SNAKE RIVER SOCKEYE SALMON CAPTIVE BROODSTOCK PROGRAM HATCHERY ELEMENT

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SNAKE RIVER SOCKEYE SALMON CAPTIVE BROODSTOCK PROGRAM HATCHERY ELEMENT

Project Progress Report

2000 Annual Report

By

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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 Marine Fisheries Service at two locations adjacent to Puget Sound in Washington State. Activities conducted by the Shoshone-Bannock Tribes and the National Marine Fisheries Service are reported under separate cover. Idaho Department of Fish and Game monitoring and evaluation activities of captive broodstock program fish releases are also reported under separate cover. Captive broodstock program activities conducted between January 1, 2000 and December 31, 2000 are presented in this report.

In 2000, 257 anadromous sockeye salmon returned to the Sawtooth Basin. Two hundred forty-three of these adults were captured at adult weirs located on the upper Salmon River and on Redfish Lake Creek. Fourteen 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 October 3, 2000.) Forty-one anadromous adults were incorporated in the captive broodstock program spawning design for year 2000. The remaining adults were released to Redfish, Alturas, and Pettit lakes for natural spawning. Two hundred thirty-three of the 243 adults were adipose fin-clipped, indicating hatchery origin, while ten were unmarked, indicating natural origin (eyed-egg or prespawn adult release).

Eighteen sockeye salmon females from the anadromous group and 146 females from two captive broodstock groups were spawned at the Eagle Fish Hatchery in 2000. Spawn pairings produced approximately 253,047 eyed-eggs with egg survival to eyed stage of development averaging 59.9%.

Eyed-eggs (65,200), presmolts (72,114), smolts (148), and adults (271) were planted or released into Stanley Basin waters in 2000. Supplementation strategies involved releases to Redfish Lake, Redfish Lake Creek, Alturas Lake, and Pettit Lake.

During this reporting period, five broodstocks and two unique production groups were in culture at the Eagle Fish Hatchery. Two of the five broodstocks were incorporated into the 2000 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 (Stanley Basin) remain as potential sources of production (Figure 1). Historically, five Stanley Basin lakes (Redfish, Alturas, Pettit, Stanley, and Yellow Belly) 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 Marine Fisheries Service (NMFS) received a petition from the Shoshone-Bannock Tribes to list Snake River sockeye salmon as endangered under the Endangered Species Act (ESA) of 1973. On November 20, 1991, NMFS declared Snake River sockeye salmon endangered. Section 4(f) of the ESA requires the development and implementation of a recovery plan for listed species. At the time of this writing, a team (appointed by NMFS) is in the process of preparing the final draft of this document.

The Idaho Department of Fish and Game (IDFG), as part of their five-year management plan, is charged with the responsibility of reestablishing sockeye salmon runs to historic areas, with emphasis placed on efforts to utilize Stanley Basin sockeye salmon and kokanee resources (IDFG 1996). In 1991, the Shoshone-Bannock Tribes, along with the 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 and 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. NMFS ESA Permit Nos. 1120, 1124, and 844 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 NMFS 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).

Idaho Department of Fish and Game participation in the Sawtooth Valley Project falls under two general areas of effort: the sockeye salmon captive broodstock program and Stanley Basin sockeye/kokanee fisheries research. Activities associated with the captive broodstock program are presented in this report.

OBJECTIVES AND 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.

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

Task 1. Develop the technology for captive broodstock propagation to meet program needs.

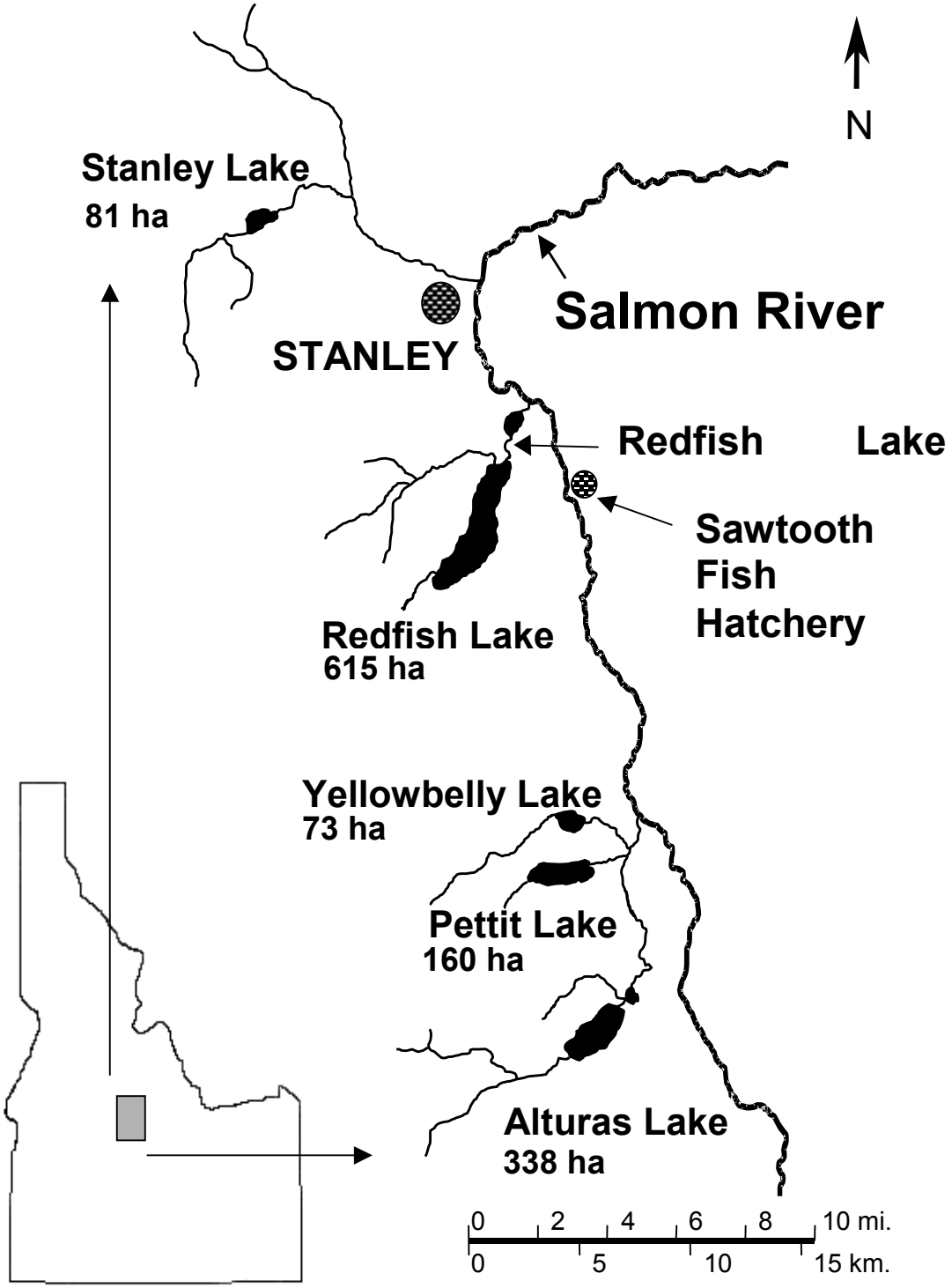

Figure 1. Stanley Basin study area.

Task 2. Trap returning anadromous adults, juvenile out-migrants, and residual sockeye salmon.
Task 3. Quantify survival, maturation rates, age-at-maturity, sex ratio, and gamete quality of captive sockeye salmon.

Objective 2. Maximize genetic diversity within captive sockeye salmon broodstocks.

