	2005	MAL	ORANGE
3D9.1BF2590DEC		WFYF	2005	MAL	ORANGE
3D9.1BF2592DD3		WFYF	2005	MAL	ORANGE
3D9.1BF2596BC0		WFYF	2005	MAL	ORANGE
3D9.1BF25842D2		WFYF	2005	MAL	ORANGE
3D9.1BF2592E1E		WFYF	2005	MAL	ORANGE
3D9.1BF2596A2D		WFYF	2005	MAL	ORANGE
3D9.1BF2594CEE		WFYF	2005	MAL	ORANGE
3D9.1BF2591FDE		WFYF	2005	MAL	ORANGE
3D9.1BF25923D2		WFYF	2005	MAL	ORANGE
3D9.1BF2584713		WFYF	2005	MAL	ORANGE
3D9.1BF2591DC1		WFYF	2005	MAL	ORANGE
3D9.1BF2595C20		WFYF	2005	MAL	ORANGE
3D9.1BF2584750		WFYF	2005	MAL	ORANGE
3D9.1BF2584920		WFYF	2005	MAL	ORANGE
3D9.1BF2584781		WFYF	2005	MAL	ORANGE
3D9.1BF25871AA		WFYF	2005	MAL	ORANGE
3D9.1BF2596239		WFYF	2005	MAL	ORANGE
3D9.1BF2592D1C		WFYF	2005	MAL	ORANGE
3D9.1BF25920D4		WFYF	2005	MAL	ORANGE
3D9.1BF259288E		WFYF	2005	MAL	ORANGE
3D9.1BF259478E		WFYF	2005	MAL	ORANGE
3D9.1BF2594F1D		WFYF	2005	MAL	ORANGE
3D9.1BF2591738		WFYF	2005	MAL	ORANGE

Appendix B. Continued.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF2592396		WFYF	2005	MAL	ORANGE
3D9.1BF2591F50		WFYF	2005	MAL	ORANGE
3D9.1BF2591019		WFYF	2005	MAL	ORANGE
3D9.1BF25835F6		WFYF	2005	MAL	ORANGE
3D9.1BF258592B		WFYF	2005	MAL	ORANGE
3D9.1BF258F726		WFYF	2005	MAL	ORANGE
3D9.1BF2591E10		WFYF	2005	MAL	ORANGE
3D9.1BF2594FEF		WFYF	2005	MAL	ORANGE
3D9.1BF25963E5		WFYF	2005	MAL	ORANGE
3D9.1BF258C97C		WFYF	2005	MAL	ORANGE
3D9.1BF2596667		WFYF	2005	MAL	ORANGE
3D9.1BF2591761		WFYF	2005	MAL	ORANGE
3D9.1BF2591050		WFYF	2005	MAL	ORANGE
3D9.1BF2594F76		WFYF	2005	MAL	ORANGE
3D9.1BF2596449		WFYF	2005	MAL	ORANGE
3D9.1BF2587792		WFYF	2005	MAL	ORANGE
3D9.1BF2591CB6		WFYF	2005	MAL	ORANGE
3D9.1BF2585EE0		WFYF	2005	MAL	ORANGE
3D9.1BF2586B61		WFYF	2005	MAL	ORANGE
3D9.1BF2596638		WFYF	2005	MAL	ORANGE
3D9.1BF2586F4C		WFYF	2005	MAL	ORANGE
3D9.1BF2590DE7		WFYF	2005	MAL	ORANGE
3D9.1BF2590E16		WFYF	2005	MAL	ORANGE
3D9.1BF2592202		WFYF	2005	MAL	ORANGE
3D9.1BF25835BD		WFYF	2005	MAL	ORANGE
3D9.1BF2592C9C		WFYF	2005	MAL	ORANGE
3D9.1BF2587466		WFYF	2005	MAL	ORANGE
3D9.1BF259175E		WFYF	2005	MAL	ORANGE
3D9.1BF2590D0A		WFYF	2005	MAL	ORANGE
3D9.1BF2591014		WFYF	2005	MAL	ORANGE
3D9.1BF25969C2		WFYF	2005	MAL	ORANGE
3D9.1BF2596673		WFYF	2005	MAL	ORANGE
3D9.1BF25878BB		WFYF	2005	MAL	ORANGE
3D9.1BF258CCC1		WFYF	2005	MAL	ORANGE
3D9.1BF258F6A1		WFYF	2005	MAL	ORANGE
3D9.1BF258452A		WFYF	2005	MAL	ORANGE
3D9.1BF2587738		WFYF	2005	MAL	ORANGE
3D9.1BF2595A44		WFYF	2005	MAL	ORANGE
3D9.1BF259261A		WFYF	2005	MAL	ORANGE
3D9.1BF2594E0C		WFYF	2005	MAL	ORANGE
3D9.1BF258C989		WFYF	2005	MAL	ORANGE
3D9.1BF2586890		WFYF	2005	MAL	ORANGE
3D9.1BF2596907		WFYF	2005	MAL	ORANGE
3D9.1BF25910C7		WFYF	2005	MAL	ORANGE
3D9.1BF259257A		WFYF	2005	MAL	ORANGE
3D9.1BF2585EAD		WFYF	2005	MAL	ORANGE
3D9.1BF2586AB7		WFYF	2005	MAL	ORANGE
3D9.1BF2590FB9		WFYF	2005	MAL	ORANGE
3D9.1BF25947C7		WFYF	2005	MAL	ORANGE

Appendix B. Continued.

Pit Tag Number	Radio Tag	Stock	BY	Sex	Tag Color
3D9.1BF25965DD		WFYF	2005	MAL	ORANGE
3D9.1BF2590F5C		WFYF	2005	MAL	ORANGE
3D9.1BF2590C42		WFYF	2005	MAL	ORANGE
3D9.1BF25976C7		WFYF	2005	MAL	ORANGE
3D9.1BF2587719		WFYF	2005	MAL	ORANGE
3D9.1BF258690E		WFYF	2005	MAL	ORANGE
3D9.1BF2590F08		WFYF	2005	MAL	ORANGE

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