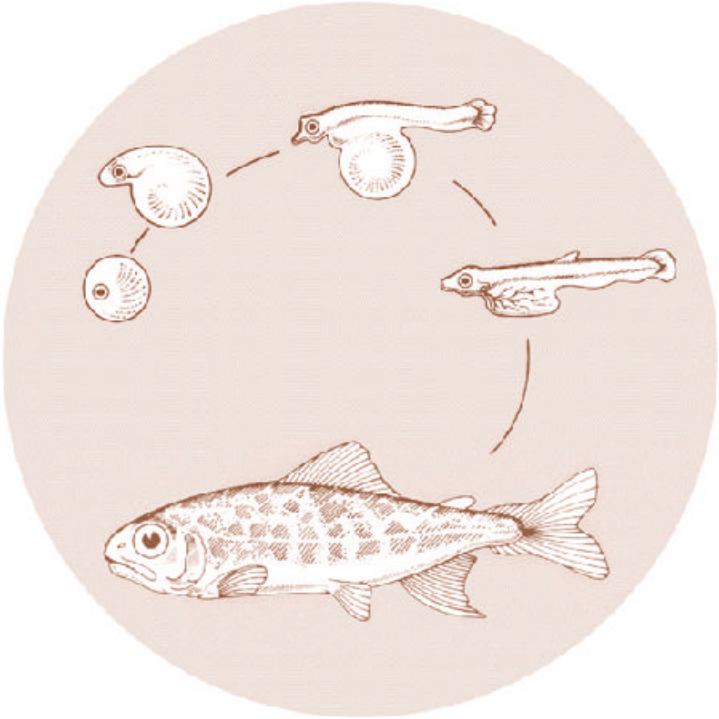
April 2001

CAPTIVE REARING INIATIVE FOR SALMON RIVER CHINOOK SALMON

Annual Progress Report 2000



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FISHERY RESEARCH

CAPTIVE REARING INITIATIVE FOR SALMON RIVER CHINOOK SALMON

ANNUAL PROGRESS REPORT
January 1, 1999 — December 31, 1999

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IDFG Report Number 01-16
April 2001

Captive Rearing Initiative for Salmon River Chinook Salmon

Project Progress Report

1999 Annual Report

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ABSTRACT

During 1999, the Idaho Department of Fish and Game (IDFG) continued developing techniques for the captive rearing of chinook salmon *Oncorhynchus tshawytscha*. Techniques under development included protocols for rearing juveniles in freshwater and saltwater hatchery environments, and fieldwork to collect brood year 1998 and 1999 juveniles and eggs and to investigate the ability of these fish to spawn naturally. Fish collected as juveniles were held for a short time at the Sawtooth Fish Hatchery and later transferred to the Eagle Fish Hatchery for rearing. Eyed-eggs were transferred immediately to the Eagle Fish Hatchery where they were disinfected and reared by family groups. When fish from either collection method reached approximately 60 mm, they were PIT tagged and reared separately by brood year and source stream. Sixteen different groups were in culture at IDFG facilities in 1999. Hatchery spawning activities of captive-reared chinook salmon produced eyed-eggs for outplanting in streamside incubation chambers in the West Fork Yankee Fork Salmon River (N=2,297) and the East Fork Salmon River (N=1,038). Additionally, a number of these eggs were maintained at the Eagle Fish Hatchery to ensure adequate brood year 1999 representation from these systems, and produced 279 and 87 juveniles from the West Fork Yankee Fork and East Fork Salmon River, respectively. Eyed-eggs were not collected from the West Fork Yankee Fork due to low adult escapement. Brood year 1998 juveniles were collected from the Lemhi River (N=191), West Fork Yankee Fork Salmon River (N=229), and East Fork Salmon River (N=185). Additionally, brood year 1999 eyed-eggs were collected from the Lemhi River (N=264) and East Fork Salmon River (N=143). Sixty-two and seven maturing adults were released into Bear Valley Creek (Lemhi River system) and the East Fork Salmon River, respectively, for spawning evaluation in 1999. Nine female carcasses from Bear Valley Creek were examined for egg retention, and of these five were spawned out, one was partially spawned, and three died before depositing eggs. However, much of the spawning related behavior observed involved female chinook salmon paired with male bull trout *Salvelinus confluentus*. Two female carcasses from the East Fork Salmon River were recovered and examined for egg retention. One of these had spawned and one had not.

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INTRODUCTION

Idaho Department of Fish and Game's (IDFG) long-term objective for salmon management is to maintain Snake River salmon populations at levels that will provide sustainable harvest (IDFG 1996). Restoring currently depressed chinook salmon *Oncorhynchus tshawytscha* populations to historic levels is a prerequisite to this condition. Artificial propagation of spring and summer chinook salmon in the Salmon River basin, through Lower Snake River Compensation Plan (LSRCP) and Idaho Power Company hatcheries, was initiated to compensate for lost production and productivity caused by the construction and operation of private and federal hydroelectric facilities in the Snake River. 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 for 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 dams in place. In reality, smolt-to-adult survival rates of wild Snake River chinook salmon declined abruptly with completion of the federal hydroelectric system by the mid-1970s (Petrosky and Schaller 1994). Survival rates used in the hatchery mitigation program models were substantially overestimated. Hence, hatchery programs have been unable to mitigate for the dams or stem the decline of target populations, and numbers of naturally-produced salmon declined at various rates throughout the Snake River basin. Spring/summer chinook salmon returns have been insufficient to meet artificial and natural smolt and adult production predictions, much less provide a consistent harvestable surplus of adults (Hassemer 1998).

The development of the Snake River hydrosystem has substantially influenced the decline of local spring/summer chinook salmon stocks by reducing productivity and survival (Schaller et al. 1999) and has contributed to the listing of Snake River chinook salmon under the Endangered Species Act (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 is increased, our challenge is to preserve the existing metapopulation structure (by preventing local or demographic extinctions) of these stocks to provide fish for future recovery actions. This project is developing technology that may be used in the recovery of the listed Snake River spring/summer chinook salmon evolutionary significant unit (ESU), which consists of 38 subpopulations (i.e. breeding units or stocks; NMFS 1995). Preserving the metapopulation structure of this ESU is consistent with the predecisional Snake River Salmon Recovery Plan (Schmitten et al. 1997, in review), and supports the Northwest Power Planning Council's goal of maintaining biological diversity while doubling salmon and steelhead runs (NPPC 1994).

The IDFG initiated a captive rearing research program for populations at high risk of extinction to maintain metapopulation structure. Captive rearing is a short-term approach to species preservation. The main goal of the captive rearing approach is to avoid demographic and environmental risks of cohort extinction; maintaining the genetic identity of the breeding unit is an important but secondary objective. The strategy of captive rearing is to prevent cohort collapse in the specified target populations by providing captive-reared adult spawners to the natural environment, which, in turn, maintain the continuum of generation to generation smolt production. Each generation of smolts, then, provides the opportunity for population maintenance or increase should environmental conditions prove favorable for that cohort.

The captive rearing program was developed primarily as a way to maximize the number of breeding units that could be reared in captivity while minimizing intervention impacts through the collection and subsequent rearing of early life stages through adulthood. Only enough juveniles or eggs are collected from target populations to provide an adequate number of spawners, about 20, to ensure that acceptable genetic diversity could be maintained without additional natural escapement. (According to the Stanley Basin Sockeye Technical Oversight Committee, it is reasonable to assume that 20 fish could encompass 95% of the genetic diversity of the population.) However, this number remains somewhat speculative because of uncertainties associated with the ability of the captive-rearing approach to produce adults with the desired characteristics for release into the wild (Fleming and Gross 1992, 1993; Joyce et al. 1993; Flagg and Mahnken 1995). Juveniles and/or eggs would be collected each year from cohorts of low resiliency populations, those expected to return 10 or fewer spawning pair to their respective spawning areas. In order to meet program objectives, we must be able to produce an adequate number of adults with the proper morphological, physiological, and behavioral attributes to successfully spawn and produce viable offspring in their native habitats.

Little scientific information regarding captive culture techniques for Pacific salmonids was available at the inception of this program. Flagg and Mahnken (1995) reviewed the status of captive broodstock technology. Following Flagg and Mahnken's (1995) work, the IDFG captive-rearing program was initiated to develop the technology for captive culture of chinook salmon and to monitor and evaluate captive-reared fish during both the rearing and post-release/spawning phases. In addition to technology development, the IDFG program also addresses population dynamics and population persistence concerns. These population level concerns are: 1) maintaining a minimum number of spawners in high-risk populations, and 2) maintaining metapopulation structure by preventing local extinctions.

This report documents activities under the captive rearing program from January 1, 1999 through December 31, 1999. This project is coordinated with the Northwest Power Planning Council's Fish and Wildlife Program (NPPC 1994) and is identified as project 9700100 in federal fiscal year 1999. Funding was provided through the Bonneville Power Administration under contract 97-BI-97538.