Task 1. Establish spawning matrices in consultation with NMFS and the program technical oversight committee.
Task 2. Produce genetically-defined progeny for use in multiple release strategies to Stanley Basin lakes.
Task 3. Take samples for genetic analysis from all wild sockeye salmon incorporated in the program.

Objective 3. Determine the efficacy of cryopreservation as a tool for meeting program goals.

Task 1. Cryopreserve milt from specific wild and broodstock sockeye salmon.
Task 2. Conduct fertilization trials using cryopreserved milt from captive broodstock adults.
Task 3. Maintain cryopreserved archives at three locations to spread the risk of loss from catastrophic events.
Task 4. Produce "designer broodstocks" from cryopreserved milt to broaden the genetic base in future brood years.

Objective 4. Technology transfer.

Task 1. Participate in the technical oversight committee process.
Task 2. Network with technical experts on issues related to culture and broodstock techniques, genetics, pathology and monitoring and evaluations.
Task 3. Continue efforts to develop a program management plan.
Task 4. Coordinate public information transfer with project cooperators.
Task 5. Provide written activity reports to satisfy the needs and requirements of IDFG, the technical oversight committee, NMFS, and BPA.

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 five wells is currently in use. Artesian flow is augmented through the use of four separate pump/motor systems. Water temperature remains a constant 13.3°C and total dissolved gas averages 100% after degassing. Water chilling capability was added 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 and linked through an

emergency service contractor. Additional security is provided by limiting public access and by the presence of three on-site residences occupied by IDFG hatchery personnel.

Facility layout at Eagle Fish Hatchery remains flexible to accommodate culture activities ranging from spawning and incubation through adult rearing. Egg incubation capacity at Eagle Fish Hatchery is approximately 180,000 eggs. Incubation is accomplished in small containers specifically designed for the program. Incubators are designed to distribute both up-welling and down-welling flow to accommodate pre- and post-hatch stages.

Several fiberglass tank sizes are used to culture sockeye salmon from fry to the adult stage including: 1) 0.7 m diameter semi-square tanks (0.91 m^3); 2) 1 m diameter semi-square tanks (0.30 m^3); 3) 2 m diameter semi-square tanks (1.42 m^3); 4) 3 m diameter circular tanks (6.50 m^3); and 5) 4 m diameter semi-square tanks (8.89 m^3). Typically, 0.7 m and 1 m tanks are used for rearing fry from ponding to approximately 1 g weight. Two and three meter tanks are used to rear juveniles to approximately 10 g and to depot and group fish by lineage or release strategy prior to distribution to Stanley Basin 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 principal") 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 used continuously since 1991 for various aspects of the sockeye salmon 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 NMFS, are incubated in vertical trays. Fry are ponded to 0.7 m fiberglass tanks. Juvenile sockeye salmon (>1 g) are held in vats or in a series of 2 m fiberglass tanks installed in 1997. Typically, juvenile sockeye salmon reared at Sawtooth Fish Hatchery are released as subyearlings or yearlings. 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 spawning. All incubation, rearing, and holding occurs on well water. Water temperature varies by time of year from approximately 2.5°C in January/February to 11.1°C in August/September. Back-up and redundancy 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 follow 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 NMFS and IDFG culture experts and at the SBSTOC level.

Fish are fed a commercial diet produced by Bio-Oregon (Warrenton, Oregon) or Moore-Clark (Bellingham, Washington). Rations are weighed daily and follow suggested feeding rates provided by the manufacturer(s). 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. Through approximately 100 g weight, fish receive a standard Bio-Oregon semi-moist formulation or Moore-Clark dry diet. Beyond 100 g weight, fish receive the Moore-Clark salmon broodstock diet or 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 kg/m^3. Age-3 and age-4 rearing densities are maintained at levels not to exceed 14 kg/m^3.

Incubation and rearing water temperature is maintained between 10.0ºC and 13.3ºC. Chilled water (9.0ºC to 11.0ºC) may be used during incubation and early rearing to even out development and growth differences that may result from a protracted spawning period. Sockeye salmon, greater than age-1, are generally maintained on chilled water. Rearing water temperature varies as a function of demand but is generally maintained between 10.0ºC and 12.0ºC.

Passive integrated transponder tags (PIT tags) are used to evaluate the over-winter survival and out-migration success of production groups released to Stanley Basin waters. 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. PIT tag procedures follow accepted, regional protocols (Prentice et al., 1990).

Chemical therapeutants are used prophylactically and for the treatment of infectious diseases. Prior to effecting 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 Basin. 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. Prior to 1994, adult sockeye salmon returns were spawned at the Sawtooth Fish Hatchery (Johnson 1993; Johnson and Pravecek 1995; Johnson and Pravecek 1996; Kline and Heindel 1999). Spawning follows accepted, standard practices as described by McDaniel et al. (1994) and Erdahl (1994). Idaho Department of Fish and Game is required by NMFS Permit No. 1120 to discuss proposed broodstock spawning matrices prior to conducting activities (Appendix A). In general, eggs produced at spawning are divided into three lots (by female) and fertilized with sperm from three 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 by lot on different water temperatures to yield lineage-specific size groups for supplementation under different strategies and to produce fish to meet future broodstock needs.

Diet Trial

Diets produced by two manufacturers are currently used at IDFG and NMFS facilities. In 1998, a diet trial was designed using brood year 1997 broodstock sockeye salmon to investigate the potential effects of different manufacturer's diets on several variables measured pre- and post-spawning (e.g., fish size, fecundity, and the survival of eggs to the eyed stage of development). At the outset of the diet trial on December 1, 1998, brood year 1997 sockeye salmon broodstock fish were rearing in two groups at the Eagle Fish Hatchery. The four primary families developed during the production of this broodstock in 1997 were equally represented in both groups. Beginning on December 1, 1998 and continuing through June 30, 2000, one group was fed Moore-Clark diets (Clark's Fry, Chinook AB, Pedigree Salmon Brood) while the other group received Bio-Oregon diets (BioDiet Grower and BioDiet Custom Brood). The Moore-Clark group consisted of 180 fish while the Bio-Oregon group consisted of 164 fish. Starting mean fish weights for Moore-Clark and Bio-Oregon groups were 60.0 g and 61.0 g, respectively. The only deviation from this feeding regime was during routine medicated feed treatments. Twice a year, both groups were placed on 28 d Erythromycin-medicated treatments. The medicated diet was produced by Bio-Oregon.

During the trial, loading density, rearing tank size, water temperature, and tank flow exchange rate remained the same or similar. Feeding rates (ration) followed the manufacturer's recommended protocols. During handling events (e.g., to record sample weight information), both groups were treated equally. Approximately two to three months in advance of spawning, diet was withheld from both groups. During the sorting process leading up to and through spawning (September and October 2000), it was necessary to combine groups. At spawning, individual fish were associated with their respective diet trial group by PIT tag code.

Milt Cryopreservation

Cryopreservation of milt from male donors has been carried out 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 specific lineage 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 Eagle Fish Health Laboratory, operated by IDFG, processes samples for diagnostic and inspection purposes from captive broodstock sockeye salmon, production sockeye salmon, and anadromous sockeye salmon. Routine fish necropsies include investigations for viral pathogens (infectious pancreatic necrosis virus and infectious hematopoietic necrosis virus), and various bacterial pathogens (e.g., bacterial kidney disease *Renibacterium salmoninarum*, bacterial gill disease *Flavobacterium branchiophilum*, coldwater disease *Flavobacterium psychrophilum*, and motile aeromonad septicemia *Aeromonas spp.*). In addition to the above, anadromous adult sockeye salmon are screened for the causative agent of whirling disease *Myxobolus cerebralis*, furunculus *Aeromonas salmonicida* and the North American strain of viral hemorrhagic septicemia virus. All laboratory diagnostic and inspection procedures follow protocols described by Thoesen (1994).

