FISHERY RESEARCH

SNAKE RIVER SOCKEYE SALMON CAPTIVE BROODSTOCK PROGRAM HATCHERY ELEMENT

ANNUAL PROGRESS REPORT
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Snake River Sockeye Salmon Captive Broodstock Program Hatchery Element

Project Progress Report

2002 Annual Report

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EXECUTIVE SUMMARY

On November 20, 1991, the National Marine Fisheries Service listed Snake River sockeye salmon *Oncorhynchus nerka* as endangered under the Endangered Species Act of 1973. In 1991, the Idaho Department of Fish and Game, the Shoshone-Bannock Tribes, and the National Marine Fisheries Service initiated efforts to conserve and rebuild populations in Idaho.

Initial steps to recover sockeye salmon included the establishment of a captive broodstock program at the Idaho Department of Fish and Game Eagle Fish Hatchery. Sockeye salmon broodstock and culture responsibilities are shared with the National Oceanic and Atmospheric Administration at two locations adjacent to Puget Sound in Washington State. Activities conducted by the Shoshone-Bannock Tribes and the National Oceanic and Atmospheric Administration are reported under separate cover. Idaho Department of Fish and Game monitoring and evaluation activities of captive broodstock program fish releases (annual report to the Bonneville Power Administration for the research element of the program) are also reported separately. Captive broodstock program activities conducted between January 1, 2002 and December 31, 2002 for the hatchery element of the program are presented in this report.

In 2002, 22 anadromous sockeye salmon returned to the Sawtooth Valley. Fifteen of these adults were captured at adult weirs located on the upper Salmon River and on Redfish Lake Creek. Seven of the anadromous sockeye salmon that returned were observed below the Sawtooth Fish Hatchery weir and allowed to migrate upstream volitionally (following the dismantling of the weir on September 30, 2002). All adult returns were released to Redfish Lake for natural spawning. Based on their marks, returning adult sockeye salmon originated from a variety of release options.

Sixty-six females from brood year 1999 and 28 females from brood year 2000 captive broodstock groups were spawned at the Eagle Hatchery in 2002. Spawn pairings produced approximately 65,838 eyed-eggs with egg survival to eyed stage of development averaging 55.1%.

Presmolts (140,410), smolts (38,672), and adults (190) were planted or released into Sawtooth Valley waters in 2002. Reintroduction strategies involved releases to Redfish Lake, Redfish Lake Creek, Alturas Lake, and Pettit Lake.

During this reporting period, five broodstocks and three unique production groups were in culture at Idaho Department of Fish and Game facilities (Eagle Fish Hatchery and Sawtooth Fish Hatchery). Three of the five broodstocks were incorporated into the 2002 spawning design, and one broodstock was terminated following the completion of spawning.

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INTRODUCTION

Numbers of Snake River sockeye salmon *Oncorhynchus nerka* have declined dramatically in recent years. In Idaho, only the lakes of the upper Salmon River (Sawtooth Valley) remain as potential sources of production (Figure 1). Historically, five Sawtooth Valley lakes (Redfish, Alturas, Pettit, Stanley, and Yellowbelly) supported sockeye salmon (Bjornn et al. 1968; Chapman et al. 1990). Currently, only Redfish Lake receives a remnant anadromous run.

On April 2, 1990, the National Oceanic and Atmospheric Administration (NOAA) received a petition from the Shoshone-Bannock Tribes (SBT) to list Snake River sockeye salmon as endangered under the Endangered Species Act (ESA) of 1973. On November 20, 1991, the NOAA declared Snake River sockeye salmon endangered.

The Idaho Department of Fish and Game (IDFG), as part of their five-year management plan, is charged with the responsibility of re-establishing sockeye salmon runs to historic areas, with emphasis placed on efforts to utilize Sawtooth Valley sockeye salmon and kokanee resources (IDFG 2001). In 1991, the SBT, along with IDFG, initiated the Snake River Sockeye Salmon Sawtooth Valley Project (Sawtooth Valley Project) with funding from the Bonneville Power Administration (BPA). The goal of this program is to conserve genetic resources and to rebuild Snake River sockeye salmon populations in Idaho. Coordination of this effort is carried out under the guidance of the Stanley Basin Sockeye Technical Oversight Committee (SBSTOC), a team of biologists representing the agencies involved in the recovery and management of Snake River sockeye salmon. The NOAA ESA Permit Nos. 1120, 1124, and 1233 authorize IDFG to conduct scientific research on listed Snake River salmon.

Initial steps by IDFG to recover the species involved the establishment of captive broodstocks at the Eagle Fish Hatchery in Idaho and at NOAA facilities in Washington State (Flagg and McAuley 1994; Johnson 1993; Johnson and Pravecek 1995; Johnson and Pravecek 1996; Pravecek and Johnson 1997; Pravecek and Kline 1998; Kline and Heindel 1999; Kline and Willard 2000; Kline and Willard 2001).

The participation of IDFG in the Sawtooth Valley Project falls under two general areas of effort: the sockeye salmon captive broodstock program (hatchery element), and Sawtooth Valley sockeye/kokanee monitoring and evaluation (research element). Activities associated with the captive broodstock program hatchery element are presented in this report.

PROGRAM GOALS

The ultimate goal of IDFG captive broodstock development efforts is to recover sockeye salmon runs in Idaho waters to self-sustaining levels that provide a degree of state and tribal harvest opportunity. The immediate project goal is to maintain this unique sockeye salmon population through captive broodstock technology and to avoid species extinction.

Objectives and Tasks

Objective 1. Develop captive broodstocks from Redfish Lake anadromous sockeye salmon.

Task a. Maintain facilities to produce sockeye salmon captive broodstocks.

Task b. Modify facilities (e.g., wells, water delivery, buildings) to meet basic fish culture needs and safety concerns to satisfy Objective 1. Complete the construction of a new single-family residence to accommodate new Hatchery Manager position. Complete the connection of a new well to existing hatchery building water distribution system (includes the purchase of new generator, variable frequency drive panel, and well pump and motor. Continue to plan the construction of covered structure over outside raceways.

Task c. Use existing and emerging conservation hatchery technologies to develop, culture, and maintain sockeye salmon captive broodstocks.

Task d. Trap returning anadromous adults, juvenile out-migrants, and residual sockeye salmon to initiate broodstocks.

Task e. Collect samples for genetic analysis from all wild and hatchery-produced sockeye salmon. Transfer samples to NOAA Fisheries and University of Idaho cooperators for analysis.

Task f. Establish spawning matrices in consultation with NOAA Fisheries and the program technical oversight committee.

Task g. Spawn captive adults using factorial designs that follow approved spawning plans.

Task h. Produce genetically defined progeny (eyed-eggs, presmolts, smolts, and adults) for use in multiple release strategies to Sawtooth Valley lakes.

Task i. Produce genetically defined progeny to meet future broodstock spawning needs. Divide broodstock eggs between NOAA Fisheries and IDFG facilities for rearing. Ship eggs and/or travel as needed to deliver eggs to NOAA Fisheries facilities.

Task j. Produce specific broodstocks from cryopreserved milt to broaden the genetic base in future spawn years.

Task k. Divide broodstock eggs produced from annual spawning events at Eagle Fish Hatchery between NOAA Fisheries and IDFG facilities for rearing. Ship eggs and/or travel as needed to deliver eggs to NOAA Fisheries facilities.

Task l. Cryopreserve milt from specific wild and hatchery-produced sockeye salmon.

Task m. Maintain cryopreserved archives at three locations to spread the risk of loss from catastrophic events.

Task n. Monitor and adaptively manage hatchery outcomes related to fish survival, maturation rates, age-at-maturity, sex ratio, diet, and gamete quality of captive sockeye salmon.

Objective 2. Determine the contribution hatchery-produced sockeye salmon make toward recovery.

Task a. Maintain and operate juvenile and adult trapping facilities at the Sawtooth Hatchery and at lake outlet locations.

Task b. PIT tag wild and hatchery-produced juveniles to facilitate evaluations of out-migration and adult return success by release location and strategy.

Task c. Differentially fin clip hatchery-produced juveniles to facilitate evaluations of out-migration and adult return success.

Task d. Estimate *O. nerka* out-migration from Sawtooth Valley lakes by release location and release strategy.

Task e. Evaluate out-migration success by release location and release strategy and adaptively manage the development of future release designs.

Task f. Develop estimates of travel time to lower Snake River hydropower projects and evaluate survival by release location and release strategy.

Task g. Identify spawning location and timing for prespawn adult sockeye released to lakes. Estimate spawning success.

Objective 3. Describe *O. nerka* population characteristics for Sawtooth Valley lakes in relation to carrying capacity and broodstock program release efforts.

Task a. Estimate *O. nerka* population variables by midwater trawl in four Sawtooth Valley lakes.

Task b. Trawl sufficiently to estimate abundance and density by age-class.

Task c. Collect scale and otolith samples from trawl captures for age and microchemistry analysis. Take tissue samples for genetic analysis. Take stomachs for diet analysis.

Task d. Develop lake carrying capacity estimates cooperatively with Shoshone-Bannock Tribes.

Task e. Monitor sport fisheries in sockeye salmon nursery lakes to determine their impact on recovery efforts (emphasis on kokanee harvest).

Objective 4. Determine the origin of wild and broodstock *O. nerka* to provide maximum effectiveness in their utilization within the broodstock program.

Task a. Use otolith microchemistry to identify the origin of *O. nerka* with unknown life histories.

Task b. Integrate microchemistry results with genetic information.

Objective 5. Technology Transfer and Professional Development.

Task a. Participate in the technical oversight committee process. Provide an adequate level of staffing at meetings to adequately present program information and to discuss program issues and challenges.

Task b. Network with technical experts on issues related to culture and broodstock techniques, genetics, pathology, and monitoring and evaluations.

Task c. Participate in essential program professional development opportunities.

Task d. Participate in essential program management and planning activities such as (but not limited to): budget meetings convened by Columbia Basin Fish and Wildlife Authority (CBFWA), BPA, Idaho Office of Species Conservation (IOSC), Northwest Power Planning Council (NWPPC) or NOAA fisheries; subbasin planning meetings; Artificial Production Review and Evaluation (APRE) meetings; Safety Net and Artificial Production Program (SNAPP) meetings; Hatchery and Genetic Management Plan (HGMP) meetings; and specific meetings considered essential to address comments and concerns of funding and review agencies such as the NWPPC and BPA.

