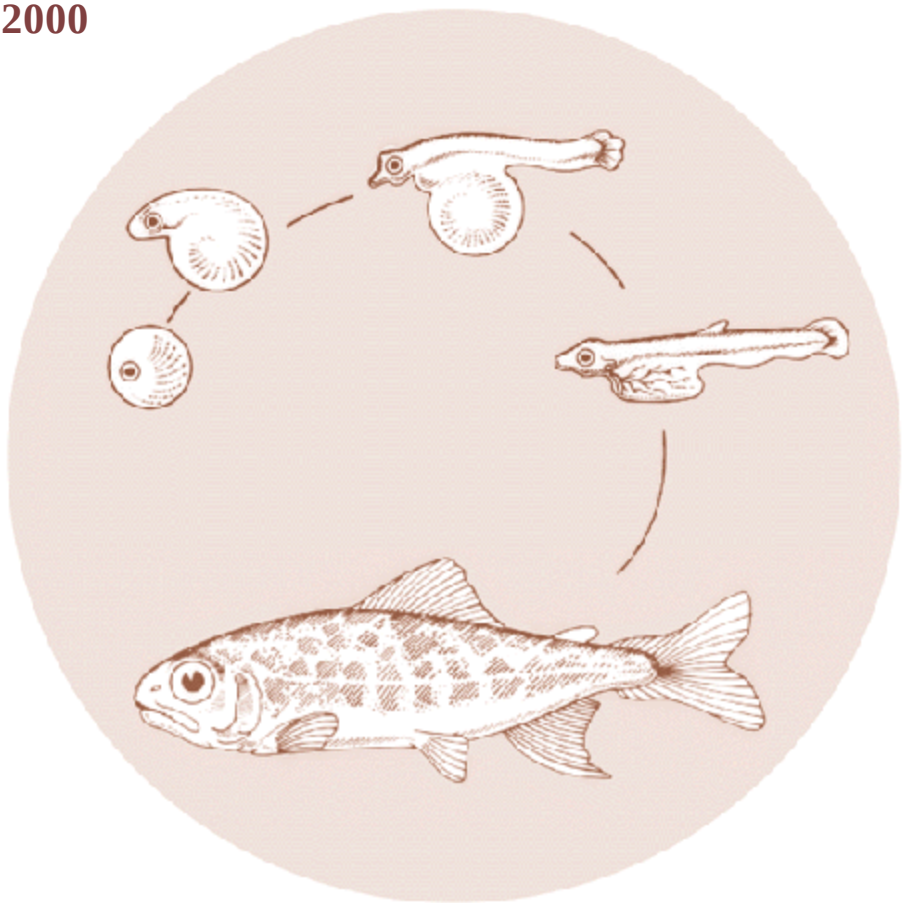
Captive Rearing Program for Salmon RiverChinook Salmon

Annual Report
2000



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FISHERY RESEARCH

CAPTIVE REARING PROGRAM FOR SALMON RIVER CHINOOK SALMON

Project Progress Report
January 1, 2000 - December 31, 2000

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April 2002

Captive Rearing Program for Salmon River Chinook Salmon

Project Progress Report

2000 Annual Report

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ABSTRACT

During 2000, 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 to establish captive cohorts from three study streams and included 503 eyed-eggs from East Fork Salmon River (EFSR), 250 from the Yankee Fork Salmon River, and 304 from the West Fork Yankee Fork Salmon River (WFYF). After collection, the eyed-eggs were immediately transferred to the Eagle Fish Hatchery, where they were incubated and reared by family group. Juveniles collected the previous summer were PIT and elastomer tagged and vaccinated against vibrio *Vibrio* spp. and bacterial kidney disease before the majority (approximately 75%) were transferred to the National Marine Fisheries Service, Manchester Marine Experimental Station for saltwater rearing through sexual maturity. Smolt transfers included 158 individuals from the Lemhi River (LEM), 193 from the WFYF, and 372 from the EFSR. Maturing fish transfers from the Manchester facility to the Eagle Fish Hatchery included 77 individuals from the LEM, 45 from the WFYF, and 11 from the EFSR. Two mature females from the WFYF were spawned in captivity with four males in 2000. Only one of the females produced viable eggs (N = 1,266), which were placed in in-stream incubators by personnel from the Shoshone-Bannock Tribe. Mature adults (N = 70) from the Lemhi River were released into Big Springs Creek to evaluate their reproductive performance. After release, fish distributed themselves throughout the study section and displayed a progression of habitat associations and behavior consistent with progressing maturation and the onset of spawning. Fifteen of the 17 suspected redds spawned by captive-reared parents in Big Springs Creek were hydraulically sampled to assess survival to the eyed stage of development. Eyed-eggs were collected from 13 of these, and survival ranged from 0% to 96%, although there was evidence that some eggs had died after reaching the eyed stage. Six redds were capped in an attempt to document fry emergence, but none were collected. A final hydraulic sampling of the capped redds yielded nothing from five of the six, but 75 dead eggs and one dead fry were found in the sixth. Smothering by fine sediment is the suspected cause of the observed mortality between the eyed stage and fry emergence.

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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 brood stock 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, and numbers of naturally produced chinook 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 (Raymond 1979; 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 pre-decisional 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 target populations by returning captive-reared adults to their 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.

The IDFG captive rearing program was developed primarily as a way to maximize the number of breeding units while avoiding the impacts of multigenerational hatchery culture (Reisenbichler and Rubin 1999) by collecting early life stages of wild individuals and rearing them through adulthood. Only enough juveniles or eggs are collected from target populations to provide an adequate number of spawners to ensure that acceptable genetic diversity could be maintained without additional natural escapement. 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, 2000 through December 31, 2000. This project is coordinated with the Northwest Power Planning Council's Fish and Wildlife Program (NPPC 1994), and funding is provided through the Bonneville Power Administration under contract 1997-00100.

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). Big Springs Creek, which flows into the Lemhi River near the town of Leadore, Idaho, was selected as a captive chinook salmon release site in 2000. The study section of this stream flows through private property, which is currently in a grazing rotation, and contains B- and C-channel conditions. The East Fork Salmon River and West Fork Yankee Fork Salmon River 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 typically reflects B and C conditions.

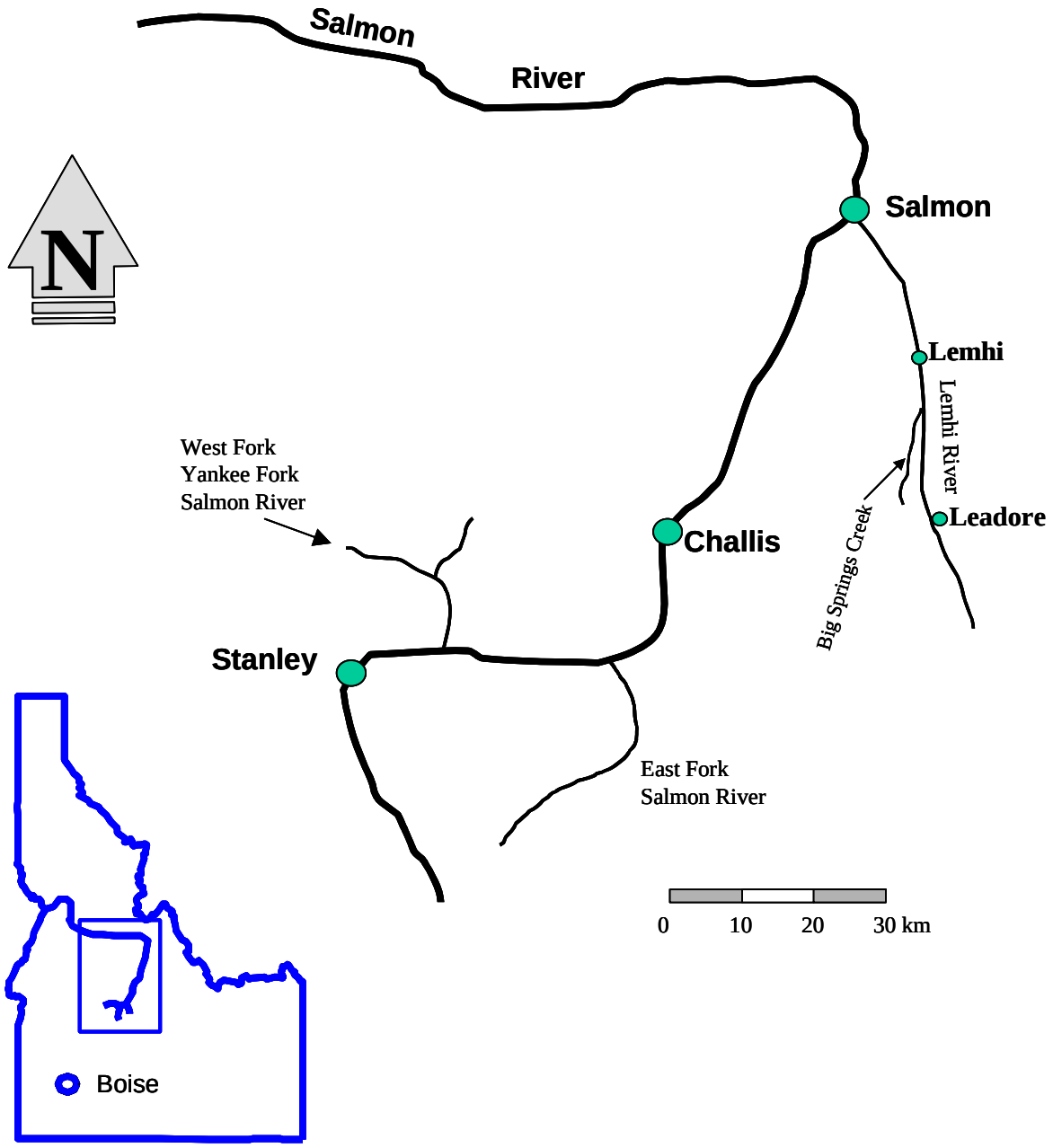

Figure 1. Location of Idaho Department of Fish and Game spring/summer chinook salmon captive rearing program study streams.