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 2000.

To determine proximate body composition, sampled fish were dried, ground, and analyzed using standardized methods for proximate composition from 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 super-critical CO^2 extractor (both are from LECO Corp., St. Joseph, Missouri).

Eyed-Egg and Fish Transfers

Eggs are shipped at the eyed stage between NMFS 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 insure proper temperature maintenance and coolers are sealed with packing tape. Idaho Department of Fish and Game and NMFS personnel are responsible for shuttling coolers to air terminals.

Fry may be transferred between IDFG and NMFS facilities. If fry transfers occur, a commercial air service is used as described above. Fish are transported in plastic fish transfer bags containing 10ºC water. Oxygen is added to the bags prior to sealing. Bags are placed in coolers containing ice chips to insure 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 for the task at hand. Fish are maintained in water of the proper quality (temperature, oxygen, chemical composition) as much as is possible 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 300 gal (1,136 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

To date, sockeye salmon have been reintroduced to Stanley Basin waters as eyed eggs, subyearlings, yearlings, 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 bio-filter ring medium until after hatch. Plastic mesh netting surrounding egg boxes allows fish to volitionally emigrate following yolk absorption. Egg boxes accommodate approximately 5,000 eggs each. Following loading, egg boxes are lowered to the lake substrate in approximately 3 m of water over known or suspected areas of lakeshore spawning.

Subyearling sockeye salmon are distributed to Stanley Basin 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 prior to the release of fish.

Yearling sockeye salmon (smolts) are distributed to Stanley Basin waters using truck-mounted transportation tanks. To date, yearling sockeye salmon 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 prior to the release of fish.

Prespawn adult sockeye salmon are distributed to Stanley Basin waters using truck-mounted transportation tanks. To date, 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 prior to 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 1996, 1997, 1998, 1999, and 2000. 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 supplementation to Sawtooth Basin 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).

BY96 Broodstock

Two primary culture groups were developed in 1996 to meet future broodstock needs.

Table 1. Summary of losses and magnitude of mortality for five captive sockeye salmon broodstocks reared at IDFG facilities in 2000.

	Broodstocks				
	BY96	**BY97**	**BY98**	**BY99**	**BY00**
Starting Inventory (January 1, 2000)	68	322	482	425[a]	770[b]
Eyed-Egg to Fry					
Undetermined	n/a	n/a	n/a	41[c]	n/a
Mechanical Loss					
Handling	0	0	0	0	n/a
Jump-out	0	0	0	0	n/a
Human Error	0	0	0	0	n/a
Noninfectious					
Lymphosarcoma	0	0	1	0	n/a
Nephroblastoma	1	0	0	0	n/a
Other	65[d]	26[d]	29[d]	7[d]	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					
Mature Males	2	150	36	0	n/a
Mature Females	0	134	8	0	n/a
Other	0	0	0	0	n/a
Relocation					
Transferred In	0	0	0	0	n/a
Transferred Out	0	0	0	0	346[e]
Planted/Released	0	10[f]	148[g]	0	0
Ending Inventory (December 31, 2000)	0	12	260	377	424

[a] December 1999 developing fry numbers.
[b] December 2000 eyed-egg numbers.
[c] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.
[d] Includes culling associated with cultural abnormalities and all undetermined, noninfectious mortality.
[e] Transferred from IDFG Eagle Fish Hatchery to NMFS for broodstock rearing.
[f] Redfish Lake release of prespawn adult sockeye salmon broodstock.
[g] Redfish Lake Creek release of smolt sockeye salmon broodstock.

Table 2. Summary of losses and magnitude of mortality for two captive sockeye salmon production groups reared at IDFG facilities in 2000.

	Production Groups	
	BY99	**BY00**
Starting Inventory (January 1, 2000)	84,845[a]	253,047[b]
Eyed-Egg to Fry		
Undetermined	7,630[c]	n\a
Mechanical Loss		
Handling	0	n\a
Jump-out	0	n\a
Human Error	0	n\a
Noninfectious		
Lymphosarcoma	0	n\a
Other	4,174[d]	n\a
Infectious		
Bacterial	0	n\a
Viral	0	n\a
Other	0	n\a
Maturation		
Mature Males	0	n\a
Mature Females	0	n\a
Other	0	n\a
Relocation		
Transferred In	0	55,224[e]
Transferred Out	400[f]	69,103[g]
Planted/Released	72,641	65,200
Ending Inventory (December 31, 2000)	0	173,195

[a] December 1999 eyed-egg numbers.
[b] December 2000 eyed-egg 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 NMFS to IDFG Sawtooth Fish Hatchery for production rearing.
[f] Transferred from IDFG Eagle Fish Hatchery to NMFS for production rearing to adult.
[g] Transferred from IDFG Eagle Fish Hatchery to Bonneville Fish Hatchery for production rearing.

The first group (ANBY96) consists of first generation progeny of the single female sockeye salmon that returned to Redfish Lake Creek in 1996 (AN96). Males crossed with this female included first generation progeny of the two female and six male sockeye salmon that returned to Redfish Lake Creek in 1993 (ANBY93) and one 1993 Redfish Lake out-migrant (OM93). The second group (BY96) consists of first generation progeny produced from two ANBY93 and one OMBY93 females crossed with cryopreserved milt from the single male sockeye salmon that returned to Redfish Lake Creek in 1992 (AN92). All fish were combined post-PIT tagging and reared collectively as BY96 broodstock. Initial inventory for the BY96 broodstock was 68 fish. Two fish (both males) matured at age-4 in 2000; neither fish were utilized in hatchery spawn crosses due to prespawn mortality. Forty-six fish (2 females and 44 males) were culled due to lack of gonadal development. At the end of the reporting period, zero fish from this broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY97 Broodstock

This group consists of progeny from ANBY94 females and cryopreserved milt from 1991 Redfish Lake out-migrant males (OM91), 1992 Redfish Lake out-migrant males (OM92), and the single male sockeye salmon that returned to Redfish Lake in 1992 (AN92). Initial inventory for BY97 broodstock was 322 fish. Two hundred eighty-four fish (150 females and 134 males) matured at age-3 in 2000. Ten maturing fish (five females and five males) were released into Redfish Lake on September 6, 2000 for volitional spawning. Eighty-nine males and 138 females were utilized for spawn crosses in 2000. At the end of the reporting period, 12 fish from this broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY98 Broodstock

Three primary culture groups were developed in 1998 to meet future broodstock needs. The first group (produced at the Big Beef Creek Hatchery and transferred to the 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 Sockeye Salmon Broodstock. Initial inventory for this reporting period was 482 fish. One hundred forty-eight BY98 smolts were released in Redfish Lake Creek on September 5, 2000. Eight females and 36 males matured at age-2 in 2000. All mature females and 34 males were utilized in hatchery spawn crosses. At the end of this reporting period, 260 BY98 broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY99 Production

Twelve families, represented by 30 unique subfamilies, were developed from BY99 production spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two production group titles: BY99 and ANHBY99. The BY99 production group was developed using male and female sockeye salmon from the ANBY96, BY96 and BY97 broodstocks (described above). Specific crosses performed to develop this production 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, 5) BY96 females x BY96 males, and 6) BY96 females x BY97 males. The ANHBY99 production 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 production 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 of developing fry and eggs for this reporting period included approximately 77,451 at Sawtooth Fish Hatchery and 7,394 at Eagle Fish Hatchery. Four hundred fry were transferred to NMFS facilities on February 17, 2000 for production rearing to adult. On July 31, 2000, 11,993 age-0 presmolts from this production group were released to Alturas (5,986) and Pettit (6,007) lakes. Additionally, 60,621 age-0 presmolts from this production group were released to Redfish (48,051), Alturas (6,003), and Pettit (6,067) lakes on October 10, 2000. Both releases were part of a fall direct-lake supplementation strategy. At the end of this reporting period, no fish from this production group remained in culture (Table 2).