Task e. Coordinate public information transfer with project cooperators.

Task f. Provide written activity reports to satisfy the needs and requirements of IDFG, the technical oversight committee, NOAA Fisheries, and BPA.

Task g. Provide one written annual project report. This report will summarize calendar year activities for the most current year where information has been summarized and where evaluations have been completed.

METHODS

Fish Culture Facilities

Eagle Fish Hatchery

Eagle Fish Hatchery is the primary Idaho site for the sockeye salmon captive broodstock program. Artesian water from three wells is currently in use. The water system was modified in 2002; three of the five wells were shut down and capped. A new well was developed and will be brought online in early 2003. Artesian flow is augmented with three 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 at Eagle Fish Hatchery in 1994. Chiller capacity accommodates incubation, a portion of fry rearing, and a portion of adult holding needs. Backup and system redundancy is in place for degassing, pumping, and power generation. Nine water level alarms are in use, linked through an emergency service contractor. A Hatchery Manager position and residence was added in 2002. Three additional on-site residences occupied by IDFG hatchery personnel provide additional security by limiting public access.

Facility layout at Eagle Fish Hatchery remains flexible to accommodate culture activities ranging from spawning and incubation through adult rearing. Egg incubation capacity at Eagle Fish Hatchery is approximately 200,000 eggs. Incubation is accomplished in small containers specifically designed for the program allowing for separation of individual subfamilies. Incubators are designed to distribute both upwelling and downwelling flow to accommodate pre- and post-hatch life stages.

Several fiberglass tank sizes are used to culture sockeye from fry to the adult stage, including: 1) 0.7 m diameter semisquare tanks (0.09 m^3); 2) 1.0 m diameter semisquare tanks (0.30 m^3); 3) 2.0 m diameter semisquare tanks (1.42 m^3); 4) 3.0 m diameter circular tanks (6.50 m^3); and 5) 4.0 m diameter semisquare tanks (8.89 m^3). Typically, 0.7 m and 1.0 m tanks are used for rearing fry from ponding to approximately 1.0 g weight. Two- and three-meter tanks are used to rear juveniles to approximately 10.0 g and to depot and group fish by lineage or release strategy prior to distribution to Sawtooth Valley waters. Three- and four-meter tanks are used to rear fish to maturity for future broodstock production (spawning). Flows to all tanks are maintained at no less than 1.5 exchanges per hour. Shade covering (70%) and jump screens are used where appropriate. Discharge standpipes are external on all tanks and assembled in two sections (“half pipe principle”) to prevent tank dewatering during tank cleaning.

Sawtooth Fish Hatchery

Sawtooth Fish Hatchery was completed in 1985 as part of the U.S. Fish and Wildlife Service Lower Snake River Compensation Plan and is located on the Salmon River, 3.5 km upstream from the confluence of Redfish Lake Creek. Sawtooth Fish Hatchery personnel and facilities have been utilized continuously since 1991 for various aspects of the sockeye captive broodstock program, including: 1) prespawn anadromous adult holding, 2) egg incubation, and 3) juvenile rearing for presmolt and smolt releases. In addition, hatchery personnel assist with many field activities, including: 1) net pen fish rearing, 2) fish trapping and handling, and 3) fish transportation and release.

Eyed-eggs, received at Sawtooth Fish Hatchery from Eagle Fish Hatchery or NOAA, are incubated in vertical trays. Fry are ponded to 0.7 m fiberglass tanks. Juvenile sockeye (>1 g) are held in vats or in a series of 2.0 m fiberglass tanks installed in 1997. Typically, juvenile sockeye salmon reared at Sawtooth Fish Hatchery are released as presmolts or smolts. Prespawn anadromous adults captured at Redfish Lake Creek or Sawtooth Fish Hatchery weirs are held in vats until release for natural spawning or transfer to the Eagle Fish Hatchery for artificial spawning. Generally, well water supplies water flow for incubation, rearing, and holding. Well water temperature varies by time of year from approximately 4.0°C minimum in January and February to 10.0°C maximum in September and October. When sockeye salmon are held for smolt releases, they may be moved to outside raceways that receive water from the Salmon River. Salmon River water temperature varies by time of year from approximately 2.0°C in January and February to 14.0°C in August and September. Backup and redundancy water systems are in place. Rearing protocols are established cooperatively between IDFG personnel and reviewed at the SBSTOC level.

Fish Culture

Fish culture methods used in the captive broodstock program follows accepted standard practices (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). Considerable coordination takes place between NOAA and IDFG culture experts and at the SBSTOC level.

Fish are fed a commercial diet produced by Bio-Oregon, Inc. (Warrenton, Oregon). Through approximately 150.0 g weight, fish receive a standard Bio-Oregon semimoist formulation. Rations are weighed daily and follow suggested feeding rates provided by the manufacturer. Bio-Oregon developed a custom broodstock diet that includes elevated levels of vitamins, minerals, and pigments. Palatability and levels of natural pigments are enhanced by the addition of natural flavors from fish and krill. Beyond 150.0 g weight, fish receive the Bio-Oregon custom broodstock diet.

Fish sample counts are conducted as needed to ensure that actual growth tracks with projected growth. In general, fish are handled as little as possible. Age-1 and age-2 sockeye salmon rearing densities are maintained at levels not to exceed 8.0 kg/m^3. Age-3 and age-4 rearing densities are maintained at levels not to exceed 14.0 kg/m^3.

Incubation and rearing water temperature is maintained between 7.0°C and 13.3°C. Chilled water (7.0°C to 10.0°C) may be used during incubation and early rearing to equalize development and growth differences that may result from a protracted spawning period. Rearing water temperature varies as a function of demand, but is generally maintained between 10.0°C and 12.0°C throughout much of the age-2, age 3, and age-4 culture history.

Passive integrated transponder (PIT) tags are used to evaluate the overwinter survival and out-migration success of production groups released to Sawtooth Valley waters. These PIT tags are also used to track sockeye salmon retained in the program as broodstock fish. Production and broodstock sockeye salmon are PIT tagged at approximately six months of age. The PIT tag procedures follow accepted, regional protocols (Prentice et al. 1990).

Chemical therapeutants are used prophylactically and for the treatment of infectious diseases. Before initiating treatments, the use of chemical therapeutants is discussed with an IDFG fish health professional. Fish necropsies are performed on all program mortalities that satisfy minimum size criteria for the various diagnostic or inspection procedures performed. Carcasses are either incinerated, land filled, or rendered.

Anadromous and Residual Adult Sockeye Salmon Trapping

Two adult traps are used to capture returning anadromous sockeye salmon in the Sawtooth Valley. The first trap is located on Redfish Lake Creek approximately 1.4 km downstream from the lake outlet. The second trap is located on the upper Salmon River at the Sawtooth Fish Hatchery weir.

A floating Merwin trap is used to capture residual sockeye salmon adults in Redfish Lake when they are incorporated into the captive broodstock program. When used, the trap is installed in October on the west side of the lake at the north end of Sockeye Beach.

Spawning Activities

Spawning has occurred at Eagle Fish Hatchery each year since 1994 (Johnson and Pravecek 1995; Johnson and Pravecek 1996; Kline and Heindel 1999; Kline and Willard 2000; Kline and Willard 2001). Before 1994, adult sockeye returns were spawned at the Sawtooth Fish Hatchery (Johnson 1993). Spawning follows accepted standard practices as described by McDaniel et al. (1994) and Erdahl (1994). The IDFG is required by NOAA Permit No. 1120 to discuss proposed broodstock spawning matrices before conducting activities. In general, spawning designs are developed to maximize genetic diversity in resultant progeny and to minimize inbreeding risks. Eggs from individual females produced at spawning are typically divided into three lots and fertilized with sperm from three different males (factorial design). Male contribution is subsequently equalized as each male is used to fertilize eggs from three different females (on average). Eggs are incubated on water temperatures determined to meet program goals for reintroduction via different release strategies and to produce fish to meet future broodstock needs.

Milt Cryopreservation

Cryopreservation of milt from male donors has been conducted in the captive broodstock program since 1991 and follows techniques described by Cloud et al. (1990) and Wheeler and Thorgaard (1991). Beginning in 1996, cryopreserved milt was used to produce lineage specific broodstocks for use in future spawn years. “Designer broodstocks” produced in this manner will increase the genetic variability available in future brood years.

Fish Health Investigations

The captive broodstock rearing program utilizes disinfectants, antibiotics, vaccinations, and antifungal treatments to control pathogens. Dosage, purpose of use, and method of application are as follows: 1) Antibiotic therapies: prophylactic erythromycin treatments are administered orally in Bio-Diet soft-moist feed obtained from Bio-Oregon to produce a dose of 100 mg/kg of body-weight for up to 28 days. When oral administration is not feasible, as with anadromous adults, an intraperitoneal injection of erythromycin is given to fish at a dose of 20 mg/kg of body weight. In addition, fingerlings are fed Oxytetracycline as needed to control outbreaks of pathogenic aeromonads, pseudomonads, and myxobacteria bacteria as needed. 2) Egg disinfection: newly fertilized eggs are water hardened in 100 mg/l solution of Iodophor for 30 minutes to inactivate viral and bacterial pathogens on the egg surface and in the perivitelline space. In addition, eyed-eggs transferred to IDFG facilities are disinfected in a 100 ppm Iodophor solution for ten minutes.

Spawning adults are analyzed for common bacteria (bacterial kidney disease *Renibacterium salmoninarum*, bacterial gill disease *Flavobacterium branchiophilum*, coldwater disease *Flavobacterium psychrophilum*, and motile aeromonad septicemia *Aeromonas* spp.) and viral pathogens (infectious pancreatic necrosis virus and infectious hematopoietic necrosis virus). In addition to the above, anadromous adult sockeye salmon are screened for the causative agent of whirling disease *Myxobolus cerebralis*, furunculous *Aeromonas salmonicida*, and the North American strain of viral hemorrhagic septicemia virus. Tissue samples are collected from the kidney, spleen, and pyloric caeca of each fish and ovarian fluid samples are collected from each female and analyzed at the Eagle Fish Health Laboratory. Results of fish health analysis of spawners will be used by IDFG and the SBSTOC to determine disposition of eggs and subsequent juveniles.

Fish health is checked daily by observing feeding response, external condition, and behavior of fish in each tank as initial indicators of developing problems. In particular, fish culturists look for signs of lethargy, spiral swimming, side swimming, jumping, flashing, unusual respiratory activity, body surface abnormalities, and unusual coloration. Presence of any of these behaviors or conditions is immediately reported to the program fish pathologist.

The presence of moribund fish is immediately reported to the fish pathologist for blood and parasite sampling; the fish pathologist routinely monitors captive broodstock mortalities to try to determine cause of death. American Fisheries Society (AFS) "Bluebook" procedures are employed to isolate bacterial or viral pathogens and to identify parasite etiology (Thoesen 1994). Dead fish are routinely analyzed for common bacterial and viral pathogens (e.g., bacterial kidney disease, infectious hematopoietic necrosis virus, etc). Genetic samples are also collected from spawned carcasses in an effort to conduct mitochondrial DNA and/or nuclear DNA evaluations for sockeye salmon broodstocks held in the program. When a treatable pathogen is either detected or suspected, the program fish pathologist prescribes appropriate prophylactic and therapeutic drugs to control the problem. Select carcasses may be appropriately preserved for pathology, genetic, and other analyses. After necropsy, carcasses that are not vital to further analysis are disposed of as per language contained in the ESA Section 10 permit for the program.

Juvenile Fish Quality Assessment

In 1999, the SBSTOC recommended applying assessments of fish quality to juvenile sockeye salmon produced in this program to provide additional perspective on factors that may affect fish survival from outplanting through out-migration. General parameters considered for investigation included: 1) proximate body composition analysis, 2) organosomatic index, and 3) fish health. Only proximate body composition was investigated in 2002.

To determine proximate body composition, sampled fish were dried, ground, and analyzed using standardized methods for proximate composition from the Association of Official Analytical Chemists (AOAC) (1990). Sample protein content was analyzed using a LECO FP 28 nitrogen analyzer. Crude lipid content in samples was analyzed using a LECO TFE 2000 supercritical CO^2 extractor (both are from LECO Corporation, St. Joseph, Missouri).

Eyed-Egg and Fish Transfers

Eggs are shipped at the eyed stage between NOAA and IDFG facilities using a commercial air service. Iodophor-disinfected (100 ppm) eggs are packed at a conservative density in perforated tubes, then capped and labeled. Tubes are wrapped with hatchery water-saturated cheesecloth and packed in small coolers. Ice chips are added to ensure proper temperature maintenance, and coolers are sealed with packing tape. Personnel from IDFG and NOAA are responsible for shuttling coolers to air terminals.

Fry may be transferred between IDFG and NOAA facilities. If fry transfers occur, a commercial air service is used as described above. Fish are transported in plastic fish transfer bags containing 10°C water. Oxygen is added to the bags before sealing. Bags are placed in coolers containing ice chips to ensure an appropriate temperature environment. Coolers are sealed with packing tape and accompanied by IDFG personnel on the aircraft.

Containers used to transport fish vary by task. In all cases, containers of the proper size and configuration are used. Appropriate temperature, oxygen, and chemical composition are maintained during the handling and transfer phases of transportation. Containers vary from five-gallon plastic buckets and coolers for short-term holding and inventory needs to barge-mounted holding tanks for mid-lake (pelagic) fish releases and net pen fish transfers. Truck-mounted tanks, used for long distance transfers, are available to the program with 250 gal (946 L), 1000 gal (3,785 L), and 2,500 gal (9,463 L) capacities. Transport guidelines are in place to not exceed 89 g/L (0.75 lb/gal).

Eyed-Egg and Fish Supplementation

Sockeye salmon have been reintroduced to Sawtooth Valley waters as eyed-eggs, presmolts, smolts, and prespawn adults.

Eyed-eggs are distributed to egg boxes manufactured by IDFG personnel specifically for this program. Plastic light baffle grids and plastic mesh netting partition and prevent eggs from falling into the biofilter ring medium until after hatch. Plastic mesh netting surrounding egg boxes allows fish to volitionally emigrate following yolk absorption. Each egg box accommodates approximately 4,000 eggs. Following loading, egg boxes are lowered to the lake substrate in approximately 3 m of water over known or suspected areas of lakeshore spawning.

Sockeye salmon presmolts are distributed to Sawtooth Valley lakes in truck-mounted transportation tanks. Fish are transferred from truck-mounted tanks to 250 gal (946 L) barge-mounted tanks for pelagic releases and net pen introductions. Adequate water temperature tempering occurs before the release of fish.

Sockeye salmon smolts are distributed to Sawtooth Valley waters using truck-mounted transportation tanks. To date, sockeye salmon smolts have only been introduced to the outlet of Redfish Lake Creek downstream of the juvenile out-migrant weir and to the Salmon River downstream of the Sawtooth Fish Hatchery weir. Adequate water temperature tempering occurs before the release of fish.

Prespawn adult sockeye salmon are distributed to Sawtooth Valley waters using truck-mounted transportation tanks. Adults have been introduced to Redfish Lake, Alturas Lake, and Pettit Lake. Fish are released at public access points at dusk. Adequate water temperature tempering occurs before the release of fish.

RESULTS AND DISCUSSION

Fish Culture

During this reporting period, five broodstock and two production groups were in culture at IDFG facilities representing brood years 1998, 1999, 2000, 2001, and 2002. A summary of losses while in culture during this reporting period is presented in Tables 1 and 2. Culture groups developed to meet future spawning needs are designated as “broodstock” groups. Culture groups developed primarily for reintroduction to Sawtooth Valley waters are designated as “production” groups. The year of development for specific culture groups may appear abbreviated (e.g., BY96 refers to brood year 1996).

BY98 Broodstock

Three primary culture groups were developed in 1998 to meet future broodstock needs. The first group (produced at the NOAA Big Beef Creek Hatchery and transferred to the IDFG Eagle Fish Hatchery in November, 1998) was developed from second generation females (ANBY91) produced from the four anadromous adults that returned to Redfish Lake Creek in 1991 (AN91) and the single anadromous male that returned to Redfish Lake Creek in 1998 (AN98). The second culture group was developed from first generation females (ANBY96) produced from the single female that returned to Redfish Lake Creek in 1996 (AN96). Males used for spawn crosses included first generation males (ANBY94) produced from the single female that returned to Redfish Lake Creek in 1994 (AN94), the single anadromous male that returned to Redfish Lake Creek in 1998 (AN98), and cryopreserved milt from first generation progeny (OMBY93) of female 1991 Redfish Lake out-migrants (OM91) and the six male sockeye salmon that returned to Redfish Lake Creek in 1993 (AN93). The third culture group was developed from first generation females and males (ANBY96) produced from the single female that returned to Redfish Lake Creek in 1996 (AN96). All fish were combined post-PIT tagging and reared collectively as BY98 broodstock. Initial inventory for this reporting period was 22 fish. Fifteen males matured in 2002; nine of the BY98 males were utilized in spawn crosses. At the end of the reporting period, zero fish from this broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY99 Broodstock

Eleven families, represented by 30 unique subfamilies, were developed from brood year 1999 broodstock spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two broodstock group titles: BY99 and ANHBY99. The BY99 broodstock group was developed using male and female sockeye salmon from the ANBY96, BY96, and BY97 broodstocks (described above). Specific crosses performed to develop this broodstock group included: 1) ANBY96 females x BY97 males, 2) ANBY96 females x ANBY96 males, 3) ANBY96 females x BY96 males, 4) BY96 females x ANBY96 males, and 5) BY96 females x BY97 males. The ANHBY99 broodstock group was developed using male and female sockeye salmon from ANBY96, BY96, BY97 broodstocks and four of the seven anadromous adults that returned to the Sawtooth Fish Hatchery in 1999 (ANH99). Specific crosses performed to develop this broodstock group included: 1) ANBY96 females x ANH99 males, 2) BY96 females x ANH99 males, 3) ANH99 female x ANBY96 males, 4) ANH99 female x BY96 males, 5) ANH99 female x BY97 males, and 6) ANH99 female x cryopreserved milt from the single male sockeye salmon that returned to Redfish Lake Creek in 1998 (AN98). Initial inventory for this reporting period included 274 fish. Forty-seven mature fish were released to Redfish Lake for volitional spawning on September 11, 2002. Of the remaining fish, 66 females and 143 males matured at age-3 in 2002. Sixty-two females and 94 males were utilized in hatchery spawn crosses. At the end of this reporting period, eight BY99 broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY00 Production

Sixteen families, represented by 49 unique sub-families, were developed from brood year 2000 production spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two production group titles: BY00 and ANHBY00. The BY00 production group was developed using male and female sockeye salmon from the BY97 and BY98 broodstocks (described above). Specific crosses performed to develop this production group included: 1) BY97 females x BY97 males, 2) BY97 females x BY98 males, and 3) BY98 females x BY97 males. Approximately 170,419 eyed-eggs were produced from BY00 spawn crosses. The ANHBY00 production group was developed using male and female sockeye salmon from BY97 and BY98 broodstocks and 38 (18 females and 20 males) of the 41 anadromous adults that returned to the Sawtooth Valley in 2000 and were retained for spawning. Specific crosses performed to develop this production group included: 1) ANH00 females x BY97 males, 2) ANH00 females x BY98 males, 3) ANH00 females x ANH00 males and 4) BY97 females x ANH00 males. Initial inventory for this reporting period included approximately 38,851 fish at Sawtooth Fish Hatchery. On May 7, 2002, 38,672 smolts were released to Redfish Lake Creek (Table 2).

BY00 Broodstock

Approximately 900 eyed-eggs were segregated from production groups described above to create the BY00 broodstock representing ten families (54 unique subfamilies). Approximately 346 eyed-eggs and 42 fry were transferred to NOAA facilities where they will remain through maturation. The majority of BY00 broodstock adults produced at NOAA facilities will contribute to future spawning designs. Inventory reporting for these fish will appear under separate cover by NOAA. Initial inventory for the BY00 broodstock at Eagle Fish Hatchery was 469 fish. Twenty-eight females and 86 males matured at age-2 in 2002. Twenty-seven females and twelve males were utilized in hatchery spawn crosses. At the end of this reporting period, 343 BY00 broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY01 Production

Sixteen families, represented by 86 unique subfamilies, were developed from brood year 2001 production spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two production group titles: BY01 and ANHBY01. The BY01 production group was developed using male and female sockeye salmon from the BY98 and BY99 broodstocks (described above). Specific crosses performed to develop this production group included: 1) BY98 females x BY99 males, and 2) BY98 females x BY98 males. Approximately 95,209 eyed-eggs were produced from BY01 spawn crosses. The ANHBY01 production group was developed using male and female sockeye salmon from the BY98 broodstock, male sockeye salmon from the BY99 broodstock, and nine (two females and seven males) of the 26 anadromous adults that returned to the Sawtooth Valley in 2001 and were retained for spawning. Specific crosses performed to develop this production group included: 1) ANH01 females x BY98 males, 2) ANH01 females x BY99 males, and 3) BY98 females x ANH01 males. Approximately 23,092 eyed-eggs were produced from ANHBY01 spawn crosses. Eagle Fish Hatchery transferred 116,600 BY01/ANHBY01 production eggs to the Sawtooth Fish Hatchery in November 2001. Approximately 116,600 eyed eggs were in culture at Sawtooth Fish Hatchery at the beginning of this reporting period. On October 7, 2002, 45,001 presmolts were released to Redfish Lake and on October 8, 2002,19,981 presmolts were released to Pettit Lake (Table 2).

BY01 Broodstock

Approximately 870 eyed-eggs were segregated from production groups described above to create the BY01 broodstock representing 11 families (50 unique subfamilies). Approximately 435 eyed-eggs were transferred to NOAA facilities where they will remain through maturation. The majority of BY01 broodstock adults produced at NOAA facilities will contribute to future spawning designs. Inventory reporting for these fish will appear under separate cover by NOAA. Initial inventory for the BY01 broodstock at Eagle Fish Hatchery was 435 developing fry. At the end of this reporting period, 323 BY01 broodstock fish were in culture (Table 1).

BY02 Production

Two hundred forty-seven spawn crosses representing 89 females and 115 males were developed from brood year 2002 production spawn crosses at the Eagle Fish Hatchery. The BY02 production group was developed using male sockeye salmon from the BY98, BY99, and BY00 broodstocks and female sockeye salmon from the BY99 and BY00 broodstocks (described above). Specific crosses performed to develop production groups included: 1) BY99 females x BY98 males, 2) BY99 females x BY99 males, 3) BY99 females x BY00 males, and 4) BY00 females x BY99 males. Approximately 65,838 eyed-eggs were produced from BY02 spawn crosses at Eagle Fish Hatchery. Eagle Fish Hatchery transferred 64,891 BY02 production eggs to the Sawtooth Fish Hatchery on November 27 and December 11, 2002 (Table 3). Approximately 29,592 eyed-eggs were transferred from the NOAA Burley Creek Hatchery to the Sawtooth Fish Hatchery on November 27 and December 4, 2002. Approximately 30,924 eyed-eggs were transferred from the NOAA Burley Creek Hatchery to incubation boxes in Pettit Lake on December 5, 2002. At the end of this reporting period, Sawtooth Fish Hatchery was incubating approximately 94,483 eyed-eggs (Table 2).

BY02 Broodstock

Approximately 840 eyed-eggs were segregated from production groups described above to create the BY02 broodstock representing 79 unique females and 106 unique males. Cryopreserved milt from AN91 males was used to cross with BY99 females. Fourteen crosses were attempted with cryopreserved milt from three AN91 males; none of the crosses were successful in fertilization. Approximately 420 eyed-eggs were transferred to NOAA facilities on November 27 and December 11, 2002 where they will remain through maturation (Table 1). The majority of BY02 broodstock adults produced at NOAA facilities will contribute to future spawning designs. Inventory reporting for these fish will appear under separate cover by NOAA. At the end of this reporting period, 420 developing fry were in culture at Eagle Fish Hatchery (Table 1).

Anadromous and Residual Sockeye Salmon Trapping

Two adult traps capture returning anadromous sockeye salmon in the Sawtooth Valley. The first trap is located on Redfish Lake Creek approximately 1.4 km downstream from the lake outlet and was operated from July 15 to October 10, 2002. The second trap is located on the upper Salmon River at the Sawtooth Fish Hatchery weir and was operated from May 28 to September 30, 2002.

In 2002, 22 anadromous sockeye salmon returned to the Sawtooth Valley. Fish were captured between July 31 and September 12, 2002. Traps on Redfish Lake Creek and the upper Salmon River at the Sawtooth Fish Hatchery intercepted eight and seven adults, respectively. Additionally, seven adult sockeye salmon were observed immediately downstream of the Sawtooth Fish Hatchery trap but were not handled. Returning adult sockeye salmon with adipose fin clips originated from 1999 presmolt (BY98) releases in Redfish, Alturas, and Pettit lakes. A portion of fish released as presmolts were also PIT tagged. A summary of adult returns is presented in Table 3.

No adult chinook salmon *O. tshawytscha* were captured at the Redfish Lake Creek trap. However, one adult male chinook was observed above the weir.

2002 Production Spawning

The IDFG is required by Permit No. 1120 to discuss proposed broodstock spawning matrices with NOAA Northwest Fisheries Science Center (NWFSC) genetics staff. In addition, the proposed broodstock spawning matrices were distributed and discussed at the SBSTOC held on July 31, 2002 in Fort Hall, Idaho (Appendix A). No objections to the proposed spawning design were aired.

During the fall of 2002, 15 age-4 fish (all male) from the BY98 broodstock, 209 age-3 fish (66 females and 143 males) from the BY99 broodstock, and 114 age-2 fish (28 females and 86 males) from the BY00 broodstock matured at the Eagle Fish Hatchery. Genetic samples were collected and analyzed for the 15 anadromous adults (ANH02) trapped in 2002. No returning adults were considered genetically unique to the captive broodstock program and none were utilized in hatchery spawning at Eagle Fish Hatchery.

Eighty-nine females and 115 males were spawned at Eagle Fish Hatchery between October 10 and November 7, 2002 to generate 119,555 green eggs. To avoid inbreeding, an effort was made to outcross fish from different brood years (e.g., BY99 females spawned with BY98 males). When this was not possible, within brood year spawn crosses were made based on a desirability matrix designed to avoid or minimize inbreeding.

Two hundred sixty-one unique subfamilies were developed from brood year 2002 production spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under one production group title, BY02. The BY02 production group was developed using male and female sockeye salmon from BY99 and BY00 broodstock and male sockeye salmon from BY98 broodstock. Specific crosses performed to develop this production group included: 1) BY99 females x BY98 males, 2) BY99 females x BY99 males, 3) BY99 females x BY00 males, and 4) BY00 females x BY99 males. Spawn crosses produced approximately 119,555 green and 65,838 eyed-eggs. Brood year 1999 female fecundity averaged 1,361 eggs, and BY00 female fecundity averaged 1,154 eggs. Egg survival to the eyed stage of development for the BY02 production group averaged 55.1% (median 61.7%) (Table 4).

In 2002, we attempted to develop production and broodstock groups at Eagle Fish Hatchery utilizing BY99 female broodstock and cryopreserved milt from the three anadromous adults that returned to Idaho in 1991 (AN91). Spawn crosses with 14 BY99 females were attempted. Approximately 100 green eggs were separated from each female and combined with cryopreserved milt from the three BY91 males. Motility on randomly selected cryopreserved milt samples was 0.0%; fertilization was unsuccessful for all crosses.

Results for brood year 2002 spawn crosses conducted by NOAA will be reported under separate cover by that agency.

2002 Broodstock Spawning

Approximately 420 eyed-eggs representing 79 unique females and 106 unique males were selected from specific spawn crosses described above and incubated for future broodstock needs. A duplicate component of 420 eyed-eggs was created at Eagle Fish Hatchery and transferred to the NOAA Burley Creek Hatchery to establish their 2002 broodstock group.

Currently, the broodstock program is limited to pooling annual broodstocks that are developed from hatchery spawning into ten family groups (determined by pedigree information). Identification of familial groups is maintained by segregating the groups into ten tanks until they are large enough to have PIT tags inserted. Pooling the broodstock into family groups reduces the unique identity of a fish into one of ten familial groups. Future genetic identification of BY02 broodstock will be determined by utilizing microsatellite DNA parental analysis to identify probable parents of each spawner. Parental determination will allow program managers to identify the parents of each fish, providing relatedness information at a higher resolution than previous use of pedigree information, resulting in a reduction of possible inbreeding and maintenance of genetic variation during hatchery broodstock spawning. Spawn crosses represented in the Eagle broodstock are presented in Table 5.

In 2002, we attempted to develop production and broodstock groups utilizing BY99 female broodstock and cryopreserved milt from the three anadromous adults that returned to Idaho in 1991 (AN91). Spawn crosses with 14 BY99 females were attempted. Approximately 100 green eggs were separated from each female and combined with cryopreserved milt from the three BY91 males. Motility on randomly selected cryopreserved milt samples was 0.0%. Fertilization was unsuccessful in all crosses.

Milt Cryopreservation

No milt from maturing sockeye salmon was cryopreserved in 2002.

Fish Health Investigations

The IDFG Eagle Fish Health Laboratory processed samples for diagnostic and inspection purposes from broodstock and production groups of sockeye salmon, anadromous adult sockeye salmon that were retained for hatchery spawning, sockeye salmon smolts obtained from out-migrant traps, and *O. nerka* obtained from trawl efforts. Eighty-six laboratory cases involving 473 individual fish were processed in 2002. The laboratory also summarized pathology findings to satisfy the needs of adjacent state agencies for issuance of sockeye salmon import and transport permits.

There was no evidence of viral pathogens in any of the production and broodstock groups in 2002. This result is consistent with results from previous years. In addition, no viral pathogens were detected in three anadromous adults examined in 2002. Sawtooth Hatchery experienced the presence of infectious hematopoietic necrosis virus (IHNV) that caused mortality in BY00 spring chinook salmon during February 2002. However, the disease was not detected in sockeye salmon reared in a nearby raceway. The Redfish Lake population remains the only sockeye salmon population in the Pacific Northwest that does not have IHNV.

Clinical bacterial kidney disease (BKD), caused by *Renibacterium salmoninarum*, did not occur in any production groups of sockeye salmon juveniles reared at Eagle Fish Hatchery or at Sawtooth Fish Hatchery. There were two cases from Sawtooth Fish Hatchery in which elevated enzyme linked immunoabsorbent assay optical density (ELISA OD) values were demonstrated; however, the levels did not indicate a clinical disease. The ELISA OD levels of two spawned captive sockeye salmon minimally exceeded background levels of BKD; however, captive sockeye salmon spawned in 2002 were free of clinical levels of BKD. Bacterial kidney disease antigen was detected in one of the three anadromous adult prespawn mortalities examined in 2002. Bacterial kidney disease antigen was also detected in 12 of 20 smolt samples collected during emigration from Redfish Lake; it was not detected at Pettit or Alturas Lake smolt trapping locations.

No furunculosis, caused by *Aeromonas salmonicida*, was detected in any of the anadromous adult prespawn mortalities. However, as a precaution, we administered intraperitoneal injections of both oxytetracycline and erythromycin shortly after the adults were trapped.

Clinical disease caused by motile *Aeromonas spp.* was present in anadromous adults, captive reared adults, and in BY99 and BY00 production sockeye salmon. Antibiotic therapy was administered once in 2002 to control losses in captive reared adults and production groups.

The myxosporean parasite *Parvicapsula minibicornis* was detected in two of three anadromous prespawning mortalities in 2002. Detection of *Parvicapsula* was made by polymerase chain reaction (PCR) at the laboratory of Dr. Simon Jones of the Department of Fisheries and Oceans, Canada. The loss of three out of 15 anadromous adults prior to spawning is unusual for the Redfish Lake sockeye salmon program. The presence of severe columnaris (*Flavobacterium columnarae*) of the gills and gas saturation caused head lesions prevents attributing the losses solely to *Parvicapsula*. *Parvicapsula* has been identified as the cause of considerable prespawning loss in Fraser River, BC sockeye salmon. *Parvicapsula* is contracted as adults hold in the estuary before entering the Columbia River mainstem. The detection of *Parvicapsula* in Redfish Lake sockeye salmon demonstrates the need to examine *Parvicapsula* in Columbia River basin sockeye salmon populations.

The myxosporean parasite, *Myxobolus cerebralis,* which can cause salmonid whirling disease, is present in the upper Salmon River in Idaho. In 2002, the Eagle Fish Health Laboratory continued to investigate the seasonal infectivity in the river water supply of the Sawtooth Fish Hatchery using sentinel rainbow trout fry. Results of these exposures are pending and will be used to assess the risk of rearing sockeye salmon on Salmon River water during the winter months. In 2002, three anadromous adults were examined for presence of the parasite. All three fish were negative for the parasite. In addition, since the inception of this project in 1991, *M. cerebralis* has not been identified in juveniles emigrating from Redfish, Pettit, or Alturas lakes. Kokanee present in these lakes have also tested negative.

In 2002, three anadromous adults were examined for the presence of *Piscirickettsia salmonis.* The results were all negative, indicating that this emerging pathogen has not become established in Idaho.

One neoplasm, thymic lymphosarcoma, was observed in one BY99 sockeye salmon. Thymic lymphosarcomas have been observed in past years at the Eagle Fish Hatchery. Slides and tissues of this tumor were deposited and cataloged in the National Registry of Tumors of Lower Vertebrates at George Washington University Medical Center, an arm of the Smithsonian Institute.

O. nerka obtained by trawling in Redfish, Pettit, and Alturas lakes were shown to be negative for viral pathogens BKD and *M. cerebralis.*

Juvenile Fish Quality Assessment

Year 2002 fish samples for proximate analysis are summarized in Table 7. Mean percent fat dry weight calculations are pending.

Eyed Egg and Fish Transfers

In all cases, the required State transfer permits were acquired before shipping. Specific details, by date, for all transfers are described below.

On August 27, 2002, IDFG and NOAA transferred BY01 presmolts from Bonneville Fish Hatchery to Alturas and Pettit Lakes. Idaho Department of Fish and Wildlife transferred BY01 presmolts on August 28, 2002, and Oregon Department of Fish and Wildlife (ODFW) transferred BY01 presmolts on August 29, 2002 from ODFW's Bonneville Fish Hatchery to Redfish Lake. These transfers provided fish for direct summer lake releases.

On September 11 and 12, 2002, NOAA transferred 131 BY99 adults to Redfish Lake to be released for volitional spawning. No mortality was associated with the transportation.

On November 27 and December 11, 2002, approximately 420 eyed-eggs from broodstock crosses were transferred from the Eagle Fish Hatchery to the NOAA Burley Creek Fish Hatchery. Fish that mature as a result of this transfer will be incorporated in future NOAA spawning designs.

On November 27 and December 11, 2002, approximately 64,891 eyed-eggs from production crosses were transferred from the Eagle Fish Hatchery to the Sawtooth Fish Hatchery. On November 27 and December 4, 2002, approximately 29,592 eyed-eggs were transferred from the NOAA Burley Creek Hatchery to the Sawtooth Fish Hatchery. Fish that result from these transfers will be used to fill spring 2003 presmolt release strategies. On December 4, 2002, approximately 30,924 eyed-eggs were transferred from the NOAA Burley Creek Hatchery to the Eagle Fish Hatchery for the Pettit Lake egg box program. Eggs were transferred to Pettit Lake and placed in egg boxes on December 5, 2002.

On September 11 and 12, 2002, NOAA transferred 131 BY99 adults to Redfish Lake to be released for volitional spawning. No mortality was associated with the transportation.

Eyed Egg and Fish Reintroductions

Pursuant to Special Condition B9 Requirement D3 of Permit No. 1120, IDFG received authorization from NOAA to carry out the following production releases of sockeye salmon in 2002 (Table 7). All sockeye salmon released were adipose fin clipped.

Smolt Releases

Age-1 sockeye salmon smolts (BY00) reared at IDFG Sawtooth Fish Hatchery were released into Redfish Lake Creek (38,672) below the Redfish Lake Creek trap on May 7, 2002. The mean weight at release was 27.6 grams. All smolts were initially reared inside on well water and later moved to outside raceways containing river water. All smolts released were adipose-clipped and coded-wire tagged. Nine hundred ninety-five of the smolts were PIT tagged.

Adult Releases

Maturing adult sockeye salmon were released to Redfish Lake in September 2002 for volitional spawning. On September 11 and 12, 101 and 30 (respectively) NOAA Manchester Marine Laboratory hatchery-reared BY99 adults (mean weight 1,350.0 grams) were released. Additionally, 47 IDFG Eagle Fish Hatchery-reared BY99 adults (mean weight 1900.0 grams) were released September 11, 2002. Efforts were made to release fish of equal sex ratios. Due to a lack of sexual dimorphism in NOAA-reared fish, sex ratios could not be positively determined in all fish. Twelve anadromous adults (seven females and five males), mean weight of 1,500.0 grams, were released on September 12, 2002.

Presmolt Releases

Presmolt releases to Sawtooth Valley lakes were conducted in August and October 2002 at midlake (pelagic) locations with the aid of a release barge on loan to IDFG from NOAA. All presmolts were from brood year 2001 and were reared at either the ODFW Bonneville Fish Hatchery (August releases) or IDFG's Sawtooth Fish Hatchery (October releases). Presmolts reared at Bonneville Fish Hatchery were adipose and right ventral fin clipped, while presmolts from Sawtooth Fish Hatchery were adipose clipped only. On August 27, Alturas Lake received 6,123 presmolts and Pettit Lake received 7,805 presmolts. These groups were adipose and right ventral fin clipped and had a mean weight of 10.56 and 11.35 grams, respectively. On August 28 and 29, Redfish Lake received 61,500 presmolts (mean weight 11.35 grams). On October 8, Pettit Lake received an additional 19,981 presmolts reared at the Sawtooth Fish Hatchery. Fish from this group were adipose fin clipped and had a mean weight of 14.8 grams. On October 8, an additional 45,001 ad-clipped presmolts (mean weight 15.3 grams) were released to Redfish Lake.

Eyed-egg Planting

On December 4, 2002, approximately 30,924 eyed-eggs were transferred from the NOAA Burley Creek Hatchery to the Eagle Fish Hatchery for the Pettit Lake egg box program. Eggs were transferred to Pettit Lake and placed in egg boxes on December 5, 2002.

Table 1. Summary of losses and magnitude of mortality for five captive sockeye salmon broodstocks reared at IDFG facilities in 2002.

	Culture Groups				
	BY98	**BY99**	**BY00**	**BY01**	**BY02**
Starting Inventory (January 1, 2002)	22[a]	274[a]	469[a]	435	840[b]
Eyed-egg to Fry					
Undetermined[c]	na	na	na	76	na
Mechanical Loss					
Handling	1[d]	0	2	1	na
Jump-out	0	0	0	0	na
Transportation	0	0	0	1	na
Noninfectious					
Lymphosarcoma	0	1	0	0	na
Nephroblastoma	0	0	0	0	na
Other[e]	6	9	10	34	na
Infectious					
Bacterial	0	0	0	0	na
Viral	0	0	0	0	na
Other	0	0	0	0	na
Maturation Spawners					
Mature Males	9	94	12	0	na
Mature Females	0	62	27	0	na
Maturation Non-Spawners					
Mature Males	6	49	74	0	na
Mature Females	0	4	1	0	na
Relocation					
Transferred In	0	0	0	0	na
Transferred Out	0	0	0	0	420[f]
Planted/Released	0	47	0	0	na
Ending Inventory (December 31, 2002)	0	8	343	323	420

[a] Starting inventory reflects an inventory adjustment made post-completion of the 2001 BPA Annual Report.
[b] December 2002 developing fry and egg numbers.
[c] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.
[d] Includes one mature male mortality post ultra-sound handling.
[e] Includes culling associated with cultural abnormalities and all undetermined, noninfectious mortality.
[f] Transferred from IDFG Eagle Fish Hatchery to NOAA for broodstock rearing.

Table 2. Summary of losses and magnitude of mortality for two captive sockeye salmon production groups reared at IDFG facilities in 2002.

	Culture Groups		
	BY00	**BY01**	**BY02**
Starting Inventory (January 1, 2002)	38,851	116,600[a]	94,483[b]
<u>Eyed-egg to Fry</u>			
Undetermined[c]	na	41,548	na
<u>Mechanical Loss</u>			
Handling	0	0	na
Jump-out	0	0	na
Transportation	0	0	na
<u>Noninfectious</u>			
Lymphosarcoma	0	0	na
Nephroblastoma	0	0	na
Other[d]	179	10,070	na
<u>Infectious</u>			
Bacterial	0	0	na
Viral	0	0	na
Other	0	0	na
<u>Maturation</u>			
Mature Males	0	0	na
Mature Females	0	0	na
Other	0	0	na
<u>Relocation</u>			
Transferred In	0	0	29,592[e]
Transferred Out	0	0	na
Planted/Released	38,672	64,982	na
Ending Inventory (December 31, 2002)	0	0	94,483[f]

[a] December 2001 developing fry and egg numbers (combined NOAA and Eagle numbers).
[b] December 2002 developing fry and egg numbers (combined NOAA and Eagle numbers).
[c] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.
[d] Includes culling associated with cultural abnormalities and all undetermined, noninfectious mortality.
[e] Transferred from NOAA to IDFG Sawtooth Fish Hatchery for production rearing.
[f] Includes 64,891 and 29,592 eyed-eggs from Eagle and NOAA facilities, respectively.

Table 3. Year 2002 anadromous sockeye salmon adult return summary.

Summary Category	Total Number Trapped	Number Trapped at Redfish Lake Cr.	Number Trapped at Sawtooth Hatchery
All Anadromous Adults	15	8	7
Anadromous Males	5	2	3
Anadromous Females	10	6	4
Unmarked Adults[a]	6	2	4
Adipose-Clipped Adults[b]	9	6	3

[a] Unmarked adults are presumably the result of eyed-egg and prespawn adult release strategies conducted in Redfish Lake in 1998. Unmarked adults could also be progeny of Redfish Lake residual sockeye salmon. Age data for these adults is not complete; confirmation of origin is pending.

[b] Adipose-clipped adults are presumably from a 1999 fall presmolt release from fish reared at Sawtooth Fish Hatchery. Age data for these adults is not complete; confirmation of origin is pending.

Table 4. Summary information for 2002 sockeye salmon spawning activities at Eagle Fish Hatchery.

Spawning Cross*		No. of Green Eggs Taken	No. of Eyed-Eggs	Mean Egg Survival to Eyed-Stage	Median Egg Survival to Eyed-Stage
Female	Male				
BY99	BY98	17,782	7,945	44.7%	43.9%
BY99	BY99	61,385	28,624	46.6%	51.9%
BY99	BY00	7,645	3,834	50.2%	51.8%
BY99	AN91CRYO	1,600	0	0.0%	0.0%
BY00	BY99	31,143	25,435	81.7%	96.6%
	TOTALS	119,555	65,838	55.1%	61.1%

Note:* AN91CRYO refers to cryopreserved milt from AN91 males.
BY98 refers to captive adults produced in spawn year 1998.
BY99 refers to captive adults produced in spawn year 1999.
BY00 refers to captive adults produced in spawn year 2000.

Table 5. Parent family and number of eyed-eggs retained for brood year 2002 captive broodstock development at Eagle Fish Hatchery.

Family Cross*		No. of Eyed-eggs Retained for Eagle Broodstock
Female	Male	
BY99	BY98	42
BY99	BY99	207
BY99	BY00	43
BY00	BY99	128
	TOTAL	420

Note:* BY98 refers to captive adults produced in spawn year 1998.
BY99 refers to captive adults produced in spawn year 1999.
BY00 refers to captive adults produced in spawn year 2000.

Table 6. Year 2002 juvenile sockeye salmon and kokanee proximate body analysis summary. Redfish Lake Creek weir = RFL, Alturas Lake Creek screw trap = ALT, and Pettit Lake Creek weir = PET. Note: CWT = coded-wire tag; Ad = adipose fin clip; Lv = left ventral fin clip; Rv = right ventral fin clip.

Sample Date	Sample Location	Description of Fish Sampled	Number Sampled	Mean Wt. (g)	Mean FL (mm)	Mean % Fat Dry Wt.
5/02/2002	RFL Weir	Hatchery-produced out-migrant (Ad only)	20	15.1	126	*Pending*
5/02/2002	RFL Weir	Wild/Natural out-migrant	20	15.6	126	*Pending*
5/07/2002	Sawtooth Fish Hatchery	Hatchery smolts (Ad/CWT)	20	29.1	144	*Pending*
May-2002	RFL Weir	Net pen-produced out-migrants (Ad/Lv)	20	24.5	144	*Pending*
May-2002	Alturas Screw Trap	Sockeye smolts	20	*Pending*	*Pending*	*Pending*
May-2002	Pettit weir	Sockeye smolts	39	*Pending*	*Pending*	*Pending*
8/27/2002	Bonneville Fish Hatchery	Hatchery presmolts (Ad/Rv)	20	11.3	104	*Pending*
10/08/2002	Sawtooth Fish Hatchery	Hatchery presmolts (Ad only & Ad/CWT)	23	15.3	117	*Pending*
Jun-02	Redfish Lake	Hook and line kokanee	5	—	—	*Pending*
Jun-02	Pettit Lake	Hook and line kokanee	1	—	214	*Pending*
Jun-02	Pettit Lake	Hook and line sockeye (Ad only)	1	—	225	*Pending*
Jun-02	Pettit Lake	Hook and line sockeye (Ad/Lv)	1	—	175	*Pending*
9/05/2002	Redfish Lake	Trawl kokanee-age 0	15	1.8	59	*Pending*
9/05/2002	Pettit Lake	Trawl kokanee-age 2	3	87.2	185	*Pending*
9/05/2002	Pettit Lake	Trawl kokanee-age 3	1	111.3	206	*Pending*
9/04/2002	Alturas Lake	Trawl kokanee-age 0	3	1.8	58	*Pending*
9/04/2002	Alturas Lake	Trawl kokanee-age 1	2	5.8	87	*Pending*
9/04/2002	Alturas Lake	Trawl kokanee-age 2	2	42.1	157	*Pending*
9/04/2002	Alturas Lake	Trawl kokanee-age 3	2	34.4	167	*Pending*

Table 7. Sockeye salmon releases made to Sawtooth Valley waters in 2002. Note: Ad = adipose fin clip; Rv = right ventral fin clip.

Release Location	Strategy (Brood Year)	Release Date	Number Released	Number PIT Tagged	Marks	Release Weight (g)	Rearing Location
Redfish Lake Creek (downstream of weir)	smolt (2000)	05/07/02	38,672	995	Ad/CWT	27.60	IDFG Sawtooth Fish Hatchery
Alturas Lake (direct lake)	presmolt (2001)	8/27/02	6,123	1,463	Ad/Rv	10.56	ODFW Bonneville Fish Hatchery
Pettit Lake (direct lake)	presmolt (2001)	8/27/02	7,805	1,434	Ad/\Rv	11.35	ODFW Bonneville Fish Hatchery
	(2001)	10/08/02	19,981	2,013	Ad/CWT(9,987)	14.80	IDFG Sawtooth Fish Hatchery
Redfish Lake (direct lake)	presmolt (2001)	08/28/02	31,000	1,002	Ad/Rv	11.35	ODFW Bonneville Fish Hatchery
	(2001)	08/29/02	30,500	-	Ad/Rv	11.35	ODFW Bonneville Fish Hatchery
	(2001)	10/08/02	45,001	1,015	Ad	15.30	IDFG Sawtooth Fish Hatchery
Redfish Lake	adult (1999)	9/11/02	101	-	None	1,350.0	NOAA Manchester Marine Lab
	(1999)	9/11/02	47	-	None	1,900.0	IDFG Eagle Fish Hatchery
	(1999)	9/12/02	30	-	None	1,350.0	NOAA Manchester Marine Lab
	(1999)	9/12/02	12	-	None	1,900.0	Anadromous returns
Pettit Lake	eyed-egg (2002)	12/05/02	30,924	-	-	-	NOAA Burley Creek

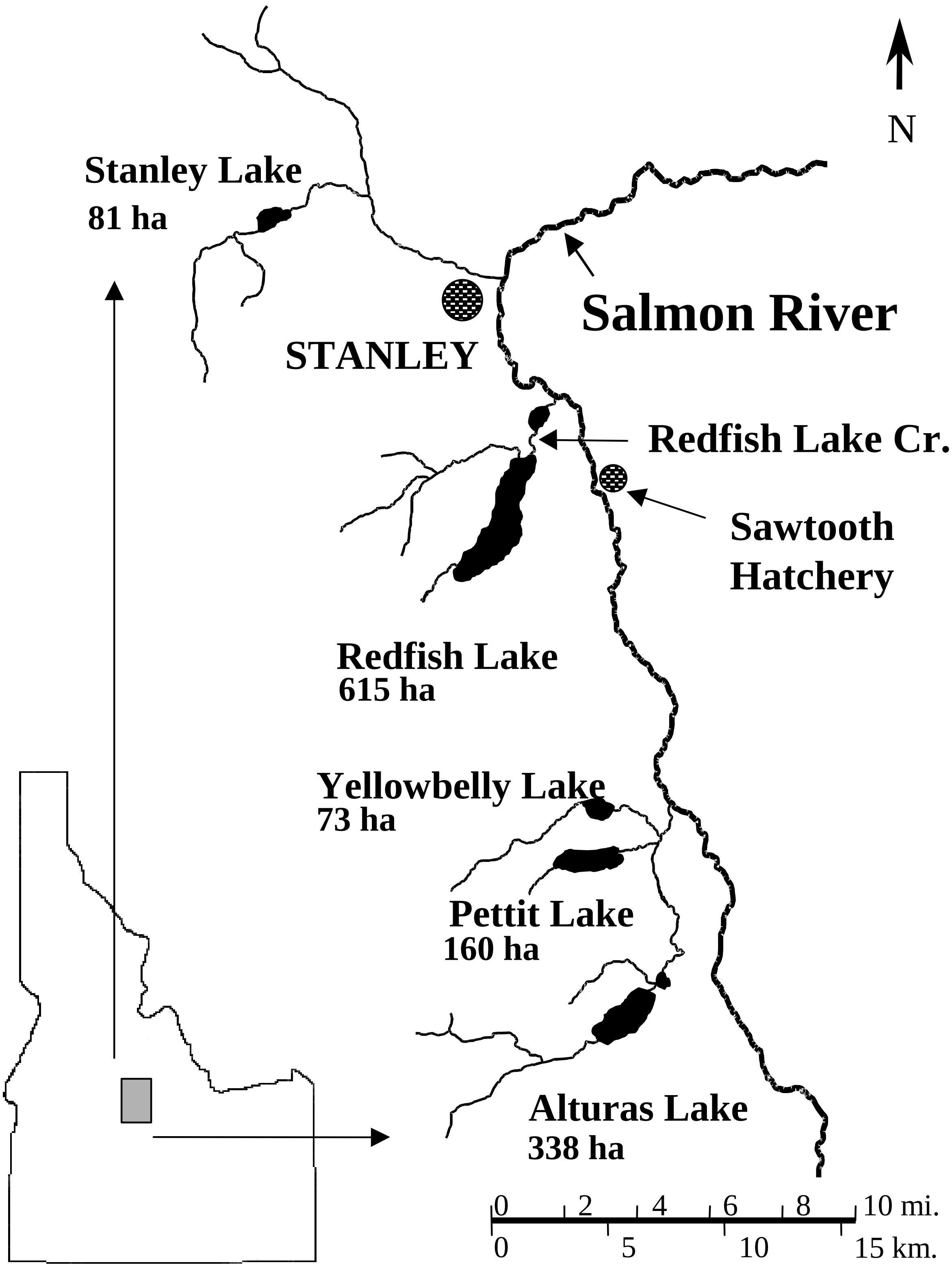

Figure 1. Sawtooth Valley study area.

ACKNOWLEDGMENTS

We wish to thank the members of the Stanley Basin Sockeye Technical Oversight Committee for their involvement and input throughout the year. We would also like to thank Brent Snider and the entire staff at the Sawtooth Fish Hatchery for their continued assistance and support. Special thanks to Cheryl Leben for her technical assistance assembling the final document.

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APPENDICES

Appendix A. Year 2002 spawning matrix memo.

IDAHO DEPARTMENT OF FISH AND GAME
EAGLE FISH HATCHERY
1800 Trout Road, Eagle ID 83616
phone (208) 939-4114, fax (208) 939 2415

July 26, 2002

M E M O R A N D U M

To: **SBSTOC**
From: **Paul Kline, Lance Hebdon, Catherine Willard**
Subject: **2002 Sockeye Spawning Matrix**

At Eagle Fish Hatchery in 2002, the primary rearing group to reach maturity will be age-3 fish produced in brood year 1999. In addition, approximately 11, age-4 BY98 males and an unknown number of age-2 BY00 males are expected to mature.

Following examination by ultrasound at Eagle Fish Hatchery on 7/25/02, the following BY99 fish are on station:

Maturing females = 110
Maturing males = 138
Unknown sex maturing = 8
Immature fish = 4

Total BY99 fish = 260
Percent maturing = 98%
Percent male of known sex maturing = 56%
Percent female of known sex maturing = 44%

Note: In September 2001, 366 BY99 fish were on station at Eagle Fish Hatchery. Fifty-five of these matured at age-2 (15% of the population).

<u>BY99 Lineages:</u>

Fifteen specific family groups have been maintained. Seven of the 15 groups were developed from the three hatchery-produced, anadromous, age-3 “jacks and jill” (ANH99) that were incorporated in the spawning design. Age-3 anadromous returns were produced from program production crosses in BY96. Two mitochondrial DNA haplotypes are represented (H9 and H25). Anadromous fish were crossed within group and out-crossed with BY96 and BY97 broodstock fish. The eight remaining major broodstock subfamilies produced in 1999 were between BY96 and BY97 broodstock adults.

Brood year 1996 production fish were generated primarily from first generation progeny of the eight wild, anadromous adults that returned in 1993. Brood year 1996 broodstock fish were produced from the single wild, anadromous female that returned in 1996; first generation progeny of the eight wild, anadromous adults that returned in 1993; and 1991 and 1993 wild, Redfish Lake out-migrants. Brood year 1997 broodstock fish were produced from the single wild, anadromous female that returned in 1994 and first generation progeny of the four wild, anadromous adults that returned in 1991. In addition, cryopreserved milt from 1991 and 1992 out-migrants was used.

BY98 Lineages:

We estimate that 11, age-4, BY98 males will mature in 2002. The majority of these adults were produced from first generation females of the eight wild, anadromous adults that returned in 1993, the single wild, anadromous female that returned in 1996, and the single wild, anadromous male that returned in 1998. In addition, the 1991 wild, anadromous adults are represented in the BY94NMFSF2 group.

BY00 Lineages:

The brood year 2000 group is discussed due to the fact that some age-2 males are expected to mature in 2002. The majority of fish from this group represent a variety of spawn crosses and are related to the hatchery-produced anadromous adults that returned in 2000, and the wild, anadromous adults that returned in 1992, 1993, 1994, 1996, and 1998. Wild, Redfish Lake out-migrants from 1991, 1992, and 1993 are also represented in this broodstock.

Cryopreserved Milt:

Cryopreserved milt is available from anadromous adults, residual sockeye salmon, wild out-migrant sockeye salmon, and a variety of first generation males produced from anadromous adults. In spawn year 2002, cryopreserved milt from unique, unrelated males will be incorporated into the spawning design to increase the temporal, effective population size.

2002 Anadromous Returns:

At the time of this writing, 47 sockeye salmon have been reported passing Lower Granite Dam. Historically, 50% to 70% of adults passing this facility successfully return to the Sawtooth Valley. While age-4 fish most likely represent the majority of the run, age-3 and age-5 adults could return. Age-3, age-4, and age-5 fish are linked to brood years 1999, 1998, and 1997, respectively. While specific lineage will be difficult, mtDNA and nDNA markers will be used to genotype adults temporarily held at the Sawtooth Hatchery. Recommendations will be made to incorporate unique or rare individuals into the spawning design. We anticipate that the majority of anadromous adults will be released for volitional spawning.

Proposed Spawning Design:

The following spawning design was developed to guide both IDFG and NOAA staff with year 2002 spawning activities. The plan takes into account pedigree information for captive fish and genetic marker information for hatchery-produced anadromous adults and has been designed to minimize the risks associated with inbreeding.

Three tiers of acceptability are proposed to guide the development of spawn crosses: In general, distant or no suspected relatedness represents a “Tier 1” cross. “Tier 2” crosses include limited relatedness (generally on one side of the family) at the grandparent level or beyond. “Tier 3” crosses include more recent relatedness at the parent level or perhaps at the sibling level.

Although not highlighted in the following matrices, cryopreserved milt and hatchery-produced, anadromous adults will be incorporated in the 2002 spawning design (see above).

No Tier 1 crosses are available if BY99 adults are crossed within group. Most BY99 adults share a common grandmother – the single wild, anadromous female that returned in 1996. In addition, there is some risk that one or more of the eight wild, anadromous adults that returned in 1993 will be a common great grandparent in these crosses. If the spawning design is followed, no relatedness at the parent or sibling level will occur (no Tier 3 crosses).

If certain BY98 and BY00 males mature, Tier one crosses are available (see matrices that follow). Where possible, these crosses will be prioritized but not relied on exclusively. Temporal effective population size and inbreeding risk will have to be balanced. Cryopreserved milt offers a good opportunity in 2002 to avoid conducting crosses between related individuals.

The following table identifies preferred crosses for spawn year 2002:

Year 2002 desirability matrix:

2002 SPAWNING DESIGN FOR CROSSES CONDUCTED WITHIN BROOD YEAR 1999 FISH				
Lineage	**BY**	**Tier**	**Lineage**	**BY**
ANH99-H9 **X** ANH99POOL	99	Tier 2	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** BY97MIX	
			BY96MIX **X** ANBY96OM93	
			BY96MIX **X** BY97MIX	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	
ANH99-H9 **X** ANBY96OM93	99	Tier 2	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** BY97MIX	
			BY96MIX **X** BY97MIX	
ANH99-H9 **X** BY97MIX	99	Tier 2	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			BY96MIX **X** ANBY96OM93	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	
ANH99-H9 X OM91AN93 X AN92CRYO	99	Tier 2	BY96MIX **X** ANBY96OM93	99
OM91AN93 X AN92CRYO X ANH99-H25			BY96MIX **X** BY97MIX	
OM91AN93 X AN92CRYO X AN99-H9				
BY96MIX **X** ANH99-H9	99	Tier 2	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** BY97MIX	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	

Appendix A. Continued.

BY96MIX **X** AHN99-H25	99	Tier 2	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** BY97MIX	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	

	99	Tier 2	BY96MIX **X** ANBY96OM93	99
			BY96MIX **X** BY97MIX	
ANBY96A3 **X** OM91AN93 X AN92CRYO			ANH99-H9 **X** ANH99POOL	
ANBY96B4 **X** OM91AN93 X AN92CRYO			ANH99-H9 **X** ANBY96OM93	
ANBY96B5 **X** OM91AN93 X AN92CRYO			ANH99-H9 **X** BY97MIX	
			BY96MIX **X** ANH99-H9	
			BY96MIX **X** AHN99-H25	

OM91AN93 X AN92CRYO **X** BY97MIX	99	Tier 2	BY96MIX **X** ANBY96OM93	99
			ANH99-H9 **X** ANH99POOL	
			ANH99-H9 **X** ANBY96OM93	
			BY96MIX **X** ANH99-H9	
			BY96MIX **X** AHN99-H25	

BY96MIX **X** ANBY96OM93	99	Tier 2	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** BY97MIX	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	
			ANH99-H9 **X** ANH99POOL	
			ANH99-H9 **X** BY97MIX	
			ANH99-H9 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** ANH99-H25	
			OM91AN93 X AN92CRYO **X** AN99-H9	

BY96MIX **X** BY97MIX	99	Tier 2	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	
			ANH99-H9 **X** ANH99POOL	
			ANH99-H9 **X** ANBY96OM93	
			ANH99-H9 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** ANH99-H25	
			OM91AN93 X AN92CRYO **X** AN99-H9	

ANBY96OM93 **X** OM91AN93 X AN92CRYO	99	Tier 2	BY96MIX **X** BY97MIX	99
			ANH99-H9 **X** ANH99POOL	
			BY96MIX **X** ANH99-H9	
			BY96MIX **X** AHN99-H25	

ANH99-H9 **X** ANH99POOL	99	Tier 3	ANH99-H9 **X** ANH99POOL	99
ANH99-H9 **X** ANBY96OM93			ANH99-H9 **X** ANBY96OM93	
ANH99-H9 **X** BY97MIX			ANH99-H9 **X** BY97MIX	
ANH99-H9 **X** OM91AN93 X AN92CRYO			ANH99-H9 **X** OM91AN93 X AN92CRYO	
OM91AN93 X AN92CRYO **X** ANH99-H25			OM91AN93 X AN92CRYO **X** ANH99-H25	

Appendix A. Continued.

OM91AN93 X AN92CRYO **X** AN99-H9			OM91AN93 X AN92CRYO **X** AN99-H9	
BY96MIX **X** ANH99-H9			BY96MIX **X** ANH99-H9	
BY96MIX **X** AHN99-H25			BY96MIX **X** AHN99-H25	
ANBY96A3 **X** OM91AN93 X AN92CRYO	99	Tier 3	ANBY96A3 **X** OM91AN93 X AN92CRYO	99
ANBY96B4 **X** OM91AN93 X AN92CRYO			ANBY96B4 **X** OM91AN93 X AN92CRYO	
ANBY96B5 **X** OM91AN93 X AN92CRYO			ANBY96B5 **X** OM91AN93 X AN92CRYO	
OM91AN93 X AN92CRYO **X** BY97MIX			OM91AN93 X AN92CRYO **X** BY97MIX	
ANBY96OM93 **X** OM91AN93 X AN92CRYO			ANBY96OM93 **X** OM91AN93 X AN92CRYO	
BY96MIX **X** ANBY96OM93	99	Tier 3	ANH99-H9 **X** ANBY96OM93	99
			BY96MIX **X** ANH99-H9	
			BY96MIX **X** AHN99-H25	
			BY96MIX **X** ANBY96OM93	
			BY96MIX **X** BY97MIX	
BY96MIX **X** BY97MIX	99	Tier 3	ANH99-H9 **X** BY97MIX	99
			BY96MIX **X** ANH99-H9	
			BY96MIX **X** AHN99-H25	
			OM91AN93 X AN92CRYO **X** BY97MIX	
			BY96MIX **X** ANBY96OM93	
			BY96MIX **X** BY97MIX	

2002 SPAWNING DESIGN FOR CROSSES BETWEEN BROOD YEARS 1998 AND 1999				
Lineage	**BY**	**Tier**	**Lineage**	**BY**
ANBY94NMFSF2 X AN98	98	Tier 1	ANBY96A3 **X** OM91AN93 X AN92CRYO	
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			BY96MIX **X** ANBY96OM93	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	99
	98	Tier 2	ANH99-H9 **X** ANH99POOL	
			ANH99-H9 **X** ANBY96OM93	
			ANH99-H9 **X** BY97MIX	
			ANH99-H9 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** ANH99-H25	
ANBY96A3 X AN98			OM91AN93 X AN92CRYO **X** AN99-H9	
ANBY96B4 X AN98			BY96MIX **X** ANH99-H9	
ANBY96B5 X AN98			BY96MIX **X** AHN99-H25	
ANBY96LL X ANBY96 POOL			ANBY96A3 **X** OM91AN93 X AN92CRYO	
			ANBY96B4 **X** OM91AN93 X AN92CRYO	
			ANBY96B5 **X** OM91AN93 X AN92CRYO	
			OM91AN93 X AN92CRYO **X** BY97MIX	
			BY96MIX **X** ANBY96OM93	
			BY96MIX **X** BY97MIX	
			ANBY96OM93 **X** OM91AN93 X AN92CRYO	99

Appendix A. Continued.

2002 SPAWNING DESIGN FOR CROSSES BETWEEN BROOD YEARS 2000 AND 1999				
Lineage	**BY**	**Tier**	**Lineage**	**BY**
			ANH00-H9 **X** ANH00-H9	
			ANH00-H9 **X** ANH00-H25	
			ANH00-H9 **X** ANBY94A+N X OM92CRYO	
			ANH00-H9 **X** ANBY94OM X OM92CRYO	
			ANH00-H9 **X** ANBY94POOL X AN92LLCRYO	
			ANBY94A+N X OM92CRYO **X** ANH00-H9	
			ANBY94OM X OM92CRYO **X** ANH00-H9	
			ANBY94B+C X OM91CRYO **X** ANH00-H9	
			ANBY94POOL X AN92LL CRYO **X** ANH00-H9	
			ANH00-H9 **X** ANBY96A3 X AN98	
			ANH00-H9 **X** ANBY96B4 X AN98	
			ANH00-H9 X ANBY96B4 X ANBY96B4	
			ANH00-H9 **X** ANBY96OM X ANBY96OM	
			ANH00-H25 **X** ANH00-H9	
			ANH00-H25 **X** ANBY94A+N X OM92CRYO	
			ANH00-H25 **X** ANBY94OM X OM92CRYO	
			ANH00-H25 **X** ANBY94B+C X OM91CRYO	
ANH99-H9 **X** ANH99POOL			ANH00-H25 **X** ANBY94POOL X AN92LLCRYO	
ANH99-H9 **X** ANBY96OM93			ANH00-H25 **X** ANBY96A3 X AN98	
ANH99-H9 **X** BY97MIX			ANBY94A+N X OM92CRYO **X** ANH00-H25	
ANH99-H9 **X** OM91AN93 X AN92CRYO			ANBY94OM X OM92CRYO **X** ANH00-H25	
OM91AN93 X AN92CRYO **X** ANH99-H25			ANBY94POOL X AN92LL CRYO **X** ANH00-H25	
OM91AN93 X AN92CRYO **X** AN99-H9			ANBY94A+N X OM92CRYO **X** ANBY94OM X OM92CRYO	
BY96MIX **X** ANH99-H9	99	Tier 2	ANBY94A+N X OM92CRYO **X** ANBY94B+C X OM91CRYO	99
BY96MIX **X** AHN99-H25			ANBY94A+N X OM92CRYO **X** ANBY94POOL X AN92LLCRYO	
			ANBY94OM X OM92CRYO **X** ANBY94A+N X OM92CRYO	
ANBY96A3 **X** OM91AN93 X AN92CRYO			ANBY94OM X OM92CRYO **X** ANBY94B+C X OM91CRYO	
ANBY96B4 **X** OM91AN93 X AN92CRYO			ANBY94OM X OM92CRYO **X** ANBY94POOL X AN92LLCRYO	
ANBY96B5 **X** OM91AN93 X AN92CRYO			ANBY94B+C X OM91CRYO **X** ANBY94A+N X OM92CRYO	
OM91AN93 X AN92CRYO **X** BY97MIX			ANBY94B+C X OM91CRYO **X** ANBY94OM X OM92CRYO	
BY96MIX **X** ANBY96OM93			ANBY94POOL X AN92LLCRYO **X** ANBY94A+N X OM92CRYO	
BY96MIX **X** BY97MIX			ANBY94POOL X AN92LLCRYO **X** ANBY94OM X OM92CRYO	
ANBY96OM93 **X** OM91AN93 X AN92CRYO			ANBY94A+N X OM92CRYO **X** ANBY96A3 X AN98	
			ANBY94A+N X OM92CRYO **X** ANBY96B4 X AN98	
			ANBY94A+N X OM92CRYO **X** ANBY96B4 X ANBY96B4	
			ANBY94A+N X OM92CRYO **X** ANBY96OM X ANBY96OM	
			ANBY94OM X OM92CRYO **X** ANBY96A3 X AN98	
			ANBY94OM X OM92CRYO **X** ANBY96B4 X AN98	
			ANBY94OM X OM92CRYO **X** ANBY96B4 X ANBY96B4	
			ANBY94OM X OM92CRYO **X** ANBY96OM X ANBY96OM	
			ANBY94OM X OM92CRYO **X** ANBY96B5 X AN98	
			ANBY94B+C X OM91CRYO **X** ANBY96OM93 X OMBY93CRYO	
			ANBY94B+C X OM91CRYO **X** ANBY96OM X ANBY96OM	
			ANBY94POOL X AN92LLCRYO **X** ANBY96OM93 X OMBY93CRYO	
			ANBY94POOL X AN92LLCRYO **X** ANBY94A+N X OM92CRYO	
	99	Tier 2	ANBY96B4 X AN98 **X** ANBY94A+N X OM92CRYO	99
			ANBY96B4 X ANBY96B4 **X** ANBY94OM X OM92CRYO	
			ANBY96B4 X ANBY96B4 **X** ANBY94B+C X OM91CRYO	
			ANBY96OM X ANBY96OM **X** ANBY94A+N X OM92CRYO	
			ANBY96OM X ANBY96OM **X** ANBY94OM X OM92CRYO	
			ANBY94A+N X OM92CRYO **X** ANBY94OM X OM92CRYO	
			ANBY94A+N X OM92CRYO **X** ANBY94B+C X OM91CRYO	

Appendix A. Continued.

			ANBY94A+N X OM92CRYO **X** ANBY94POOL X AN92LLCRYO	
ANH99-H9 **X** ANH99POOL			ANBY94OM X OM92CRYO **X** ANBY94A+N X OM92CRYO	
BY96MIX **X** ANH99-H9	99	Tier 1	ANBY94OM X OM92CRYO **X** ANBY94B+C X OM91CRYO	00
BY96MIX **X** AHN99-H25			ANBY94OM X OM92CRYO **X** ANBY94POOL X AN92LLCRYO	
			ANBY94B+C X OM91CRYO **X** ANBY94A+N X OM92CRYO	
			ANBY94B+C X OM91CRYO **X** ANBY94OM X OM92CRYO	
			ANBY94POOL X AN92LLCRYO **X** ANBY94A+N X OM92CRYO	
			ANBY94POOL X AN92LLCRYO **X** ANBY94OM X OM92CRYO	

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