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 the effectiveness of each form of captive culture 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 to 2000 have been brought into captivity to continue the project. Hassemer et al. (1999; 2001) summarize the project's activities from inception through 1999.

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 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.

METHODS

Egg Collections

Chinook salmon for the captive rearing study were collected from the East Fork Salmon River, West Fork Yankee Fork Salmon River, and Yankee Fork Salmon River as eyed-eggs in 2000. Eyed-eggs were collected using hydraulic sampling methods described by McNeil (1964). This system consists of two main components. The first is a gas-powered pump attached to a 3.8 cm diameter aluminum probe via flexible tubing (Figure 2). Holes drilled near the top of the probe allow air to infuse 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 (Figure 2). When the pump is on, water is forced through the probe, which is worked into the substrate within the net frame. The air/water stream then 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 channels them into the net. In order to minimize disturbance to the redd, sampling is begun slightly below estimated nest pocket locations and progresses upstream.

This prevents the fine materials lifted out of the substrate from settling back into the redd and possibly smothering the eggs. Care is also taken to keep people behind or to the side of the net frame to minimize redd trampling.

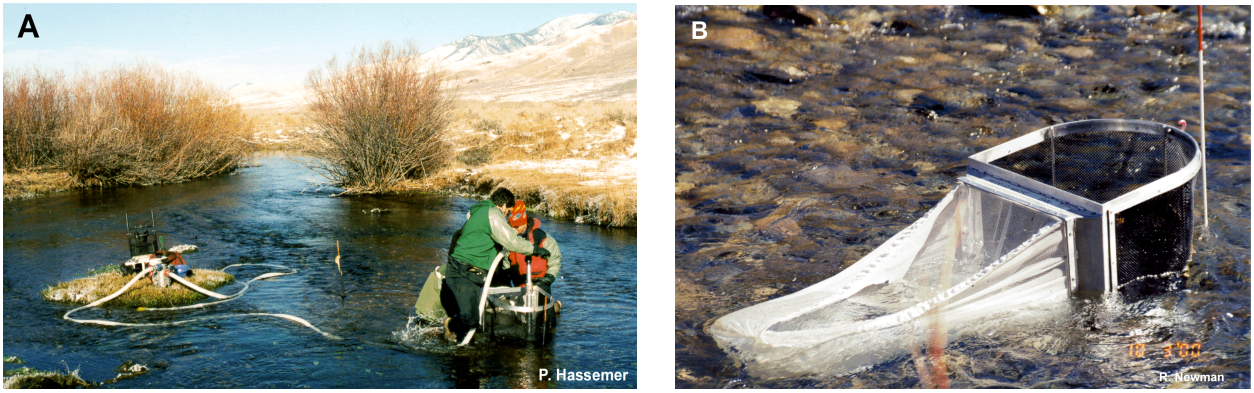

Figure 2. Hydraulic sampling gear including (A) the pump and probe, and (B) the collection net used to collect eyed-eggs from naturally spawned redds.

To facilitate eyed-egg collections, redd locations were marked, construction and completion dates were determined, and stream temperatures were monitored. When the redd was completed and the female no longer present, iron rods were driven into the streambed just upstream of the pit and downstream of the pillow along the central axis of the redd. This arrangement helped locate the redd and identified the most productive sampling locations even after algal growth had obscured its location. A thermograph was deployed in the study reach, which recorded water temperature at 2 h intervals. Daily average water temperature was computed to track the number of Celsius temperature units (CTUs) received by the developing embryos. Eyed-eggs were collected after receiving 300-400 CTUs.

Eyed-eggs were also collected from redds spawned by captive-reared chinook salmon in Big Springs Creek to determine fertilization and survival to eye-up. These redds were sampled using the procedures described above with two modifications. In order to sample as many redds as possible in a short time, we began sampling near the center of the redd pillow. Although this probably resulted in some additional fine loading, we felt this was acceptable due to the experimental, as opposed to production, nature of these redds. In addition, eggs in some redds had received approximately 470 CTUs at the time of sampling. These redds were allowed to receive the additional thermal exposure to ensure that the latest spawned redds received at least 300 CTUs, and all redds could be sampled in one trip. At collection, the disposition of each egg was determined. Opaque eggs or those with fungal growth were classified as dead, and the remainder were classified as either live or blank (unfertilized) based on the presence or absence of a visible embryo.

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 therapeutants (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). Fish were fed a standard commercial diet produced by Bio-Oregon, Inc. (Warrenton, Oregon) until they reached approximately 150 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 in which fish were 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.

Group identities were maintained by tank segregation and passive integrated transponder (PIT) tags. Eggs from individual redds were hatched in separate incubators, and their resulting juveniles were reared in separate tanks until they were PIT tagged. They were then placed in common tanks by stream origin and/or brood year for the remainder of their rearing.

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

Facilities and Protocols

The Eagle Fish Hatchery was the primary Idaho site for the culture of captive-reared chinook salmon in 2000. Specific pathogen-free artesian water from five wells was used, and artesian flow was augmented with four separate pump/motor systems. Water temperature remained a constant 13.3°C and total dissolved gas averaged 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 was 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 the Eagle Fish Hatchery remained flexible to accommodate all life stages on station. Several fiberglass tank sizes were used to culture chinook from fry to the adult stage, including: 0.7 m diameter semi-square tanks (0.1 m^3); 1 m diameter semi-square tanks (0.30 m^3); 2 m diameter semi-square tanks (1.42 m^3); 3 m diameter circular tanks (6.5 m^3); and 4 m diameter semi-square tanks (8.9 m^3). Typically, 0.7 m and 1 m tanks were used for rearing fry from ponding to approximately 1 g. Two and 3 m tanks were used to rear juveniles to approximately 20 g and 1,000 g, respectively. Age-3 fish were transferred to 6 m tanks, separated by stream origin, until they were released into their natal waters or spawned in the hatchery. 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 from the Eagle Fish Hatchery 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 paper towels 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 of eggs transferred to remote field locations for incubation in streamside or in-stream incubation systems was the same as described above.

Fish were transported between NMFS and IDFG facilities or to remote release sites in truck-mounted insulated tanks (typically 3,785 L and 9,463 L capacity) with alarm and back-up oxygen systems on board. 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 and/or cellular telephones to provide routine or emergency communication capability. Prior to releasing transported fish, transport water was tempered to within 2.0°C of the receiving water. The IDFG obtained the appropriate permits for interstate transfer of captive chinook salmon between facilities.

Maturation Sorting

In 2000, determination of sex and maturation in captive chinook salmon populations was conducted using non-lethal genetic sex determination and physical sorting. Genetic sex determinations were conducted by personnel from NMFS Northwest Fisheries Science Center, Conservation Biology Division, Seattle, Washington. To facilitate this process, fin tissue was sampled from anesthetized brood year 1994, 1995, 1996, 1997, and 1998 chinook salmon at Eagle Fish Hatchery and Manchester Marine Laboratory. Tissue samples were stored in 95% ethanol and transferred to NMFS for analysis. Physical maturation sorts were conducted, generally twice a week, from August through October 2000. Fish from brood year 1994, 1995, 1996, 1997, and 1998 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 general populations and taken off feed.

Monitoring Programs

Growth and Survival Brood Years 1994 and 1995

Project activities in 2000 ended the contribution of brood years 1994 and 1995. Growth, maturity, and mortality data for these groups 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

The ability of captive-reared fish to construct redds, find mates, spawn, and produce viable eggs was assessed in Big Springs Creek in the fall of 2000. Spawn timing was also compared between captive-reared fish in Big Springs Creek and wild fish spawning in the Lemhi River. Maturing, captive-reared Lemhi River adults were marked with Floy tags and released

into Big Springs Creek. Floy tag numbers were associated with PIT tag codes to facilitate carcass identification if the PIT tag was expelled during spawning or otherwise lost. Males and females received different color Floy tags to enable shoreline observers to differentiate the sexes. Fish were released into a 3.2 km section of Big Springs Creek approximately 8 km above its confluence with the Lemhi River. Blocking weirs were constructed at the upper and lower extent of the reach to confine study fish to this section, and eight additional weirs were built to prevent fish from moving into side channels or irrigation ditches. Releases were made into a large pool near the upper blocking weir, and fish distributed themselves within the reach. Transportation and tempering were conducted as described above, and releases were conducted according to protocols identified in the original permit application.

Observers conducted two passes or “scans” of the study area each day, identifying individuals, recording migration patterns, noting habitat associations, and summarizing behaviors. A recording thermograph was deployed within the study reach to monitor the thermal histories of redds constructed by captive chinook salmon. 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 for progress and/or completion. Gravel size was noted as well as the number of nests completed. When carcasses were recovered, locations were noted and they were measured for FL, inspected for milt or egg retention, and scanned for PIT tags and associated Floy tag identification numbers.

Post spawn sampling was performed on Big Springs Creek to assess egg survival to the eyed stage of development and emergence. Redds spawned by captive-reared parents were hydraulically sampled initially in an attempt to collect eyed-eggs, and later in hopes of recovering fry. Between the time of these two samples, redd caps that had been constructed using the method of Fraley et al. (1986) were placed over redds in Big Springs Creek. Traps consisted of square steel frames with arched 2 mm netting. A mesh "sock" containing a sample bottle lay in the current on the downstream side of the trap. Traps were checked by emptying the sample bottle into a white enamel pan and visually searching the collected material for fish. Emergent fish were preserved in 95% ethanol. Redd caps were sampled twice per week between February and March 2001.