BY99 Broodstock

Approximately 1,019 eyed-eggs representing 11 families (30 unique subfamilies) were produced from 1999 spawning at the Eagle Fish Hatchery and segregated from production groups described above to create the BY99 broodstock. Approximately 594 eyed-eggs were transferred to NMFS facilities where they will remain through maturation. The majority of BY99 broodstock adults produced at NMFS facilities will contribute to future spawning designs. Inventory reporting for these fish will appear under separate cover by NMFS. Initial inventory for the BY99 broodstock at Eagle Fish Hatchery was 425 developing fry. At the end of this reporting period, 377 BY99 broodstock fish were in culture (Table 1).

BY00 Production

Sixteen families, represented by 49 unique subfamilies, 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 Stanley Basin 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. Approximately 82,628 eyed-eggs were produced from ANHBY00 spawn crosses. Eagle Fish Hatchery transferred BY00/ANHBY00 production eggs to the Sawtooth Fish Hatchery (76,177 eyed-eggs) and Bonneville Fish Hatchery (69,103 eyed-eggs) in November and December 2000. Approximately 39,177 eyed-eggs were transferred from the Big Beef Creek Hatchery to the Sawtooth Fish Hatchery in November and December 2000. Eyed-eggs were transferred to incubation boxes in Pettit Lake in November (20,760 eyed-eggs from the Big Beef Fish Hatchery and 44,440 eyed-eggs from the Eagle Fish Hatchery). At the end of this reporting period, approximately 110,641 and 62,554 developing fry were in culture at Sawtooth Fish Hatchery and Eagle Fish Hatchery, respectively (Table 2). Progeny from these crosses will be released throughout the summer and fall of 2001. Pending the development of a final release plan, a portion may be held for a 2002 smolt release.

BY00 Broodstock

Approximately 770 eyed-eggs were segregated from production groups described above to create the BY00 broodstock representing ten families (54 unique subfamilies). Approximately 346 eyed-eggs were transferred to NMFS facilities where they will remain through maturation. An additional 42 eyed-eggs are scheduled to be transferred to NMFS, as fry, in early February 2001 for broodstock rearing. The majority of BY00 broodstock adults produced at NMFS facilities will contribute to future spawning designs. Inventory reporting for these fish will appear under separate cover by NMFS. At the end of this reporting period, 424 developing fry (382 Eagle broodstock and 42 NMFS broodstock) were in culture at the Eagle Fish Hatchery (Table 1).

Anadromous and Residual Sockeye Salmon Trapping

Two adult traps are used to capture returning anadromous sockeye salmon in the Sawtooth Basin. The first trap is located on Redfish Lake Creek approximately 1.4 km downstream from the lake outlet and was operated from July 5 to September 26, 2000. The second trap is located on the upper Salmon River at the Sawtooth Fish Hatchery weir and was operated from May 30 to October 12, 2000.

In 2000, 257 anadromous sockeye salmon returned to the Sawtooth Basin. Traps on Redfish Lake Creek and the upper Salmon River at the Sawtooth Fish Hatchery intercepted 119 and 124 adults, respectively. Additionally, 14 adult sockeye salmon were observed immediately downstream of the Sawtooth Fish Hatchery trap but were not handled. Fish were captured between July 22 and September 15, 2000 (Figure 2). Returning adult sockeye salmon originated from a variety of release options including: 1) 1996 prespawn adult and eyed-egg releases in Redfish Lake, 2) 1997 presmolt releases in Redfish, Alturas, and Pettit lakes, and 3) 1998 smolt releases in Redfish Lake Creek and the upper Salmon River. The 1998 smolt release consisted of fish reared at the Sawtooth Fish Hatchery and at the Bonneville Fish Hatchery. With the exception of out-migrants originating from prespawn adult and eyed-egg releases, all juveniles released in 1997 and 1998 were adipose fin-clipped. A portion of fish released as presmolts and smolts were also PIT-tagged. Additionally, fish released as smolts and reared at the Bonneville Fish Hatchery were left ventral fin-clipped and coded wire-tagged. A summary of adult returns is presented in Table 3.

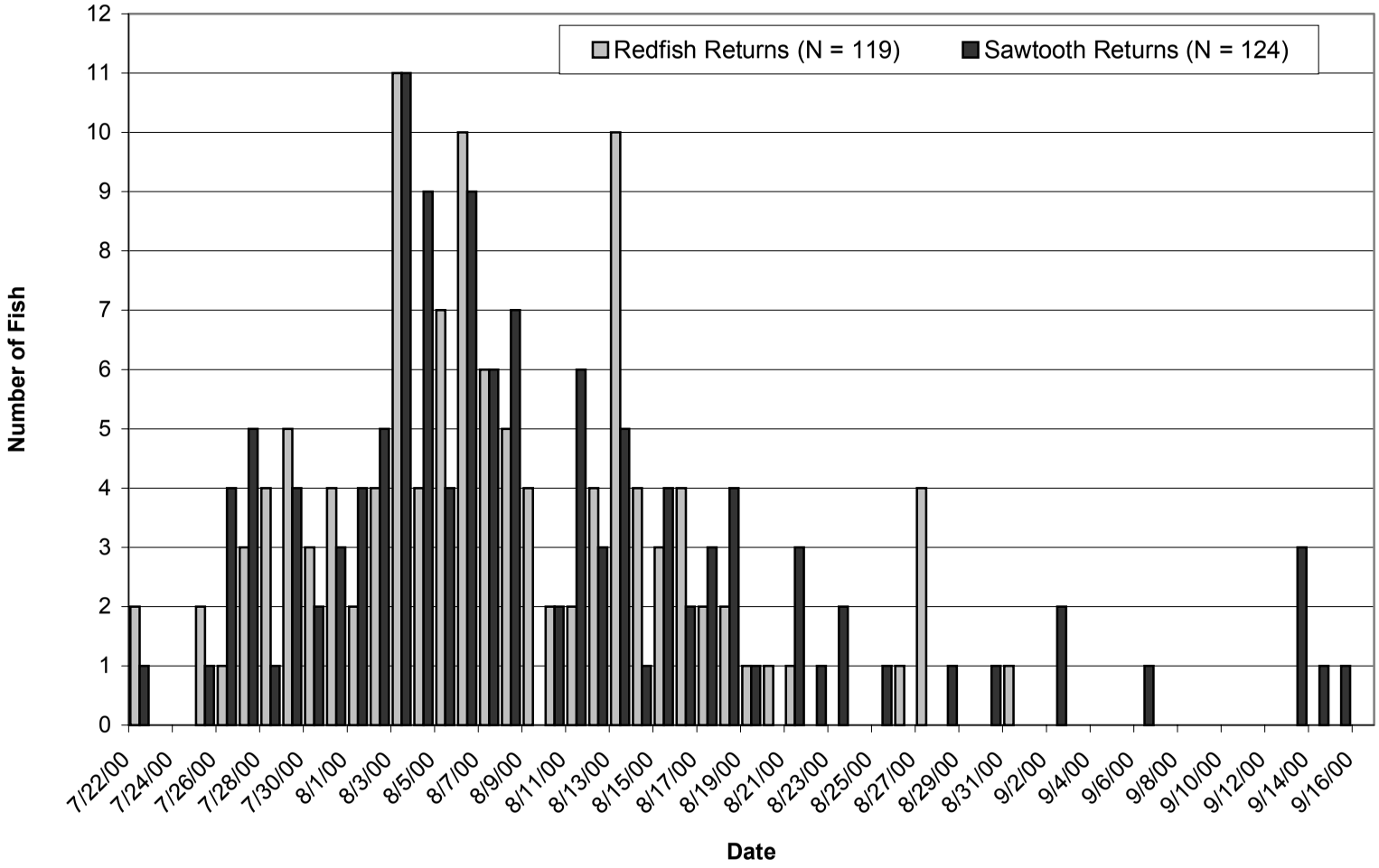

Figure 2. Year 2000 anadromous sockeye salmon returns, by date, to Sawtooth Fish Hatchery and Redfish Lake Creek trap sites.

