FISHERY RESEARCH

CAPTIVE REARING PROGRAM FOR SALMON RIVER CHINOOK SALMON

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CAPTIVE REARING PROGRAM FOR SALMON RIVER CHINOOK SALMON

Project Progress Report

2009 Annual Report

By

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ABSTRACT

During 2009, 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 2009; brood year 2005 (BY05) represented the final brood cohorts collected for full-term captive rearing studies in the EFSR and WFYF. During 2009, no captive Chinook remained in freshwater rearing at Eagle Fish Hatchery (FH). All remaining brood years (BY04 and BY05) were rearing to maturity in saltwater at the Manchester Research Station, Manchester, Washington (Manchester) during 2009. Maturing fish transfers from Manchester to Idaho for release to natal waters included 103 individuals from the WFYF and 120 from the EFSR. All maturing captive-reared Chinook salmon were released in 2009. 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. Sixteen redds were constructed by volitionally spawning captive-reared Chinook salmon females in the WFYF and 15 constructed upstream of the East Fork trap in the EFSR. Fin samples from Chinook salmon parr were collected in the WFYF (n = 93) and the EFSR (n = 230) to assess production levels from volitional spawning events resulting from program releases conducted in 2008. 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 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). 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 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 its natal stream 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, 2009 through December 31, 2009. 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 39364 and 44419.

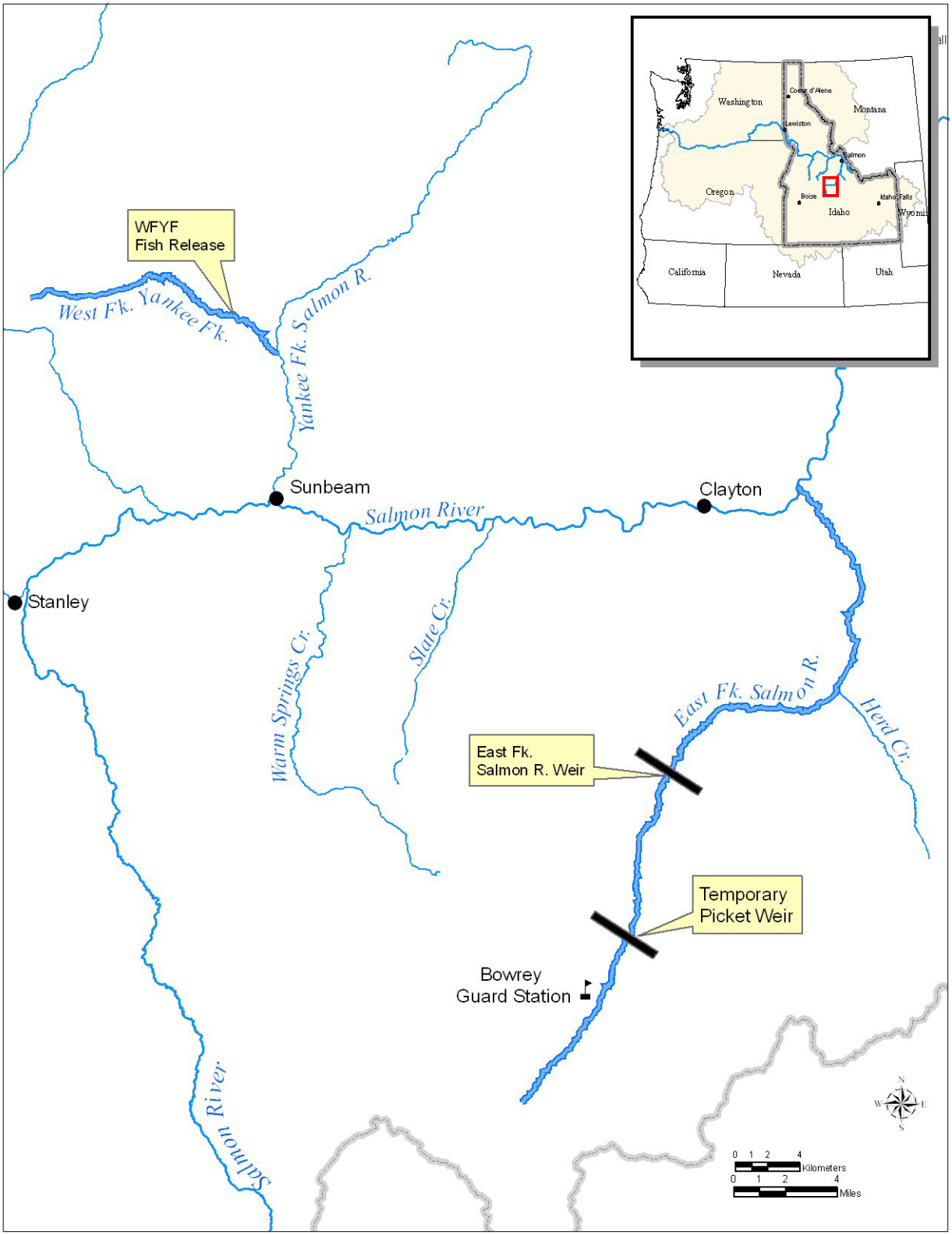


Figure 1. Location of study streams included in the Idaho Department of Fish and Game Captive Rearing Program for Salmon River Chinook salmon.

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 2007-403-00.

Juvenile Rearing, Marking, and Transportation

No juvenile rearing was performed during 2009. 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 during 2009 included 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 BY04 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

During 2009, unlike previous years, installation of a fish weir in the EFSR was not utilized to keep captive reared fish confined upstream of the weir. Instead, they were released below the historic study area and allowed to disperse and spawn amongst natural fish. Thus, assessment of captive reared Chinook salmon spawning success was performed alongside natural Chinook spawning observations. Generally, study sections were divided into multiple reaches of varying length to permit systematic observations of Chinook salmon spawning. 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.

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 hand-held 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 as in years previous, 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:

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 spring of 2010.

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 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.

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, and any apparent difference determined statistically significant if the confidence intervals of their means did not overlap.

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, 2009. 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 2009. 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 2009; 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 2009. Mature adults were transported on July 8 and included fish from two brood years (BY04 and BY05) for the WFYF stock and two brood years (BY04 and BY05) for the EFSR stock (Appendix A). On July 20, EFSR Chinook were transported from the holding pond and released to the EFSR for volitional spawning.

On June 17, spaghetti tags were attached to EFSR and WFYF Chinook salmon destined for release to their natal streams. A total of 103 WFYF and 122 EFSR Chinook salmon were tagged during this event (Table 2). Post-tagging mortality occurred in one fish (EFSR). No mortalities were observed during transport of the WFYF and EFSR stocks in 2009.

On July 8, 103 and 121 Chinook salmon were released into the WFYF and EFSR satellite weir holding pond, respectively (Table 2). One mortality was observed in the EFSR stock during holding at the satellite holding pond prior to release; therefore, 120 Chinook salmon were released into the EFSR for volitional spawning. Radio transmitters were not utilized in captive-reared Chinook salmon released into the WFYF in 2009.

Table 2. Number of captive-reared Chinook salmon tagged and released into their natal waters (West Fork Yankee Fork Salmon River = WFYF and East Fork Salmon River = EFSR). Tagging mortalities, mean fork length (FL), and mean weight of adults are summarized by stock, brood year (BY), and sex. No transfer mortalities were observed in 2009.

			Tagged		Released		
Stock / Release Location	**BY**	**Sex**	**Number Tagged**	**Tagging Mortalities**	**Number Released [a]**	**Mean FL (mm)**	**Mean Wt. (g)**
EFSR	2004	Female	5	0	5	545.0	2,474
EFSR	2004	Male	1	0	1	638.0	3,909
EFSR	2005	Female	109	1	107	522.2	2,239
EFSR	2005	Male	7	0	7	493.3	1,831
		Total EFSR	**122**	**1**	**120**		
WFYF	2004	Female	2	0	2	459.5	1,675
WFYF	2004	Male	0	0	0	NA	NA
WFYF	2005	Female	96	0	96	525.4	2,222
WFYF	2005	Male	5	0	5	514.0	2,033
		Total WFYF	**103**	**0**	**103**		
		TOTAL ALL	**225**	**1**	**223**		

[a] One EFSR BY 2005 female captive Chinook mortality occurred while holding at the EFSR adult trap ponds.

Fish Health Monitoring

Pathogen Sampling and Detection

During calendar year 2009, 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 2009, 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 2009.

Growth and Survival of Brood Year 2004

Brood year 2004 captive-reared Chinook salmon were transferred as smolts to Manchester in May 2006. 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 427 BY04 EFSR eyed-eggs collected, 212 fish (49.7%) survived to maturity (productive mature adult); 203 fish (47.5%) died as immature fish (n = 125) or unproductive mature fish (n = 78). It should be noted that 156 (98 immature and 58 mature) of the total 203 mortalities (76.8%) occurred in age-2 fish at MAN between May 17 and May 19, 2006. An additional 12 BY04 EFSR fish were unaccounted or missing (2.8%). Of the 264 BY04 WFYF eyed-eggs collected, 233 fish (88.3%) survived to maturity (productive mature adult), 31 fish (11.7%) died as immature fish (n = 17) or unproductive mature fish (n = 14; Figure 3).

Of the 212 fish that matured in the EFSR cohort, eight fish (3.8%) matured as age-2 (precocial) adults, 91 fish (42.9%) matured as age-3 fish, 107 fish (50.5%) matured as age-4 fish, and six fish (2.8%) matured as age-5 fish. Of the 203 fish that died during culture of the EFSR cohort, one fish (0.5%) died as age-1, 156 fish (76.8%) died as age-2, 18 fish (8.9%) died as age-3, 24 fish (11.8%) died as age-4, and four fish (2.0%) died as age-5 fish (Figure 3).

Of the 233 fish that matured in the WFYF cohort, 67 fish (28.8%) matured as age-2 (precocial) adults, 76 fish (32.6%) matured as age-3 fish, 88 fish (37.8%) matured as age-4, and two fish (0.8%) matured as age-5 fish. Of the 31 fish that died in culture from the WFYF cohort, two fish (6.5%) died as age-1, four fish (12.9%) died as age-2, nine fish (29.0%) died as age-3, 15 fish (48.4%) died as age-4, and one fish (3.2%) died as age-5 fish (Figure 3).

A total of 540 fish reached maturity from a total of 691 (including unproductive mature fish). Precocity rates (age-2 maturation) averaged 29.5% in the EFSR stock and 37.4% in the WFYF stock for BY04, compared to brood years 97-03 average rate of 35.4% (Hassemer et al. 2001; Venditti et al. 2002, 2003a, 2003b, 2005). The average maturation rate (productive mature adult) combined for both stocks of BY04 fish (64.4%) was greater than the average of the previous five brood years (BY99-03 = 58.8%). Compared to brood years 1997-2003 mean weight at maturity, BY04 age-3 were similar in weight, age-4 fish weighed less, and age-5 were heavier (Figure 4). The mean length at maturity of BY04 EFSR and WFYF fish combined was very similar to that of previous brood years for all ages (Figure 5).

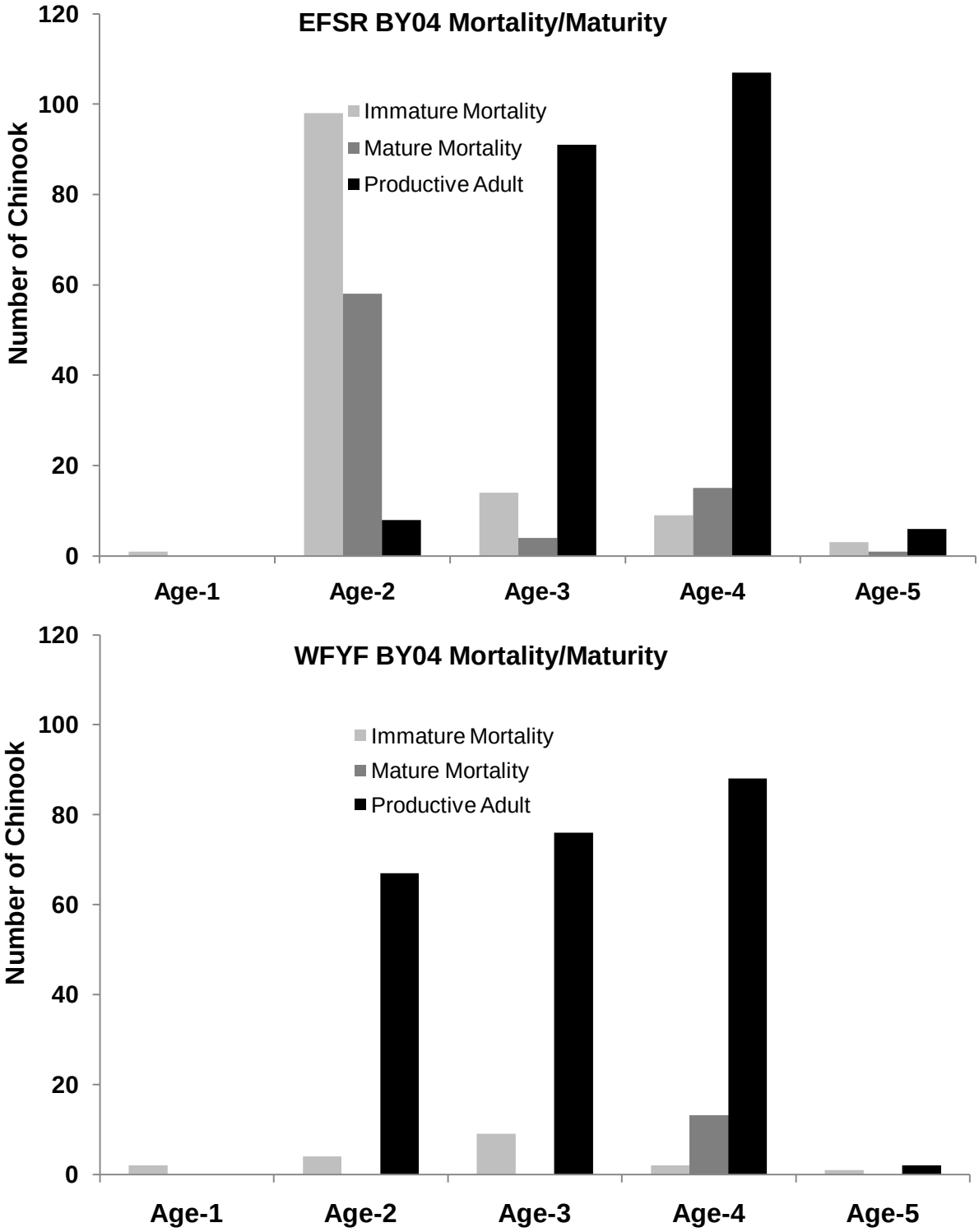


Figure 3. Mortality by age and age at maturation for East Fork Salmon River (EFSR) and West Fork Yankee Fork (WFYF) captive-reared brood year 2004 (BY04) stocks. Immature Mortality = fish that died prior to reaching sexual maturity; Mature Mortality = fish that reached sexual maturity but did not spawn; Productive Adult = fish that reached sexual maturity and were released to spawn.

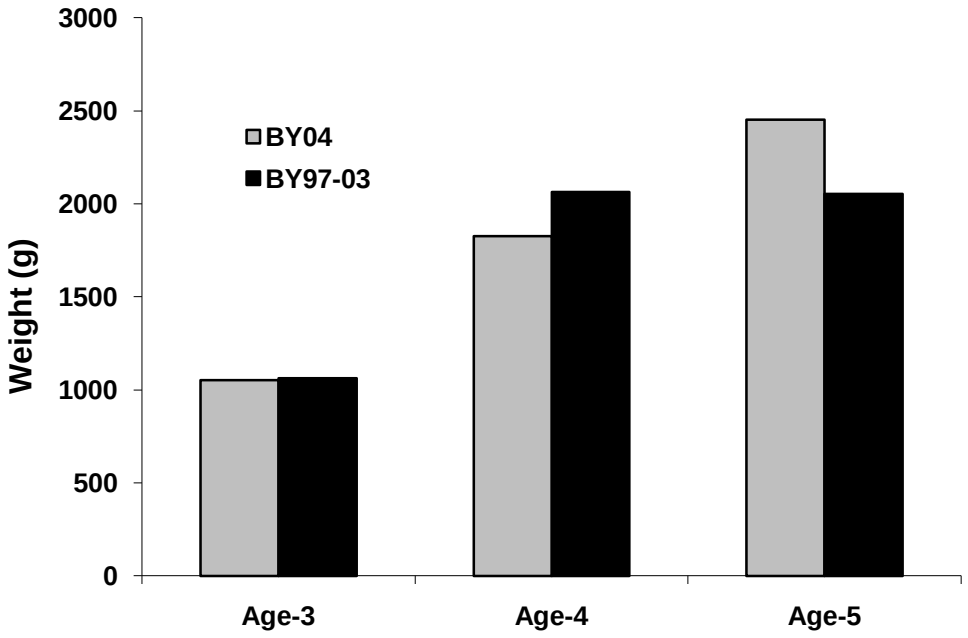


Figure 4. Weight at maturity by age for captive-reared Chinook salmon from brood year 2004 (BY04) and the average of BY98-BY03. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish.

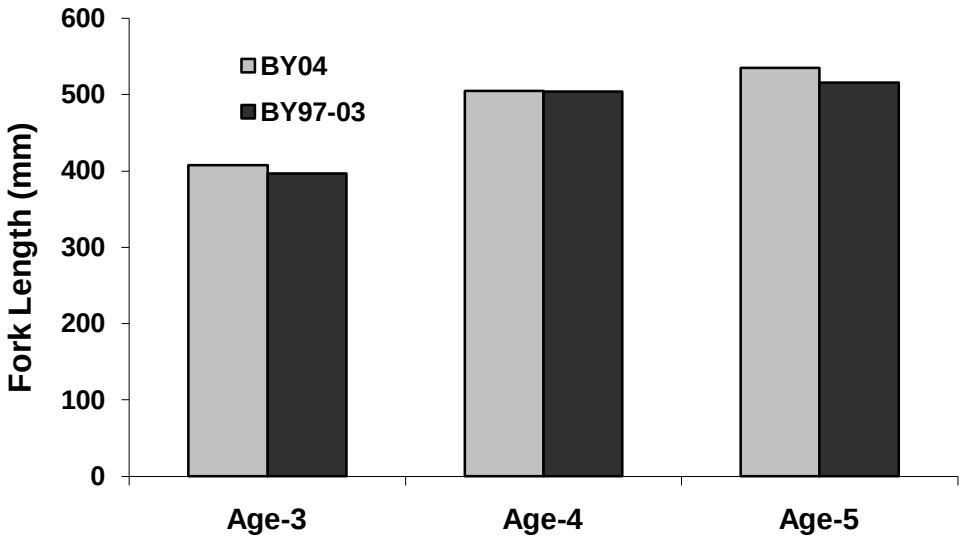


Figure 5. Length at maturity by age for captive-reared Chinook salmon from brood year 2004 (BY04) and the average of BY98-BY03. No data is available for BY97 age-3, BY00 age-5, or BY01 age-5 fish.

Volitional Spawning

In 2009, maturing adults were released into their natal streams for natural spawning and spawning observation studies on July 8 in the WFYF and July 20 on the EFSR (Appendix B). Fish destined for the EFSR upstream study section were held at the EFSR satellite weir holding ponds July 8-19 then subsequently released on July 20. No transportation mortalities occurred in either the WFYF or EFSR stocks. However, one mortality occurred while fish were 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 2009; habitat associations were not recorded as was done in previous years.

Radio tags were not implanted in adults released into the WFYF for natural spawning in 2009; therefore, radio tracking was not conducted. Radio-tagging of captive reared adults in previous years revealed consistent findings, including prolonged holding in one or two pools, downstream migration out of the WFYF, and upstream migration. Thus, radio tagging and subsequent tracking were not deemed necessary in 2009.

Between August 24 and September 21, 2009, sixteen redds constructed by captive-reared adults were identified within the WFYF and an additional 12 were located in the Yankee Fork downstream of the WF confluence. The number of redds per captive female (0.29) was higher than the 2001-2008 average (0.19; Table 3). Between August 10 and September 21, 2009, three redds constructed by natural adult Chinook salmon were identified in the WFYF by ground observers compared to the previous five-year average of five (Appendix C). Annual Chinook salmon aerial redd counts conducted by IDFG Region 7 staff in WFYF trend sites identified one redd in 2009, compared to the previous five-year average of 2.8 (Table 4).

Between August 16 and September 18, 2009, 15 redds constructed by captive-reared adults were identified upstream of the EF weir, and an additional four were located downstream of the weir. The number of redds per captive female (0.17) was less than the previous five-year average of 0.41 (Table 3), though a blocking weir was not installed to confine captive spawning to a specific upstream area in 2009. Between August 5 and September 21, 2009, 49 redds constructed by natural adults were identified upstream of the EF weir, and an additional 66 were located within 6 km downstream of the weir (Appendix C). Annual Chinook salmon aerial redd counts conducted by IDFG Region 7 staff in EFSR trend sites (NS-1a and NS-1b) identified 22 redds in 2009, compared to the previous five-year average of 54 (Table 4).

Table 3. Number of captive-reared female Chinook salmon released and redds produced by these fish, 2001-2009 in the West Fork Yankee Fork Salmon River (WFYF), Yankee Fork Salmon River (YFSR) 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
WFYF	2009	98	28[b]	0.29
YFSR	2009			
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
EFSR	2009	112	19	0.17

[a] No fish survived to spawn post release in 2003 due to unknown causes (Venditti et al. 2004).
[b] Includes twelve redds located in the YFSR, downstream of the WFYF confluence

Table 4. Number of redds observed from aerial counts, 2000-2009 on the West Fork Yankee Fork Salmon River (WFYF) and East Fork Salmon River (EFSR).

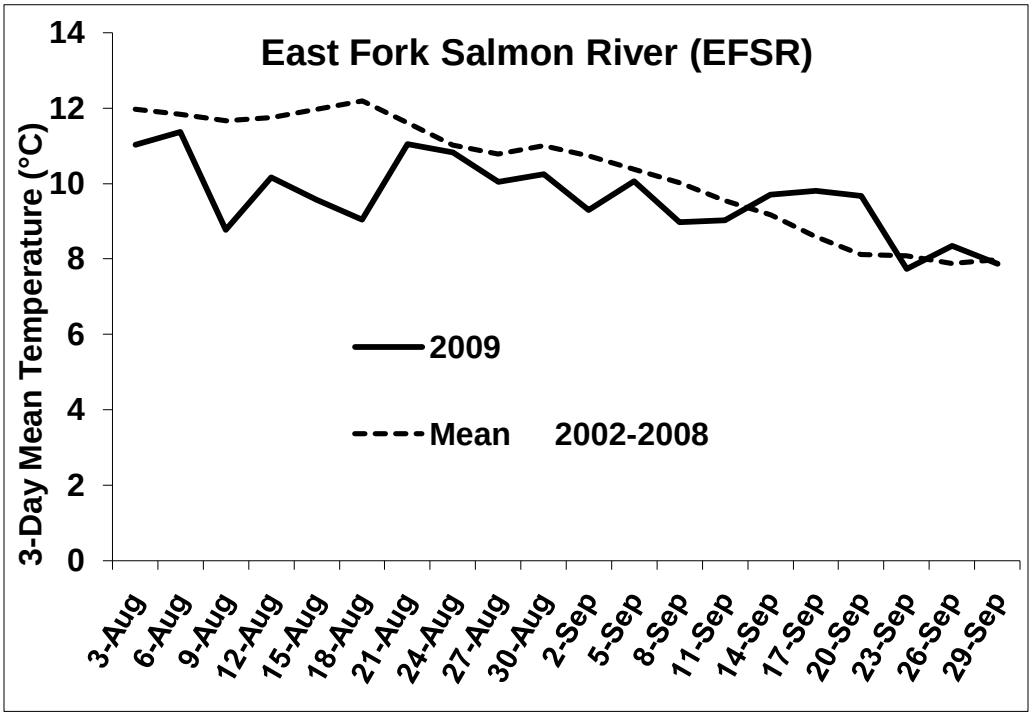
Stream	Section Description	Number of Redds									
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
WFYF	WFYF mouth to Lightning Cr[5]	4	10	10	18	5	1	0	7	1	1
	Lightning Cr to Cabin Cr[6]	0	3	1	7	0	0	0	0	0	0
	Total	**4**	**13**	**11**	**25**	**5**	**1**	**0**	**7**	**1**	**1**
EFSR	Mouth of East Fork to Herd Cr (NS-2a)[1]	12	17	56	15	38	12	7	3	34	13
	Herd Cr to 3.5 mi downstream of EF Weir (NS-2b)[2]	20	59	79	60	37	18	19	31	40	24
	3.5 mi downstream of EF Weir to EF Weir (NS-1a)[3]	18	48	100	93	55	32		21	50	13
	EF Weir to Bowrey Guard Station (NS-1b)[4]	9	12	44	59	24	16	2	25	27	9
	Total	**59**	**136**	**279**	**227**	**154**	**78**	**28**	**80**	**151**	**59**

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 2009, water temperatures during August and September in the EFSR were cooler than the average of the previous six years (10.3°C), while those in the WFYF were warmer than the six-year average (9.5°C; Figure 6). Water temperatures during August and September averaged 9.6°C in the EFSR (minimum 6.3°C / maximum 11.5°C) and 10.1°C in the WFYF (minimum 5.9°C / maximum 12.6°C).

Discharge (flow) of the EFSR during 2009 was above average during most of the year (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.



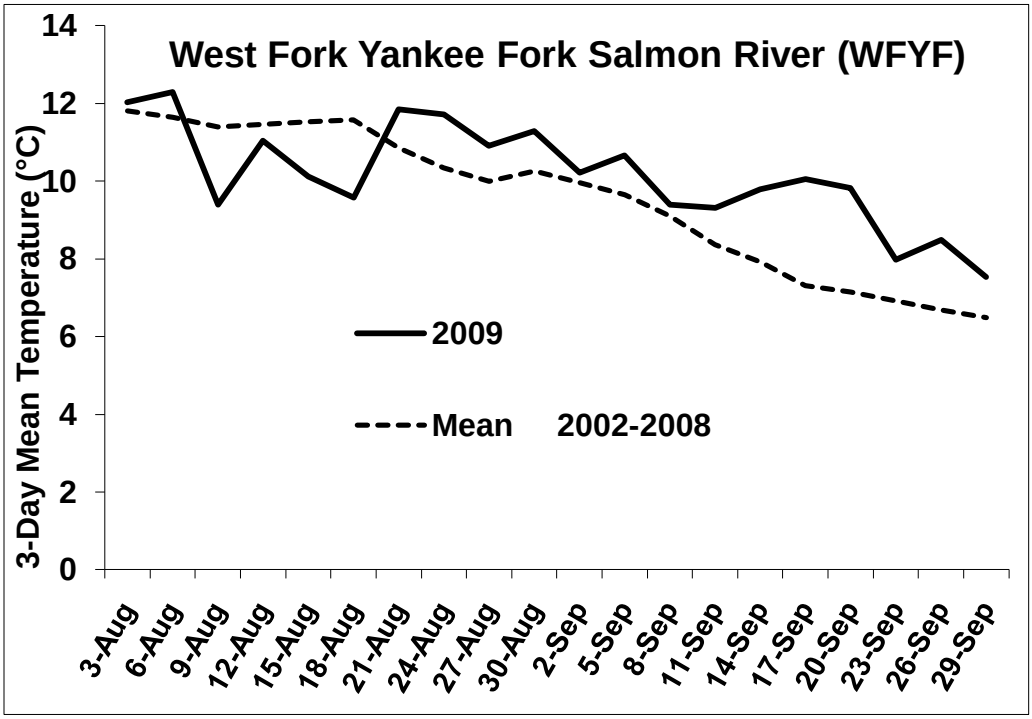


Figure 6. Three-day moving average temperatures in 2009 for the East Fork Salmon River (EFSR) and the West Fork Yankee Fork (WFYF) compared to the mean for 2002-2008.

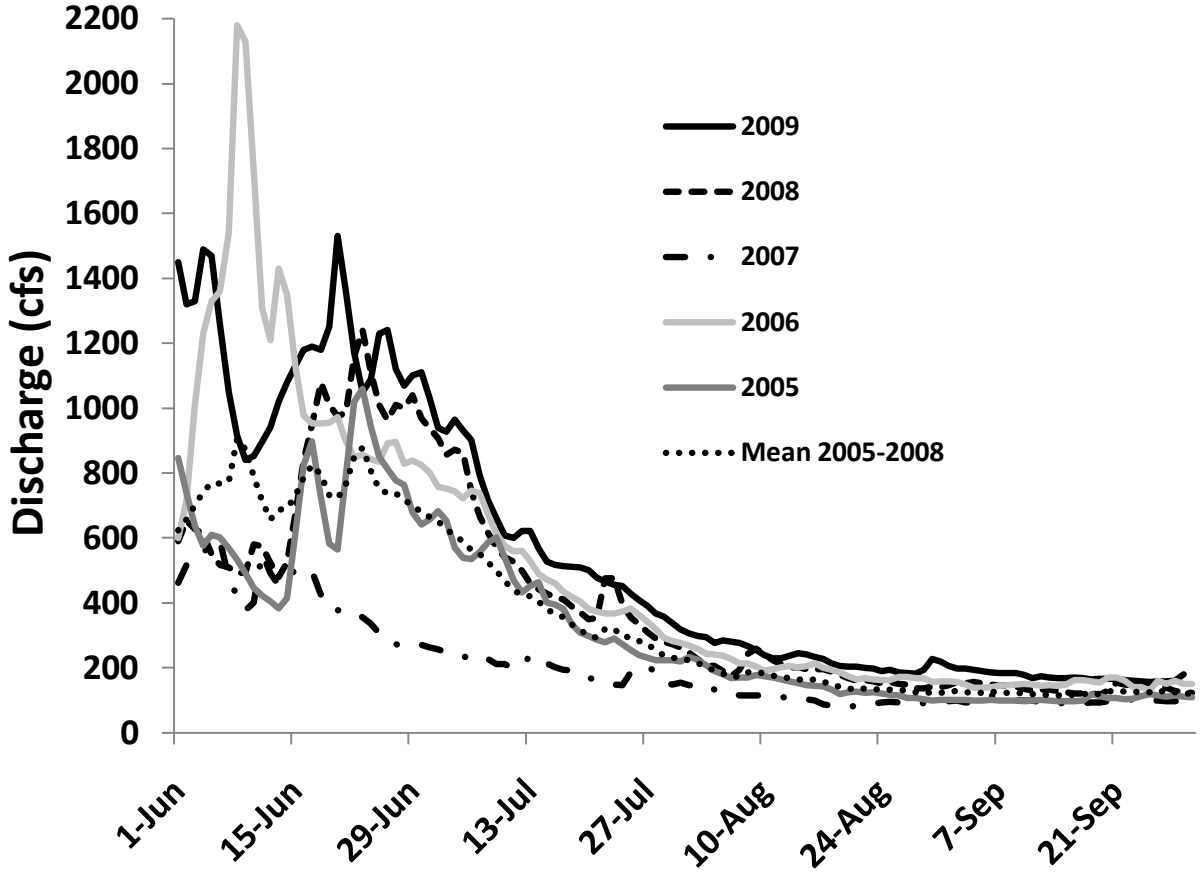


Figure 7. Discharge of the East Fork Salmon River (EFSR), June 1 – September 30, 2009.

Production Estimation

Juvenile Genetic Sampling

Genetic samples from 230 Chinook salmon juveniles were collected from the EFSR and 93 from the WFYF from April to November in 2009, with no reported mortalities. Samples collected in 2009 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 September 29 and November 5, 2008 (BY08) included eggs from 15 redds constructed by captive-reared female adult Chinook salmon and 15 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 7 and April 29, 2009, 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 600 BY08 natural origin eyed-eggs initially placed into capsules, 536 live fry were enumerated and released back into the stream (Table 5). Survival (± 95% CI) ranged from 77.5% to 100% and averaged 89.3% (± 0.04%); (Figure 8). Of the initial 600 captive eyed-eggs placed into capsules, 491 live fry were recovered and released. Survival ranged from 47.5% to 97.5% for all captive redds and averaged 81.8% (± 0.08%). Natural origin progeny demonstrated slightly better survival to emergence than captive-reared progeny from brood year 2008 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 BY08 eggs from 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 2008 (BY08) eyed-eggs collected in the East Fork Salmon River (EFSR). Eyed-eggs were collected during October and November 2008, counted into egg capsules, and returned to the redd. Capsules were then retrieved and live fry enumerated in April 2009.

Redd Number	Origin	Date Redd Completed	Eyed Eggs in Capsule	Date Retrieved	Dead (eggs, parts, fry)	Live Fry	Egg to Fry Survival
1	Natural	8/17/08	40	4/7/2009	0	31	77.5%
2	Natural	8/17/08	40	4/7/2009	0	36	90.0%
3	Natural	8/12/08	40	4/7/2009	1	39	97.5%
4	Natural	8/17/08	40	4/7/2009	0	32	80.0%
5	Natural	8/17/08	40	4/7/2009	0	34	85.0%
6	Natural	8/19/08	40	4/7/2009	0	37	92.5%
7	Natural	8/19/08	40	4/14/2009	1	39	97.5%
8	Natural	8/21/08	40	4/7/2009	0	34	85.0%
9	Natural	8/22/08	40	4/14/2009	3	33	82.5%
10	Natural	8/20/08	40	4/14/2009	0	39	97.5%
11	Natural	8/23/08	40	4/14/2009	0	40	100.0%
12	Natural	8/25/08	40	4/22/2009	1	32	80.0%
13	Natural	8/25/08	40	4/22/2009	0	38	95.0%
14	Natural	8/25/08	40	4/22/2009	0	39	97.5%
15	Natural	8/28/08	40	4/22/2009	0	33	82.5%
16	Captive	9/8/08	40	4/22/2009	0	33	82.5%
17	Captive	9/8/08	40	4/22/2009	3	33	82.5%
18	Captive	9/10/08	40	4/28/2009	1	34	85.0%
19	Captive	9/10/08	40	4/28/2009	0	39	97.5%
20	Captive	9/10/08	40	4/28/2009	0	29	72.5%
21	Captive	9/13/08	40	4/28/2009	0	34	85.0%
22	Captive	9/13/08	40	4/28/2009	0	25	62.5%
23	Captive	9/10/08	40	4/28/2009	0	39	97.5%
24	Captive	9/13/08	40	4/29/2009	13	19	47.5%
25	Captive	9/10/08	40	4/28/2009	3	33	82.5%
26	Captive	9/15/08	40	4/28/2009	0	38	95.0%
27	Captive	9/15/08	40	4/28/2009	0	39	97.5%
28	Captive	9/15/08	40	4/29/2009	1	28	70.0%
29	Captive	9/15/08	40	4/28/2009	0	39	97.5%
30	Captive	9/15/08	40	4/29/2009	2	29	72.5%

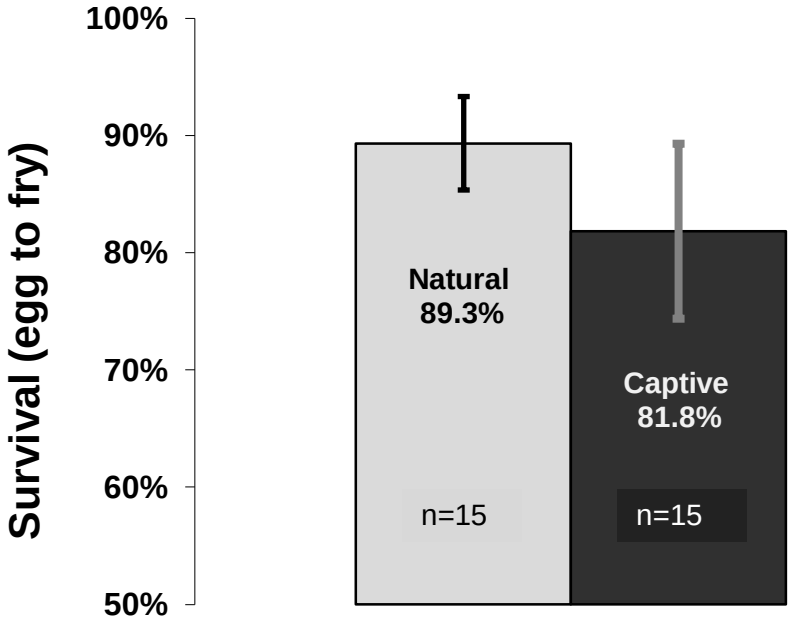


Figure 8. Comparison of egg-to-fry survival from brood year 2008 (BY08) eyed-egg collections from redds produced from natural versus captive-reared Chinook salmon in the East Fork Salmon River (EFSR). Error bars represent the 95% C.I. of the mean, and n is the sample size.

During 2009, no eggs were collected for broodstock captive culture. All eyed-eggs collected during 2009 were used as research subjects for this emergence survival study as described in the methods section. Brood year 2009 (BY09) eyed-eggs were used to establish either capsule (treatment) or hatchery (genetics) study groups. BY09 naturally spawned eyed-eggs were collected from September 29 to November 17, 2009 in EFSR study area. Collections totaled 2,472 live eyed-eggs from the EFSR and included eggs from 13 redds constructed by captive-reared female adult Chinook salmon (n = 1,289) and 15 redds constructed by natural returning fish (n = 1,183; 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, BY09 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 2010 reporting.

Table 6. Summary of brood year 2009 (BY09) eyed-egg collections in the East Fork Salmon River (EFSR) as part of the emergence survival study during 2009. 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 sample sizes in the treatment capsule column.

Name	Origin	Collection Date	Capsules	Genetics	Survival to Eye	CTUs at Collection
JTG04EF	Natural	9/29/09	40	62	97.2%	464
JTG05EF	Natural	9/29/09	40	28	97.2%	464
KBK05EF	Natural	9/29/09	40	20	100.0%	425
DPR03EF	Natural	9/30/09	40	25	100.0%	424
JTG06EF	Natural	9/30/09	40	35	98.8%	461
DPR05EF	Natural	9/30/09	40	39	95.4%	415
DPR06EF	Natural	9/30/09	40 & 99	39	96.9%	415
DPR07EF	Natural	10/1/09	40	46	97.8%	420
DPR09EF	N/C [a]	10/1/09	40	44	82.5%	420
EJS02EF	Natural	10/1/09	40	45	98.9%	420
JTG09EF	Natural	10/6/09	40	30	94.9%	421
JTG10EF	Natural	10/6/09	40	26	93.0%	421
KBK26EF	Natural	10/6/09	40	20	94.3%	381
KBK24EF	Natural	10/7/09	40	65	92.8%	370
EJS15EF	Natural	10/7/09	40	66	99.1%	360
JTG53EF	Captive	10/14/09	40	45	82.8%	357
DPR13EF	Captive	10/20/09	40	32	97.3%	314
KBK37EF	Captive	10/20/09	41	26	87.4%	344
KBK36EF	Captive	10/20/09	40	33	100.0%	344
DPR11EF	Captive	10/20/09	40	47	94.9%	334
DPR18EF	Captive	10/27/09	40	41	93.6%	333
DRP16EF	C/N [b]	10/27/09	40	8	91.5%	333
KBK38EF	Captive	11/4/09	40	42	89.5%	328
KBK40EF	Captive	11/4/09	40	34	57.8%	309
KBK42EF	Captive	11/4/09	40	40	89.4%	309
KBK43EF	Captive	11/4/09	40	96	84.4%	309
DPR20EF	Captive	11/17/09	40	106	81.1%	314
JTG61EF	Captive	11/17/09	40	112	84.1%	275

[a] Natural female and captive-reared male(s).
[b] Captive-reared female and natural male(s).

East Fork Salmon River Weir Operations

In 2009, 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 10 through September 21, one hundred ninety adult Chinook salmon (60 females, 79 males, 51 jacks) were trapped at the facility and released upstream (Table 7). Fin clips were collected from 193 adult Chinook for genetic analyses, including three additional carcasses found post-spawn (1 female and 2 males) which likely bypassed the fish ladder and managed to swim under the partially opened radial gate used to manage upstream water levels during periods of high runoff. Twelve adipose-clipped Chinook salmon (hatchery origin) were trapped and subsequently relocated back to the mainstem Salmon River. Additional species trapped included bull trout *Salvelinus confluentus*, westslope cutthroat trout *O. clarkii lewisi*, rainbow trout *O. mykiss*, and mountain whitefish *Prosopium williamsoni* (Table 8).