The spawning of wild fish was also monitored in the East Fork Salmon River, West Fork Yankee Fork Salmon River, and Lemhi River to facilitate the collection of eyed-eggs for brood year representation and to compare spawn timing with captive-reared individuals. Observers walked index reaches of these streams approximately three times per week between July 16 and September 18, 2000. Redds were identified and shoreline vegetation was marked with flagging identifying the date and level of completion of the redd. Spawning surveys on the West Fork Yankee Fork Salmon River ended in early August when the area was closed due to extensive fires.

Hatchery Spawning and Gamete Evaluations

Maturing adults from the West Fork Yankee Fork Salmon River were retained for hatchery spawn crosses, gamete evaluations, and milt cryopreservation at the Eagle Fish Hatchery. Several spawning variables were investigated including: gamete quality, fecundity, and egg survival to the eyed stage of development. Spawning followed a dissimilarity matrix developed by the University of Idaho Hagerman Fish Culture Experiment Station (Hagerman,

Idaho) designed to minimize inbreeding and maximized genetic diversity based on the mitochondrial haplotypes and nuclear genotypes present in maturing fish.

Spawning followed accepted, standard practices as described by McDaniel et al. (1994) and Erdahl (1994). In general, eggs produced at spawning were divided into multiple sub-lots (by female) and fertilized with fresh milt from unique males (factorial design). Milt was preharvested and examined for motility prior to use. Eggs were incubated by sub-lot 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. We estimated fecundities 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

In 2000, milt was cryopreserved from captive-reared, mature brood year 1997 males from the West Fork Yankee Fork Salmon River and brood year 1998 males from the West Fork Yankee Fork Salmon River, East Fork Salmon River, and Lemhi River. Cryopreservation of milt from male donors has been used in the captive rearing program since 1997 and follows standard techniques (Cloud et al. 1990; Wheeler and Thorgaard 1991). Cryopreserved milt is stored at the Eagle Fish Hatchery.

Hatch Box Program

Eyed-eggs (N = 1,266) produced from spawning captive-reared chinook salmon at the Eagle Fish Hatchery were transferred to in-stream or streamside incubation boxes in cooperation with the Shoshone-Bannock Tribes. In-stream incubation consisted of Jordan-Scotty boxes 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 plumbed with flow-through spring water.

Fish Health

Mortalities from within the program were examined by the IDFG Eagle Fish Health Laboratory for diagnostic and inspection purposes. Routine fish necropsies included investigations for viral, bacterial, and parasitic disease agents. Fifty laboratory cases involving 82 individual chinook salmon were processed in 2000. The majority of samples analyzed in 2000 originated from groups reared at the Eagle Fish Hatchery. However, mortalities from adult chinook salmon transferred to the Eagle Fish Hatchery from the Manchester Marine Experimental Station were also necropsied at the Eagle Fish Health Laboratory in 2000. The laboratory summarized pathology findings to satisfy the needs of adjacent state agencies for issuance of chinook salmon import and transport permits.

Brood year 1998 chinook salmon destined for transfer to the Manchester Marine Experimental Station for saltwater rearing are vaccinated against *Vibrio* spp. and bacterial kidney disease. Chinook salmon held at the Eagle Fish Hatchery received prophylactic aquamycin treatments using medicated feeds. In addition, erythromycin may be delivered to specific stocks through intraperitoneal injection.

RESULTS AND DISCUSSION

Egg Collections

Lemhi River

No eyed-egg collections were made in this system in 2000.

Yankee Fork Salmon River

Eyed-eggs were collected on September 28, 2000 from two redds (N_1 = 120, N_2 = 130) located in the main Yankee Fork Salmon River. These redds were located at the mouth of Rankin Creek, approximately 3.6 km downstream from the mouth of the West Fork Yankee Fork Salmon River (Table 1). Eggs were transferred to the Eagle Fish Hatchery for incubation and rearing.

East Fork Salmon River

Egg collections to establish a brood year 2000 culture group from the East Fork Salmon River took place on October 3, 2000. Five hundred three eggs were collected from two redds (N_1 = 244, N_2 = 259; Table 1). Eggs were transferred to the Eagle Fish Hatchery for incubation and rearing immediately after collection. A number of additional redds were known to exist in the East Fork Salmon River, but unresolved access issues limited where we could sample.

West Fork Yankee Fork Salmon River

Four redds located in the West Fork Yankee Fork Salmon River were sampled on October 18, 2000. We collected 115, 83, 102, and four eyed-eggs, respectively, from these redds. Eyed-eggs from the fourth redd were combined with those from the third redd. Three hundred four eyed-eggs were transported to the Eagle Fish Hatchery for incubation and rearing (Table 1).

Table 1. Summary of eyed-egg collections in the East Fork Salmon River, Yankee Fork Salmon River, and West Fork Yankee Fork Salmon River to establish brood year 2000 culture groups.

Stream	Date	Eggs collected	Redds sampled
Yankee Fork Salmon River	09/28/00	250	2
East Fork Salmon River	10/03/00	503	2
West Fork Yankee Fork Salmon River	10/17/00	304	4

Fish Culture

The following information reflects culture history for the reporting period January 1, 2000 through December 31, 2000. During this reporting period, seven rearing groups were in culture at IDFG facilities. Summaries of losses, transfers, and releases while in culture are presented in Tables 2, 3, 4, and 5. In addition to stock (Lemhi River = LEM, West Fork Yankee Fork Salmon River = WFYF, Yankee Fork Salmon River = YFSR, and East Fork Salmon River = EFSR), captive chinook culture groups are further defined by collection method through the descriptors "NP," "NE," or "SN." The acronym "NP" (natural parr) denotes a naturally spawned culture group that was brought into captivity at the parr life-history stage. The acronym "NE" (natural egg) denotes a naturally spawned group that was collected at the eyed-egg life-history stage and brought into captivity. The acronym "SN" (safety net) denotes a culture group resulting from hatchery crosses of captive-reared parents.

Brood Year 1994

Initial inventory for this reporting period included one brood year 1994 EFSR-NP chinook salmon in culture at the Eagle Fish Hatchery. Three brood year 1994 LEM-NP and two WFYF-NP fish were transferred from the NMFS Manchester Marine Experimental Station to the Eagle Fish Hatchery on April 28, 2000, to complete maturation. On July 24, 2000, one brood year 1994 LEM-NP maturing female was released to Big Springs Creek for natural spawning and evaluation. One WFYF-NP female was retained for spawning but produced poor eggs that proved to be non-viable. At the end of the reporting period, zero fish from this cohort remained in culture at the Eagle Fish Hatchery (Tables 2, 3, 4).

Brood Year 1995

At the beginning of this reporting period, one brood year 1995 LEM-NP female was in culture at the Eagle Fish Hatchery. Seventeen maturing brood year 1995 LEM-NP females were transferred from the NMFS Manchester Marine Experimental Station to the Eagle Fish Hatchery on April 28, 2000 to complete maturation in freshwater. On July 24, 2000, 15 maturing females were released to Big Springs Creek for natural spawning and evaluation. At the end of the reporting period, zero brood year 1995 fish remained in culture at the Eagle Fish Hatchery (Table 2).

Brood Year 1996

At the beginning of the reporting period, 33 LEM-NP and six 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 2000 after being transferred to saltwater rearing as smolts in 1998. Twenty-seven maturing LEM-NP and 16 maturing WFYF-NP were transferred to the Eagle Fish Hatchery from the Manchester Marine Experimental Station on June 6, 2000 to complete their maturation in fresh water. On July 24, 2000, 36 maturing LEM-NP (4 males, 32 females) were released to Big Springs Creek for natural spawning and evaluation. One maturing WFYF-NP female was used for hatchery spawning in 2000. At the end of the reporting period, 11 LEM-NP and five WFYF-NP brood year 1996 captives remained in culture at the Eagle Fish Hatchery (Tables 2, 3).

Brood Year 1997

At the beginning of the reporting period, 24 LEM-NP and 23 WFYF-NP brood year 1997 chinook salmon were in culture at the Eagle Fish Hatchery. Collections of brood year 1997 EFSR-NP chinook were not conducted due to low adult escapement. On June 6, 2000, 18 maturing LEM-NP and 16 maturing WFYF-NP were transferred to the Eagle Fish Hatchery from the Manchester Marine Experimental Station to complete maturation in fresh water. On July 24, 2000, 20 maturing LEM-NP (3 females, 17 males) were released to Big Springs Creek for natural spawning and evaluation. Eighteen maturing WFYF-NP males were used for hatchery spawn crosses and gamete evaluations (N = 3) and milt cryopreservation (N = 15). At the end of this reporting period, 17 LEM-NP and 13 WFYF-NP fish remained in culture at the Eagle Fish Hatchery (Tables 2, 3).

Table 2. Summary of losses and magnitude of mortality for six Lemhi River captive chinook salmon culture groups reared at IDFG facilities in 2000.

	Culture Groups					
	BY94-NP	**BY95-NP**	**BY96-NP**	**BY97-NP**	**BY98-NP**	**BY99-NE**
Starting Inventory (January 1, 2000)	0	1	33	24	188	244
Eyed-Egg to Fry						
Undetermined[a]	n/a	n/a	n/a	n/a	n/a	n/a
Mechanical Loss						
Handling	0	0	6	2	1	1
Jump-out	0	0	0	0	0	0
Non-infectious						
Other[b]	2	3	6	3	4	2
Infectious						
Bacterial	0	0	0	0	3	0
Viral	0	0	0	0	0	0
Other	0	0	0	0	0	0
Maturation						
Mature Males	0	0	0	0	9	0
Mature Females	0	0	0	0	0	0
Non-Viable	0	0	1	0	0	0
Cryopreservation	0	0	0	0	3	0
Relocation						
Transferred In	2	17	27	18	13	0
Transferred Out	0	0	0	0	158	0
Planted/Released	0	15	36	20	0	0
Ending Inventory (December 31, 2000)	0	0	11	17	23	241

[a] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.
[b] Includes culling associated with cultural anomalies, and all undetermined, non-infectious mortality.

Table 3. Summary of losses and magnitude of mortality for six West Fork Yankee Fork Salmon River captive chinook salmon culture groups reared at IDFG facilities in 2000.

	Culture Groups					
	BY94-NP	**BY96-NP**	**BY97-NP**	**BY98-NP**	**BY99-SN**	**BY00-NE**
Starting Inventory (January 1, 2000)	0	6	23	219	279	304[a]
Eyed-Egg to Fry						
Undetermined[b]	n/a	n/a	n/a	n/a	n/a	8
Mechanical Loss						
Handling	0	1	1	1	0	0
Jump-out	0	0	0	0	0	0
Non-infectious						
Other[c]	1	1	6	0	12	0
Infectious						
Bacterial	0	0	1	0	0	0
Viral	0	0	0	0	0	0
Other	0	0	0	0	0	0
Maturation						
Mature Males	0	0	3	24	0	0
Mature Females	1	1	0	0	0	0
Non-Viable	0	0	0	0	0	0
Cryopreservation	0	0	15	3	0	0
Relocation						
Transferred In	2	2	16	25	0	0
Transferred Out	0	0	0	193	0	0
Planted/Released	0	0	0	0	0	0
Ending Inventory (December 31,2000)	0	5	13	23	267	296

[a] Fall 2000 inventory.
[b] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.
[c] Includes culling associated with cultural anomalies, and all undetermined, non-infectious mortality.

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 recommend 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). Approximately 300 eyed-eggs from 1998 EFSR spawn crosses were retained at

the Eagle Fish Hatchery for the establishment of a captive rearing safety net group (Hassemer et al. 1999). Progeny from individual spawn crosses were reared separately until PIT tagging, and equal numbers of fish from the 37 subfamilies produced were retained to maximize the genetic representation of this culture group. On May 11, 2000, 227 EFSR-SN and 145 EFSR-SN smolts were transferred to the Manchester Marine Experimental Station to complete rearing in saltwater. The mean fish weight in each of these groups at transfer was 47.3 g for the safety net fish and 46.0 g for the natural parr. Five EFSR-SN and nine EFSR-NP males matured at age-2 in 2000. At the beginning of the reporting period, 258 EFSR-SN and 176 EFSR-NP fish from brood year 1998 were on station at the Eagle Fish Hatchery. Ending balances for the 2000 reporting period were 19 EFSR-SN and 23 EFSR-NP fish (Table 4).

On May 9, 2000, 193 WFYF-NP and 158 LEM-NP smolts were transferred to the Manchester Marine Experimental Station to complete rearing in saltwater. Mean fish weight at transfer for these groups was 67.7 g (WFYF-NP) and 55.7 g (LEM-NP), respectively. Nine LEM-NP and 24 WFYF-NP males matured at age-2 in 2000. Five maturing WFYF-NP males were used for hatchery spawn crosses and gamete evaluations (N = 2) and milt cryopreservation (N = 3). Milt from three mature LEM-NP males was cryopreserved. At the end of the reporting period, 23 LEM-NP and 23 WFYF-NP fish remained on station at the Eagle Fish Hatchery (Tables 2, 3)

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 to recommend that beginning in 1999 chinook collections be made at the eyed-egg stage of development. Hydraulic-sampling of eggs in 1999 yielded 264 and 143 eyed-eggs from the LEM and EFSR, respectively. No brood year 1999 eggs were collected from the West Fork Yankee Fork Salmon River in 1999 because of low spawning escapement (less than five). At the end of the reporting period, 241 LEM-NE and 137 EFSR-NE presmolts were on station at the Eagle Fish Hatchery (Tables 2, 4).

Approximately 300 WFYF-SN and 91 EFSR-SN eyed-eggs produced from hatchery spawning to establish brood year 1999 captive cohorts for these systems were retained at the Eagle Fish Hatchery. The selection of eggs for inclusion in the hatchery groups was based on nuclear and mitochondrial DNA data generated to guide 1999 spawn crosses. At the end of the reporting period, 267 WFYF-SN and 75 EFSR-SN brood-year 1999 presmolts, respectively, were on station at the Eagle Fish Hatchery (Tables 3, 4).

Brood Year 2000

Eyed-egg collections in 2000 resulted in an initial inventory of 503 EFSR-NE, 304 WFYF-NE, and 250 YFSR-NE eyed-eggs. At the end of this reporting period, 497 EFSR-NE, 296 WFYF-NE, and 227 YFSR-NE developing fry were in culture (Tables 3, 4, 5).

Table 4. Summary of losses and magnitude of mortality for six East Fork Salmon River captive chinook salmon culture groups reared at IDFG facilities in 2000.

	Culture Groups					
	BY94-NP	**BY98-NP**	**BY98-SN**	**BY99-NE**	**BY99-SN**	**BY00-NE**
Starting Inventory (January 1, 2000)	1[a]	176	258[a]	141	87	503[b]
Eyed-Egg to Fry						
Undetermined[c]	n/a	n/a	n/a	n/a	n/a	6
Mechanical Loss						
Handling	0	3	0	0	0	0
Jump-out	0	0	0	0	0	0
Non-infectious						
Other[d]	3	3	5	4	12	0
Infectious						
Bacterial	0	0	0	0	0	0
Viral	0	0	0	0	0	0
Other	0	0	0	0	0	0
Maturation						
Mature Males	0	8	5	0	0	0
Mature Females	0	0	0	0	0	0
Non-Viable	0	0	0	0	0	0
Cryopreservation	0	3	0	0	0	0
Relocation						
Transferred In	2	9	0	0	0	0
Transferred Out	0	145	227	0	0	0
Planted/Released	0	0	0	0	0	0
Ending Inventory (December 31, 2000)	0	23	19	137	75	497

[a] Starting inventory reflects an inventory adjustment made post-completion of the 1999 BPA Annual Progress Report.
[b] Fall 2000 inventory.
[c] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.
[d] Includes culling associated with cultural anomalies, and all undetermined, non-infectious mortality.

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 smaller than their ocean-reared counterparts. Inventories conducted between June and September 1996 to 1998 indicated that

captive-reared fish had grown to approximately 200, 380, and 520 mm FL in each year, respectively (Figures 3, 4). By 1999 only freshwater-reared individuals remained in culture and were approximately 500 mm FL, indicating that little additional growth was realized between the fourth and fifth year of life (Figure 3). In contrast, ocean-reared spring/summer chinook salmon returning to the Columbia River basin between 1991 and 1996 generally averaged 740-800 mm FL (Fryer 1998). This 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.

Table 5. Summary of losses and magnitude of mortality for one Main Yankee Fork Salmon River captive chinook salmon culture group reared at IDFG facilities in 2000.

	Culture Group
	BY00-NE
Starting Inventory (January 1, 2000)	250[a]
Eyed-Egg to Fry	
Undetermined[b]	23
Mechanical Loss	
Handling	0
Jump-out	0
Non-infectious	
Other[c]	0
Infectious	
Bacterial	0
Viral	0
Other	0
Maturation	
Mature Males	0
Mature Females	0
Non-Viable	0
Cryopreservation	0
Relocation	
Transferred In	0
Transferred Out	0
Planted/Released	0
Ending Inventory (December 31,2000)	227

[a] Fall 2000 inventory.
[b] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.
[c] Includes culling associated with cultural anomalies, and all undetermined, non-infectious mortality.

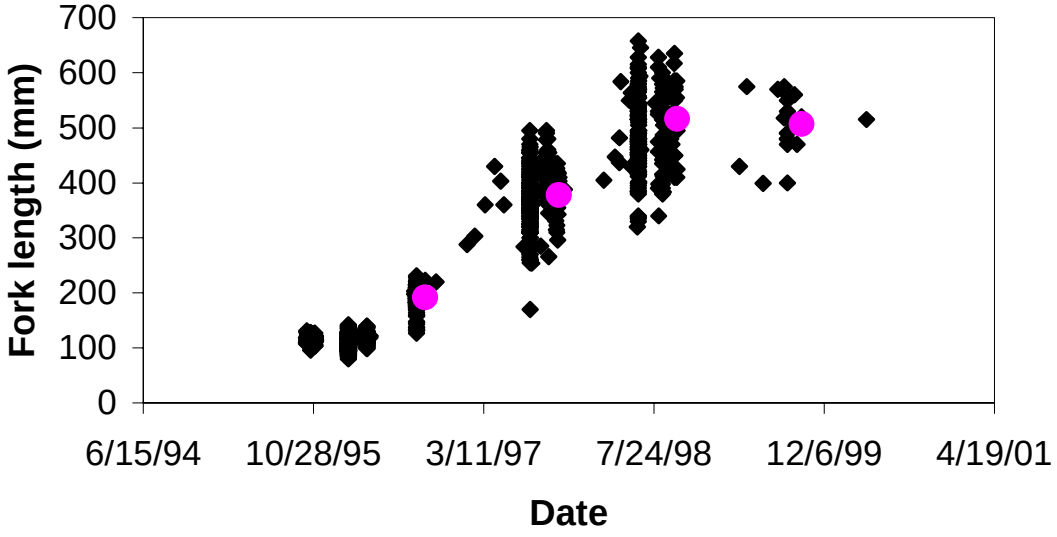

Figure 3. Growth of brood year 1994 chinook salmon reared in saltwater at the Manchester Marine Experimental Station. Circles represent average lengths in samples collected during September and October.