Table 3. Year 2000 anadromous sockeye salmon adult return summary.

Summary Category	Total Number Trapped	Number Trapped at Redfish Lake Cr.	Number Trapped at Sawtooth Fish Hatchery
All Anadromous Adults	243	119	124
Anadromous Males	158	73	85
Anadromous Females	85	46	39
Unmarked Adults[a]	10	10	0
Adipose-Clipped Adults[b]	43	17	26
Adipose-Clipped and Left Ventral-Clipped Adults[c]	190	92	98

[a] Unmarked adults are presumably the result of eyed-egg and prespawn adult release strategies conducted in Redfish Lake in 1996. Unmarked adults could also be progeny of Redfish Lake residual sockeye salmon.

[b] Adipose-clipped adults are the result of presmolt and smolt release strategies conducted in 1997 and 1998, respectively. All juveniles released with an adipose clip (only) were reared at IDFG facilities.

[c] Adipose and left ventral-clipped adults are the result of smolt releases conducted in 1998. All juveniles released with adipose and left ventral clips were reared at the Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery.

One adult chinook salmon *O. tshawytscha* female was captured at the Redfish Lake Creek trap and passed upstream on August 31, 2000.

The Idaho Department of Fish and Game is required by Permit No. 1120 to discuss proposed broodstock spawning matrices with NMFS Northwest Fisheries Science Center (NWFSC) genetics staff. In 2000, this was accomplished by distributing and discussing a proposed spawning matrix at the Stanley Basin Sockeye Technical Oversight Committee (SBSTOC) held on September 20, 2000 in Manchester, Washington (Appendix A). Representatives from NMFS Conservation Biology and Resource Enhancement and Utilization Technologies divisions (NWFSC) were present at this meeting. No objections to the proposed spawning design were aired. During the fall of 2000, 284 age-3 fish (150 females and 134 males) from the BY97 broodstock and 44 age-2 fish (8 females and 36 males) from the BY98 broodstock matured at the Eagle Fish Hatchery. Five mature BY96 females and five mature BY96 males were released to Redfish Lake in September 2000 for volitional spawning. In addition to these maturing broodstocks, 41 of the 257 anadromous adults (ANH00) that returned to the Stanley Basin in 2000 (18 females and 23 males) were transferred to the Eagle Fish Hatchery and incorporated in the spawning design. Eggs from crosses performed with anadromous adults contributed to both production and broodstock program needs.

2000 Production Spawning

One hundred sixty-four females and 128 males were spawned at Eagle Fish Hatchery between October 5 and October 27, 2000 to generate 432,304 green eggs. To avoid inbreeding, an effort was made to outcross fish from different brood years (e.g., BY96 females spawned with BY97 males and BY96 anadromous males). When this was not possible, within brood year spawn crosses were made based on a desirability matrix designed to avoid or minimize inbreeding.

Sixteen families, represented by 49 unique subfamilies, 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. 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. Spawn crosses produced approximately 307,417 green and 170,419 eyed-eggs. Brood Year 1997 and 1998 female fecundity averaged 2,922 and 1,433 eggs, respectively. Egg survival to the eyed stage of development for the BY00 production group averaged 57.1% (median 69.0%) (Table 4).

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 Stanley Basin 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. Spawn crosses produced approximately 125,882 green and 82,628 eyed-eggs. Fecundity for ANH00 females averaged 2,772 eggs. Egg survival to the eyed stage of development for the ANHBY00 production group averaged 66.0% (median 81.4%) (Table 4).

Final release plans will be developed by the Stanley Basin Sockeye Technical Oversight Committee.

Table 4. Summary information for 2000 sockeye salmon spawning activities at Eagle Fish Hatchery.

Spawning Cross*			Mean		Median
Female	**Male**	**No. of Green Eggs Taken**	**No. of Eyed-Eggs**	**Egg Survival to Eyed Stage**	**Egg Survival to Eyed Stage**
ANH00	ANH00	7,415	5,867	81.6%	95.9%
ANH00	BY97	29,587	19,094	64.4%	86.1%
ANH00	BY98	7,149	7,061	98.8%	99.2%
BY97	ANH00	81,736	50,606	62.3%	78.2%
BY97	BY97	206,509	110,021	55.6%	68.3%
BY97	BY98	88,305	53,671	60.9%	74.2%
BY98	BY97	11,603	6,727	52.6%	65.4%
	TOTALS	432,204	253,047	59.9%	72.7%

Note: * ANH00 refers to year 2000 anadromous sockeye salmon.
BY97 refers to captive adults produced in spawn year 1997.
BY98 refers to captive adults produced in spawn year 1998.

2000 Broodstock Spawning

Approximately 770 eyed-eggs representing ten unique families (56 subfamilies) were selected from specific spawn crosses described above and incubated separately for future broodstock needs. Spawn crosses represented in the Eagle broodstock are presented in Table 5.

Diet Trial

One hundred thirty-eight BY97 female sockeye salmon that had been fed different manufacturer's diets from age-1 through maturation spawned in 2000. Female sockeye salmon from both diet trial groups were spawned with BY97, BY98, and ANH00 males. Mate selection was based on the desirability matrix approved by the SBSTOC, and specific spawn crosses were made without regard to diet history. Overall, females from each diet trial group spawned with a comparable array of males selected on the basis of lineage.

Due to the loss or failure of PIT tags, we were unable to associate 19 of these fish with their original diet trial group. Fifty-nine and 60 females from Bio-Oregon and Moore-Clark diet trial groups, respectively, generated the information presented in Table 6. These data indicate that females from the Moore-Clark diet group were larger and more fecund than females from the Bio-Oregon diet group. However, egg survival to the eyed stage of development was greater for the Bio-Oregon diet group than for the Moore-Clark diet group. Based on these preliminary results, the SBSTOC felt that a similar diet trial should be conducted by NMFS at their freshwater facility in Washington State. These data also suggest the need to revisit the theoretical and practical aspects of broodstock nutrition.

Milt Cryopreservation

In 2000, no milt from maturing sockeye salmon was cryopreserved, and no crosses were performed utilizing cryopreserved milt.

Fish Health Investigations

In 2000, the Eagle Fish Health Laboratory, operated by IDFG, processed samples for diagnostic and inspection purposes from captive broodstock sockeye salmon, production sockeye salmon juveniles reared at Eagle and Sawtooth fish hatcheries, and anadromous adult sockeye salmon. Eighty-eight laboratory accessions involving 408 individual fish were processed in 2000. Cause of mortality and magnitude of loss for all sockeye salmon broodstocks and production groups maintained at Eagle and Sawtooth fish hatcheries during the term of the reporting period are presented in Tables 1 and 2.

Table 5. Parent family and number of eyed-eggs retained for brood year 2000 captive broodstock development at Eagle Fish Hatchery.

Family Cross*		No. of Eyed-eggs
Female	**Male**	**Retained for Eagle Broodstock**
ANH00 H9	ANH00 H9	33
ANH00 H9	ANH00 H25	33
ANH00 H9 BY97	BY97 ANH00 H9	58
ANH00 H9	BY98	32
ANH00 H25	ANH00 H9	33
ANH00 H25	BY97	32
ANH00 H25	BY98	8
BY97	ANH00 H25	33
BY97	BY97	56
BY97 BY98	BY98 BY97	64
	TOTAL	**382**

Note: * ANH00 refers to year 2000 anadromous sockeye salmon.
ANH00 H9 refers to female mitochondrial haplotype “H9.”
ANH00 H25 refers to female mitochondrial haplotype “H25.”
BY97 refers to captive adults produced in spawn year 1997.
BY98 refers to captive adults produced in spawn year 1998.
ANH00 H9 refers to female mitochondrial haplotype “H9.”
ANH00 H25 refers to female mitochondrial haplotype “H25.”
BY97 refers to captive adults produced in spawn year 1997.
BY98 refers to captive adults produced in spawn year 1998.

Table 6. Body weight, fecundity, and egg survival to the eyed state of development for two groups of BY97 sockeye salmon females fed different diets from December 1, 1998 through July 1, 2000*.

Diet Trial Group	Number of Fish	Mean body Weight (g)	Fecundity	Egg Survival to Eyed Stage of Development
Moore-Clark	60	3,378	3,001	48.42
Bio-Oregon	59	2,874	2,868	63.96

Note: * Mean body weight = carcass plus egg weight.

There was no evidence of viral pathogens in any of the production and broodstock groups in 2000. This result is consistent with results from previous years. In addition, no viral pathogens were detected in the 45 anadromous adults examined in 2000. The Redfish Lake population remains the only sockeye salmon population in the Pacific Northwest that does not have infectious hematopoietic necrosis virus.

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 a few cases from Sawtooth Fish Hatchery where elevated ELISA OD values were demonstrated but not at levels indicating clinical disease. Captive adult sockeye salmon spawned in 2000 were also free of clinical levels of BKD. Bacterial kidney disease was present in five of the 45 anadromous adults examined in 2000. Following trapping, anadromous adults were assembled at the Sawtooth Fish Hatchery and held for September release to Stanley Basin lakes or for transfer to Eagle Fish Hatchery for spawning. There were two prespawn mortalities at the Sawtooth Fish Hatchery during this holding period. One of the five clinical cases documented in 2000 was for one of the two prespawn mortalities. The remaining four clinically infected fish were part of the group of 43 individuals transferred to Eagle Fish Hatchery for spawning. Two of the clinically infected fish were female. Eggs from these two females were culled pursuant to criteria specified in NMFS permit No. 1120.

Furunculosis, caused by *Aeromonas salmonicida*, was detected in a single prespawn mortality at Sawtooth Fish Hatchery. We administered intraperitoneal injections of both Oxytetracycline and Erythromycin shortly after furunculosis was demonstrated. This action probably prevented horizontal transmission of disease agents to the other adults held in common vats.

The myxosporean parasite, *Myxoblous cerebralis,* which can cause salmonid whirling disease, is present in the upper Salmon River. In 2000, the Eagle Fish Health Laboratory initiated a study to demonstrate the seasonal infectivity in the river water supply of the Sawtooth Fish Hatchery using sentinel rainbow trout fry. In addition, two groups of sockeye salmon fry were exposed as part of this study to examine relative susceptibility to the disease. These tests are still in progress but will be used to evaluate the risk of rearing sockeye salmon on river water

if this rearing strategy becomes necessary. In 2000, 45 anadromous adults were examined for presence of the parasite. Forty-one percent (18 fish) of these adults were positive for *M. cerebralis*. Considering the fact that sockeye salmon have been reared almost exclusively on pathogen free well water at the Sawtooth Fish Hatchery, these data suggest that smolts are being infected during seaward migration. In addition, since the inception of this project in 1991, *M. cerebralis* has not been identified in juveniles emigrating from Redfish or Alturas lakes.

In 2000, 45 anadromous adults were also examined for the presence of *Piscirickettsia salmonis.* The results were all negative, indicating that this emerging pathogen has not become established in Idaho.

Two cases of neoplasms were detected in broodstock sockeye salmon reared at the Eagle Fish Hatchery in 2000. One thymic lymphosarcoma was observed in one brood year 1998 sockeye salmon, and one nephroblastoma was observed in one brood year 1996 sockeye salmon. Thymic lymphosarcomas have been observed in past years at the Eagle Fish Hatchery. However, this was the first time a nephroblastoma has been observed in this program. 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.

Juvenile Fish Quality Assessment

In 2000, the following groups of fish were sampled for proximate body composition analysis: 1) hatchery-produced out-migrants from Redfish and Alturas lakes, wild/natural out-migrants from Redfish and Alturas lakes, 3) brood year 1999 hatchery-produced presmolts at Eagle and Sawtooth fish hatcheries, and 4) kokanee trawl samples from Redfish, Alturas, and Pettit lakes.

Generally, hatchery-produced sockeye salmon collected as migrating smolts from Redfish and Alturas lakes exhibited lower dry weight fat levels than wild/natural out-migrants from the same lakes. Additionally, dry weight fat levels for presmolts sampled prior to release to lakes were lower for fish reared at Eagle Fish Hatchery than for fish reared at the Sawtooth Fish Hatchery. Year 2000 proximate analysis data are summarized in Table 7.

Eyed-Egg and Fish Transfers

In 2000, 110,641 eyed-eggs from year 2000 production spawning crosses were transferred from the NMFS Big Beef Creek Hatchery and the Eagle Fish Hatchery to the Sawtooth Fish Hatchery. Fish that result from this transfer will be used to fill summer and fall 2001 direct lake presmolt release strategies. The Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery received approximately 108,280 eyed-eggs from the NMFS Big Beef Creek Hatchery and the Eagle Fish Hatchery. Fish that result from this transfer will be used to fill spring 2002 smolt release strategies. Three hundred forty-six eyed-eggs from broodstock spawning crosses were transferred from the Eagle Fish Hatchery to the Big Beef Creek Hatchery. An additional 42 eyed-eggs are scheduled to be transferred to NMFS, as fry, in early February 2001. Fish that result from these transfers will be incorporated in future spawning designs. Four hundred BY99 fry were transferred from the Eagle Fish Hatchery to NMFS Big Beef Creek Hatchery for production rearing to adult. To assist NMFS with the development of

appropriate spawn crosses, approximately 50 ml of milt was transferred from the Eagle Fish Hatchery to the Big Beef Creek Hatchery on October 11.

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

On February 17, 2000, 400 BY99 production fry were transferred to NMFS Big Beef Creek Hatchery for adult supplementation rearing.

On December 4 and 8, 2000, approximately 346 eyed-eggs from broodstock crosses were transferred from the Eagle Fish Hatchery to the NMFS Big Beef Creek Hatchery. Fish that mature as a result of this transfer will be incorporated in future NMFS spawning designs.

On November 21 and 29 and December 6, 2000, approximately 69,103 and 39,177 eyed-eggs (108,280 total) from production crosses were transferred from the Eagle Fish Hatchery and the NMFS Big Beef Creek Hatchery, respectively, to the Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery.

On November 29 and 30, 2000, approximately 44,440 and 20,760 eyed-eggs (65,200 total) from production crosses were transferred from Eagle Fish Hatchery and the NMFS Big Beef Creek Hatchery, respectively, to hatch boxes in Pettit Lake.

On November 30 and December 6 and 15, 2000, approximately 76,177 and 34,464 eyed-eggs (110,641 total) from production crosses were transferred from the Eagle Fish Hatchery and the NMFS Big Beef Creek Hatchery, respectively, to the Sawtooth Fish Hatchery.

On October 11, 2000, milt harvested from the five brood year 1997, one brood year 1998, and two anadromous sockeye salmon was transferred from Eagle Fish Hatchery to the NMFS Big Beef Creek Hatchery to accommodate spawning needs. Approximately 42.5 ml, 2.1 ml, and 6.5 ml of milt from brood year 1997, brood year 1998, and anadromous adults, respectively, was shipped.