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 2009 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. Disposition of natural origin adult Chinook salmon trapped at the East Fork Salmon River (EFSR) weir facility during 2009.

	Gender			
	Females	**Males**	**Jacks**	**Total**
June	1	0	0	1
July	33	19	16	68
August	25	58	32	115
Sept	1	2	3	6
Total	**60**	**79**	**51**	**190**

	Age			
Age (length)[a]	**3 (≤64 cm)**	**4 (64-82 cm)**	**5 (>82 cm)**	**Total**
Females	n/a	26	34	60
Males	n/a	65	14	79
Jacks	51	n/a	n/a	51
Total	**51**	**91**	**48**	**190**

	Recaptures			
Age (length)	**3 (≤64 cm)**	**4 (64-82 cm)**	**5 (>82 cm)**	**Total**
Females	n/a	1	0	1
Males	n/a	9	1	10
Jacks	6	n/a	n/a	6
Total [b]	**6**	**11**	**1**	**18**

[a] Fish were assigned ages based upon a previously established age-at-length relationship from natural origin EFSR Chinook salmon scale aging.
[b] Not including multiple recaptures of the same fish.

Table 8. Summary of additional fish trapped at the East Fork Salmon River weir and genetic samples collected from these fish during 2009. Bull trout numbers are only 2009 'novel/new' fish trapped and recaptured, the number of previous year's fish trapped and subsequently recaptured are excluded from this summary.

Species	**Trapped [a]**	**Recaptured**	**Genetics samples collected**
Bull trout	117	23	121 [b]
Westslope cutthroat trout	6	2	5
Rainbow/Cutthroat trout hybrid	1	0	1
Mountain whitefish	98	1	45
Catostomus spp.	0	0	0
Steelhead (adult)	0	0	0
Sockeye salmon	0	0	0

[a] Includes trapping mortality.
[b] Includes five duplicate samples from fish which shed their original 2009 PIT tag and genetics were subsequently re-sampled.

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APPENDICES

Appendix A. Summary of fish transfers conducted by the Chinook Salmon Captive Rearing Project during 2009. 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.

Stream Source	BY	MAN to WFYF	Transfer Date	MAN to POND	Transfer Date	POND to EFSR	Transfer Date
WFYF-NE	2004	2	8-Jul				
WFYF-NE	2005	101	8-Jul				
EFSR-NE	2004			6	8-Jul	6	20-Jul
EFSR-NE	2005			115	8-Jul	114	20-Jul

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 2009. 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 or male.

Pit Tag Number	Stock	BY	Sex	Tag Color
3D9.1BF258F6AC	EFSR	2005	Female	Orange
3D9.1BF258D17B	EFSR	2005	Female	Orange
3D9.1BF2591AB8	EFSR	2005	Female	Orange
3D9.1BF2584710	EFSR	2005	Female	Orange
3D9.1BF2584602	EFSR	2005	Female	Orange
3D9.1BF2587434	EFSR	2005	Female	Orange
3D9.1BF258C91D	EFSR	2005	Female	Orange
3D9.1BF25835AF	EFSR	2005	Female	Orange
3D9.1BF2586DEF	EFSR	2005	Female	Orange
3D9.1BF2591EFD	EFSR	2005	Female	Orange
3D9.1BF258CA4A	EFSR	2005	Female	Orange
3D9.1BF258CC60	EFSR	2005	Female	Orange
3D9.1BF2591E7F	EFSR	2005	Female	Orange
3D9.1BF2590C56	EFSR	2005	Female	Orange
3D9.1BF2586BA9	EFSR	2005	Female	Orange
3D9.1BF2584312	EFSR	2005	Female	Orange
3D9.1BF2596555	EFSR	2005	Female	Orange
3D9.1BF2592D9E	EFSR	2005	Female	Orange
3D9.1BF2592018	EFSR	2005	Female	Orange
3D9.1BF25962AA	EFSR	2005	Female	Orange
3D9.1BF25954F7	EFSR	2005	Female	Orange
3D9.1BF25877A1	EFSR	2005	Female	Orange
3D9.1BF2590D8B	EFSR	2005	Female	Orange
3D9.1BF259682D	EFSR	2005	Female	Orange
3D9.1BF2594E1E	EFSR	2005	Female	Orange
3D9.1BF2594FED	EFSR	2005	Female	Orange
3D9.1BF258CFA3	EFSR	2005	Female	Orange
3D9.1BF25844E3	EFSR	2005	Female	Orange
3D9.1BF25857D5	EFSR	2005	Female	Orange
3D9.1BF2592217	EFSR	2005	Female	Orange
3D9.1BF2591E75	EFSR	2005	Female	Orange
3D9.1BF25857D0	EFSR	2005	Female	Orange
3D9.1BF2586D13	EFSR	2005	Female	Orange
3D9.1BF2594730	EFSR	2005	Female	Orange
3D9.1BF25966CA	EFSR	2005	Female	Orange
3D9.1BF2584297	EFSR	2005	Female	Orange
3D9.1BF259250D	EFSR	2005	Female	Orange
3D9.1BF2594889	EFSR	2005	Female	Orange
3D9.1BF258CC3D	EFSR	2005	Female	Orange

Appendix B. Continued.

Pit Tag Number	Stock	BY	Sex	Tag Color
3D9.1BF258F719	EFSR	2005	Female	Orange
3D9.1BF2594EA4	EFSR	2005	Female	Orange
3D9.1BF25843CE	EFSR	2005	Female	Orange
3D9.1BF2591F57	EFSR	2005	Female	Orange
3D9.1BF25956A0	EFSR	2005	Female	Orange
3D9.1BF259209C	EFSR	2005	Female	Orange
3D9.1BF2592DA3	EFSR	2005	Female	Orange
3D9.1BF259172F	EFSR	2005	Female	Orange
3D9.1BF25959BC	EFSR	2005	Female	Orange
3D9.1BF2590FF0	EFSR	2005	Female	Orange
3D9.1BF2594DDF	EFSR	2005	Female	Orange
3D9.1BF259657D	EFSR	2005	Female	Orange
3D9.1BF25849A0	EFSR	2005	Female	Orange
3D9.1BF25835E4	EFSR	2005	Female	Orange
3D9.1BF2591BEE	EFSR	2005	Female	Orange
3D9.1BF2592DC1	EFSR	2005	Female	Orange
3D9.1BF2595B10	EFSR	2005	Female	Orange
3D9.1BF2586B5D	EFSR	2005	Female	Orange
3D9.1BF25867FF	EFSR	2005	Female	Orange
3D9.1BF2591D6C	EFSR	2005	Female	Orange
3D9.1BF258D3B2	EFSR	2005	Female	Orange
3D9.1BF258F6A6	EFSR	2005	Female	Orange
3D9.1BF2587666	EFSR	2005	Female	Orange
3D9.1BF2594DCF	EFSR	2005	Female	Orange
3D9.1BF25848CC	EFSR	2005	Female	Orange
3D9.1BF259662C	EFSR	2005	Female	Orange
3D9.1BF2591BF9	EFSR	2005	Female	Orange
3D9.1BF2592478	EFSR	2005	Female	Orange
3D9.1BF2590E4A	EFSR	2005	Female	Orange
3D9.1BF2586D03	EFSR	2005	Female	Orange
3D9.1BF25847AE	EFSR	2005	Female	Orange
3D9.1BF258CAE1	EFSR	2005	Female	Orange
3D9.1BF25872AE	EFSR	2005	Female	Orange
3D9.1BF2584830	EFSR	2005	Female	Orange
3D9.1BF25875BD	EFSR	2005	Female	Orange
3D9.1BF2594DD0	EFSR	2005	Female	Orange
3D9.1BF2590EFF	EFSR	2005	Female	Orange
3D9.1BF2592550	EFSR	2005	Female	Orange
3D9.1BF2584910	EFSR	2005	Female	Orange
3D9.1BF2590FCD	EFSR	2005	Female	Orange
3D9.1BF2594844	EFSR	2005	Female	Orange
3D9.1BF25922A5	EFSR	2005	Female	Orange
3D9.1BF2594FB2	EFSR	2005	Female	Orange
3D9.1BF2592D09	EFSR	2005	Female	Orange

Appendix B. Continued.

Pit Tag Number	Stock	BY	Sex	Tag Color
3D9.1BF2590E4D	EFSR	2005	Female	Orange
3D9.1BF2590E0F	EFSR	2005	Female	Orange
3D9.1BF25868E1	EFSR	2005	Female	Orange
3D9.1BF25845AE	EFSR	2005	Female	Orange
3D9.1BF25925D0	EFSR	2005	Female	Orange
3D9.1BF258470A	EFSR	2005	Female	Orange
3D9.1BF259171F	EFSR	2005	Female	Orange
3D9.1BF2597530	EFSR	2005	Female	Orange
3D9.1BF25869FA	EFSR	2005	Female	Orange
3D9.1BF2584898	EFSR	2005	Female	Orange
3D9.1BF2584548	EFSR	2005	Female	Orange
3D9.1BF25899A0	EFSR	2005	Female	Orange
3D9.1BF2591F0D	EFSR	2005	Female	Orange
3D9.1BF25963AB	EFSR	2005	Female	Orange
3D9.1BF2596AB1	EFSR	2005	Female	Orange
3D9.1BF2591E52	EFSR	2005	Female	Orange
3D9.1BF2584785	EFSR	2005	Female	Orange
3D9.1BF25841A1	EFSR	2005	Female	Orange
3D9.1BF2591C4A	EFSR	2005	Female	Orange
3D9.1BF25849FC	EFSR	2005	Female	Orange
3D9.1BF25844F6	EFSR	2005	Female	Orange
3D9.1BF2594D9C	EFSR	2005	Female	Orange
3D9.1BF2590CD7	EFSR	2005	Female	Orange
3D9.1BF2584BB4	EFSR	2005	Female	Orange
3D9.1BF2591C4D	EFSR	2005	Male	White
3D9.1BF2592625	EFSR	2005	Male	White
3D9.1BF2594610	EFSR	2005	Male	White
3D9.1BF2585E78	EFSR	2005	Male	White
3D9.1BF2591DF3	EFSR	2005	Male	White
3D9.1BF25910B3	EFSR	2005	Male	White
3D9.1BF259171D	EFSR	2005	Male	White
3D9.1BF2433CE0	EFSR	2004	Female	Green
3D9.1BF2433D1C	EFSR	2004	Female	Green
3D9.1BF2430B77	EFSR	2004	Female	Green
3D9.1BF243105E	EFSR	2004	Female	Green
3D9.1BF242F490	EFSR	2004	Female	Green
3D9.1BF242C4CD	EFSR	2004	Male	Green
3D9.1BF258CC13	WFYF	2005	Female	White
3D9.1BF2584828	WFYF	2005	Female	White
3D9.1BF258359B	WFYF	2005	Female	White
3D9.1BF259100E	WFYF	2005	Female	White
3D9.1BF258C909	WFYF	2005	Female	White
3D9.1BF259101B	WFYF	2005	Female	White
3D9.1BF2591E2B	WFYF	2005	Female	White

Appendix B. Continued.

Pit Tag Number	Stock	BY	Sex	Tag Color
3D9.1BF258C91B	WFYF	2005	Female	White
3D9.1BF2594FAC	WFYF	2005	Female	White
3D9.1BF2584B25	WFYF	2005	Female	White
3D9.1BF258F725	WFYF	2005	Female	White
3D9.1BF2594832	WFYF	2005	Female	White
3D9.1BF2587632	WFYF	2005	Female	White
3D9.1BF2596C35	WFYF	2005	Female	White
3D9.1BF25842AF	WFYF	2005	Female	White
3D9.1BF2590CAC	WFYF	2005	Female	White
3D9.1BF25969AB	WFYF	2005	Female	White
3D9.1BF2594682	WFYF	2005	Female	White
3D9.1BF258D1E2	WFYF	2005	Female	White
3D9.1BF25967ED	WFYF	2005	Female	White
3D9.1BF2596AE1	WFYF	2005	Female	White
3D9.1BF2594E5B	WFYF	2005	Female	White
3D9.1BF259603B	WFYF	2005	Female	White
3D9.1BF2594E19	WFYF	2005	Female	White
3D9.1BF2584626	WFYF	2005	Female	White
3D9.1BF2594ED7	WFYF	2005	Female	White
3D9.1BF258CA74	WFYF	2005	Female	White
3D9.1BF2592E2E	WFYF	2005	Female	White
3D9.1BF2587515	WFYF	2005	Female	White
3D9.1BF258360C	WFYF	2005	Female	White
3D9.1BF2590E6E	WFYF	2005	Female	White
3D9.1BF2591DCC	WFYF	2005	Female	White
3D9.1BF25928BE	WFYF	2005	Female	White
3D9.1BF2590DDB	WFYF	2005	Female	White
3D9.1BF2592450	WFYF	2005	Female	White
3D9.1BF25847DA	WFYF	2005	Female	White
3D9.1BF2594EAE	WFYF	2005	Female	White
3D9.1BF2591CF2	WFYF	2005	Female	White
3D9.1BF2590D91	WFYF	2005	Female	White
3D9.1BF2594661	WFYF	2005	Female	White
3D9.1BF2590E2D	WFYF	2005	Female	White
3D9.1BF2587017	WFYF	2005	Female	White
3D9.1BF259595D	WFYF	2005	Female	White
3D9.1BF2590E6C	WFYF	2005	Female	White
3D9.1BF2594F91	WFYF	2005	Female	White
3D9.1BF25847BE	WFYF	2005	Female	White
3D9.1BF2591D5E	WFYF	2005	Female	White
3D9.1BF259633D	WFYF	2005	Female	White
3D9.1BF2591CAD	WFYF	2005	Female	White
3D9.1BF2586A0B	WFYF	2005	Female	White
3D9.1BF258C9F8	WFYF	2005	Female	White

Appendix B. Continued.

Pit Tag Number	Stock	BY	Sex	Tag Color
3D9.1BF2584721	WFYF	2005	Female	White
3D9.1BF2591ABD	WFYF	2005	Female	White
3D9.1BF2587853	WFYF	2005	Female	White
3D9.1BF2584885	WFYF	2005	Female	White
3D9.1BF2586AD4	WFYF	2005	Female	White
3D9.1BF258CAF3	WFYF	2005	Female	White
3D9.1BF2591D90	WFYF	2005	Female	White
3D9.1BF2584324	WFYF	2005	Female	White
3D9.1BF2592D6C	WFYF	2005	Female	White
3D9.1BF259466E	WFYF	2005	Female	White
3D9.1BF258CB7A	WFYF	2005	Female	White
3D9.1BF25924BD	WFYF	2005	Female	White
3D9.1BF2592558	WFYF	2005	Female	White
3D9.1BF25851B9	WFYF	2005	Female	White
3D9.1BF259653D	WFYF	2005	Female	White
3D9.1BF2590F4B	WFYF	2005	Female	White
3D9.1BF258699D	WFYF	2005	Female	White
3D9.1BF2596412	WFYF	2005	Female	White
3D9.1BF25947DF	WFYF	2005	Female	White
3D9.1BF2592363	WFYF	2005	Female	White
3D9.1BF2596B3E	WFYF	2005	Female	White
3D9.1BF25857B4	WFYF	2005	Female	White
3D9.1BF2594E8F	WFYF	2005	Female	White
3D9.1BF258688C	WFYF	2005	Female	White
3D9.1BF2596278	WFYF	2005	Female	White
3D9.1BF259651F	WFYF	2005	Female	White
3D9.1BF2590FF6	WFYF	2005	Female	White
3D9.1BF25962DE	WFYF	2005	Female	White
3D9.1BF2596C5D	WFYF	2005	Female	White
3D9.1BF25847F7	WFYF	2005	Female	White
3D9.1BF2591FC6	WFYF	2005	Female	White
3D9.1BF259562D	WFYF	2005	Female	White
3D9.1BF2591E80	WFYF	2005	Female	White
3D9.1BF2592DA5	WFYF	2005	Female	White
3D9.1BF2584308	WFYF	2005	Female	White
3D9.1BF2584803	WFYF	2005	Female	White
3D9.1BF25947C2	WFYF	2005	Female	White
3D9.1BF258789D	WFYF	2005	Female	White
3D9.1BF258D31F	WFYF	2005	Female	White
3D9.1BF2592050	WFYF	2005	Female	White
3D9.1BF2584DAA	WFYF	2005	Female	White
3D9.1BF25848A7	WFYF	2005	Female	White
3D9.1BF2585EE9	WFYF	2005	Female	White
3D9.1BF2592538	WFYF	2005	Female	White

Appendix B. Continued.

Pit Tag Number	Stock	BY	Sex	Tag Color
3D9.1BF2592DD1	WFYF	2005	Female	White
3D9.1BF25962A8	WFYF	2005	Male	Orange
3D9.1BF25964B9	WFYF	2005	Male	Orange
3D9.1BF258D090	WFYF	2005	Male	Orange
3D9.1BF2591E76	WFYF	2005	Male	Orange
3D9.1BF2584707	WFYF	2005	Male	Orange
3D9.1BF242FD38	WFYF	2004	Female	Green
3D9.1BF24314A0	WFYF	2004	Female	Green

Appendix C. Summary of Chinook salmon redds observed during ground counts in the West Fork Yankee Fork Salmon River (WFYF), Yankee Fork Salmon River (YFSR), and the East Fork Salmon River (EFSR) during 2009. Origin of redds observed were natural (N), both female and male; captive-reared (C), both female and male; captive female and natural male (C/N); or natural female and captive male (N/C).

			Location			
Stream	Redd	Date	Easting	Northing	Zone	Origin
EFSR	KBK01EF	8/5/09	703483	4879676	11	N
EFSR	DPR01EF	8/7/09	705005	4886797	11	N
EFSR	DPR02EF	8/9/09	703172	4878115	11	N
EFSR	JTG01EF	8/11/09	704667	4885165	11	N
EFSR	JTG02EF	8/12/09	703352	4880352	11	N
EFSR	JTG03EF	8/12/09	703399	4880040	11	N
EFSR	JTG04EF	8/12/09	703186	4878129	11	N
EFSR	JTG05EF	8/12/09	703472	4883141	11	N
EFSR	JTG06EF	8/13/09	702145	4875936	11	N
EFSR	KBK03EF	8/16/09	703910	4884026	11	N
EFSR	KBK04EF	8/16/09	703904	4883863	11	C/N
EFSR	KBK05EF	8/16/09	703525	4883332	11	N
EFSR	KBK06EF	8/16/09	703513	4883271	11	N
EFSR	KBK07EF	8/16/09	703396	4881223	11	N
EFSR	KBK08EF	8/16/09	703470	4879817	11	N
EFSR	DPR03EF	8/17/09	701576	4874191	11	N
EFSR	DPR04EF	8/18/09	705605	4887691	11	N
EFSR	DPR05EF	8/18/09	705331	4887233	11	N
EFSR	DPR06EF	8/18/09	705325	4887196	11	N
EFSR	DPR07EF	8/18/09	705250	4887073	11	N
EFSR	DPR08EF	8/18/09	705080	4887015	11	N
EFSR	DPR09EF	8/18/09	704663	4885080	11	N/C
EFSR	EJS02EF	8/18/09	703386	4880982	11	N

Appendix C. Continued.

EFSR	EJS04EF	8/18/09	703453	4878597	11	N
EFSR	EJS05EF	8/18/09	703443	4878550	11	N
EFSR	EJS06EF	8/18/09	703452	4878555	11	N
EFSR	EJS08EF	8/20/09	704710	4885942	11	N
EFSR	EJS09EF	8/20/09	704702	4885884	11	N
EFSR	EJS10EF	8/20/09	704711	4885460	11	N
EFSR	EJS11EF	8/20/09	704702	4885400	11	N
EFSR	JTG07EF	8/20/09	704622	4884773	11	N
EFSR	JTG08EF	8/20/09	704446	4884488	11	N
EFSR	JTG09EF	8/20/09	703922	4883907	11	N
EFSR	JTG10EF	8/20/09	703504	4883248	11	N
EFSR	JTG11EF	8/20/09	703477	4882873	11	N
EFSR	JTG12EF	8/20/09	703481	4882863	11	N
EFSR	JTG13EF	8/21/09	703340	4880765	11	N
EFSR	KBK24EF	8/24/09	704774	4885542	11	N
EFSR	KBK26EF	8/25/09	703336	4881262	11	N
EFSR	KBK27EF	8/25/09	703173	4878127	11	N
EFSR	DPR10EF	8/25/09	705006	4886810	11	N
EFSR	EJS13EF	8/26/09	704774	4886275	11	N
EFSR	EJS14EF	8/26/09	704713	4885900	11	N
EFSR	EJS15EF	8/26/09	704644	4885087	11	N
EFSR	JTG53EF	8/29/09	705314	4887184	11	C/N
EFSR	JTG54EF	8/29/09	703625	4883536	11	N
EFSR	JTG55EF	8/29/09	703620	4883516	11	N
EFSR	JTG59EF	9/2/09	704727	4886188	11	N
EFSR	KBK35EF	9/2/09	703647	4883608	11	N
EFSR	KBK36EF	9/3/09	703391	4881220	11	C/N
EFSR	KBK37EF	9/3/09	703466	4079803	11	C/N
EFSR	DPR11EF	9/4/09	703605	4883515	11	C
EFSR	DPR13EF	9/6/09	703172	4878115	11	C
EFSR	DPR14EF	9/7/09	705283	4887086	11	N
EFSR	DPR15EF	9/7/09	705004	4886805	11	N
EFSR	DPR16EF	9/7/09	703911	4884031	11	C/N
EFSR	DPR17EF	9/7/09	703902	4883865	11	C
EFSR	DPR18EF	9/7/09	703625	4883536	11	C/N
EFSR	PBG01EF	9/7/09	703330	4881268	11	C
EFSR	KBK38EF	9/10/09	703906	4884033	11	C/N
EFSR	DPR20EF	9/14/09	703500	4883262	11	C/N
EFSR	DPR21EF	9/16/09	703916	4884033	11	C
EFSR	JTG61EF	9/18/09	703914	4884033	11	C
WFYF	JTG01WF	8/10/09	679402	4915218	11	N
WFYF	DPR01WF	8/24/09	679552	4915077	11	N
WFYF	DPR02WF	8/24/09	679415	4915201	11	C/N

Appendix C. Continued.

WFYF	EJS02WF	8/25/09	678512	4915560	11	C
WFYF	KBK01WF	8/31/09	679021	4915463	11	C
WFYF	KBK02WF	8/31/09	679488	4915215	11	C
WFYF	KBK03WF	9/1/09	677424	4915947	11	C
YFSR	DPR03WF	9/3/09	681988	4908890	11	C
YFSR	DPR04WF	9/3/09	681984	4908899	11	C
YFSR	DPR05WF	9/3/09	681993	4908955	11	C
YFSR	DPR06WF	9/3/09	681996	4908944	11	C
YFSR	DPR07WF	9/3/09	682051	4909594	11	C
YFSR	DPR08WF	9/3/09	682049	4909613	11	C
WFYF	DPR09WF	9/3/09	679556	4915080	11	C/N
WFYF	DPR10WF	9/3/09	679549	4915087	11	C
WFYF	DPR11WF	9/3/09	679390	4915206	11	C
WFYF	JTG02WF	9/8/09	681985	4908811	11	C
YFSR	JTG03WF	9/8/09	681989	4908850	11	C
YFSR	JTG04WF	9/8/09	681992	4908894	11	C
YFSR	JTG05WF	9/8/09	681994	4908911	11	C/N
YFSR	JTG06WF	9/8/09	682008	4908953	11	C
YFSR	JTG07WF	9/8/09	682045	4909608	11	C
WFYF	KBK04WF	9/9/09	681086	4913290	11	C
WFYF	KBK05WF	9/9/09	681030	4913355	11	C
WFYF	KBK06WF	9/9/09	681021	4913367	11	C
WFYF	KBK07WF	9/9/09	680167	4914258	11	C
WFYF	KBK08WF	9/9/09	679630	4914932	11	C
WFYF	KBK09WF	9/9/09	679573	4915056	11	C
WFYF	DPR12WF	9/13/09	680084	4914334	11	C
WFYF	DPR13WF	9/21/09	676639	4916208	11	C
WFYF	DPR14WF	9/21/09	675759	4916866	11	N

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