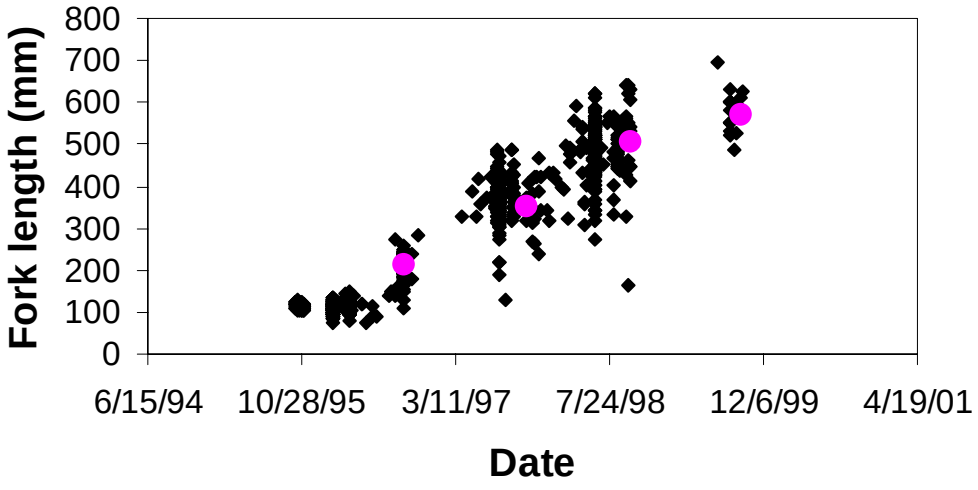

Figure 4. Growth of brood year 1994 chinook salmon reared in freshwater at the Eagle Fish Hatchery. Circles represent average lengths in samples collected during September and October.

Most captive-reared chinook salmon from brood year 1994 matured at age-3 or -4, with relatively little precocial 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 East Fork Salmon River and West Fork Yankee Fork Salmon River groups and ranged between approximately 8% and 12% of the mature males in each group. Lemhi River males had a higher precocial rate (61.5%), but several confounding factors may be present. First, few males from this group matured, suggesting that males from the Lemhi River group may have had a higher juvenile mortality rate than males from the other groups. Second, the overall percentages of precocial males in the three groups were similar. Precocial male development was 2.8% (6 of 216) in those from the West Fork Yankee Fork Salmon River group, 3.5% (7 of 199) in the East Fork Salmon River group, and 4.1% (8 of 193) in the Lemhi River group. This also suggests Lemhi River males experienced higher prematuration mortality than those in the other groups.

Mortality in brood year 1994 fish was relatively evenly split between those 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%; Figure 5). However, it is unknown how many adults released for volitional spawning actually reproduced.

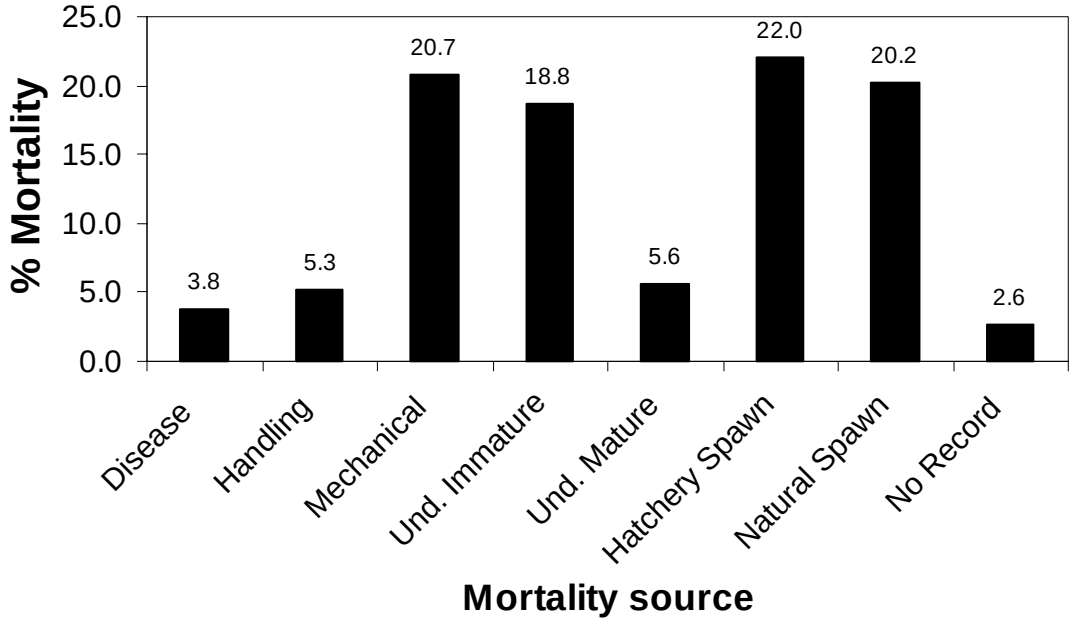

Figure 5. Sources of mortality in brood year 1994 captive-reared chinook salmon. Diseases resulting in death included bacterial kidney disease and fungus. Those dying from undetermined causes are classified as Und.

Growth and Survival of Brood Year 1995

Growth rates of brood year 1995 chinook salmon reared at the two facilities were also similar. Inventories conducted between August and September 1997 to 1999 at the Eagle Fish Hatchery indicated captive-reared fish had grown to approximately 210, 383, and 423 mm FL in each year, respectively (Figure 6). Fish from this brood year at the Manchester Marine Experimental Station were sampled June through August 1997 to 2000 and had reached mean lengths of 191, 330, 514, and 578 mm FL in each year, respectively (Figure 7). Again, captive-reared fish were smaller than anadromous returnees to the Columbia River basin (Fryer 1998).

Maturation of brood year 1995 LEM-NP (the only culture group from this brood year) in culture at the Eagle Fish Hatchery experienced lower precocial maturation than the previous cohort, but age-3 and -4 maturation followed the same trend observed previously. Precocial male development in this group was relatively low, with approximately 7% (4 of 60) of fish maturing at age-2. The following year 13 males matured as jacks out of 47 fish in culture (28%), and finally, in 1988, one male and four females from six fish remaining matured as age-4 adults.

Brood year 1995 culture mortalities were fractionally higher than the previous cohort, with 43.1% of the stock surviving to maturity. Important sources of culture mortality for this cohort were outbreaks of bacterial kidney disease and coldwater disease. Other causes of mortality were similar to the previous brood year; however, handling and mechanical deaths were considerably diminished, and a greater percentage of the cohort was released for volitional spawning (Figure 8).

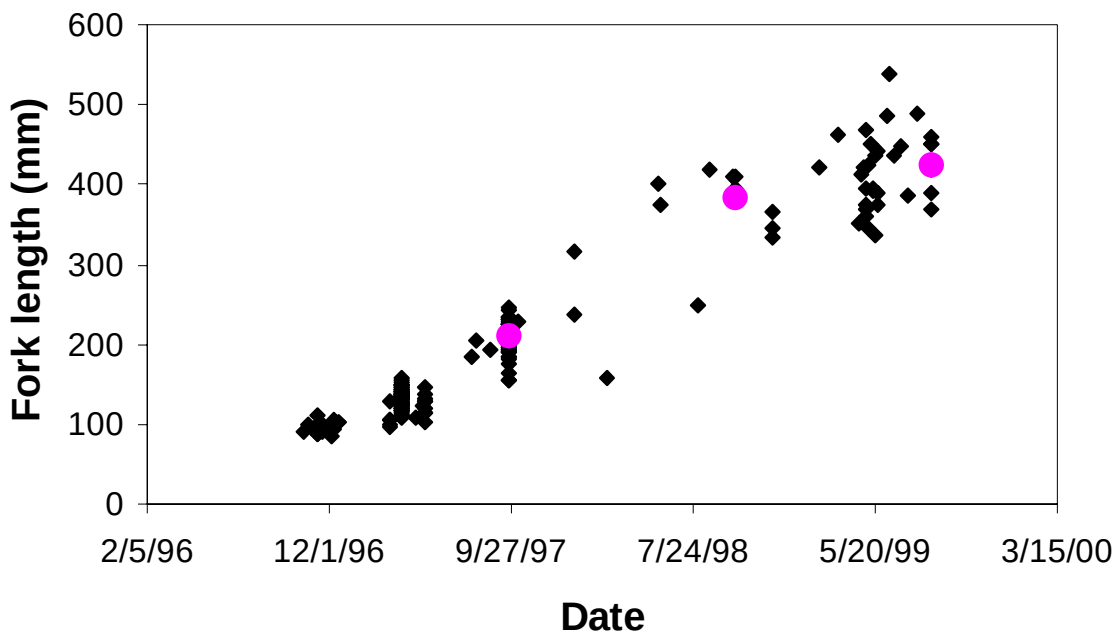

Figure 6. Growth of brood year 1995 chinook salmon reared in freshwater at the Eagle Fish Hatchery. Circles represent average length in samples collected during August and September.

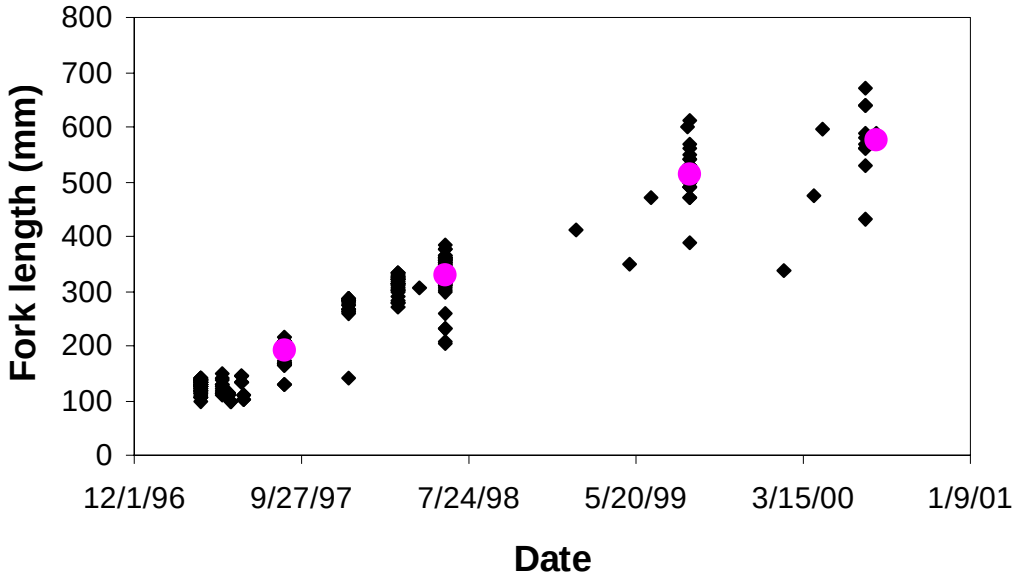

Figure 7. Growth of brood year 1995 chinook salmon reared in saltwater at the Manchester Marine Experimental Station. Circles represent average lengths in samples collected during June and August.

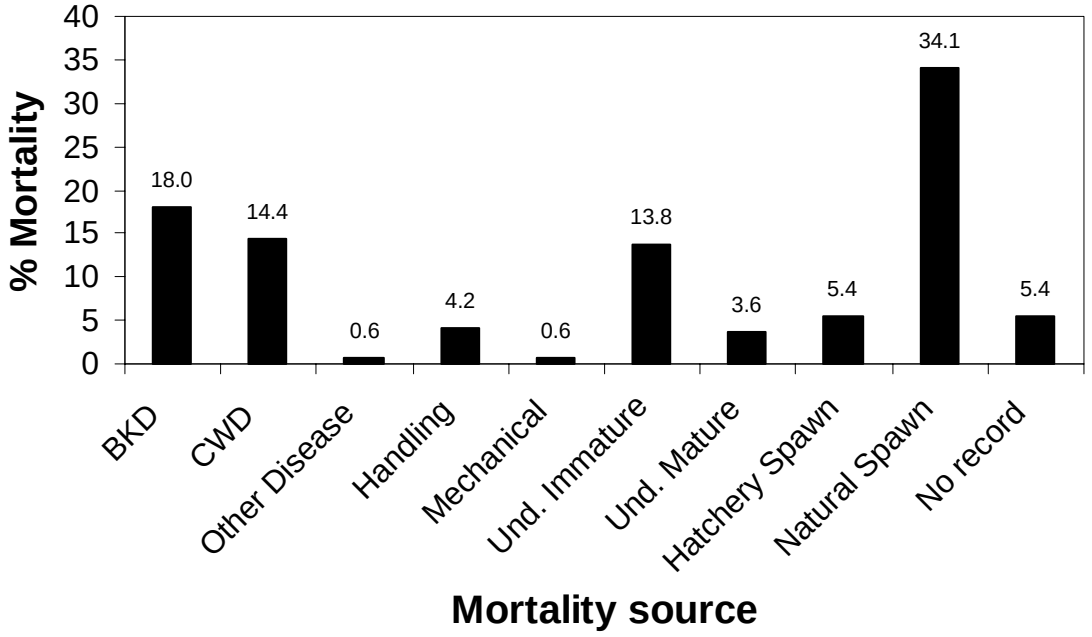

Figure 8. Sources of mortality in brood year 1995 captive-reared chinook salmon. BKD = bacterial kidney disease; CWD = coldwater disease, and Und = those dying of undetermined causes.

Big Springs Creek Spawning Evaluation

Maturing, captive-reared chinook salmon (N = 70) were Floy tagged on July 5, 2000 and released into Big Springs Creek on July 11-12, 2000 (Appendix A). Fish were released into a large pool near the upper end of the study section and were allowed to distribute themselves throughout the reach for approximately 24 h before observations began. The downstream blocking weir failed on the evening of July 11, and an unknown number of fish escaped downstream before it could be repaired the next morning.

Graphical analysis of behavior and habitat associations over the study period shows a progression of changes that are consistent with those expected as their maturation progressed toward spawning (Briggs 1953). The habitat associations of these fish followed a general pattern of fish being mainly associated with cut banks or overhead vegetation early in the study period and then generally moving into open water as time progressed (Figure 9). A similar trend was observed in fish behavior over the study period. While fish were mainly associated with overhead cover, holding position was the dominant behavior observed (Figure 10). Then as fish began to be observed in open water, reproductive behaviors correspondingly began to dominate their activity budget (Figure 9). These patterns conformed to our intuitive expectations of their behavior. Immature fish inhabiting sheltered areas are afforded some measure of protection from predators as they mature. Then, as the reproductive urge became more powerful and they began preparations for spawning, open water habitats increase in importance.

Captive-reared fish continued to behave normally after spawning commenced (Berejikian et al. 2001; Berejikian et al. 1997). Females excavated, maintained, and defended redds in a manner consistent with the behavior of wild salmon. Males, although few in the study area, appeared to readily court females and compete for spawning privileges. There was no evidence of spawning behavior inconsistent with the sexual morphology of the captive-reared fish, and no instances of inter-species mating (See Hassemer et al. 2001). However, the peak of spawning activity for captive-reared fish in Big Springs Creek occurred approximately three weeks later than in naturally produced Lemhi River fish.

Fifteen redds spawned by captive-reared chinook salmon in Big Springs Creek were hydraulically sampled on November 6-7, 2000 to verify egg deposition and to determine fertilization and their survival to the eyed stage of development. Seventeen excavation sites were identified in the study section, but two were not sampled because one was classified as a test dig, and one was superimposed on another redd. Eggs were recovered from 13 of the 15 redds sampled, and of these nine (69.2%) contained live eggs (Table 6). The percentage of live eggs in these redds ranged from 0-95.8%.

A large percentage of eggs from several redds were found to be blank or unfertilized (Table 6). These eggs appeared to be alive when first removed from the gravel, but turned opaque shortly after collection. Unfortunately, this was not noticed until most of the redds had been sampled and may have resulted in a disproportionate number of eggs from some redds being classified as dead. From a production standpoint, dead and unfertilized eggs are functionally equivalent and will not change the overall success (or failure) of the redd. However, this proportion will become important in future efforts to determine the cause of “in gravel” mortality. In the future, crews conducting this type of collection should examine eggs immediately upon collection and monitor their condition for at least 10-15 min before making a final determination as to their status.

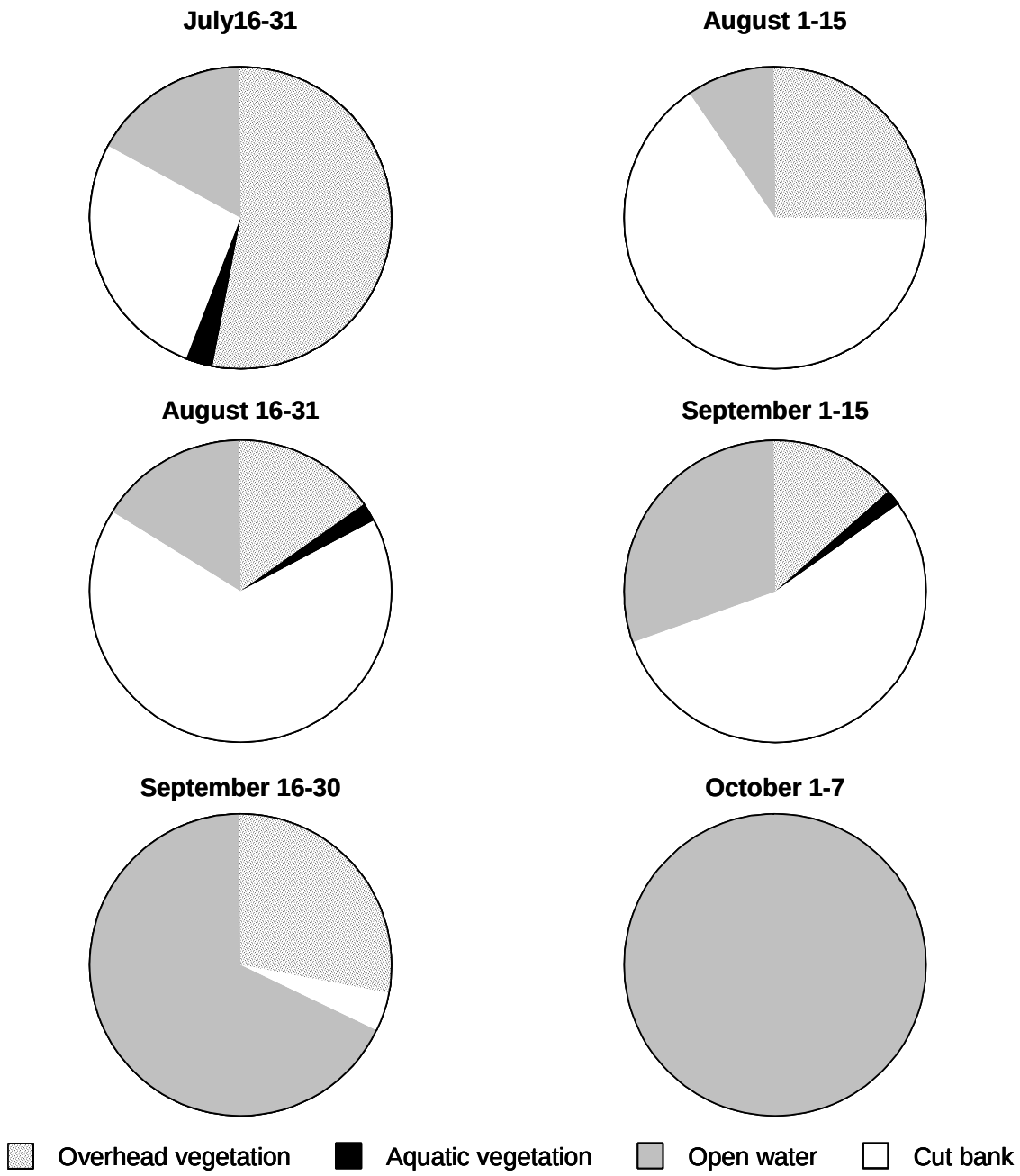

Figure 9. Habitat associations of captive-reared chinook salmon released into Big Springs Creek July 16 to October 7, 2000. Charts represent an approximate two-week period except the last chart, which represents one week.

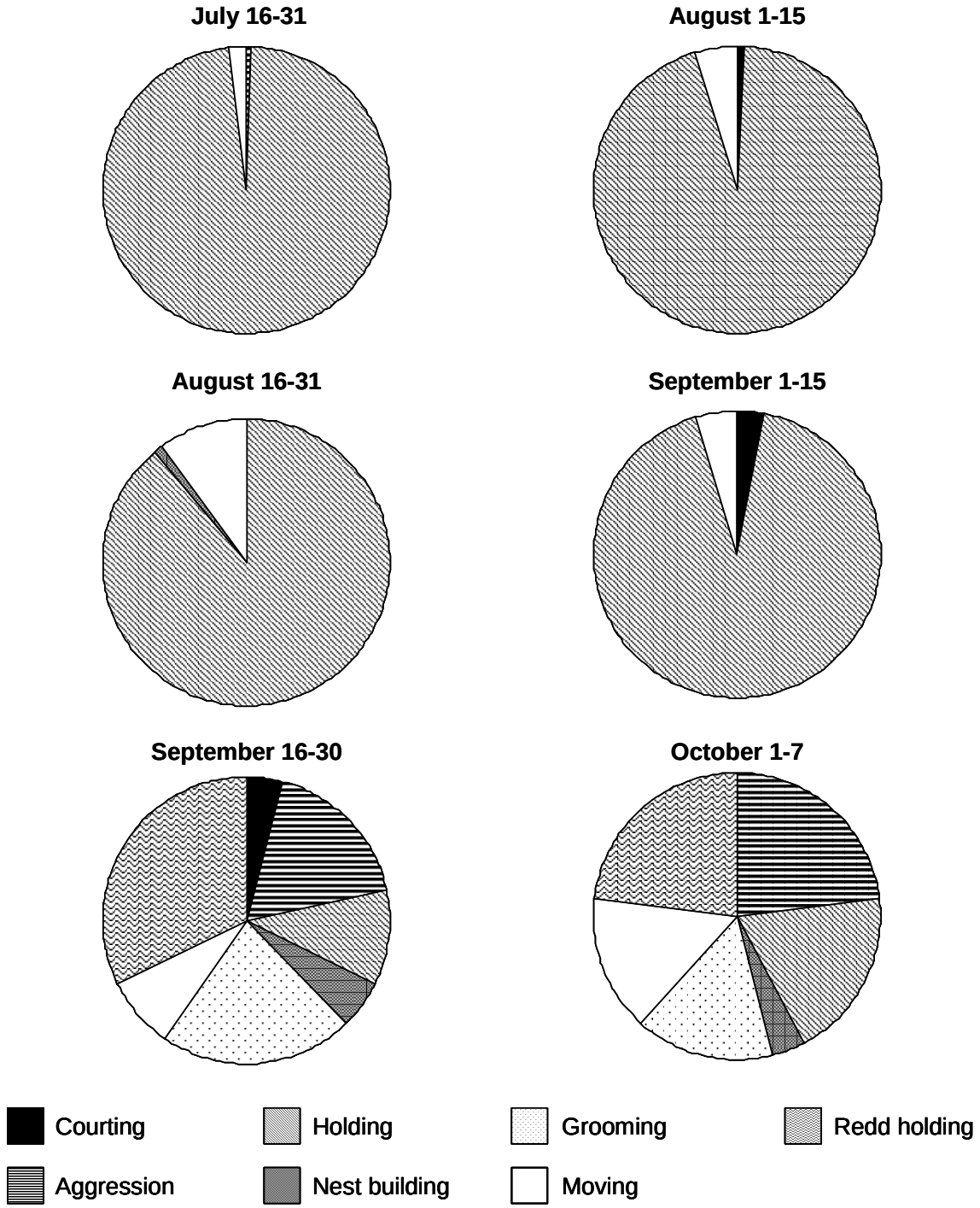

Figure 10. Activity budget of captive-reared chinook salmon released into Big Springs Creek July 16 to October 7, 2000. Charts represent an approximate two-week period except the last chart, which represents one week.

Table 6. Number and disposition of eggs collected from redds spawned by chinook salmon reared in captivity in Big Springs Creek on November 6 and 7, 2000.

Redd	Date	Live	Dead	Blank[a]
E12	11/06/00	0	38	0
R6	11/06/00	0	46	0
R8	11/06/00	21	3	0
R9	11/06/00	23	1	0
R5	11/06/00	11	16	0
R4	11/06/00	7	75	0
R2	11/06/00	0	11	0
R3	11/06/00	8	42	0
E15[b]	11/06/00	0	0	0
R11	11/07/00	2	12	0
R10	11/07/00	6	54	0
E18	11/07/00	0	0	0
E17	11/07/00	2	0	16
Willow	11/07/00	11	3	0
R1/R1.1[c]	11/07/00	0	14	21
Total		**91**	**315**	**37**
Percent		**20.5**	**71.1**	**8.4**

[a] Eggs were considered blank or unfertilized if they appeared to be live when sampled, but became opaque shortly after collection.
[b] Probably a test dig based on its size and location in the stream cross-section.
[c] This was a two redd complex with a late redd superimposed on an earlier one.

Some of the eggs in the Big Springs Creek redds died after developing to the eyed stage. Smothering by fine sediments is the most likely cause of this mortality. The substrate in Big Springs Creek is substantially smaller and contains more fines and organic debris than either the East Fork Salmon River or West Fork Yankee Fork Salmon River (personal observation), and qualitatively more of these fine materials were flushed from redds in Big Springs Creek than from those in the other study streams.

We attempted to document fry emergence from redds spawned by captive-reared fish by redd capping and a second hydraulic sampling. Six captive-spawned redds were capped in late January and were checked twice weekly through the end of February. No fry were collected in the redd caps. After emergence should have been completed based on the number of CTUs, we returned to the stream and hydraulically sampled the capped redds. No fry or eggs were collected from five of the six redds sampled, and the sixth redd yielded approximately 75 dead eggs and one dead fry. Again, smothering by fine sediments is the suspected cause of mortality.

Gamete Evaluations

West Fork Yankee Fork Salmon River

Six individuals from this stock were spawned at the Eagle Fish Hatchery during the reporting period. One brood year 1996 WFYF-NP female with saltwater rearing history was spawned at the Eagle Fish Hatchery. This fish produced 1,323 green eggs, which were divided into four sub-lots of equal size. Each sub-lot was then fertilized with milt from one of three brood year 1997 WFYF-NP males with saltwater rearing history or one brood year 1998 WFYF-NP male with freshwater rearing history. The four sub-lots produced 1,266 eyed-eggs. Mean egg survival to the eyed stage of development was 95.7%. One additional brood year 1994 WFYF-NP female reared in saltwater was spawned with a second brood year 1998 WFYF-NP male, yielding 625 green eggs. All of these eggs were determined to be non-viable and later culled.

Cryopreservation

Milt from 24 captive-reared chinook salmon from brood years 1997 and 1998 was cryopreserved on October 4 and November 11, 2000. Eight of the brood year 1997 males were reared in freshwater; the others were from saltwater. Milt collection in 2000 produced a total of 615, 0.5 ml straws (Table 7). No program transfers of cryopreserved milt were conducted and no cryopreservation activities were performed at the University of Idaho or Washington State University in 2000.

Table 7. Summary of milt cryopreservation activities at the Eagle Fish Hatchery during 2000. (BY = Brood Year, WFYF = West Fork Yankee Fork Salmon River, EFSR = East Fork Salmon River, and LEM = Lemhi River).

Brood Year/Stock	Number of Males Used	Number of 0.5 ml Straws Cryopreserved	Average Milt Motility	Motility Range
BY97 WFYF	15	435	98.5%	90.0% to 100.0%
BY98 EFSR	3	60	97.6%	95.0% to 100.0%
BY98 WFYF	3	60	98.3%	95.0% to 100.0%
BY98 LEM	3	60	100.0%	N/A

Hatch Box Program

1999 Production

Eyed-eggs were placed in incubation systems in the West Fork Yankee Fork Salmon River and East Fork Salmon River and monitored by personnel from the Shoshone-Bannock Tribe during the 1999-2000 incubation period. Data on these egg plants was not available for inclusion in the project's 1999 annual report (Hassemer et al. 2001) and will be reported here.

Eyed-eggs produced from the West Fork Yankee Fork Salmon River spawn crosses were planted in Whitlock-Vibert boxes in modified refrigerators (N = 1,468) and in Jordan-Scotty boxes (N = 829) approximately 3 km upstream of the confluence with the mainstem Yankee Fork Salmon River. A total of 1,038 East Fork Salmon River eyed-eggs were planted in Jordan-Scotty boxes approximately 31 km upstream of the confluence of the East Fork Salmon River and mainstem Salmon River (Table 8). Following emergence from the incubators, incubation systems were examined and dead eggs and fry enumerated to determine an estimated hatching rate for individual locations. Estimated hatching rates were variable and ranged from 78.0% to 90.0% for West Fork Yankee Fork Salmon River streamside incubators. The Jordan-Scotty incubators on the East Fork Salmon River were lost before an estimated hatch rate was determined (Table 8).

Table 8. Summary of 1999 captive chinook salmon eyed-egg transfers and hatching rates for in-stream and streamside incubation boxes.

Location	Number of Eyed-Eggs Transferred	Dates Transferred	Number of Eyed-Eggs Planted	Estimated Hatching Rate
West Fork Yankee Fork Salmon River	829[a]	10/13/99	829	90.0%
West Fork Yankee Fork Salmon River	1,468[b]	10/13/99	1,468	78.0%
East Fork Salmon River	1,038[c]	11/02/99	1,038	Unknown[d]

[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 incubators.
[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 "modified refrigerators" 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 incubators.
[d] Incubators were lost before an estimated hatch rate was determined.

2000 Production

A total of 1,266 eyed-eggs were placed in incubation systems in the West Fork Yankee Fork Salmon River and monitored by personnel from the Shoshone-Bannock Tribe during the 2000-2001 incubation period. Eyed-eggs produced from West Fork Yankee Fork Salmon River spawn crosses were planted in modified refrigerator incubators (N = 200), Whitlock-Vibert boxes (N = 200), and Jordan-Scotty boxes (N = 866) approximately 3 km upstream of the confluence with the mainstem Yankee Fork Salmon River (Haddix 2002). Following emergence from the incubators, these systems were examined and dead eggs/fry enumerated to determine an estimated hatching rate for individual locations. Estimated hatching rates ranged from 78.0% to 88.0% (Table 9).

Fish Health

In 2000, 50 laboratory accessions, representing 82 captive-reared chinook salmon, were generated at the Eagle Fish Health Laboratory (Tables 2, 3, 4, 5). Principle pathogens screened for included the causative agents for bacterial kidney disease (BKD) and whirling disease *Myxobolus cerebralis*. In addition, maturing chinook salmon transferred to Idaho from the NMFS Manchester Marine Experimental Station 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 saltwater 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. No evidence of either of these exotic pathogens was detected in study fish.

Monitoring for BKD in captive-reared chinook salmon has been routinely conducted since the inception of the program in 1995. Of the 82 fish examined in 2000, there were no demonstrated clinical levels of the disease. Clinical levels of BKD have been detected in IDFG and NMFS captive-reared chinook salmon, and approximately 30% of the mortalities in 1999 demonstrated clinical levels of the disease. In 2000, brood years 1997 and 1998 were anaesthetized and vaccinated with 0.1 ml of the experimental BKD vaccine Renogen (*Anthrobacter* spp.) in an effort to reduce clinical levels of the disease in the future.

In 1999, the parasitic gill copepod *Salmincola californiensis* was observed in brood year 1998 Lemhi River chinook natural parr. Fish infested with gill parasites were treated with the parasiticide Ivermectin in addition to manually removing the parasites with forceps. During this year's BKD vaccination process, Lemhi River fish were visually examined for the presence of *Salmincola*. No parasites were observed indicating that the oral intubation of Ivermectin was effective in eliminating the parasite.

Chinook salmon juveniles collected as natural parr 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 collected as parr, the prevalence of infection has averaged approximately 38%. No mortality has been attributed to the parasite, but occasional skeletal deformities have been observed.

Table 9. Summary of 2000 captive chinook salmon eyed-egg transfers and hatching rates for in-stream and streamside incubation boxes.

Location	Number of Eyed-Eggs Transferred	Dates Transferred	Number of Eyed-Eggs Planted	Estimated Hatching Rate
West Fork Yankee Fork Salmon River	1,266[a]	11/08/00	1,266	82.7%

[a] All eyed-eggs produced at Eagle Fish Hatchery from brood year 1996 West Fork Yankee Fork Salmon River captive chinook salmon. Eggs were planted in "modified refrigerator," Jordan-Scotty, and Whitlock-Vibert incubation systems.

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APPENDICES

Appendix A. Summary of rearing location, size, and identification tags on Lemhi River captive-reared chinook salmon released into Big Springs Creek on July 24, 2000.

Brood Year	Stock	Rearing Origin	PIT Tag #	Sex	Weight (g)	Length (cm)	Tag #
1994	LEMHI	Seawater	1F7E750F5F	F	1403	55	E00029
1995	LEMHI	Seawater	200D6E796C	F	797	43	E00028
1995	LEMHI	Seawater	416D636A3D	F	2290	59	E00030
1995	LEMHI	Seawater	200F3C6134	F	2407	58	E00031
1995	LEMHI	Seawater	222E27231E	F	3973	68	E00032
1995	LEMHI	Seawater	200C22743E	F	2108	56	E00033
1995	LEMHI	Seawater	200E475734	F	3657	64	E00034
1995	LEMHI	Seawater	416D062B09	F	2425	58	E00035
1995	LEMHI	Seawater	416D543741	F	1240	49	E00036
1995	LEMHI	Seawater	1F7A464061	F	4503	67	E00037
1995	LEMHI	Seawater	NO TAG #1	F	2346	58	E00038
1995	LEMHI	Seawater	204B400451	F	1643	53	E00039
1995	LEMHI	Seawater	204B017420	F	2084	57	E00040
1995	LEMHI	Seawater	200B7A0259	F	2366	56	E00041
1995	LEMHI	Seawater	200E71065B	F	3317	64	E00042
1995	LEMHI	Freshwater	2010413F50	F	1402	47	E00304
1996	LEMHI	Seawater	416B6E494D	F	1577	51	E00378
1996	LEMHI	Seawater	222E334013	F	2180	55	E00380
1996	LEMHI	Seawater	4165280654	F	1599	51	E00381
1996	LEMHI	Seawater	416C282300	F	1638	52	E00382
1996	LEMHI	Seawater	2231547C58	F	1944	52	E00383
1996	LEMHI	Seawater	223169773D	F	1825	53	E00384
1996	LEMHI	Seawater	2231514376	F	2219	55	E00385
1996	LEMHI	Seawater	4170465724	F	1722	50	E00386
1996	LEMHI	Seawater	223162552E	F	2420	56	E00387
1996	LEMHI	Seawater	22316F281A	F	1327	48	E00388
1996	LEMHI	Seawater	222E280335	F	936	42	E00389
1996	LEMHI	Seawater	222E244846	F	3002	56	E00390
1996	LEMHI	Seawater	416D1E0905	F	1644	54	E00391
1996	LEMHI	Seawater	1F7E70195A	F	2525	55	E00392
1996	LEMHI	Seawater	416C216720	F	1426	48	E00393
1996	LEMHI	Seawater	22314F1B67	F	2004	53	E00394
1996	LEMHI	Seawater	22316D0A4A	F	2548	58	E00395
1996	LEMHI	Seawater	2231663F2A	F	2603	56	E00396
1996	LEMHI	Seawater	222E1B502D	F	2385	56	E00397
1996	LEMHI	Seawater	4165175E46	M	1474	48	099
1996	LEMHI	Seawater	416C4E3157	M	1084	43	098
1996	LEMHI	Seawater	222E256017	F	2197	56	E00398
1996	LEMHI	Seawater	222E372C39	F	2445	57	E00399
1996	LEMHI	Seawater	222E332647	F	2289	56	E00400
1996	LEMHI	Seawater	415A277A34	M	1619	50	097
1996	LEMHI	Freshwater	41706D1374	F	1298	44	E00305
1996	LEMHI	Freshwater	416D32594E	F	1268	43	E00306
1996	LEMHI	Freshwater	416D3B7D14	F	1559	45	E00307
1996	LEMHI	Freshwater	2231684560	F	1806	48	E00308

Appendix A. (Continued.)

Brood Year	Stock	Rearing Origin	PIT Tag #	Sex	Weight (g)	Length (cm)	Tag #
1996	LEMHI	Freshwater	222E314779	F	931	36	E00310
1996	LEMHI	Freshwater	222E254F5F	F	1186	45	E00312
1996	LEMHI	Freshwater	2231593F79	F	2219	53	E00314
1996	LEMHI	Freshwater	222E450A69	F	1994	52	E00317
1996	LEMHI	Freshwater	222E1E2112	F	931	42	E00319
1997	LEMHI	Seawater	515F58101B	F	804	37	E00043
1997	LEMHI	Seawater	5160332210	F	967	40	E00044
1997	LEMHI	Seawater	515F5D715A	F	1468	45	E00045
1997	LEMHI	Seawater	515B4C0059	M	717	36	022
1997	LEMHI	Seawater	515B7A0D36	M	1051	42	023
1997	LEMHI	Seawater	5160251C02	M	1042	42	082
1997	LEMHI	Seawater	515B44646E	M	710	40	083
1997	LEMHI	Seawater	515B401A0E	M	511	34	084
1997	LEMHI	Seawater	51602C2826	M	638	36	085
1997	LEMHI	Seawater	5160347A2E	M	1465	46	086
1997	LEMHI	Seawater	5160345D20	M	1280	45	087
1997	LEMHI	Seawater	515B7B3866	M	1012	41	088
1997	LEMHI	Seawater	515D330579	M	1292	45	089
1997	LEMHI	Seawater	515D380C38	M	762	38	090
1997	LEMHI	Seawater	5160331C05	M	1366	46	091
1997	LEMHI	Seawater	515D3E165F	M	1242	43	092
1997	LEMHI	Seawater	516031274E	M	1180	43	093
1997	LEMHI	Seawater	515B553B5A	M	1252	43	094
1997	LEMHI	Freshwater	5160274B6F	M	2061	50	077
1997	LEMHI	Freshwater	515B410222	M	704	38	078

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