Eyed Egg and Fish Supplementation

Pursuant to Special Condition B. 9. Requirement D. 3. of Permit No. 1120, IDFG received authorization from NMFS to carry out the following production releases of sockeye salmon in 1999 (Table 8). All sockeye salmon released were adipose fin-clipped.

Table 7. Year 2000 juvenile sockeye salmon and kokanee proximate body analysis summary. Redfish Lake Creek weir = RFL, Alturas Lake Creek screw trap = ALT.

Sample Date	Sample Location	Description of Fish Sampled	Number Sampled	Mean Weight (g)	Mean Length (mm)	Mean % Fat Dry Weight
5/22/00	RFL weir	Hatchery-produced out-migrants	20	10.8	112	3.57
5/22/00	RFL weir	Wild/natural out-migrants	8	16.7	128	11.82
5/23/00	ALT trap	Hatchery-produced out-migrants	3	10.2	113	0.59 [a]
5/23/00	ALT trap	Wild/natural out-migrants	4	4.4	86	5.74
7/27/00	Eagle Fish Hatchery	Hatchery presmolts	20	7.8	95	9.30
7/27/00	Sawtooth Fish Hatchery	Hatchery presmolts	20	2.2	60	28.70
9/25/00	Alturas Lake	Kokanee trawl samples	18	n/a	n/a	20.83
9/29/00	Redfish Lake	Kokanee trawl samples	8	n/a	n/a	17.17
10/11/00	Sawtooth Fish Hatchery	Hatchery presmolts	20	11.1	105	33.77

[a] The value reported for mean % fat dry weight is suspect and may have resulted from small sample size and/or analytical error.

Smolt Releases

Age-1 sockeye salmon smolts (BY98) were released into Redfish Lake Creek (148) below the Redfish Lake Creek trap on May 9, 2000. All smolts were reared at Eagle Fish Hatchery. All smolts released were adipose fin-clipped and PIT tagged. Mean weight at release was 258.8 g.

Adult Releases

On October 5, 6, and 7, maturing adult sockeye salmon were released to Redfish, Pettit, and Alturas lakes. All lakes received adults produced exclusively in the hatchery (captive) in addition to hatchery-produced anadromous adults that returned to the Stanley Basin in 2000. Redfish Lake received 46 captive hatchery-reared adults and 118 hatchery-produced anadromous adults. Thirty-six of the captive adults were reared in seawater at the NMFS Manchester Marine Experiment Station. The remaining 10 captive adults were reared at the Eagle Fish Hatchery. Alturas Lake received 25 captive hatchery-reared adults (NMFS Manchester Marine Experiment Station) and 52 hatchery-produced anadromous adults. Pettit Lake received 28 hatchery-produced anadromous adults. Sex ratios for captive adult release groups were approximately equal. All hatchery-reared adult sockeye salmon were Floy-tagged prior to release.

Presmolt Releases

Presmolt releases to Stanley Basin lakes were conducted in July and October during 2000 at mid-lake (pelagic) locations with the aid of a release barge on loan to IDFG from NMFS. All fish were produced in brood year 1999 and were reared at either Eagle or Sawtooth fish hatcheries. On July 31, Alturas Lake received 5,986 presmolts and Pettit Lake received 6,007 presmolts. Mean weights for fish reared at the Eagle and Sawtooth fish hatcheries were 8.45 g and 2.95 g, respectively. In addition to being adipose fin-clipped, Eagle-reared fish were right ventral fin-clipped and Sawtooth-reared fish were left ventral fin-clipped.

On October 11, Redfish Lake received 48,051 presmolts, Alturas Lake received 6,003 presmolts, and Pettit Lake received 6,067 presmolts. All October released presmolts were reared at the Sawtooth Fish Hatchery and were adipose fin-clipped. Mean weights at release for Redfish, Alturas, and Pettit groups were 10.8 g, 12.8 g, and 13.9 g, respectively.

Eyed-Egg Releases

On November 29 and 30, Pettit Lake received 65,200 eyed-eggs from brood year 2000 spawning at the Eagle Fish Hatchery (44,440 eggs) and the NMFS Big Beef Creek Hatchery (20,760 eggs). At planting, eyed-eggs had accumulated between 350-400 Celsius temperature units. Eyed-eggs were placed into Eagle Fish Hatchery egg boxes and transferred by boat to the north shore of the lake where they were positioned on substrate at an approximate depth of 4 m.

Table 8. Sockeye salmon releases made to Sawtooth Basin waters in 2000.

Release Location	Strategy (Brood Year)	Release Date	Number Released	Number PIT Tagged[a]	Release Weight (g)	Rearing Location
Redfish Lake Creek (downstream of weir)	smolt (1998)	05/09/00	148	148	258.8	IDFG Eagle Fish Hatchery
Redfish Lake (direct lake)	presmolt (1999)	10/11/00	48,051	—	10.8	IDFG Eagle Fish Hatchery
Redfish Lake (boat ramp)	adult (1997)	09/05/00	36	—	985.0	NMFS Manchester Marine Laboratory
	(1997)	09/06/00	10	—	3,300.0	IDFG Eagle Fish Hatchery
	(1996)	09/06,07/00	118	—	1,500.0	Anadromous return
Alturas Lake (direct lake)	presmolt (1999)	07/31/00	2,917	—	8.5	IDFG Eagle Fish Hatchery
	(1999)	07/31/00	3,069	—	3.0	IDFG Sawtooth Fish Hatchery
	(1999)	10/11/00	6,003	—	12.8	IDFG Sawtooth Fish Hatchery
Alturas Lake (boat ramp)	adult (1997)	09/05/00	25	—	994.0	NMFS Manchester Marine Laboratory
	(1996)	09/07/00	52	—	1,500.0	Anadromous return
Pettit Lake	presmolt (1999)	07/31/00	2,915	—	8.5	IDFG Eagle Fish Hatchery
	(1999)	07/31/00	3,092	—	3.0	IDFG Sawtooth Fish Hatchery
	(1999)	10/11/00	6,067	—	13.9	IDFG Sawtooth Fish Hatchery
Pettit Lake	adult (1996)	09/07/00	28	—	1500.0	Anadromous return
Pettit Lake	eyed-egg (2000)	11/29,30/00	65,200	—	—	(20,760 NMFS origin, 44,440 IDFG origin)

[a] Only the smolts for the 2000 release year were PIT tagged. Additional lake out-migrants will be PIT tagged during trapping activities in 2001.

ACKNOWLEDGMENTS

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LITERATURE CITED

AOAC. 1990. Official Methods of Analysis of the Association of Official Analytical Chemists, 15th ed. Association of Official Analytical Chemists, Inc., Arlington, Virginia. 1298 pp.

Bjornn, T. C., D. R. Craddock, and D. R. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon *Oncorhynchus nerka*. Transactions of the American Fisheries Society, 97:360-373.

Bromage, N. R., and R. J. Roberts. 1995. Broodstock Management and Egg and Larval Quality. Blackwell Science Ltd. Cambridge, Massachusetts.

Chapman, D. W., W. S. Platts, D. Park, and M. Hill. 1990. Status of Snake River sockeye salmon. Don Chapman Consultants, Inc. Boise, Idaho.

Cloud, J. G., W. H. Miller, and M. J. Levenduski. 1990. Cryopreservation of sperm as a means to store salmonid germ plasm and to transfer genes from wild fish to hatchery populations. The Progressive Fish Culturist, 52:51-53.

Erdahl, D. A. 1994. Inland Salmonid Broodstock Management Handbook. United States Department of the Interior, Fish and Wildlife Service. 712 FW 1.

Flagg, T. A., and W. C. McAuley. 1994. Redfish Lake sockeye salmon captive broodstock rearing and research. Coastal Zone and Estuarine Studies Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 92-40, Contract No. DE-AI79-92BP41841. Portland, Oregon.

IDFG (Idaho Department of Fish and Game). 1996. Fisheries management plan, 1996-2000. Idaho Department of Fish and Game. Boise, Idaho.

Johnson, K. A. 1993. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-BI79-91BP21065. Portland, Oregon.

Johnson, K. A. and J. J. Pravecek. 1995. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-BI79-91BP21065. Portland, Oregon.

Johnson, K. A. and J. J. Pravecek. 1996. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-BI79-91BP21065. Portland, Oregon.

Kline, P. A., and J. A. Heindel. 1999. Snake River sockeye salmon captive broodstock program hatchery element. Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-BI79-91BP21065. Portland, Oregon.

Leitritz, E., and R. C. Lewis. 1976. Trout and salmon culture (hatchery methods). California Department of Fish and Game Fish Bulletin 164.

McDaniel, T. R., K. M. Prett, T. R. Meyers, T. D. Ellison, J. E. Follett, and J. A. Burke. 1994. Alaska Sockeye Salmon Culture Manual. Special Fisheries Report No. 6. Alaska Department of Fish and Game, Juneau, Alaska.

Pennell, W., and B. A. Barton. 1996. Principles of Salmonid Aquaculture. Elsevier Science B. V. Amsterdam, The Netherlands.

Piper, G. R., I. B. McElwain, L. E. Orme, J. P. McCraren, L. G. Gowler, and J. R. Leonard. 1982. Fish Hatchery Management. U.S. Fish and Wildlife Service, Washington, D.C.

Pravecek, J. J., and K. A. Johnson. 1997. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-BI79-91BP21065. Portland, Oregon.

Pravecek, J. J., and P. A. Kline. 1998. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-BI79-91BP21065. Portland, Oregon.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990. Feasibility of using implanted passive integrated transponder (PIT) tags in salmonids. *In* N. C. Parker, A. E. Giorgi, R. C. Heidinger, D. B. Jester, Jr., E. D. Prince, and G. A. Winans (editors), Fish-marking techniques, International Symposium and Educational Workshop on Fish-marking Techniques. Am. Fish. Soc. Sympos. 7:317-322.

Thoesen, J. C. editor. 1994. Blue Book. Version 1. Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens. Fish Health Section, American Fisheries Society. Bethesda, Maryland.

Wheeler, P. A., and G. A. Thorgaard. 1991. Cryopreservation of rainbow trout semen in large straws. Aquaculture, 93:95-100.

APPENDICES

Appendix A. Year 2000 spawning matrix memo.

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

September 16, 2000

M E M O R A N D U M

To: **Robin Waples (NMFS)**
Madison Powell (U of I)
Steven Kalinowski (NMFS)
SBSTOC Cooperators

From: **Paul Kline, Keith Johnson, Jeff Heindel**

Subject: **2000 Sockeye Spawning Matrix Review**

Pursuant to Special Condition B.2. of Permit No. 1120, the Idaho Department of Fish and Game (IDFG) has established a desirability matrix to direct spawning for captive broodstock and anadromous adults in the year 2000. The first draft of this design was discussed at the July 25, 2000 SBSTOC meeting.

Two attachments are provided to facilitate this process. The first attachment reviews the current inventory of maturing adults at the IDFG Eagle Fish Hatchery. Lineage definitions and notes are provided to clarify broodstock nomenclature.

The second attachment presents the proposed desirability matrix to guide year 2000 spawning. Three levels of spawning preference have been identified. The primary criterion used to establish this matrix was the premise that inbreeding should be avoided. However, this is not the only concern. In 1996, one female sockeye salmon returned to Idaho. This female was spawned with first generation males produced from the eight anadromous adults that returned in 1993. In 1998, approximately 27% of this broodstock matured at age-2. Now, approximately 13% of the progeny from 1998 spawn crosses are maturing this year at age-2. While this year's age-2 rate of maturation is lower than what we observed in 1998, it is still atypically high. Because of unknowns associated with the potential heritibility of this characteristic, spawn crosses using BY98 males and females have been prioritized no higher than "second preference."

Additional unknowns surround the 42 anadromous adults retained for spawning. While mtDNA haplotype information has been generated, and could be used to prioritize spawn crosses within this group, crossing these fish with BY97 program fish appears to be a relatively safe scenario that avoids inbreeding risk. Are there compelling reasons for not crossing anadromous adults within group? In addition, what emphasis should be placed on retaining progeny of these adults for future broodstock needs; are they already represented in the program? Or are progeny of these adults desirable because the parents demonstrated a level of survival success? Is this success strictly an environmental phenomenon or did genetics play a role?

Appendix A. Year 2000 spawning matrix memo (continued).

The majority of production from spawn year 2000 will be dedicated to satisfying program release strategies. In addition, approximately 800 total eyed-eggs from select spawn crosses will be retained at NMFS and IDFG hatcheries to produce this year's broodstock groups. Eggs retained to meet future broodstock needs will represent the full diversity of spawn crosses conducted.

With the exception of year 2000 anadromous returns, Idaho and Washington inventories of maturing adults are similar in makeup. In 2000, fresh milt from anadromous males may be shipped to NMFS hatchery staff to best address the approved spawning matrix. A portion of the eyed-eggs produced from anadromous females spawned at the IDFG Eagle Fish Hatchery will be transferred to NMFS to spread risk.

The proposed matrix will be discussed at the upcoming SBSTOC meeting to be held September 20, 2000 in Manchester, Washington.

Appendix A. Year 2000 spawning matrix memo (continued).

SBSTOC 9/20/00

Proposed Sockeye Salmon Spawning Design for
Brood Year 2000 at Eagle Fish Hatchery

Inventory

ANH00 (age-4)

Total inventory = 42 anadromous adults
Number of maturing fish = 42
Marks and Sex:
No Clip (4 fish) 3 ♀'s, 1 ♂
Ad Clip Only (12 fish) 7 ♀'s, 5 ♂'s
Ad, Lv Clip (26 fish) 7 ♀'s, 19 ♂'s

Lineage: ANBY93 ♀ & ♂'s x ANBY93 ♀ & ♂'s
ANBY93 ♀ & ♂'s x OMBY93 ♀ & ♂'s

Note: ANBY93 = AN93 ♀ (2) x AN93 ♂ (6)
OMBY93 = OM91 and OM92 ♀ & ♂'s x AN93 ♀ & ♂'s

Brood Year 1996 (age-4)

Total inventory = approx. 49 fish
Number of maturing fish = 4
Sex of maturing fish = all male

Lineage: AN96 ♀ x ANBY93 F_1 ♂'s
AN96 ♀ x OMBY93 F_1 ♂'s

Note: ANBY93 = AN93 ♀ (2) x AN93 ♂ (6)
OMBY93 = OM91 and OM92 ♀&♂'s x AN93 ♀&♂'s

Brood Year 1997 (age-3)

Total inventory = 285 fish
Number of maturing fish = 270 (94%)
Sex of maturing fish = 50% ♀: 50% ♂ (135 ♀'s, 135 ♂'s)

Lineage: ANBY94 ♀'s x OM91 Cryo ♂'s
ANBY94 ♀'s x OM92 Cryo ♂'s
ANBY94 ♀'s x AN92 Cryo ♂

Note: ANBY94 = AN94 ♀ x ANBY91 F_1 ♂'s
AN94 ♀ x OM92 ♂'s

Appendix A. Year 2000 spawning matrix memo (continued).

Brood Year 1998 (age-2)

Total inventory = 336 fish
Number of maturing fish = 42 (12.5%)
Sex of maturing fish = 29% ♀: 71% ