FISHERY RESEARCH

SNAKE RIVER SOCKEYE SALMON CAPTIVE BROODSTOCK PROGRAM OPERATION AND MAINTENANCE ELEMENT

ANNUAL PROGRESS REPORT
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Snake River Sockeye Salmon Captive Broodstock Program Operation and Maintenance Element

Project Progress Report

2022 Annual Report

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EXECUTIVE SUMMARY

The Snake River Sockeye Captive Broodstock Program was initiated to recover Snake River Sockeye in the Sawtooth Valley. Program objectives are shared between cooperating agencies (Idaho Department of Fish and Game, NOAA Fisheries, and Shoshone-Bannock Tribes), with program funding provided by Bonneville Power Administration. The cooperators meet quarterly, Stanley Basin Sockeye Technical Oversight Committee, updating current findings and planning for future activities. Objectives for the Snake River Sockeye Captive Broodstock Program are summarized below:

1. Develop captive broodstocks from Redfish Lake Sockeye Salmon; culture broodstocks and produce progeny for reintroduction.

2. Determine the contribution hatchery-produced Sockeye Salmon make toward avoiding population extinction and increasing population abundance.

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

4. Utilize genetic analysis to discern the origin of wild and hatchery produced Sockeye Salmon to provide maximum effectiveness in their utilization within the broodstock program.

5. Transfer technology through participation in the technical oversight committee process, provide written activity reports, and participate in essential program management and planning activities.

The Snake River Sockeye Captive Broodstock Operation and Maintenance Element covers activities related to maintaining a Sockeye Salmon captive broodstock at Eagle Fish Hatchery. This report covers program activities during calendar year 2022. Five year classes (brood years) of captive broodstock and four unique production groups were in culture at Idaho Department of Fish and Game's Eagle Fish Hatchery in 2022. Three of the five brood years of captive broodstock were incorporated into the 2022 spawning design.

A total of 6,660 *Oncorhynchus nerka* genetic samples were genotyped during 2022. These genetic samples included captive broodstock at Eagle FH and Burley Creek FH, anadromous adults returning to the Sawtooth basin, and Monitoring and Evaluation samples collected during creel, trawling, and smolt out-migration. Two additional sets of genetic samples were collected and analyzed from juvenile and adult Sockeye Salmon collected at Lower Granite Dam's juvenile fish facility and adult ladder.

Seven hundred and sixty-one anadromous Sockeye Salmon were trapped at two locations during 2022. The Sawtooth Fish Hatchery weir on the upper Salmon River intercepted 174 Sockeye Salmon adults and the Redfish Lake Creek trap intercepted 587 Sockeye Salmon adults. The adult Sockeye Salmon (345 females and 416 males) originated from a variety of release strategies, as evidenced by mark types and genetic parentage analysis. One hundred fifty-one anadromous Sockeye Salmon (113 females and 126 males) remained at Eagle Fish Hatchery and were incorporated into the spawning matrix.

Four hundred fifty-seven female Sockeye Salmon (113 anadromous females, one BY18, 340 BY19, and three BY20 captive females) were spawned at the Eagle Fish Hatchery in 2022.

Spawn pairings produced approximately 860,682 green eggs. Egg survival to the eyed stage of development averaged 74.7% (642,565 eyed eggs).

Smolts (908,313), adults (1,340), and eyed eggs (9,733) were released into Sawtooth Valley waters in 2022. Reintroduction strategies involved releases to Redfish Lake, Pettit Lake, Redfish Lake Creek, and the upper Salmon River.

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INTRODUCTION

Numbers of Snake River Sockeye Salmon *Oncorhynchus nerka (O. nerka)* declined over the course of the 20th century, dramatically so from the 1950s until and subsequent to the 1991 ESA listing of the stock. 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 and Pettit lakes receive a remnant anadromous run.

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

In 1991, the SBT, along with the Idaho Department of Fish and Game (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 conducted 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. National Oceanic and Atmospheric Administration Fisheries Service ESA Permit Nos. 1454, 1124-7R, and Fishery Management and Evaluation Plan (FMEP) authorize IDFG to conduct scientific research on listed Snake River Sockeye Salmon.

Initial steps to recover Snake River Sockeye Salmon included the establishment of a captive broodstock program at the IDFG's Eagle Fish Hatchery (FH). Broodstock and fish culture responsibilities for the listed stock are shared with the NOAA's Manchester Research Station and Burley Creek FH adjacent to Puget Sound in Washington State. Activities conducted by the Shoshone-Bannock Tribes and the NOAA are reported separately. Idaho Department of Fish and Game monitoring and evaluation activities associated with captive broodstock program fish releases are reported separately (in an annual report to the Bonneville Power Administration for the Monitoring and Evaluation element of the program). Captive broodstock program activities conducted between January 1, 2022, and December 31, 2022, for the Operation and Maintenance element of the program are presented in this report. For past annual reports for the Snake River Sockeye Salmon Project go to Columbia Basin Fish and Wildlife Program's website at: cbfish.org - Columbia Basin Fish & Wildlife Program

SNAKE RIVER SOCKEYE CAPTIVE BROODSTOCK OBJECTIVES

The immediate goal of the program is to utilize captive broodstock technology to conserve the population's remaining genetic diversity. Long-term goals include increasing the number of individuals in the population to address delisting criteria and to provide sport and treaty harvest opportunities. Below are the objectives and tasks covered in this report:

Objectives and Tasks

1. Rear Snake River Sockeye Salmon captive broodstocks.
    a. Monitor rearing metrics; survival, growth, maturation, fish health, densities, and water quality.
    b. Produce captive reared adults for spawning and reintroduction to Sawtooth Valley lakes.

2. Trap anadromous adults to incorporate into captive broodstock spawning design.
    a. Trap anadromous returning adults in the Sawtooth Valley.
    b. Transport anadromous adults to Eagle FH.
    c. Release anadromous adults to Sawtooth Valley lakes.

3. Individually identify captive broodstock and anadromous returns to aid in the development of adult release and spawning plans.
    a. Genetically sample and PIT tag captive broodstock juveniles.
    b. Genetically sample and PIT tag anadromous returning adults.
    c. Analyze genetic information.
    d. Develop adult release plan.
    e. Develop spawning plan.

4. Spawn Sockeye Salmon captive and anadromous broodstock.
    a. Spawn male and female Sockeye Salmon.
    b. Monitor egg development through the eyed egg stage.
    c. Select eyed eggs to represent next generation of captive broodstock.
    d. Distribute eyed eggs to production facilities.

5. Transfer technology through participation in the technical oversight committee process, provide written activity reports, and participate in essential program management and planning activities.
    a. Update Sockeye program data in FINS database.
    b. Assist with development of Snake River AOP/SOP.
    c. Provide Sockeye program information at quarterly SBSTOC meetings.
    d. Participation in program essential meetings.

6. Eagle Fish Hatchery annual maintenance projects.
    a. Improvements made during 2022.
    b. Future facility improvements.

Idaho Department of Fish and Game's participation in the Snake River Sockeye Salmon Captive Broodstock Program includes two areas of effort: 1) Sockeye Salmon captive broodstock culture and smolt production, and 2) Sockeye Salmon monitoring and evaluation. Although objectives and tasks from both components overlap and contribute to achieving the same goals, work directly related to Sockeye Salmon captive broodstock monitoring and evaluation will appear under a separate cover. This report covers activities associated with operation and maintenance of the captive broodstock program including fish culture, anadromous trapping, genetic evaluations, broodstock spawning, program reporting, and facility improvements.

FACILITIES

Eagle Fish Hatchery

Eagle FH is the primary Idaho site for the Sockeye Salmon captive broodstock program. Artesian water from three wells is currently in use. Artesian flow is augmented with three separate pump/motor systems. Water temperature remains a constant 13.5°C and total dissolved gas averages 100% after degassing. The main captive broodstock building receives water from wells #1 and #2 (up to 1,000 gallons per minute). Up to 300 gallons per minute (gpm) can be chilled to 8°C allowing the program to rear at a variety of water temperatures. Rearing capacity for the main building is approximately 1,500 fish per brood year. Isolated holding and spawning of anadromous Sockeye Salmon is conducted in the original hatchery building. Up to 500 gpm of water is supplied from well #3. Approximately 150 gpm can be chilled to 7^{o}C and mixed to provide a variety of rearing temperatures. Backup and system redundancy is in place for degassing, pumping, and power generation. An automated alarm system monitors flow at nine locations with two alarms tied to the chiller operations. Mountain Alarm provides alarm service for the facility. Three on-site residences provide housing for full-time hatchery personnel. A dormitory is available to house temporary staff.

Facility layout at Eagle FH accommodates culture activities ranging from egg incubation through adult rearing and spawning. Egg incubation uses a combination of vertical stack incubators and small isolation upwellers. Thirty-six vertical stack incubators, each holding eight trays, will incubate up to 1,000,000 green eggs. Each tray contains four smaller baskets to maintain family group separation during incubation. An additional 250,000 green eggs can be incubated using isolated upwellers. Incubation in these small containers specifically designed for the program (Heindel et al. 2005) allow for separation of individual subfamilies. These incubators are designed to distribute both upwelling and downwelling flow to accommodate pre- and post-hatch life stages.

Fiberglass tanks of several sizes are used to culture Sockeye Salmon from fry to adult life stages, including: 1) 0.7 m diameter semi-square tanks (0.09 m^3); 2) 1.0 m diameter semi-square tanks (0.30 m^3); 3) 2.0 m diameter semi-square tanks (1.42 m^3); 4) 3.0 m diameter circular tanks (6.50 m^3); and 5) 4.0 m diameter semi-square tanks (17.6 m^3). Typically, 0.7 m and 1.0 m tanks are used for rearing fry from ponding to approximately 10.0 g. Two-meter tanks are used to rear juveniles to approximately 50.0 g and to temporarily hold mature adults during spawning operations. Three- and four-meter tanks are used to rear fish to maturity for broodstock production (spawning) or releasing to Sawtooth Valley waters for volitional 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.

Springfield Fish Hatchery

Springfield Fish Hatchery is located in Bingham County, Idaho near the town of Springfield. Construction of the facility was completed in 2013 from funding provided by BPA through the Idaho Fish Accords. A confined aquifer underlying the Springfield FH site supplies groundwater for hatchery operations. The facility has a water right for 50 cfs. There are nine artesian wells located on the northern section. Six of the wells (wells 5, 7, 8, 10, 11, and 12) supply groundwater for hatchery production operations. These six wells feature a dual-head design that allows water delivery by both artesian flow and pumping. Due to elevation differences, artesian

flow cannot supply the hatchery building, but can supply outdoor raceways. The ambient water temperature remains a constant 9.9°C and ambient temperature total dissolved gas (TDG) levels currently range from 100% - 101% after aeration and degassing. Additionally, a chiller supplies up to 110 gpm of water chilled to 5.0°C for use in incubation or early rearing. Backup and system redundancy is in place for degassing, pumped water delivery, chilled water supply, and power generation. Springfield FH facilities are designed to rear up to one million Sockeye Salmon smolts annually for release to Redfish Lake Creek. Rearing protocols are established cooperatively among IDFG personnel and reviewed by the SBSTOC.

Eyed eggs, received by Springfield FH from Eagle FH and NOAA Fisheries, are incubated in vertical stack incubators. Swim-up fry are ponded into fiberglass vats and reared indoors for five to six months. Juveniles are transferred (during ad-clipping) to outdoor raceways in July and reared through release as smolts the following May. Juvenile Sockeye Salmon reared at Springfield FH are released as smolts into Redfish Lake Creek following acclimation at Sawtooth Fish Hatchery. No adult holding or spawning is planned at Springfield FH. For additional information, Springfield Fish Hatchery Annual (Progress) Reports to Bonneville Power Administration can be found on Columbia Basin Fish and Wildlife Program's website at: cbfish.org - Columbia Basin Fish & Wildlife Program.

Oxbow Fish Hatchery

The Oregon Department of Fish and Wildlife's (ODFW) Oxbow Fish Hatchery (Oxbow FH) was originally constructed in 1913 and was operated as a state-funded hatchery until 1952. In 1952, the facility was modified and expanded using funding from the Mitchell Act, a Columbia River Fisheries Development Program set up to enhance declining fish runs in the Columbia River Basin. Oxbow FH receives 7.2°C water through gravity flow from Oxbow Springs. Flow rate is highly variable depending on the time of year with the lowest flows reaching 1,135.5 liters per minute (300 gpm) in the summer and fall. Water rights for Oxbow FH are 3.30 cubic meters per second (116.51 cfs).

Eyed eggs, received at Oxbow FH from Eagle FH or NOAA, are incubated in vertical-stack incubators. Fry are ponded to fiberglass troughs. Juvenile Sockeye Salmon (>1 g) are held in larger fiberglass troughs (4.53 cubic meters). Sockeye Salmon are transferred to outside raceways (133 cubic meters) for final rearing to the smolt stage. Juvenile Sockeye Salmon reared at Oxbow FH will be acclimated and released into Tanner Creek, a tributary to the Columbia River, from ODFW's Bonneville FH (current plan) or transferred back to Idaho and released as smolts into Redfish Lake Creek and the Salmon River. Releasing smolts at Bonneville FH is part of a cooperative Sockeye Reintroduction Program led by the Nez Perce Tribe (NPT). Adults returning to Bonneville FH traps will be shared between the Sockeye Captive Broodstock program for release to Redfish and Pettit lakes and with the NPT for reintroduction back to Wallowa Lake. Rearing protocols are established cooperatively between IDFG and ODFW personnel and reviewed at the SBSTOC level.

Sawtooth Fish Hatchery / Trap

Construction of the Sawtooth Fish Hatchery (Sawtooth FH) 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. Between 1991 and 2021 Sawtooth FH personnel and facilities were utilized for various aspects of the Sockeye

Salmon captive broodstock program, including 1) prespawn anadromous adult trapping and holding, 2) egg incubation, and 3) juvenile rearing for presmolt and smolt releases. Currently, only adult collection and smolt acclimation occurs at Sawtooth FH. Beginning in 2018, Sockeye Salmon smolts are transferred to Sawtooth FH for acclimation before releasing to Redfish Lake Creek in May. Sawtooth FH personnel assist with many field activities, including, 1) fish trapping and handling, 2) smolt feeding and monitoring during acclimation, and 3) fish transportation and release.

Prespawn anadromous adults captured at the Sawtooth FH trap are transferred to Eagle FH, released upstream of the Sawtooth FH intake, or transported and released directly to Pettit Lake for volitional spawning. Sockeye Salmon trapped at Sawtooth FH may be temporarily held (two days maximum) in adult holding facilities at Redfish Lake Creek prior to transfer to the Eagle FH.

Redfish Lake Creek Trap

The Redfish Lake Creek trap is located approximately 1.4 km downstream from the lake outlet. It is operated for adult trapping from early July through mid-October. Sockeye Program personnel stationed at the trap monitor trapping activities during the trapping season. On-site personnel provide security at the site and are responsible for transporting anadromous Sockeye Salmon to Eagle FH. Construction to replace the old weir was completed in 2018. The new weir and trap include a streamside trap/holding area for adults, along with a smolt/adult work-up area, and a dormitory for staff operating the trap.

Prespawn anadromous adults captured at the Redfish Lake Creek trap are transferred to Eagle FH or released to Redfish Lake Creek above the weir. Sockeye Salmon may be temporarily held (two days maximum) in adult holding facilities at Redfish Lake Creek prior to transfer to the Eagle FH.

METHODS

Fish Culture

Fish culture methods used in the captive broodstock program follow accepted, standard practices (for an overview of standard methods, see Leitritz and Lewis 1976; Piper et al. 1982; Erdahl 1994; McDaniel et al. 1994; Bromage and Roberts 1995; Pennell and Barton 1996; Wedemeyer 2001) and conform to the husbandry requirements detailed in ESA Section 10 Propagation Permit Number 1454 for IDFG rearing of ESA-listed Snake River Sockeye Salmon. Additionally, considerable coordination was carried out between NOAA and IDFG culture experts, as well as program cooperators on the SBSTOC.

Fish were fed a commercial diet produced by EWOS® Canada LTD (EWOS). Rations were weighed daily and feeding rates follow manufacturer recommendations. The product's palatability and levels of natural pigments were enhanced by the addition of natural flavors from fish and krill.

Fish sample counts were conducted as needed to ensure that actual growth tracked with projected growth. In general, fish were handled as little as possible. Age-1 and age-2 Sockeye Salmon rearing densities were maintained at levels not exceeding 8.0 kg/m^3. Age-3 and age-4 rearing densities were maintained at levels not exceeding 16.0 kg/m^3.

Incubation and rearing water temperature was maintained between 7.0°C and 13.5°C. Chilled water (7.0°C to 11.0°C) was used during incubation and early rearing to equalize development and growth differences that resulted from a protracted spawning period. Rearing water temperature varied as a function of demand but was 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 were used to track Sockeye Salmon retained in the program as broodstock fish; these fish were PIT tagged at approximately 14 months of age. The PIT tag procedures followed accepted, regional protocols (Prentice et al. 1990).

Anadromous Sockeye Salmon Trapping

Two adult traps were used to capture returning anadromous Sockeye Salmon in the Sawtooth Valley. The first trap was located on Redfish Lake Creek approximately 1.4 km downstream from the lake outlet. The second trap was located on the upper Salmon River at the Sawtooth FH weir.

Anadromous Sockeye Salmon may also be collected at the Lower Granite Dam adult trap. During years of extremely poor migration conditions, the Sockeye Program and cooperators will review migration parameters to determine if trap and haul is warranted. If Emergency Sockeye Trap and Haul is implemented, Sockeye Program staff will coordinate with Lower Granite Dam operators and develop a trapping protocol to address the current operations of the LGD trap and develop a Standard Operation Procedure (SOP) for the current trapping season. Sockeye Salmon adults collected during trap and haul are transferred to Eagle FH.

Spawning Activities

Throughout the program's history, Snake River Sockeye Salmon have been spawned at a variety of locations. Before 1994, adult Sockeye Salmon returns were spawned at the Sawtooth FH (Johnson 1993). Hatchery spawning of Sockeye Salmon has occurred at Eagle FH each year since 1994 (BPA Annual (Progress) Reports covering spawning activities for the Snake River Sockeye Salmon Program can be found on the Columbia Basin Fish and Wildlife Program's website at: cbfish.org - Columbia Basin Fish & Wildlife Program). Spawning activities in 2022 followed accepted, standard practices as described by Erdahl (1994) and McDaniel et al. (1994). Prior to spawning adults at Eagle FH, the Idaho Department of Fish and Game is required by NOAA Permit No. 1454 to discuss proposed broodstock spawning matrices with SBSTOC members.

Historically, the broodstock program used pedigree information to pool eyed eggs developed from hatchery spawning into broodstock rearing groups. Identification of familial groups was maintained by tank segregation until juveniles were large enough to PIT tag. From 2005 through 2017, breeding protocols relied on DNA microsatellite genotypes to assign individuals to a pedigree. Microsatellite data were generated from DNA samples at 16 loci. Kinship coefficients and mean kinship coefficients were used to determine relative founder contribution in the population, genetic importance, and relative relatedness. Beginning in 2018, the genetics program transitioned from microsatellites to single nucleotide polymorphisms (SNP's). The IDFG Eagle Genetics Lab genotypes each individual with up to 382 SNP loci to determine parentage and relatedness to individuals within the captive broodstock. Spawning plans also considered heterozygosity and genetic diversity among and within individuals. Genetic-based spawning plans

provide a higher level of resolution than was possible with the initial tank-based pedigree information and can minimize the loss of heterozygosity and inbreeding.

Fish Health Investigations

When required, the captive broodstock rearing program has utilized various disinfectants, antibiotics, vaccinations, and antifungal treatments to control pathogens. When used, the dosage, purpose of use, and method of application were as follows:

1. Antibiotic therapies: Erythromycin treatments are administered orally in feed to produce a dose of 100 mg/kg of bodyweight 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, fish may be fed oxytetracycline as needed to control outbreaks of pathogenic myxobacteria, as well as aeromonad and pseudomonad bacteria.

2. Egg disinfection: Newly fertilized eggs are water hardened in 100 mg/L solution of buffered Iodophor for 20 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 mg/L buffered Iodophor solution for ten minutes upon receipt, prior to loading of incubators.

3. Anadromous adult formalin treatments: Anadromous adults transferred from the Sawtooth Valley are treated with formalin in a static bath for one hour at 167 parts per million (ppm) to control *Ichthyophthirius* spp. In addition, formalin treatments are administered three to five times per week to control *Saprolegnia.*

4. Egg formalin treatments: Developing eggs are treated three to five times per week with formalin to control *Saprolegnia*. This is a flow-through treatment administered at 1,667 ppm for 20 minutes.

Captive broodstock female spawners were analyzed for bacterial kidney disease (BKD) *Renibacterium salmoninarum* and the viral pathogen infectious hematopoietic necrosis virus (IHNv). In addition to the above, anadromous adult Sockeye Salmon were screened for bacterial gill disease *Flavobacterium branchiophilum*, Coldwater disease *Flavobacterium psychrophilum*, motile aeromonad septicemia *Aeromonas* spp, the causative agent of whirling disease *Myxobolus cerebralis* (up to 20 head wedges), furunculous *Aeromonas salmonicida*, *Parvicapsula minibicornis* (up to 30 males and 30 females sampled), infectious pancreatic necrosis virus, and the North American strain of viral hemorrhagic septicemia. Tissue samples were collected from the kidney and spleen of each fish and the Eagle FH staff collected ovarian fluid samples from each spawned female for analysis at the Eagle Fish Health Laboratory. Results of fish health analysis of spawners were used by IDFG and the SBSTOC to determine disposition of eggs and subsequent juveniles.

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

Presence of moribund fish was 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 were employed to isolate bacterial or viral pathogens and to identify parasite etiology (Thoesen 1994). Moribund fish were routinely analyzed for common bacterial and viral pathogens (e.g., bacterial kidney disease, infectious hematopoietic necrosis virus, etc.). When a treatable pathogen was either detected or suspected, the program fish pathologist prescribed appropriate therapeutic drugs to control the problem. Select carcasses were appropriately preserved for pathology, genetic, and other analyses. After necropsy, carcasses that were not vital to further analysis were disposed of as per language contained in the ESA Section 10 permit for the program.

Genetic Investigations

Laboratory Protocol

Genomic DNA from samples was extracted following the methods for the Nexttec Genomic DNA Isolation Kit from XpressBio (Thurmont, Maryland). Protocols of library preparation for next-generation genotyping followed Campbell et al. (2015) using Genotyping-In-Thousands by sequencing (GT-Seq) technology. Briefly, library preparation begins with an initial multiplex polymerase chain reaction (PCR) that to ligates sequencing primers to the target sequences that are known to contain single-nucleotide polymorphisms (SNPs). Samples were processed using a panel of 363 SNPs targeting sequences described by Hasselman et al. (2018). In a subsequent PCR, the sample was “barcoded” by ligating an additional sequence to the target that identifies the sample’s tray of origin (i7 barcode) and its position on the tray (i5 barcode). After barcoding, the quantity of DNA was normalized for each sample using a SequalPrep™ Normalization Plate Kit (Applied Biosystems) that binds a standard amount of amplicon product to allow for normalization of concentrations. All samples per tray were then pooled into a single ‘plate library’ that was quantified by a Qubit fluorometer (Thermo Fisher). Concentrations were normalized again before being pooled. Loci were genotyped by sequencing the target location on an Illumina NextSeq. A custom bioinformatics pipeline was used to assign resulting sequences and the genotypes back to individual samples using the unique combination of i5 and i7 barcodes. Standardized genotypes were stored on a Progeny database server (www.progenygenetics.com) housed at the Eagle Fish Genetics Laboratory (EFGL).

Analyses

Selection of broodstock for spawning follows internationally recognized standards for captive breeding programs. The primary threat to the genetic health of captive populations is the loss of genetic diversity (Ballou et al. 2010) and maintaining a large effective population size (N_e) is the best approach to preserving existing genetic variation (Wright 1931). Therefore, selection of broodstock for spawning uses methods that maximize N_e. The genetic parameter of ‘mean kinship’ (MK) is the foundation of the Sockeye Salmon broodstock selection process. Mean kinship is a measure of an animal’s relatedness to that of the entire current population. Selecting individuals for breeding with low MK values has been demonstrated to maximize genetic diversity, minimize the rate of adaptation to the captive environment, minimize the rate of random genetic drift (and therefore, by definition, maximize N_e), and minimize long-term accumulation of inbreeding (Lacy 2009, Fernandez and Toro 1999, Montgomery et al. 1997, and Ballou and Lacy 1995). Equalizing representation from family groups in which each family member has an equal MK value is also an important step in maximizing N_e (Allendorf 1993, Borlase et al. 1993). The

combination of MK values and parentage assignments were used to identify individuals that are prioritized for spawning.

Genetic analyses comprise a two-step process. The first step performs parentage analysis of the maturing broodstock so that individuals can be placed within the existing, long-term pedigree of the captive breeding program. The second step analyzes the updated pedigree in order to select individual broodstock in a manner that maximizes the retention of genetic diversity.

Parentage Analysis: Parentage assignment using SNP genotypes was performed using the program SNPPIT (Anderson 2010). We allowed up to 10% missing genotype data for a sample before excluding the sample from consideration in parentage. We used an estimated SNP genotyping error rate of 1% or a per allele rate of 0.5%. SNPPIT assesses the confidence of parentage assignments using several parameters and parentage assignments are accepted only if LOD scores are ≥ 14, false discovery rate (FDR) <1%, and posterior probability relationship identifies a parent-offspring trio (C_Se_Se).

Pedigree Analysis: The program PMx (Ballou et al. 2011) provides tools to support the genetic management of pedigreed populations and was used for analysis of the updated pedigree of the captive broodstock. The program provides summary statistics for the maturing individuals including 'Mean Kinship', which can be interpreted as measure of the genetic importance of each individual. The rankings of mean kinship values, along with parentage assignments for each individual, were used to select broodstock for spawning or release.

Eyed Egg and Fish Transfers

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

Eyed eggs received from NOAA Fisheries were picked up at the Alaska Air Gold Streak Facility at the Boise airport. Eggs were transferred to Eagle FH, tempered to match holding water temperature, and placed in a flow through water bath. Eggs were held for one night before being transported by vehicle to Springfield FH. Eyed eggs were transferred in 40-quart water filled coolers. Ice chips were added to maintain or slightly lower the temperature to match Springfield FH incubation temperatures.

Eyed eggs from Eagle FH destined for production at Springfield FH were driven between facilities. Eggs were placed in egg shipping tubes at approximately 2,500 eggs per tube. Eyed eggs were then placed in 40-quart, water filled, transport coolers and ice chips were added to temper transport water to match Springfield FH incubation temperatures.

Eyed eggs from Eagle FH destined for production at ODFW's Oxbow FH were driven between facilities. Eggs were placed in egg shipping tubes at approximately 1,250 eggs per tube. Eyed eggs were then placed in 40-quart, water filled, transport coolers and ice chips were added to temper transport water to match Oxbow FH incubation temperatures.

Containers used to transport fish varied by task. In all cases, containers of the proper size and configuration were used. Appropriate temperature, oxygen, and chemical composition was maintained during the handling and transfer phases of transportation. Containers varied from five-gallon plastic buckets and coolers for short-term holding and inventory needs to truck-mounted tanks. Truck-mounted tanks, used for long distance transfers, were available to the program with 1,514 L (400 gallon), 3,785 L (1,000 gallon), 7,570 L (2,000 gallon), 11,355 L (3,000 gallon), and 18,926 L (5,000 gallon) capacities. Transport density guidelines were in place not to exceed 120 grams/liter (1.00 pounds/gallon).

Eyed Egg and Fish Supplementation

Multiple release strategies are implemented to reintroduce Sockeye Salmon back to Sawtooth Valley waters. During this reporting period, Sockeye Salmon were released as eyed eggs, smolts and pre-spawn adults.

Eyed eggs were distributed to egg boxes manufactured by IDFG personnel specifically for this program. Plastic light baffle grids and plastic mesh netting partitioned egg box chambers and prevented eggs from falling into the biofilter ring medium until after hatch. Plastic mesh netting surrounded all egg boxes and allowed fish to volitionally swim up leaving the egg box following yolk absorption. Individual egg boxes accommodated approximately 3,000 eggs. Following loading, egg boxes were lowered to the lake substrate in approximately 3 m of water over known or suspected areas of lakeshore spawning.

Sockeye Salmon smolts are distributed to Sawtooth Valley waters using truck-mounted transportation tanks. This group is first transferred from Springfield FH to Sawtooth FH and acclimated for approximately one to two weeks before release to Redfish Lake Creek. Smolt releases take place in early May.

Prespawn adult Sockeye Salmon are distributed to Sawtooth Valley waters using truck-mounted transportation tanks. Adults are released to Sawtooth Valley lakes in in mid-September. Transport tanks are tempered to receiving water temperatures prior to the release of fish. Prespawn adults were released into Sawtooth Valley lakes during this reporting period.

RESULTS AND DISCUSSION

Fish Culture

Within the program, culture groups are designated as either “broodstock” or “production” groups, depending on their purpose. Culture groups developed to meet future spawning needs are designated as “broodstock” groups and are maintained at Eagle FH. Culture groups developed primarily for reintroduction to Sawtooth Valley waters are designated as “production” groups, and maintained at Springfield FH. Captive broodstock in culture at Eagle FH were represented by brood years 2018, 2019, 2020, 2021, and 2022. Three production groups in culture at IDFG facilities in 2022 were represented by brood years 2020, 2021, and 2022. The year of development for specific culture groups may be abbreviated (e.g., BY18 refers to brood year 2018).

Fish health of captive reared Sockeye Salmon remained good with no pathogens of concern identified from samples analyzed. Survival of captive broodstock reared at Eagle FH was

96.9% across all brood years during 2022. Captive broodstock representing brood years BY18, BY19, and BY20 matured during 2022 and were released to spawn volitionally in Redfish Lake or remained at Eagle FH and incorporated into the broodstock spawning design. Of the 1,415 captive broodstock that matured, 695 were released to Redfish Lake and 720 were held for spawning at Eagle FH.

Brood Year 2018 Broodstock

Four hundred twenty-seven females and 440 males were spawned at Eagle FH between September 27 and November 6, 2018, yielding 862,957 green eggs. Eight hundred fifty-two unique subfamilies were developed from BY18 spawn crosses at Eagle FH. (Baker et al. 2019).

Approximately 3,013 eyed eggs representing 811 subfamilies (410 unique females and 432 unique males) were selected from specific spawn crosses described above to represent BY18 captive broodstock. Two similar groups were selected, with 1,508 eyed eggs retained at Eagle FH and a second group of 1,505 eyed eggs transferred to NOAA Fisheries, for incubation and rearing.

The 2022 starting inventory for the BY18 captive broodstock at Eagle FH was six fish. Mortality for the year was three fish and three matured. Of the three maturing fish, one female was incorporated into the spawning matrix and two males were culled as unproductive. Ending inventory for the BY18 captive broodstock was zero fish (Table 1).

Rearing of the BY 18 captive broodstock cohort was completed in 2022. This group had an overall survival from eyed egg to adult of 79.64%. Mature adults were either released or incorporated into the Eagle FH spawning design. From this group, 477 captive reared adults were released to Redfish Lake and 724 captive reared adults were incorporated into spawning designs. Age at maturation for the BY18 cohort was 7.6% age two, 92.7% age 3, and 0.3% age 4.

Brood Year 2019 Broodstock

Four hundred sixty-nine females and 347 males were spawned at Eagle FH between September 20 and November 7, 2019, yielding 1,005,762 green eggs. Nine hundred thirty-four unique subfamilies were developed from BY19 spawn crosses at Eagle FH. (Baker et al. 2020).

Approximately 3,000 eyed eggs representing 918 subfamilies (463 unique females and 345 unique males) were selected from specific spawn crosses described above to represent BY19 captive broodstock. Two similar groups were selected, with 1,500 eyed eggs retained at Eagle FH and a second group of 1,500 eyed eggs transferred to NOAA Fisheries, for incubation and rearing.

The 2022 starting inventory for the BY19 captive broodstock at Eagle FH was 1,312 fish. Mortality for the year was 83 fish and 1,220 matured. Of the 1,220 maturing fish, 624 (284 males and 340 females) were incorporated into the spawning matrix, nine fish were culled as unproductive and 585 maturing Sockeye Salmon were released to Redfish Lake and two adults were released to Pettit Lake. Ending inventory for the BY19 captive broodstock was nine fish (Table 1).

Brood Year 2020 Broodstock

Four hundred sixty-four females and 504 males were spawned at Eagle FH between September 24 and November 12, 2020, yielding 958,562 green eggs. Nine hundred twenty-five unique subfamilies were developed from BY20 spawn crosses at Eagle FH. (Baker et al. 2021).

Approximately 3,001 eyed eggs representing 870 subfamilies (440 unique females and 496 unique males) were selected from specific spawn crosses described above to represent BY20 captive broodstock. Two similar groups were selected, with 1,501 eyed eggs remaining at Eagle FH and a second group of 1,500 eyed eggs transferred to NOAA Fisheries, for incubation and rearing.

The 2022 starting inventory for the BY20 captive broodstock at Eagle FH was 1,412 fish. Mortality for the year was 13 fish and 192 matured (170 males and 22 females). Of the maturing fish, 69 (66 males and 3 females) were incorporated into the spawning matrix, 108 were released to Redfish Lake (92 males and 16 females), and 15 were not used in spawning (12 males and 3 females). Ending inventory for the BY20 captive broodstock was 1,207 fish (Table 1).

Brood Year 2020 Production

The 2022 starting inventory for the BY20 smolt production group at Springfield FH was 910,183 fingerlings. A total 908,313 smolts were released on May 3-5, 2022. (Table 2). Cumulative mortality from eyed egg to smolt for the Springfield FH smolt release group was 64,025 juveniles (93.4% survival to release).

Brood Year 2021 Broodstock

Four hundred thirty-seven females and 411 males were spawned at Eagle FH between September 28 and November 16, 2021, yielding 873,813. green eggs. Eight hundred seventy-three unique subfamilies were developed from BY21 spawn crosses at Eagle FH. (Baker et al. 2022).

Approximately 3,003 eyed eggs representing 850 subfamilies (428 unique females and 410 unique males) were selected from specific spawn crosses described above to represent BY21 captive broodstock. Two similar groups were selected, with 1,502 eyed eggs remaining at Eagle FH and a second group of 1,501 eyed eggs transferred to NOAA Fisheries, for incubation and rearing.

The 2022 starting inventory for the BY21 captive broodstock at Eagle FH was 1,502 eyed eggs/developing fry. The BY21 captive broodstock group was marked/tagged (adipose clipped, PIT tagged, and genetically sampled) in December 2022. Mortality for the year was 67 fry. Ending inventory for the BY21 captive broodstock was 1,435 fingerlings (Table 1).

Brood Year 2021 Production

A total of 897,828 BY20 eyed eggs from production spawn crosses at Eagle FH and Burley Creek FH were transferred to Springfield FH. Inventory for this production group at Springfield FH for the end of the year was 849,210 fish. Juvenile rearing for the production group at Springfield FH will continue until smolts are released in 2023 (Table 2).

Anadromous Sockeye Salmon Trapping

Redfish Lake Creek trap was operated from July 18 to October 21, 2022. The first Sockeye adult was trapped July 28 and the last adult was trapped on October 19. During this period, a total of 587 Sockeye Salmon adults were trapped. Initially, all trapped adults were transported to Eagle FH to ensure genetic representation throughout the 2022 return. Beginning on August 25, a portion of the returning adults were direct released to Redfish Lake. In total, 440 adults were transported to Eagle FH and 147 adults were directly released to Redfish Lake.

A second trap at Sawtooth FH collected Sockeye Salmon adults on the Salmon River. This trap was operated from June 15 to October 7. The first Sockeye Salmon adult was trapped on July 28 and the last adults were collected on September 22. A total of 174 Sockeye Salmon adults were collected at the Sawtooth FH trap, an additional 59 were seined from below the Sawtooth FH weir on September 22. Of the Sockeye Salmon collected on the Salmon River, 111 were transported to Eagle FH and 63 were transported to Redfish Lake and released after trapping.

Four anadromous Chinook Salmon adults were trapped at the Redfish Lake Creek trap. Three were hatchery reared (ad-clipped) and transferred to Sawtooth FH to be incorporated into the Sawtooth FH spawning program. One natural (unclipped) male was trapped and released above the weir for volitional spawning.

2022 Spawning Activities

Results from 2022 Eagle FH spawning activities are reviewed below. Results from spawning activities conducted by NOAA Fisheries personnel at Burley Creek FH will appear separately and can be found on the Columbia Fish and Wildlife website at: cbfish.org - Columbia Basin Fish & Wildlife Program. The year of development for specific broodstocks may be abbreviated (e.g., BY18 refers to brood year 2018).

Four hundred fifty-seven females and 476 males were spawned at Eagle FH between September 27 and November 15, 2022. Nine hundred twelve unique subfamilies were developed from BY22 spawn crosses at Eagle FH. To simplify tracking, families were grouped under one production group title: BY22. The BY22 captive broodstock group was developed using male Sockeye Salmon from the BY19, BY20, and 126 anadromous males that were collected during 2022 trapping activities. Female Sockeye Salmon represented in spawn crosses for 2022 included captive broodstock from BY18, BY19, BY20, and 113 anadromous females that were collected during trapping activities in 2022. Spawn crosses were made to maximize genetic diversity by crossing between different brood years and captive by anadromous (Table 4). Spawn crosses produced approximately 860,682 green eggs and 642,565 eyed eggs. Brood year 2019 female fecundity averaged 1,907 green eggs per female, BY20 female fecundity averaged 1,026 green eggs per female, and ANH22 (anadromous) female fecundity averaged 1,841 green eggs per female. Egg survival to the eyed stage of development for the BY22 production group averaged 74.66% (median 84.06%, Table 4). In 2022, of the 283 anadromous adults sampled at Eagle FH, infectious hematopoietic necrosis virus (IHNv) was not detected.

Approximately 3,006 eyed eggs representing 712 subfamilies (356 unique females and 408 unique males) were selected from specific spawn crosses described above to represent BY22 captive broodstock. Two similar groups were selected, with 1,503 eyed eggs remaining at Eagle

FH and a second group of 1,503 eyed eggs transferred to NOAA Fisheries, for incubation and rearing.

Historically, broodstock families were kept separated in individual tanks until PIT tagging and then pedigree information for the familial line was utilized to make spawn crosses. Genetic identification of BY22 captive broodstock will be determined by utilizing SNP's DNA markers. Spawn crosses represented in the Eagle FH BY22 captive broodstock are presented in Table 5.

A total of 1,089,834 BY22 eyed eggs were transferred to Springfield FH for smolt production rearing. Production spawn crosses at Eagle FH provided 533,395 eyed eggs and Burley Creek FH provided 556,439 eyed eggs. Egg incubation and juvenile rearing for the BY22 production group will continue at Springfield FH until smolts are released in May 2024.

A total of 50,000 BY22 eyed eggs were transferred to Oregon Department of Fish and Wildlife's Oxbow FH for smolt production rearing. Production spawn crosses at Eagle FH provided 50,000 eyed. Eggs were selected from the peak of spawning, maximizing individual representation while minimizing temperature units (TU's) between egg groups. Only eggs from captive female x captive male spawn crosses were represented in this group. Egg incubation and juvenile rearing for the BY22 production group will continue at Oxbow FH until smolts are released in May 2024.

Fish Health Investigations

The IDFG Eagle Fish Health Laboratory processed samples for diagnostic and inspection purposes from captive broodstock and production groups of Sockeye Salmon, including anadromous adults that were retained for hatchery spawning and smolts obtained from out-migrant traps. One hundred thirty-two laboratory accessions involving 1,549 individual fish were processed in 2022. Laboratory accessions included samples from Eagle FH (92 accessions), Springfield FH (ten accessions), NOAA Fisheries (25 accessions), Redfish Lake Creek Springfield FH smolts (three accessions), and Sawtooth FH acclimation (two accessions). Total fish sampled (1,549) included 689 fish from Eagle FH (one BY18, 396 BY19, 14 BY20, and 278 ANH22), 240 fish from Springfield FH (210 BY20 and 30 BY21), 490 fish from NOAA Fisheries, 80 (BY20) fish from Redfish Lake Creek smolt release, and 50 (BY20) from Sawtooth FH acclimation group. Observations made from previous years prioritized the pathogens that were most important for these examinations. All female adults used for captive broodstock purposes were examined for viruses and bacterial kidney disease (BKD). Anadromous adults were examined for a broad array of pathogens, since these pose the greatest threat of introduction of an exotic pathogen to the captive broodstock program. All production lots were examined prior to release as juveniles. The Eagle Fish Health Lab also summarized pathology findings to satisfy the needs of adjacent state agencies for issuance of Sockeye Salmon transport permits.

Viral Pathogens

Viral pathogens were not detected in Sockeye Salmon (captive broodstocks, production groups, or anadromous adults) during calendar year 2022. Samples were collected at Eagle FH from captive broodstock and anadromous adults representing BY18, BY19, BY20, and ANH22 (90 accessions and 684 fish). These samples were analyzed at IDFG's Eagle Fish Health Lab. Eagle Fish Health Lab began sampling NOAA Fisheries captive broodstock in 2015 (previously these samples were collected and analyzed by NOAA Fisheries staff) and continued sampling in 2022. Samples were collected from spawned captive broodstock at Burley Creek FH representing

BY17, BY18, BY19, and BY20 (13 accessions and 356 fish sampled) and from Manchester Research Station representing BY17, BY18, and BY19 (five accessions and 50 fish sampled). Two production groups (BY20 and BY21) from Springfield FH were sampled (ten accessions and 240 fish) and analyzed at Eagle Fish Health Lab in 2022. Springfield FH smolts (BY20) were sampled pre-release at Sawtooth FH during acclimation (two accessions and 50 fish sampled) and at Redfish Lake Creek (three accessions and 80 smolts sampled). All virology samples from these groups resulted in negative detection of viral pathogens for 2022.

Bacterial Pathogens

Fish health sampling for *Renibacterium salmoninarum*, the causative agent for BKD, is a standard fish health sampling protocol for broodstock and production groups of Redfish Lake Sockeye Salmon. A total of 1,346 fish from calendar year 2022 were sampled for BKD via enzyme-linked immunosorbent assay (ELISA) techniques at Eagle Fish Health Lab. One hundred and eight broodstock females (83 anadromous females at Eagle FH, 17 captive females at Eagle FH, and eight captive females at Burley Creek FH) tested positive for BKD. Eggs from positive females with a high ELISA value ($\geq$ 0.40) were culled (52 anadromous females; 46,431 eyed eggs), moderate ELISA value ($\geq$ 0.25 and < 0.40) were released to Pettit Lake in the egg box program (eight anadromous females; 9,733 eyed eggs), and low ELISA value ($\geq$ 0.12 and < 0.25) were used for production eggs at Springfield FH, but not kept for replacement captive broodstock in 2022. Sockeye Salmon smolts from Springfield FH were sampled prior to release. Bacterial Kidney Disease was not detected in these smolt groups during 2022.

Parasitic Pathogens

The myxosporean parasite *Myxobolus cerebralis (M. cerebralis)*, the causative agent of whirling disease in salmonid fish, is present in the upper Salmon River. Positive results have been confirmed in returning anadromous adults tested for *M. cerebralis* via Pepsin-trypsin digest (PTD) testing; this is consistent with positive detections in 17 of the last 20 return years. Samples collected from anadromous adults (62 samples) were grouped in five fish pools. During 2022, six pools tested positive for *M. cerebralis.*

Eggs and adult anadromous Sockeye Salmon were treated with formalin to control *Saprolegnia*. Eggs were treated at 1,667 ppm for 20 minutes three times per week. Anadromous adults were treated at 167 ppm for one hour after arrival at Eagle FH and three times per week during adult holding at Eagle FH.

Genetic Investigations

A total of 6,660 *O. nerka* genetic samples were genotyped during 2022. These genetic samples were collected from Eagle FH captive broodstock (1,447 samples), NOAA captive broodstock (1,429 samples), anadromous returns (764 samples), adults sampled at Lower Granite Dam (385 samples), juveniles sampled at Lower Granite Dam (16 samples), out-migrating smolts from Pettit Lake (467 samples) and Redfish Lake (1,829 samples), basin lake trawling (73 samples), and Pettit Lake gill netting (46 samples). An additional 179 samples were genotyped and designated as re-clips representing samples taken from fish that shed PIT tags or for quality assurance checks.

All captive broodstock spawned at Eagle FH and Burley Creek FH in 2022 successfully genotyped and received a parentage assignment. The pedigrees for the captive broodstock were

expanded by another generation and rankings of 'Mean Kinship' along with parentage assignments were used to select individuals to keep for spawning or release for volitional spawning in Sawtooth Valley lakes.

Eyed Egg and Fish Transfers

In all cases, the required State transfer permits were acquired before transport of eggs or fish in the Snake River Sockeye Salmon program. Specific details, by date, for all transfers are described below.

Eagle FH and NOAA Fisheries transferred 1,089,834 eyed eggs to Springfield FH for the BY22 smolt production group. Eyed eggs from NOAA Fisheries were first transferred to Eagle FH and then delivered the next day to Springfield FH with eyed eggs from Eagle FH. Springfield FH received five shipments of eyed eggs in 2022. Eyed eggs were transferred between November 17 and December 14, 2022. Eagle FH transferred 533,395 and Burley Creek FH transferred 556,439 eyed eggs during 2022. Burley Creek FH received 1,503 eyed eggs from Eagle FH production for replacement captive broodstock for the NOAA Fisheries program. Brood Year 2022 eyed eggs were transferred to Burley Creek FH between November 17 and December 7, 2022. Oxbow FH (ODFW) received one shipment of 50,000 eyed eggs on November 23, 2022.

Fish Reintroductions

Sockeye Salmon eyed eggs and fish were transferred and/or released to various locations in 2022. In all cases, the required State transfer permits were acquired prior to shipping. Additionally, pursuant to Special Condition B. 13. of Permit No. 1454, IDFG received authorization from NOAA Fisheries to conduct all production releases of Sockeye Salmon made in 2022 (Table 7). All Sockeye Salmon juveniles and adults released to Sawtooth Valley waters in 2022 were marked/tagged prior to release.

Adult Releases

Captive reared adult Sockeye Salmon not required to meet egg production goals were released from IDFG and NOAA Fisheries facilities (Table 7). Eagle FH staff released 693 (321 females, 372 males) adult Sockeye Salmon to Redfish Lake on September 13-15, 2022. Mean weight of the Eagle FH captive reared Sockeye Salmon was 1.19 kg. Sockeye Program staff assisted with the transfer and release of 55 female Sockeye Salmon adults from Burley Creek FH to Redfish Lake on September 14, 2022. Mean weight of the Burley Creek FH captive reared Sockeye Salmon was 1.44 kg.

Captive reared adult Sockeye Salmon from Eagle FH and Burley Creek FH were released into Pettit Lake for volitional spawning during 2022 (Table 7). Eagle FH released two captive reared Sockeye salmon (one female and one male) and 100 captive reared Sockeye salmon (60 females and 40 males) were released from Burley Creek FH on September 14 into Pettit Lake (mean weight 1.35 kg).

Four hundred ninety anadromous adult Sockeye salmon were released to Redfish Lake for volitional spawning. These adults (213 females and 277 males) were released between August 25 and October 19, 2022 (Table 7).

Smolt Releases

The BY20 production group reared at Springfield FH was released between May 3-5, 2022. This group was first transferred to Sawtooth FH beginning April 17 and finishing April 24 to start an 11-to-17-day acclimation period at Sawtooth FH. A total of 908,313 smolts (37.4 grams/fish) were released over a three-day period. All smolts reared at Springfield FH were adipose fin clipped. A smolt survival study initiated in 2019 continued in 2022, maintaining an increased number of PIT-tagged fish in the Springfield FH release group. A total of 49,839 PIT-tagged smolts were released from Springfield FH (Table 7).

Eyed Egg Releases

The eyed egg release program remains an outlet to release eyed eggs to Sawtooth Valley lakes from female Sockeye Salmon displaying moderate levels of *Renibacterium salmoninarum* infection (or BKD). Eyed eggs from females testing in the moderate ELISA value range ($\geq$0.25 to <0.40) were released to Pettit Lake in specially made egg boxes. During 2022, eight females tested positive (moderate range), and the resulting eyed eggs (9,733) were released to Pettit Lake on December 14, 2022 (Table 7).

Transfer of Program Information

Sockeye Salmon Captive Broodstock Program information is shared throughout the year, internally with IDFG biologists, with Sockeye Program cooperators, data requests from biologists outside the Department, and through shared databases and annual meetings. The Sockeye Program continues to provide culture related data entered into the Fish Inventory System (FINS) database. This database has six modules containing trapping, holding, spawning, incubation, rearing, and release data for the program. The Snake River Annual Operating Plan was updated covering upcoming releases and expected returns. Changes in program protocols were updated in the Salmon River Standard Operating Plan and the plans were reviewed by cooperating biologists working in the Snake River drainage. The Stanley Basin Sockeye Technical Oversight Committee continues to meet quarterly each year. Due to Covid-19 travel restrictions, the first two quarterly meetings were virtual meetings, the SBSTOC cooperators met back in person for the third quarter meeting in Stanley, Idaho. These meetings serve as a forum to share cooperator updates and discuss program goals and objectives. Sockeye Program information was also shared through IDFG's Anadromous Managers meeting, Hatchery Managers meeting, and through bi-weekly Sockeye coordination calls (virtual meetings) with IDFG Sockeye Program staff.

Facility Improvements and Future Projects

The Sockeye captive broodstock Operation and Maintenance (O&M) contract provides funding for routine service and maintenance on facility buildings and equipment. Two service agreements are in place to address chillers and generators. Carrier Corporation provides semi-annual service on the two chillers in operation at Eagle FH. This includes operational diagnostic checks and annual coil cleaning. Northwest Power Systems provides semi-annual service on the three hatchery generators used to backup submersible motors supplying water to the facility and the ultra-violet water treatment system for the anadromous building.

2022 Facility Improvements

Several projects were completed during 2022 under the Sockeye Salmon captive broodstock O&M contract. Additional BPA funding was received through BPA's Asset Management Program. One, 50hp submersible well pump and motor unit was purchased during 2022 using FY21 deferred maintenance funds. The plate heat exchanger used with the anadromous building chiller unit was rebuilt and ten additional plates were added. Funding for this project was from FY22 deferred maintenance funding.

Future Projects

Fiscal Year 2023 funding from BPA's Asset Management Program will be used to service and replace a 50hp submersible motor and pump. Funding has also been approved to purchase a second smolt transport trailer for the Sockeye Program. Funds to cover this purchase have been approved from BPA's Idaho Fish Accord carryover funding.

An automated security gate is scheduled to be installed in 2023. This gate will provide after hours security for the Eagle Facility. Funding for this project will be split between Sockeye O&M, Idaho Fish Genetics, Idaho Fish Health Lab, and Idaho Wildlife Health Lab programs.

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Table 1. Summary of losses and magnitude of mortality in Snake River Sockeye Salmon captive broodstock at Eagle Fish Hatchery during 2022.

	Captive Broodstock Groups				
	BY18	**BY19**	**BY20**	**BY21**	**BY22**
Starting Inventory (January 1, 2022)	6	1,312	1,412	1,502	3,006[a]
Eyed egg to Fry					
Undetermined[b]	n/a	n/a	n/a	31	n/a
Mechanical Loss					
Handling	0	0	0	0	n/a
Jump-out	0	0	0	0	n/a
Transportation	0	0	0	0	n/a
Noninfectious					
Lymphosarcoma	0	0	0	0	n/a
Nephroblastoma	0	0	0	0	n/a
Other[c]	3	83	13	36	n/a
Infectious					
Bacterial	0	0	0	0	n/a
Viral	0	0	0	0	n/a
Other	0	0	0	0	n/a
Maturation Spawners					
Mature Males	0	284	66	0	n/a
Mature Females	1	340	3	0	n/a
Maturation Nonspawners					
Mature Males	2	4	12	0	n/a
Mature Females	0	5	3	0	n/a
Relocation					
Transferred In	0	0	0	0	n/a
Transferred Out	0	0	0	0	1,503
Planted/Released	0	587	108	0	n/a
Ending Inventory (December 31, 2022)	0	9	1,207	1,435	1,503[a]

[a] December 2022 developing fry and egg numbers.

[b] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss (April 1 inventory). Includes culling associated with cultural abnormalities, non-maturing, and all undetermined noninfectious mortality.

Table 2. Summary of losses and magnitude of mortality in Snake River Sockeye Salmon production groups during 2022.

	BY20 Springfield	BY21 Springfield	BY22 Springfield	BY22 Oxbow
Starting Inventory (January 1, 2022)	910,183	897,828	1,089,837[a]	50,000[a]
Eyed egg to Fry				
Undetermined[b]	n/a	28,282	na	n/a
Mechanical Loss				
Handling	0	0	n/a	n/a
Jump-out	0	0	n/a	n/a
Transportation	0	0	n/a	n/a
Noninfectious				
Lymphosarcoma	0	0	n/a	n/a
Nephroblastoma	0	0	n/a	n/a
Other[c]	1,870	20,336	n/a	n/a
Infectious				
Bacterial	0	0	0	n/a
Viral	0	0	0	n/a
Other	0	0	0	n/a
Maturation				
Mature Males	0	0	n/a	n/a
Mature Females	0	0	n/a	n/a
Other	0	0	n/a	n/a
Relocation				
Transferred In	0	0	0	n/a
Transferred Out	0	0	0	n/a
Planted/Released	908,313	0	0	n/a
Ending Inventory (December 31, 2022)	0	849,210	1,089,837[a]	50,000[a]

[a] December 2022 developing fry and egg numbers (combined NOAA and Eagle FH numbers).
[b] Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss (April 1 inventory).
[c] Culling associated with cultural abnormalities, fish health sampling, special studies, and all undetermined, noninfectious mortality.

Table 3. Calendar year 2022 anadromous Snake River Sockeye Salmon adult return summary.

Summary category	Total number trapped	Number trapped at RFLC[a] weir	Number trapped at SFH[b] weir	Number trapped at LGD[c] trap	Number trapped at other[d] traps
All anadromous adults	761	587	174	0	0
Anadromous males	416	328	88	0	0
Anadromous females	345	259	86	0	0
Unmarked adults	39	39	0	0	0
AD-clipped adults[e]	722	548	174	0	0

[a] RFLC = Redfish Lake Creek.
[b] SFH = Sawtooth Fish Hatchery.
[c] LGD = Lower Granite Dam
[d] Other = East Fork Salmon River Trap, Yankee Fork Trap, Hell's Canyon Dam adult trap.
[e] AD = adipose fin clip.

Table 4. Summary information for 2022 Snake River Sockeye Salmon spawning activities at Eagle Fish Hatchery.

Spawning Cross*		No. of Green	No. of	Mean Egg Survival	Median Egg Survival
Female	**Male**	**Eggs Taken**	**Eyed eggs**	**to Eyed-Stage**	**to Eyed-Stage**
ANH22	ANH22	175,806	123,689	70.36%	84.73%
ANH22	BY19	26,084	21,146	81.07%	89.55%
ANH22	BY20	6,158	3,823	62.08%	66.46%
BY18	BY19	1,146	375	32.72%	32.66%
BY19	ANH22	53,438	39,163	73.29%	80.95%
BY19	BY19	496,693	378,482	76.20%	84.21%
BY19	BY20	98,278	73,849	75.14%	81.17%
BY20	BY19	2,031	1,422	70.01%	80.75%
BY20	BY20	1048	616	58.78%	50.91%
	TOTALS	**860,682**	**642,565**	**74.66%**	**84.06%**

Note:* ANH22 refers to anadromous adults returning in 2022.
BY18 refers to captive adults produced in spawn year 2018.
BY19 refers to captive adults produced in spawn year 2019.
BY20 refers to captive adults produced in spawn year 2020.

Table 5. Parent family and number of Snake River Sockeye Salmon eyed eggs retained for brood year 2022 captive broodstock development at Eagle Fish Hatchery.

Family Cross*		No. of Eyed eggs Retained
Female	**Male**	**for Eagle FH Broodstock**
ANH22	ANH22	153
ANH22	BY19	19
BY18	BY19	4
BY19	ANH22	147
BY19	BY19	988
BY19	BY20	180
BY20	BY19	8
BY20	BY20	4
	TOTAL	**1,503**

Note:* ANH22 refers to anadromous adults returning in spawn year 2022.
BY18 refers to captive adults produced in spawn year 2018.
BY19 refers to captive adults produced in spawn year 2019.
BY20 refers to captive adults produced in spawn year 2020.

Table 6. Number of *Oncorhynchus nerka* samples genotyped during 2022.

Sample Group	No. of Genetic Samples Genotyped
Eagle BY19 Captive Brood	1,447
NOAA BY19 Captive Brood	1,429
Re-clips Captive Broodstock	179
Anadromous adults sampled at LGD	385
Out-migrants Sampled at LGD	16
Anadromous Returns (ANH22)	764
Pettit Lake Out-migrants	467
Redfish Lake Out-migrants	1,829
Trawling	73
Pettit Lake Gill Netting	46
Redfish Lake Creel	25
TOTAL:	6,660

Note: ANH22 refers to anadromous adults returning in spawn year 2022.
BY19 refers to captive adults produced in spawn year 2019.

Table 7. Snake River Sockeye Salmon releases made to Sawtooth Valley waters in 2022.

Release Location	Strategy (Brood Year)	Release Date	Number Released	Number PIT Tagged	Marks[a]	Release Weight (grams)	Rearing Location
Redfish Lake Creek	smolt						
	2020	5/3 - 5/4/2022	908,313	49,839	Ad	37.4	IDFG: Springfield FH
Redfish Lake	adult						
	2019	9/14 - 9/15/2022	585	585	Ad	1,298	IDFG: Eagle FH
	2020	9/20/2022	108	108	Ad	609	IDFG: Eagle FH
Redfish Lake	adult						
	2019	9/14/2022	55	55	Ad	1,435	NOAA: Burley Cr. FH
Redfish Lake	anadromous						
	ANH22[b]	9/15/2022	170	14	Ad	1,080	Anadromous
	ANH22[b]	Direct Release	320	11	Ad	1,080	Anadromous
Pettit Lake	adult						
	2019	9/15/2022	2	2	Ad	1,504	IDFG: Eagle FH
Pettit Lake	adult						
	2018	9/14/2022	4	4	Ad	2,231	NOAA: Burley Cr. FH
	2019	9/14/2022	96	96	Ad	1,350	NOAA: Burley Cr. FH
Pettit Lake	eyed eggs						
	2022	12/14/2022	9,733	na	na	na	IDFG: Eagle FH

[a] Ad = adipose fin clip.
[b] ANH22 refers to anadromous returning Sockeye Salmon in 2022; representing brood years 2017, 2018, and 2019.

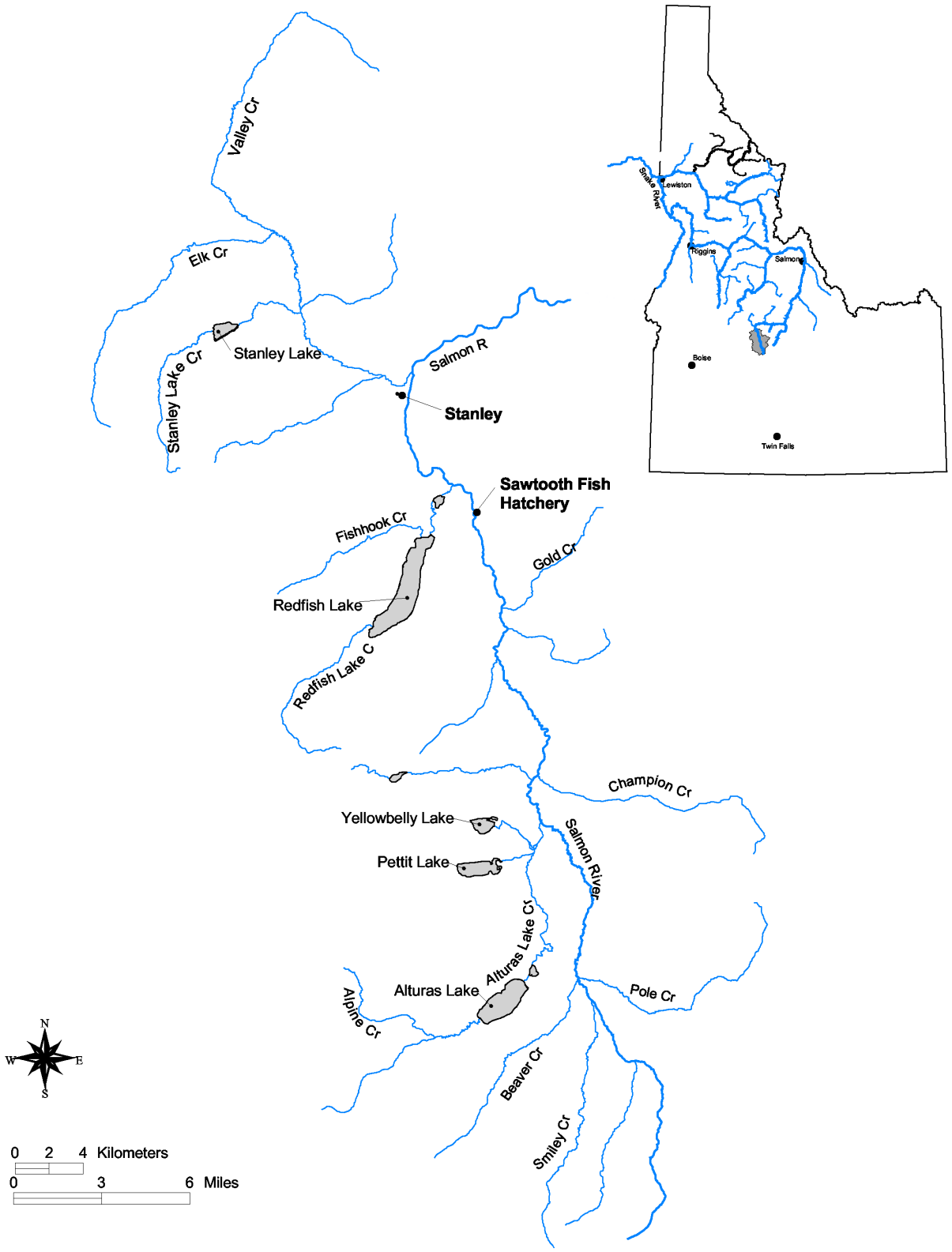

Figure 1. Sawtooth Valley study area.

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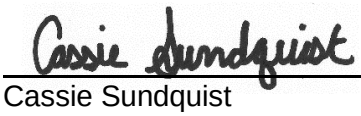

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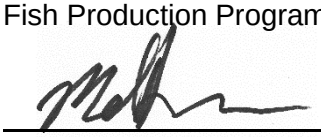

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