STUDY AREA

Three streams were selected for the initiation of the captive rearing program: the Lemhi River, the East Fork Salmon River, and the West Fork Yankee Fork Salmon River (Figure 1). Water quality is high in all three streams, and water temperatures are ideal for chinook salmon rearing. Habitat quality is relatively pristine with some localized riparian degradation, sedimentation, and impact from grazing, mining, logging, road building, and irrigation diversion. The Lemhi River 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). Bear Valley Creek, a tributary of Hayden Creek, which flows into the Lemhi River approximately 30 km upstream of its confluence with the Salmon River, was also selected as a captive chinook salmon release site, and contains near pristine B and C channel conditions. The other streams drain relatively sterile watersheds of mainly granitic parent material associated with the Idaho batholith. The lower 30 km of the East Fork Salmon River runs through ranch and grazing property developed during the last century, but the upper reaches reflect near pristine conditions with little historical

disturbance from logging, mining, or agriculture. Stream habitat in the East Fork Salmon River typically reflects B and C conditions. The West Fork Yankee Fork Salmon River remains primarily roadless, and has remained nonimpacted by land use practices for nearly half a century. Stream habitat in the West Fork Yankee Fork Salmon River typically reflects B and C conditions.

PROGRAM HISTORY

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 agreement that Oregon would initiate a captive broodstock program for selected Grande Ronde River chinook salmon populations, and Idaho would initiate a captive rearing research program for selected Salmon River chinook salmon populations. The primary focus of each of these programs was to evaluate each form of captive culture's effectiveness at meeting population conservation objectives. Implicit within each research project was the objective to develop and test appropriate fish culture protocols, specific to the captive culture of chinook salmon for conservation management of depressed populations.

The Idaho chinook salmon captive rearing program was initiated in 1995 with the collection of brood year 1994 chinook salmon parr from the three study streams. Since then, naturally-spawned chinook salmon progeny from brood years 1995-1999 have been brought into captivity to continue the project. Hassemer et al. (1999) summarized the project's activities from inception through 1998.

METHODS

Captive culture of chinook salmon is a relatively new field, and because of this the role of the Chinook Salmon Captive Propagation Technical Oversight Committee (CSCPTOC) is very important to the success of the program. The CSCPTOC provides a forum of peer review and discussion of all activities and culture protocols associated with this program. This allows for an adaptive management approach to all phases of the program, which supports technological and overall program development as new information becomes available.

The goal of this project is to develop and test chinook salmon captive rearing, a specific form of captive culture. To achieve this goal, program activities are divided into two functional bodies including fish culture and field evaluations. Success of the program is dependent on synchronous development of effective rearing technology and the evaluation of post-release adult chinook salmon behavior and spawning success. The methods described here cover both aspects of evaluation.

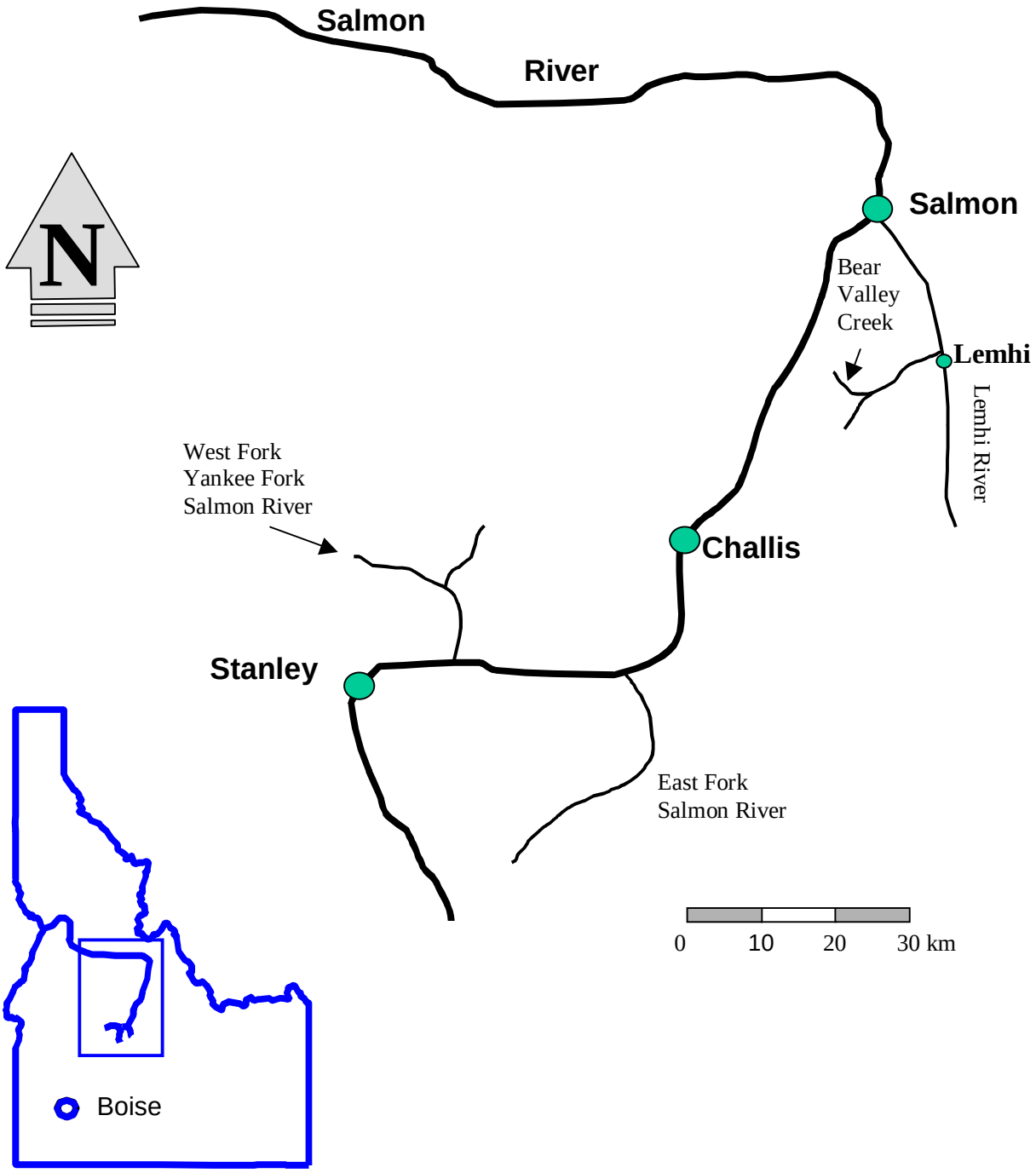

Figure 1. Location of Idaho Department of Fish and Game spring/summer chinook salmon captive rearing program study streams.

Collection for Captive Rearing

Chinook salmon for the captive-rearing study were collected from the wild as eyed-eggs or as juveniles (parr or smolts) in 1999. Eyed-eggs were collected using hydraulic sampling methods described by McNeil (1964). To facilitate eyed-egg collections, the location of redds and their corresponding construction and completion dates were estimated, and recording thermographs were located near completed redds to track the number of Celsius temperature units (CTUs) received by the developing embryos. Redds were sampled when the eggs had received approximately 300-400 CTUs. Juvenile chinook salmon were collected using rotary screw traps (E.G. Solutions, Corvallis, OR) and beach seines. Rotary screw traps are passive capture devices generally positioned in the thalweg of the stream. Stream flow turns a baffled cylinder that funnels captured fish to a live well for temporary holding. Idaho Department of Fish and Game and cooperator personnel from the Shoshone-Bannock Tribes attended traps on a daily basis. Captured juveniles may also have been temporarily held in streamside live boxes until transfer to Sawtooth Fish Hatchery for initial rearing. Beach seines were also used to collect juvenile chinook salmon over a broad range of stream distance. Following the location of juveniles by snorkeling, a beach seine was positioned downstream of the target assemblage of fish. Snorkelers then worked cooperatively with seine handlers to capture fish. Fish collected with this method were temporarily held in streamside live boxes until transfer to Sawtooth Fish Hatchery.

Fish Culture

The IDFG provided daily staffing for the culture of Snake River captive-reared chinook salmon. Captive fish were reared using standard fish culture practices and approved theraputants (for an overview of standard methods see Leitritz and Lewis 1976; Piper et al. 1982; Erdahl 1994; Bromage and Roberts 1995; McDaniel et al. 1996; Pennell and Barton 1996). Fish were fed a standard commercial diet produced by BioOregon (Warrenton, OR) until they reached approximately 75 g, after which time they received a special brood diet enhanced with natural flavors from fish and krill. Rearing tank size, density, and food ration varied with fish age, and were managed to promote optimum growth and for the attainment of program objectives and goals. Routine inventories were conducted periodically where fish were anesthetized, weighed to the nearest 0.1 g, and measured to the nearest 1 mm fork length to track growth and to insure that projected weights tracked closely with actual weights.

Group identities were maintained by tank segregation and passive integrated transponder (PIT) tags. Individuals collected by screw traps or beach seines were reared separately, by stream origin and brood year, throughout their life cycle, while those collected as eggs were initially incubated and reared as separate family groups. All captive-reared chinook salmon were PIT tagged after reaching approximately 60 mm fork length. Once PIT tagged, individuals from the separate family groups were combined into common tanks by stream origin and brood year for the remainder of their rearing.

Mortalities were typically examined by a fish pathologist and analyzed for common bacterial and viral pathogens. In addition, tissue samples were removed, frozen (-80°C), and transferred to the NMFS for subsequent genetic analysis.

Facilities and Protocols

Juvenile chinook salmon brought into the captive rearing program were initially held at the Sawtooth Fish Hatchery before transfer to the Eagle Fish Hatchery. Presmolts were held in 0.5 m^3 semisquare fiberglass tanks, by stream origin, on specific pathogen-free well water, which varied in temperature between approximately 2.5°C in January and February to 11.1°C in August and September. Backup and redundancy systems were in place to ensure water flow and temperature remained within acceptable limits. While at the Sawtooth Fish Hatchery, 1 mm diameter fish food was provided to begin the conversion to a hatchery diet. Juveniles remained at the Sawtooth facility for several days to several weeks before being transferred to the Eagle Fish Hatchery.

Eagle Fish Hatchery was the primary Idaho site for the culture of captive-reared chinook salmon. Specific pathogen-free artesian water from five wells was used, and artesian flow was augmented through the use of four separate pump/motor systems. Water temperature remains a constant 13.3°C, and total dissolved gas averages 100% after degassing. Water chilling capability was added in 1994 and is used during the early incubation of captive-reared chinook salmon. Backup and system redundancy is in place for degassing, pumping, and power generation. Nine water level alarms were in use and linked through an emergency service operator. Additional security was provided by limiting public access and by the presence of three on-site residences occupied by IDFG hatchery personnel.

Facility layout at Eagle Fish Hatchery remained flexible to accommodate the various life stages on station. Fiberglass tanks ranging in size from 1-6 m in diameter were used to culture chinook salmon from presmolts to maturity. One meter semisquare tanks (0.30 m^3) were used to acclimate presmolts to hatchery diets following collection. Two and 3 m semisquare tanks (1.42 m^3, and 6.50 m^3, respectively) were used to rear juveniles to approximately 20 g and 1,000 g, respectively. Age-3 fish were transferred to 6 m circular tanks (44.5 m^3) where they remained until maturity, and mature fish were held, by stream origin, in 4 m semisquare tanks (8.89 m^3) until release in their natal waters. Flow to all tanks was maintained at no less than 1.5 exchanges per hour, and shade covering (70%) and jump screens were used where appropriate. Tank discharge standpipes were assembled in two sections ("half pipe principle") to prevent tank dewatering when removed for tank cleaning.

Egg and Fish Transfers

Eyed-eggs were transferred from collection locations to the Eagle Fish Hatchery and to streamside incubators. Eggs collected from redds were packed at a conservative density in perforated shipping tubes, capped, and labeled to identify lineage. Tubes were wrapped in cheesecloth saturated with river water and packed in small, insulated coolers. Ice chips were added to maintain proper temperature and a moist environment during transport. Once the eggs arrived at the Eagle Fish Hatchery, they were immediately disinfected in a 100 ppm iodine solution for 30 min. Packaging for eggs transferred to remote field locations for incubation in streamside or instream incubation systems was the same as described above.

Fish were transported to and from collection locations in truck-mounted, insulated tanks (typically 1,136 L capacity) with alarm and back-up oxygen systems on board. For longer duration trips (e.g., from NMFS Washington State facilities to Idaho), larger capacity truck-mounted tanks were used (3,785 L and 9,463 L capacity). The IDFG obtained the appropriate permits for interstate transfer of captive chinook salmon to and from NMFS facilities. All

vehicles were equipped to provide the appropriate conditions (temperature, oxygen, capacity) to facilitate safe transport of fish to and from specified destinations. In addition, all vehicles had two-way radios or cellular telephones to provide routine or emergency communication capability. Prior to releasing transported fish at a hatchery or remote release locations, transport water was tempered to within 2.0°C of the receiving water.

Maturation Sorting

In 1999, determination of sex and maturation in captive chinook salmon populations were conducted using nonlethal genetic sex determination and physical sorting. Genetic sex determinations were conducted in June and July 1999 by Eric LaHood (NMFS Northwest Fisheries Science Center, Seattle, WA). To facilitate this process, fin tissue was sampled from anesthetized brood year 1994 and 1995 chinook salmon at Eagle Fish Hatchery and Manchester Marine Laboratory on June 8 and 10, 1998, respectively. Tissue samples were stored in 95% ethanol and transferred to NMFS for analysis. Physical maturation sorts were conducted, generally twice a week, between July 31 and September 29, 1999. Fish from brood year 1994, 1995, and 1996 were anesthetized in MS-222 and examined for signs of maturation. These signs included changes in body coloration, the development of other secondary sex characteristics, and by physical manipulation of the gonads through the body wall. Fish judged to be maturing were isolated, by stock, from nonmaturing fish.

Monitoring Programs

Growth and Survival Brood Year 1994

Project activities in 1999 ended the contribution of brood year 1994 fish, the first cohort to complete their entire life history in captivity. Growth, maturity, and mortality data for this group of fish were tracked over time and summarized for each of these categories. Due to the relatively low number of individuals in later years, no attempt was made to compare the relative advantages and disadvantages between freshwater and saltwater rearing strategies. However, these data are presented separately for both rearing methods. Additionally, these data will be maintained in project databases and this analysis will be undertaken as additional brood years complete their life cycles.

Spawning Behavior Monitoring

In 1999, prespawn adult releases were made into Bear Valley Creek (Lemhi River system) and the East Fork Salmon River. All fish destined for release into these streams were marked with visible external tags (Petersen disc or Floy) to facilitate fish-specific behavioral observations, and fork lengths, weights, and unique morphological data were associated with individual PIT tag codes. In addition, fish for release in the East Fork Salmon River were fitted with radio transmitters. Transportation and tempering were conducted as described above, and releases were conducted according to protocols identified in the original permit application. Telemetry equipment used to monitor activity in the East Fork Salmon River was manufactured by Advanced Telemetry Systems and included model R2000 receivers, three-element Yagi antennas, and type 201, model 10-28 (15 g dry weight) and model 5 (20 g dry weight) transmitters.

The Bear Valley Creek study section began approximately 1.6 km upstream of its confluence with Hayden Creek and extended upstream approximately 2.0 km to a natural barrier. Within the study section, stream habitat was classified as riffle, run, or pool, and each riffle/pool section was uniquely identified and numbered. To ensure that fish remained in the release section, a temporary blocking weir was constructed at the downstream end of the evaluation section. Upstream and downstream trap boxes were installed in this weir to facilitate the movement of wild/natural adult chinook salmon into the study area or resident species (primarily bull trout *Salvelinus confluentus* and cutthroat trout *O. clarki*) moving into or out of the reach.

Maturing fish were released into three large pools in the lower meadow reach of Bear Valley Creek, and daily behavioral monitoring was initiated. Observers conducted two passes or "scans" of the study area each day, identifying individuals, recording migration patterns, noting utilized habitat types, and summarizing behavioral characteristics. Additionally, a recording thermograph was deployed within the study reach to monitor the thermal histories of redds constructed by captive chinook salmon. If weather became inclement or water visibility was otherwise impaired, surveys were temporarily suspended. Following the first observation of spawning-related behavior, monitoring was intensified. During the peak spawn period, survey personnel recorded general health and condition of the fish, mate pairing, nest digging, and spawning behavior. Attempts at redd construction were classified as test digs or completed redds. Areas of excavation were flagged upon initial observation and monitored closely for progress and/or completion. Gravel size was noted as well as the number of nests completed. Interactions between bull trout and chinook salmon were also recorded. Fidelity to redd sites was recorded for females as well as the degree of wandering observed among males. When carcasses were recovered, locations were noted, and they were measured for fork length, inspected for milt or egg retention, and scanned for PIT tags and associated external tag identification numbers.

Maturing adults were released into the East Fork Salmon River approximately 31 km upstream of its confluence with the mainstem Salmon River, and telemetry investigations were conducted on an every-other-day basis. The frequency of tracking increased to daily following first observations of spawning-related behavior. When radio-tagged fish were located, their positions were recorded on global positioning system (GPS) receivers (Lowrance GPS model GlobalNav 212). If observers were able to make visual contact with radio-tagged fish, behavioral observations (as described above for Bear Valley Creek) were recorded.

Production Monitoring

In July 1999, brood year 1998 production was monitored using standardized IDFG snorkeling techniques. Two groups of snorkelers surveyed Bear Valley Creek to assess fry production from captive adult chinook salmon planted in 1998. Each group consisted of two snorkelers and one data recorder. Snorkel crews surveyed the entire study area on Bear Valley Creek from the blocking weir location upstream to the natural barrier at the upper end of the section. Following similar procedures, biologists from the Shoshone-Bannock Tribes conducted snorkel investigations on the West Fork Yankee Fork Salmon and East Fork Salmon rivers to assess production from 1998 outplants.

Hatchery Spawning and Gamete Evaluations

Maturing adults from the West Fork Yankee Fork Salmon River and East Fork Salmon River stocks were retained as a precautionary measure to offset risk of cohort loss associated with low wild/natural adult escapement and low numbers of captive adults available to outplant. We investigated several spawning variables in the hatchery, including gamete quality, fecundity, and egg survival to the eyed stage of development. Where possible, comparisons were made between seawater and freshwater rearing treatments.

For the East Fork Salmon River stock, a spawning matrix was developed by Dr. Madison Powell and Joyce Faler (University of Idaho Hagerman Fish Culture Experiment Station, Hagerman, Idaho) to minimize inbreeding and maximize genetic diversity. Fin tissue from maturing adults and samples of cryopreserved milt from three-year-old males were analyzed for genetic differences using mitochondrial and nuclear DNA markers. Mitochondrial haplotypes and nuclear genotypes were identified in the maturing fish and used to construct the spawning matrix. Crosses were prioritized for outcrossing similar maternal lineages followed by outcrossing similar nuclear genotypes.

Spawning followed accepted, standard practices as described by McDaniel et al. (1994) and Erdahl (1994). In general, eggs produced at spawning were divided into sublots (by female) and fertilized with fresh or cryopreserved milt from unique males (factorial design). Milt was preharvested and examined for motility prior to use. Eggs were incubated by sublot to yield lineage-specific groups. Overall egg quality was judged by examining egg size, clarity of ovarian fluid, and presence/absence of polarized or overripe eggs. Fecundities were developed by applying subsample weights (number of eggs per gram) to total egg weight for each female. Egg survival to the eyed stage was determined by subtracting dead or unfertilized eggs from the total estimated number of eggs for each female.

Cryopreservation

Milt has been cryopreserved in the captive rearing program since 1997 following the techniques of Cloud et al. (1990) and Wheeler and Thorgaard (1991). In 1999, we cryopreserved milt from brood year 1996 and 1997 West Fork Yankee Fork chinook salmon. All milt collected and cryopreserved in 1999 is stored at the Eagle Fish Hatchery in liquid nitrogen bottles equipped with temperature and volume alarms.

Hatch Box Program

Eyed-eggs produced from 1999 spawning activities at Eagle Fish Hatchery were transferred to instream or streamside incubation boxes in cooperation with the Shoshone-Bannock Tribes. Instream incubation consisted of Jordan-Scotty units anchored to the channel bottom at locations with suitable water depth, velocity, and substrate conditions. Streamside incubation systems consisted of Whitlock-Vibert hatch boxes placed in larger incubation environments (modified refrigerators) plumbed with flow-through spring water. Haddix (2000) provides a more comprehensive overview of the methods used for hatch box incubation.

Fish Health

The Eagle Fish Health Laboratory examined chinook salmon mortalities during this reporting period. Routine fish necropsies included investigations for viral, bacterial, and

parasitic disease agents. The majority of samples analyzed in 1999 originated from groups reared at Eagle Fish Hatchery. However, mortalities received from the Sawtooth Fish Hatchery shortly after field collection and adult chinook salmon transferred to Eagle Fish Hatchery from the Manchester Marine Laboratory were also necropsied at the Eagle Laboratory in 1999. Juvenile chinook salmon destined for transfer to the Manchester Marine Laboratory for seawater rearing are vaccinated against *Vibrio spp*. Chinook salmon held at Eagle Fish Hatchery receive periodic Aquamycin treatments (or prophylaxis) using medicated feeds. In addition, Erythromycin may be delivered to specific stocks through intraperitoneal injection.

RESULTS

Collections for Captive Rearing

Brood Year 1998

Lemhi River—In October 1999, 191 age-0 chinook salmon parr were collected from the Lemhi River and transferred to the Sawtooth Fish Hatchery for temporary rearing. These fish were collected in an IDFG weir being operated for management purposes.

West Fork Yankee Fork Salmon River—In July 1999, 229 age-0 chinook salmon parr were collected from the West Fork Yankee Fork Salmon River and transferred to the Sawtooth Fish Hatchery for temporary rearing.

East Fork Salmon River—In August 1999, 85 age-0 chinook salmon parr were collected from the East Fork Salmon River and transferred to the Sawtooth Fish Hatchery for temporary rearing. An additional 100 age-0 parr were collected from this system in October 1999 and transferred to Sawtooth Fish Hatchery for temporary rearing. The October group of fish was provided by NMFS personnel who collected these fish by electrofishing as part of an ongoing Bonneville Power Administration funded study (Achord et. al 1998), but were too small to be PIT tagged.

Brood Year 1999

Lemhi River—Two hundred sixty-four eyed-eggs were hydraulically sampled from seven redds in the Lemhi River during September and October 1999 and transferred to the Eagle Fish Hatchery for final incubation and rearing. On September 22, 1999, 168 eggs were collected from three redds, which were completed between August 25 and 29, 1999. Eggs in these redds had accumulated approximately 290 CTUs when sampled. Another 96 eyed-eggs were collected from four additional redds on October 19, 1999. Observations indicated these redds were completed on September 8, 1999, and their eggs had accumulated approximately 300 CTUs at the time of sampling.

West Fork Yankee Fork Salmon River—-No brood year 1999 eyed-eggs were collected from this system as a result of low adult escapement in 1999.

East Fork Salmon River—On September 23, 1999, 143 eyed-eggs were collected from one redd in the East Fork Salmon River and transferred to the Eagle Fish Hatchery for final

incubation and rearing. Observations indicated this redd was completed on August 25, 1999, and sampling was conducted after the accumulation of 290 CTUs.

Fish Culture

The following information reflects culture history for the reporting period January 1, 1999 through December 31, 1999. During this reporting period, 16 rearing groups were in culture at IDFG facilities. Summaries of losses, transfers, and releases while in culture are presented in Tables 1, 2, and 3. In addition to the stock description (LEM = Lemhi River, WFYF = West Fork Yankee Fork Salmon River, and EFSR = East Fork Salmon River) of culture groups within brood years, captive chinook groups are further defined by collection method through the use of the descriptors "NP," "NE," or "SN." The acronym "NP" (natural parr) denotes a naturally-spawned culture group that was taken into captivity at the parr life history stage. The acronym "NE" (natural egg) denotes a naturally-spawned group that was collected at the egg life history stage and taken into captivity. The acronym "SN" (safety net) denotes a culture group resulting from hatchery crosses of captive-reared adults.

Brood Year 1994

At the beginning of the reporting period, seven LEM-NP, two WFYF-NP, and 12 EFSR-NP brood year 1994 chinook salmon were on station at Eagle Fish Hatchery (Tables 1, 2, and 3). On July 8, 1999, maturing LEM-NP (N=4), WFYF-NP (N=3), and EFSR-NP (N=8) brood year 1994 adults were transferred from the Manchester Marine Laboratory to Eagle Fish Hatchery to complete maturation in fresh water. On August 24, 1999, nine LEM-NP and seven EFSR-NP maturing adults were released into Bear Valley Creek (Lemhi River system) and the East Fork Salmon River, respectively, to spawn naturally. Three WFYF-NP and five EFSR-NP adults were retained for hatchery spawn crosses and resultant gamete evaluations. At the end of the reporting period, one EFSR-NP remained in culture at the Eagle facility. This fish is expected to mature in 2000. No individuals from brood year 1994 remained in culture at the Eagle Fish Hatchery from LEM-NP or WFYF-NP stocks at the end of the reporting period.

Brood Year 1995

Thirty-six brood year 1995 LEM-NP chinook salmon were on station at Eagle Fish Hatchery at the beginning of the reporting period (Table 1). No WFYF-NP or EFSR-NP brood year 1995 chinook salmon were collected. In 1999, 25 brood year 1995 LEM-NP adults were lost to bacterial kidney disease *Renibacterium salmoninarum*. Twenty-one maturing adults were transferred to Eagle Fish Hatchery from the Manchester Marine Laboratory on July 8, 1999 to complete maturation in fresh water. On August 24, 1999, 25 maturing adults were released to Bear Valley Creek (Lemhi River system) for natural spawning and evaluation. No adults were retained at the Eagle facility for hatchery spawn crosses. At the end of the reporting period, one fish from brood year 1995 remained in culture at the Eagle Fish Hatchery. Maturation is expected in 2000.

Table 1. Summary of losses and magnitude of mortality for six Lemhi River captive chinook salmon culture groups from brood year (BY) 1994-1999 reared at IDFG facilities in 1999. The acronyms NP and NE refer to natural parr and natural egg groups, respectively.

	Culture Groups					
	BY94-NP	**BY95-NP**	**BY96-NP**	**BY97-NP**	**BY98-NP**	**BY99-NE**
Starting Inventory (January 1, 1999)	7	36	41	135	191[a]	264[a]
Eyed-egg to Fry						
Undetermined[b]	n/a	n/a	n/a	n/a	n/a	20
Mechanical Loss						
Handling	0	0	1	1	1	0
Jump-out	0	0	0	7	0	0
Noninfectious						
Other[c]	1	6	2	0	1	0
Infectious						
Bacterial	1	25	1	0	1	0
Viral	0	0	0	0	0	0
Other	0	0	0	0	0	0
Hatchery Spawning						
Mature Males	0	0	0	0	0	0
Mature Females	0	0	0	0	0	0
Nonviable	0	0	0	0	0	0
Relocation						
Transferred In	4	21	12	11	0	0
Transferred Out	0	0	0	102	0	0
Planted/Released	9	25	16	12	0	0
Ending Inventory (December 31, 1999)	0	1	33	24	188	244

[a] Fall 1999 inventory.
[b] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.
[c] Includes culling associated with cultural anomalies and all undetermined, noninfectious mortality.

Table 2. Summary of losses and magnitude of mortality for five West Fork Yankee Fork Salmon River captive chinook salmon culture groups from brood year (BY) 1994-1999 reared at IDFG facilities in 1999. The acronyms NP and SN refer to natural parr and safety net groups, respectively.

	Culture Groups				
	BY94-NP	**BY96-NP**	**BY97-NP**	**BY98-NP**	**BY99-SN**
Starting Inventory (January 1, 1999)	2	26	200	229[a]	300[a]
Eyed-egg to Fry					
Undetermined[b]	n/a	n/a	n/a	n/a	21
Mechanical Loss					
Handling	0	12	0	3	0
Jump-out	0	0	8	0	0
Noninfectious					
Other[c]	1	2	1	7	0
Infectious					
Bacterial		1	3	1	0
Viral	0	0	0	0	0
Other	0	0	0	0	0
Hatchery Spawning					
Mature Males	0	3	20	0	0
Mature Females	2	0	0	0	0
Nonviable	1	0	0	0	0
Relocation					
Transferred In	3	0	18	0	0
Transferred Out	0	0	165	0	0
Planted/Released	0	0	0	0	0
Ending Inventory (December 31,1999)	0	6	23	219	279

[a] Fall 1999 inventory.
[b] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.
[c] Includes culling associated with cultural anomalies and all undetermined, noninfectious mortality.

Table 3. Summary of losses and magnitude of mortality for five East Fork Salmon River captive chinook salmon culture groups from brood year (BY) 1994-1999 reared at IDFG facilities in 1999. The acronyms NP, SN, and NE refer to natural parr, safety net, and natural egg groups, respectively.

	Culture Groups				
	BY94-NP	**BY98-NP**	**BY98-SN**	**BY99-NE**	**BY99-SN**
Starting Inventory (January 1, 1999)	12	185	261	143[a]	91[a]
Eyed-egg to Fry					
Undetermined[b]	n/a	n/a	n/a	2	4
Mechanical Loss					
Handling	0	0	0	0	
Jump-out	0	3	0	0	0
Noninfectious					
Other[c]	4	5	5	0	0
Infectious					
Bacterial	3	1	0	0	0
Viral	0	0	0	0	0
Other	0	0	0	0	0
Hatchery Spawning					
Mature Males	0	0	0	0	0
Mature Females	2	0	0	0	0
Nonviable	3	0	0	0	0
Relocation					
Transferred In	8	0	0	0	0
Transferred Out	0	0	0	0	0
Planted/Released	7	0	0	0	0
Ending Inventory (December 31,1999)	1	176	256	141	87

[a] Fall 1999 inventory.
[b] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.
[c] Includes culling associated with cultural anomalies and all undetermined, noninfectious mortality.

Brood Year 1996

At the beginning of the reporting period, 41 LEM-NP and 26 WFYF-NP brood year 1996 chinook salmon were in culture at the Eagle Fish Hatchery. No brood year 1996 EFSR-NP were in culture at IDFG facilities in 1999 after being transferred to seawater rearing as smolts in 1998. Twelve maturing LEM-NP males were transferred to Eagle Fish Hatchery from the Manchester Marine Laboratory on July 8, 1999 to complete maturation in fresh water. On August 24, 1999, all maturing LEM-NP males (N=16) were released to Bear Valley Creek (Lemhi River system) for natural spawning and evaluation. Three maturing WFYF-NP males were retained for hatchery spawn crosses, gamete evaluations, and milt cryopreservation, and none were released in 1999.

On July 22, 1999, 12 brood year 1996 WFYF-NP died at the Eagle Fish Hatchery as a result of a water inflow obstruction to the rearing tank. Circumstances of mortality for brood year 1996 chinook salmon are presented in Tables 1 and 2. At the end of the reporting period, 33 LEM-NP and six WFYF-NP brood year 1996 captives remained in culture at the Eagle Fish Hatchery.

Brood Year 1997

At the beginning of the reporting period, 135 LEM-NP and 200 WFYF-NP brood year 1997 chinook salmon, collected in the fall of 1998, were in culture at the Eagle Fish Hatchery. Collections of brood year 1997 EFSR-NP chinook were not conducted due to low adult escapement in 1997. On May 13, 1999, 102 LEM-NP and 165 WFYF-NP brood year 1997 smolts were transferred to the Manchester Marine Laboratory to complete rearing in seawater. Mean fish weight at transfer for these groups was 52.8 g (LEM-NP) and 45.9 g (WFYF-NP). Eleven LEM-NP and 18 WFYF-NP brood year 1997 precocial males were transferred to Eagle Fish Hatchery from the Manchester Marine Laboratory on August 6, 1999 to complete maturation in fresh water. On August 24, 1999, all maturing LEM-NP males (N=12) were released to Bear Valley Creek (Lemhi River system) for natural spawning and evaluation. Twenty maturing WFYF-NP males were retained for hatchery spawn crosses, gamete evaluations, and milt cryopreservation. No maturing WFYF-NP males were released in 1999. At the end of the reporting period, 24 LEM-NP and 23 WFYF-NP fish remained in culture at Eagle Fish Hatchery.

Brood Year 1998

A combination of low spawning escapement into the East Fork Salmon River and low numbers of maturing adults at the Eagle Fish Hatchery in 1998 prompted members of the CSCPTOC to advocate the initiation of a brood year 1998 EFSR-SN culture group. Eggs collected from maturing, captive adults at the Eagle Fish Hatchery were retained to assure the availability of future brood years in the absence of natural production (i.e., low adult spawner escapement to a given drainage). Approximately 300 eyed-eggs from 1998 EFSR-NP spawn crosses (Hassemer et. al 1999) were retained at the Eagle Fish Hatchery to establish the safety net group. Progeny from individual spawn crosses were reared separately until PIT tagging, and fish from 37 subfamilies were retained to maximize the genetic representation of this culture group. At the beginning of the reporting period, 261 brood year 1998 EFSR-SN sac fry were on station at Eagle Fish Hatchery. Ending balance for the 1999 reporting period was 256 fish (Table 3).

Transfers of brood year 1998 NP captives from Sawtooth Fish Hatchery to Eagle Fish Hatchery began on August 4, 1999 with the transfer of 229 WFYF-NP juveniles. Additional transfers occurred on August 25 (N=85 EFSR-NP juveniles) and October 14, 1999 (N=191 LEM-NP and 100 EFSR-NP juveniles). At the end of the reporting period, 188 LEM-NP, 219 WFYF-NP, and 176 EFSR-NP fish remained on station at the Eagle Fish Hatchery (Tables 1, 2 and 3).

Transfers of brood year 1998 captive groups to seawater rearing at the NMFS Manchester Marine Laboratory in Washington State are planned for May 2000.

Brood Year 1999

Concerns expressed by CSCPTOC members about disease history, parasite infestations, skewed sex ratios, and poor feed conversions of past natural parr collection groups prompted CSCPTOC members in 1999 to initiate the collection of fertilized chinook eggs at the "eyed" stage of development. Hydraulic sampling, a method now used more frequently to collect salmonid embryos throughout the Northwest, yielded 264 and 143 brood year 1999 eyed-eggs from the Lemhi and East Fork Salmon rivers, respectively. No brood year 1999 eggs were collected from the West Fork Yankee Fork Salmon River in 1999 as a result of low spawning escapement (less than five). At the end of the reporting period, 244 LEM-NE and 141 EFSR-NE sac fry were on station at the Eagle Fish Hatchery (Tables 1 and 3).

Eyed-eggs from 1999 spawn crosses were retained at the Eagle Fish Hatchery to establish brood year 1999 safety-net groups for the West Fork Yankee Fork Salmon River and East Fork Salmon River populations. Eggs were selected for retention based on nuclear and mitochondrial DNA data generated to guide the crosses of WFYF-NP and EFSR-NP gametes. The safety net groups were established with 300 (WFYF-SN) and 91 (EFSR-SN) eyed-eggs. At the end of the reporting period, 279 WFYF-SN and 87 EFSR-SN sac fry were on station at Eagle Fish Hatchery (Tables 2 and 3).

Monitoring Programs

Growth and Survival of Brood Year 1994

The growth rates of brood year 1994 chinook salmon reared in freshwater and saltwater were similar, but maturing fish from each group were generally smaller than their ocean-reared conspecifics. Inventories conducted between June and September 1996-1998 indicated that captive-reared fish had grown to approximately 200, 380, and 520 mm fork length in each year, respectively. By 1999, only freshwater-reared individuals remained in culture and were approximately 500 mm fork length, indicating that little additional growth was realized between the fourth and fifth year of life. In contrast, ocean-reared spring/summer chinook salmon returning to the Columbia River basin between 1991 and 1996 generally averaged 740-800 mm fork length (Fryer 1998). This apparent difference in size between captive- and ocean-reared chinook salmon may affect the ability of captive-reared individuals to compete for mates, defend territories, and avoid predation.

Most captive-reared chinook salmon from brood year 1994 matured at age-3 or -4, with relatively little precocial (age-2) development regardless of rearing history. However, age-3

maturation was exclusively male and age-4 maturation predominantly female. The percentage of precocial male development was relatively low in the EFSR-NP and WFYF-NP groups, and ranged between approximately 8% and 12% of the mature males in each group. Lemhi River males had a much higher precocial rate (61.5%), but several confounding factors may be present. First, very few males from this group matured, suggesting that males from the LEM-NP groups may have had a higher mortality rate than males from the other groups. Second, the overall percentages of precocial males in the three groups were very similar. Precocial development was 2.8% in the WFYF-NP group (6 precocial out of 216 fish brought into the program), 3.5% in the EFSR-NP (7 of 199), and 4.1% in the LEM-NP (8 of 193). This also suggests LEM-NP males may have experienced higher mortality than those in the other groups.

Mortality in the brood year 1994 fish was relatively evenly split between causes related to culture activities (52.5%) and reproductive maturity (45.8%). Approximately 50% of the mortality associated with fish culture was attributable to a flow blockage and a chloramine T treatment in 1996. Other causes of mortality during rearing included jumping out of the tank, handling, and tagging. Disease was a relatively minor source of mortality and accounted for less than 2% of that observed. Mortality associated with sexual maturity was further broken down into hatchery spawning activities (16%) and those released to spawn volitionally (29.8%). However, it is unknown how many of the adults released for volitional spawning actually reproduced.

Spawning Behavior Monitoring

Bear Valley Creek—Study fish to be released into this system were marked at the Eagle Hatchery on August 20, 1999 and released on August 24, 1999. The release group contained nine brood year 1994, 25 brood year 1995, 16 brood year 1996, and 12 brood year 1997 LEM-NP chinook, and included 29 males and 33 females. Mark combinations identified each individual by brood year and rearing strategy (freshwater vs. seawater). Additionally, PIT tag number, sex determination, weight, and fork length were recorded (Table 4). Behavioral observations commenced immediately upon release and continued through October 12, 1999.

We recorded 433 unique observations of outplanted chinook salmon. Observations were associated with 30 of the 33 female and seven of the 29 males released to the study section. First signs of agonistic behavior were recorded shortly after release on August 30. First signs of test digging were recorded on August 31. Most redd construction activity was observed between September 10 and September 30. A total of 31 suspected redds were identified during the survey period. Between August 31 and September 15, 1999, most observed behavior consisted of holding and traveling, and little spawning activity was observed during this time (Figure 2). In the following weeks (September 16 to October 12, 1999), courting and other spawning-related behaviors became the dominant behaviors observed (Figure 2). The frequency of inter- and intra-specific aggression remained relatively constant throughout the observation period (Figure 2).

Over 30 direct observations of chinook salmon spawning were recorded. In some cases, chinook salmon redds were superimposed on bull trout redds or on other chinook salmon redds. Several chinook salmon females were observed moving from one area of excavation to another. Some females were observed working gravel at four different locations. There were approximately 11 observations of bull trout and chinook salmon paired over the same redd. In many of these cases, we observed spawning-related behavior between bull trout and chinook salmon.

A total of six male and 11 female carcasses were recovered. Nine female carcasses were examined for egg retention. Five of the nine females (56%) appeared to have spawned and deposited the vast majority of their eggs. The mean number of retained eggs for these five females was 17.2 (range three to 30 eggs). One partially-spawned female was recovered with 698 retained eggs, and three females were recovered that appeared to have died before spawning (mean retained eggs = 1,536, range 1,175 to 1,933).

East Fork Salmon River—Study fish to be released into this stream were marked at the Eagle Fish hatchery on August 20, 1999 and released on August 25, 1999. The release group contained seven brood year 1994 EFSR-NP chinook salmon, including six females and one male. Five of the females were seawater reared, and the male and one female had been reared at the Eagle Fish Hatchery. All fish received an individually-numbered Petersen disc tag and internal radio transmitters that were used to identify an individual's brood year, rearing strategy, PIT tag number, sex, weight, and fork length (Table 5). Behavioral observations began immediately upon release and continued until September 24, 1999.

Observations of captive-reared chinook salmon included spawning related behavior and the recovery of carcasses and transmitters. On September 15, we observed one of the six captive-reared females in close proximity to what appeared to be a completed redd. Her caudal fin was worn, but no male chinook salmon were observed in the vicinity. Her carcass was recovered on September 24, and only ten retained eggs were found in her body cavity. The remaining five captive-reared females were not observed participating in spawning-related activity or observed near suspected redds. Three transmitters were recovered from the five females not observed spawning in September. Two of the three recovered transmitters were not associated with carcasses when found. The third transmitter was recovered from a carcass that had most eggs intact in the body cavity. This fish had a large body wound and may have been attacked by a predator before spawning. The single captive-reared male was observed on several occasions but never in close proximity to wild/natural or captive-reared females. The transmitter from this fish was recovered on September 24.

Production Monitoring

Snorkel surveys were conducted in July 1999 in Bear Valley Creek, the East Fork Salmon River, and the West Fork Yankee Fork Salmon River to document presence/absence of young-of-the-year chinook salmon produced from 1998 adult outplants to these systems. Surveys were conducted near locations where captive adults were released or eggs were planted. No juvenile chinook salmon were observed during these surveys.

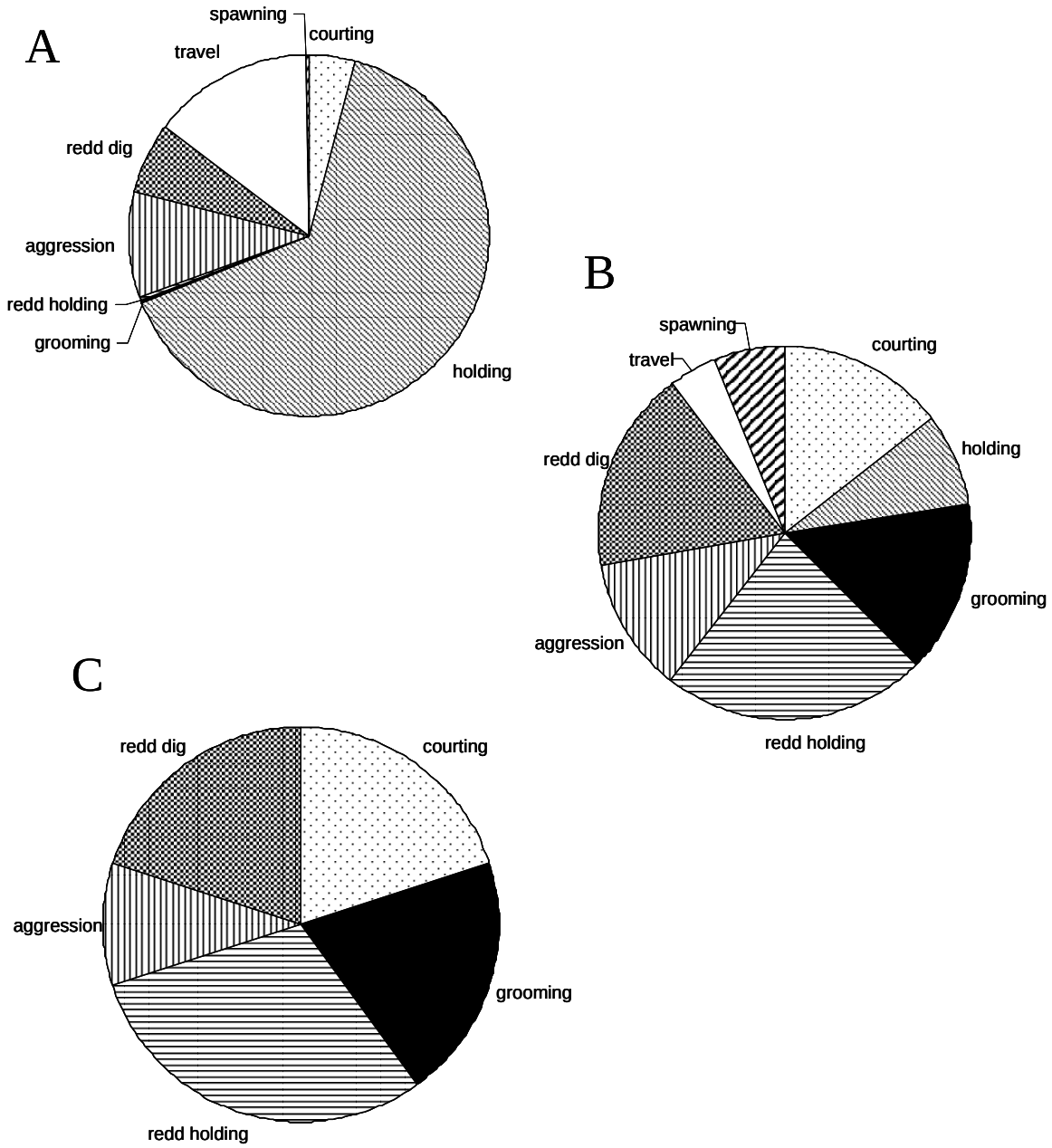

Figure 2. Observed behavior of captive-reared chinook salmon released into Bear Valley Creek for volitional spawning. Each chart represents an approximate two-week period (A—August 31 to September 15, B—September 16 to 30, C—October 1 to 12, 1999).

Table 4. Summary of Lemhi River captive chinook salmon releases to Bear Valley Creek on August 24, 1999.

Brood Year	Stock	Rearing Origin	PIT Number	Sex	Weight (g)	Fk. Length (cm)	Tag Type	Tag Number	Tag Color
1994	Lemhi R.	Seawater	204B114B39	F	2000	55	Petersen	012	White
1994	Lemhi R.	Seawater	204C481834	F	2100	55	Petersen	020	White
1994	Lemhi R.	Seawater	204C386C70	F	1450	52	Petersen	038	White
1994	Lemhi R.	Seawater	204B2C3831	F	2650	60	Petersen	043	White
1994	Lemhi R.	Freshwater	7F7A0F2729	F	2700	56	Petersen	000	White
1994	Lemhi R.	Freshwater	200E181F1B	F	1250	47	Petersen	013	White
1994	Lemhi R.	Freshwater	1F7C0C0E4B	F	1500	49	Petersen	039	White
1994	Lemhi R.	Freshwater	1F7E400122	F	1450	48	Petersen	046	White
1994	Lemhi R.	Freshwater	204C474706	F	1950	53	Petersen	084	White
1995	Lemhi R.	Seawater	2036332453	F	2050	53	Petersen	003	White
1995	Lemhi R.	Seawater	2010423658	F	1250	47	Petersen	006	White
1995	Lemhi R.	Seawater	416D74043C	F	1500	50	Petersen	011	White
1995	Lemhi R.	Seawater	416C34305E	F	740	39	Petersen	015	White
1995	Lemhi R.	Seawater	200F6D1153	F	1500	49	Petersen	022	White
1995	Lemhi R.	Seawater	4165290640	F	1450	49	Petersen	029	White
1995	Lemhi R.	Seawater	200B202312	F	1500	51	Petersen	034	White
1995	Lemhi R.	Seawater	200F661952	F	2550	57	Petersen	041	White
1995	Lemhi R.	Seawater	416B7D1955	F	3200	61	Petersen	044	White
1995	Lemhi R.	Seawater	222E283671	F	3150	60	Petersen	047	White
1995	Lemhi R.	Seawater	200C256F40	F	1850	50	Petersen	050	White
1995	Lemhi R.	Seawater	1F7A561A77	F	2300	54	Petersen	051	White
1995	Lemhi R.	Seawater	416B641B4E	F	2000	53	Petersen	054	White
1995	Lemhi R.	Seawater	2010497512	F	2400	56	Petersen	071	White
1995	Lemhi R.	Seawater	203643481F	F	1600	49	Petersen	073	White
1995	Lemhi R.	Seawater	41706D213D	F	2050	54	Petersen	076	White
1995	Lemhi R.	Seawater	4170732F05	F	1350	47	Petersen	077	White
1995	Lemhi R.	Seawater	2010410807	F	2050	53	Petersen	078	White
1995	Lemhi R.	Seawater	416C174610	F	1700	50	Petersen	088	White
1995	Lemhi R.	Seawater	416C1F5134	F	2250	55	Petersen	089	White
1995	Lemhi R.	Freshwater	416D537D35	F	928	42	Petersen	002	White
1995	Lemhi R.	Freshwater	1F7A636024	F	1180	46	Petersen	010	White
1995	Lemhi R.	Freshwater	200F515729	F	1150	45	Petersen	017	White
1995	Lemhi R.	Freshwater	200E4F0E75	F	1250	45	Petersen	074	White
1995	Lemhi R.	Freshwater	201034425A	M	600	37	Petersen	016	Yellow

Table 4. Continued.

Brood Year	Stock	Rearing Origin	PIT Number	Sex	Weight (g)	Fk. Length (cm)	Tag Type	Tag Number	Tag Color
1996	Lemhi R.	Seawater	416C60305F	M	793	38	Petersen	021	White
1996	Lemhi R.	Seawater	22316A0922	M	548	35	Petersen	000	Yellow
1996	Lemhi R.	Seawater	2231680E48	M	647	37	Petersen	002	Yellow
1996	Lemhi R.	Seawater	222E303250	M	569	35	Petersen	007	Yellow
1996	Lemhi R.	Seawater	222E206D70	M	582	35	Petersen	011	Yellow
1996	Lemhi R.	Seawater	222E26213E	M	744	39	Petersen	012	Yellow
1996	Lemhi R.	Seawater	416C597713	M	626	36	Petersen	014	Yellow
1996	Lemhi R.	Seawater	4170602817	M	495	34	Petersen	018	Yellow
1996	Lemhi R.	Seawater	222E21255B	M	660	37	Petersen	022	Yellow
1996	Lemhi R.	Seawater	222E46290E	M	562	35	Petersen	025	Yellow
1996	Lemhi R.	Seawater	1F7B770867	M	894	41	Petersen	028	Yellow
1996	Lemhi R.	Freshwater	22316D3E2D	M	564	34	Petersen	001	Yellow
1996	Lemhi R.	Freshwater	415A183761	M	520	36	Petersen	017	Yellow
1996	Lemhi R.	Freshwater	222E237844	M	288	29	Petersen	019	Yellow
1996	Lemhi R.	Freshwater	2231653226	M	316	29	Petersen	020	Yellow
1996	Lemhi R.	Freshwater	2231547F4F	M	330	32	Petersen	026	Yellow
1997	Lemhi R.	Seawater	515F4F7917	M	121	21	Floy	004	Yellow
1997	Lemhi R.	Seawater	515B425141	M	114	20	Floy	005	Yellow
1997	Lemhi R.	Seawater	515C006E3E	M	97	19	Floy	006	Yellow
1997	Lemhi R.	Seawater	515F551C08	M	139	21	Floy	007	Yellow
1997	Lemhi R.	Seawater	515F566A51	M	153	22	Floy	008	Yellow
1997	Lemhi R.	Seawater	5160252217	M	82	19	Floy	009	Yellow
1997	Lemhi R.	Seawater	515C005726	M	183	24	Floy	010	Yellow
1997	Lemhi R.	Seawater	515B782603	M	132	21	Floy	011	Yellow
1997	Lemhi R.	Seawater	515D2E3D61	M	127	21	Floy	012	Yellow
1997	Lemhi R.	Seawater	515B480B04	M	124	20	Floy	013	Yellow
1997	Lemhi R.	Seawater	515B7B3103	M	64	17	Floy	014	Yellow
1997	Lemhi R.	Freshwater	51602C3858	M	176	22	Floy	003	Yellow

Table 5. Summary of East Fork Salmon River captive chinook salmon released on August 25, 1999.

Brood Year	Stock	Rearing Origin	PIT Number	Sex	Weight (g)	Fk. Length (cm)	Tag Type	Tag Number	Tag Color	Radio Frequency
1994	EFSR	Seawater	2043473422	F	2650	60	Petersen	015	White	150.109
1994	EFSR	Seawater	204B2A0A61	F	2600	60	Petersen	017	White	151.533
1994	EFSR	Seawater	20433E322D	F	2250	55	Petersen	027	White	150.259
1994	EFSR	Seawater	20433E6E71	F	1500	53	Petersen	039	White	151.861
1994	EFSR	Seawater	20484C6567	F	3050	63	Petersen	042	White	150.131
1994	EFSR	Freshwater	204C4C6662	F	1650	52	Petersen	011	White	150.512
1994	EFSR	Freshwater	204E7E474D	M	1000	40	Petersen	018	White	151.842

Gamete Evaluations

West Fork Yankee Fork Salmon River—Two brood year 1994 WFYF-NP females with seawater rearing history produced 2,597 eyed-eggs in 1999. Three brood year 1996 WFYF-NP freshwater rearing treatment males and three brood year 1997 WFYF-NP seawater rearing treatment males were used in the spawning design. Mean fecundity for the brood year 1994 females was 1,644 eggs, and mean egg survival to the eyed stage of development was 79.0% (Table 6). One additional brood year 1994 WFYF-NP female reared in seawater was spawned yielding 1,172 eggs; however, all eggs were determined to be nonviable and later culled. No brood year 1994 WFYF-NP females from freshwater rearing were spawned in 1999. Four unique subfamilies were produced from 1999 spawn crosses. Mean fork length and weight for brood year 1994 female spawners was 536 mm and 1,572 g, respectively. Brood year 1996 males used in spawn crosses averaged 288 mm fork length and 270 g in weight. Mean fork length and weight for brood year 1997 male spawners was 193 mm and 84 g, respectively.

East Fork Salmon River—In 1999, 1,129 eyed-eggs were produced from EFSR-NP spawn crosses at Eagle Fish Hatchery. Two brood year 1994 females (one freshwater and one seawater rearing history fish) and cryopreserved milt from four males was used in the spawning design. Milt was obtained from brood year 1994 EFSR-NP males cryopreserved in 1997 and 1998. We did not attempt to fertilize eggs produced from three captive females (two freshwater and one seawater history fish) based on observations of substantial egg deformation, egg retention, yolk polarization, and discolored ovarian fluid. Fecundity and egg survival to the eyed stage of development was 391 eggs and 10.5%, respectively, for the brood year 1994 freshwater rearing group female (Table 6). Fecundity and egg survival to the eyed stage of development for the seawater rearing group female was 2,596 and 41.9%, respectively (Table 6). The brood year 1994 freshwater reared female was 520 mm in fork length and 1,449 g in weight, and the seawater reared fish was 625 mm fork length and weighed 2,528 g.

Table 6. Summary of 1999 spawning data for West Fork Yankee Fork Salmon River (WFYF) and East Fork Salmon River (EFSR) captive chinook salmon. Data for males reflects the use of fresh milt, except where noted. FW and SW reference freshwater and seawater rearing treatments.

Stock and Rearing History	Number of Unique Females Spawned[a]	Number of Unique Males Spawned	Mean Female Fecundity	Mean Egg Survival to the Eyed Stage	Number of Eyed-Eggs Produced
WFYF–SW	2	6[b]	1,644	79.01%	2,597
EFSR–FW	1	4 cryo[c]	391	10.49%	41
EFSR–SW	1	4 cryo[c]	2,596	41.91%	1,088

[a] All females from brood year 1994.
[b] Three and three of the six males from brood years 1996 and 1997.
[c] Cryopreserved milt was used in the EFSR spawning matrix and was obtained from brood year 1994 males collected from age-3 (two males) and age-4 (two males) fish.

Cryopreservation

On September 29, 1999, milt from maturing brood year 1996 (N=1) and brood year 1997 (N=17) WFYF-NP captive chinook salmon was cryopreserved at Eagle Fish Hatchery. The brood year 1996 male and one brood year 1997 male were reared in freshwater, and the remaining 16 brood year 1997 males were products of seawater rearing. Milt collection in 1999 produced a total of 448, 0.5 ml straws (Table 7). No milt cryopreservation was conducted on Lemhi River or East Fork Salmon River males in 1999.

Cryopreserved milt from brood year 1994 EFSR-NP males was utilized in the 1999 spawning design for EFSR-NP adults at Eagle Fish Hatchery. Forty-seven, 0.5 ml straws from brood year 1994 EFSR-NP males cryopreserved in 1997 (two males) and 1998 (two males) were used to fertilize 2,987 green eggs. These crosses produced 1,129 eyed-eggs for a 37.8% survival rate.

Hatch Box Program

Brood Year 1998—Eyed-eggs were transferred to incubation boxes in all three study streams in 1998 and were monitored throughout the 1998-1999 incubation period by biologists from the Shoshone-Bannock Tribes. A total of 9,320 eyed-eggs were planted in Whitlock-Vibert boxes at Hayden Creek, a tributary to the Lemhi River, approximately 7 km upstream of their confluence. The West Fork Yankee Fork Salmon River received 3,393 eyed-eggs in one Whitlock-Vibert box approximately 3 km upstream of the confluence with the mainstem Yankee Fork Salmon River. East Fork Salmon River eyed-eggs were planted in 15 Jordan-Scotty units (N=15,240) and one Whitlock-Vibert box (N=2,039) approximately 31 km upstream of the confluence of the East Fork Salmon River and mainstem Salmon River. Following emergence and emigration from the incubation sites, incubation systems were examined and dead eggs/fry enumerated to determine an estimated hatching rate for individual locations. Estimated hatching rates were variable and ranged from a low of 62.3% for East Fork Salmon River streamside incubators to a high of 92.1% for West Fork Yankee Fork Salmon River streamside incubators (Table 8).

Table 7. Summary of September 29, 1999 milt cryopreservation activities at the Eagle Fish Hatchery. (BY = Brood Year, WFYF = West Fork Yankee Fork Salmon River, and NP = natural parr collection groups.)

Rearing Group	Number of Males Used	Number of 0.5 ml Straws Cryopreserved	Average Milt Motility	Motility Range
BY96 WFYF-NP	1	24	98.0%	—
BY97 WFYF-NP	17	424	98.1%	90.0% to 100.0%

Brood Year 1999—Eyed-eggs were placed in incubation systems in the West Fork Yankee Fork Salmon River and East Fork Salmon River and again were monitored by personnel from the Shoshone-Bannock Tribes during the 1999-2000 incubation period. Eyed-

eggs produced from WFYF-NP spawn crosses were planted in one Whitlock-Vibert box (N=1,468) and in one Jordan/Scotty unit (N=829) approximately 3 km upstream of the confluence with the mainstem Yankee Fork Salmon River. A total of 1,038 eyed-eggs produced from EFSR-NP spawn crosses at the Eagle Fish Hatchery were planted in one instream Jordan-Scotty unit approximately 31 km upstream of the confluence of the East Fork Salmon River and mainstem Salmon River (Table 9). Due to continued hatching and development of eggs/embryos, hatching and survival results will be summarized in 2000 reporting.

FISH HEALTH

In 1999, 82 laboratory accessions (representing 125 mortality events) were generated at the Eagle Fish Health Laboratory for captive-reared chinook salmon (Tables 1, 2, and 3). Principle fish health concerns included the presence of bacterial kidney disease (BKD), whirling disease *Myxobolus cerebralis* (WD), and the presence of the parasitic gill copepod *Salmincola californiensis*. In addition, maturing chinook salmon transferred to the State of Idaho from the NMFS Manchester Marine Laboratory in Washington State were screened for the North American strain of viral hemorrhagic septicemia (NA VHS) and *Piscirickettsia salmonis*. These pathogens do not occur in Idaho but have recently been identified in fish reared at a seawater net pen location in close proximity to the NMFS facility. Because of the risk associated with the potential introduction of NA VHS, ovarian fluid and tissues sampled from NMFS-origin fish were "blind-passed" to improve our ability to detect the virus. There was no evidence of virus demonstrated from routine procedures in addition to these extra procedures.

Table 8. Summary of brood year 1998 captive chinook salmon eyed-egg transfers and hatching rates for instream and streamside incubators (Haddix 2000).

Location	Number of Eyed-eggs Transferred	Dates Transferred	Number of Eyed-eggs Planted	Estimated Hatching Rate
West Fork Yankee Fork	3,451[a]	11/2/98	3,393	92.13%
Lemhi River Hayden Creek Site	9,324[b]	11/2/98	9,320	75.00%
East Fork Salmon River	15,240[c]	11/2/98, 11/7/98	15,240	91.04%
East Fork Salmon River Big Boulder Creek Site	2,039[d]	11/2/98, 11/7/98	2,039	62.29%

[a] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 West Fork Yankee Fork Salmon River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside incubation system.
[b] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 Lemhi River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside incubation system.
[c] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 East Fork Salmon River captive chinook salmon. Eggs planted in Jordan/Scotty in-gravel units at 15 locations.
[d] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 East Fork Salmon River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside location.

Monitoring for BKD in captive chinook salmon has been conducted routinely since the inception of the program in 1995. Of the 125 fish examined in 1999, 37 demonstrated clinical levels of this disease. The majority of mortality associated with BKD (25 cases) occurred in brood year 1995 LEM-NP. In addition to this loss, the following mortality was associated with BKD in 1999: 1) five (combined) brood year 1994 LEM-NP, WFYF-NP, and EFSR-NP fish, 2) four (combined) brood year 1996 LEM-NP and WFYF-NP fish, 3) one brood year 1997 WFYF-NP fish, and 4) two (combined) brood year 1998 LEM-NP and EFSR-NP fish. All BKD-related mortality was associated with rearing groups collected as natural parr or smolts. No BKD was identified in the EFSR-SN group on station during this reporting period. As an additional precaution, brood year 1998 LEM-NP, WFYF-NP, and EFSR-NP were given two intraperitoneal injections with Erythromycin within two months of collection. Periodic prophylactic treatments with Erythromycin-medicated feed also occurred in 1999.

In 1999, LEM-NP infested with gill parasites were treated with the parasiticide Ivermectin. The treatment was administered by gastric intubation to all age-classes in culture. During Ivermectin treatments, gill parasites were also manually removed using forceps. Prior efforts to control the infestation by manual removal had not been effective. In addition, the handling associated with repeated attempts at manual removal, the degree of gill necrosis, and a generally poor feeding response most likely exacerbated BKD-related mortality observed in brood year 1995 LEM-NP chinook salmon described above. By the end of this reporting period, Ivermectin treatment had resulted in the elimination of the parasite in all age-classes. Current practice is to administer Ivermectin shortly after natural parr are collected and brought into the hatchery

Natural chinook juveniles collected from the Lemhi River (and to a lesser extent, the West Fork Yankee Fork Salmon River) are infected with *Myxobolus cerebralis*, the causative agent of salmonid whirling disease. For Lemhi River chinook salmon juveniles, the prevalence of infection has averaged approximately 38%. No mortality has been attributed to the parasite, but occasional deformities have been observed.

Table 9. Summary of brood year 1999 captive chinook salmon eyed-egg transfers to instream and streamside incubators.

Destination	**Number of Eyed-Eggs Transferred**	**Dates Transferred**
West Fork Yankee Fork	829[a]	10/13/99
West Fork Yankee Fork	1,468[b]	10/13/99
East Fork Salmon River	1,038[c]	11/2/99

[a] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 West Fork Yankee Fork Salmon River captive chinook salmon. Eggs planted in Jordan/Scotty in-gravel units.
[b] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 West Fork Yankee Fork Salmon River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside incubation system.
[c] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 East Fork of the Salmon River captive chinook salmon. Eggs planted in Jordan/Scotty in-gravel units.

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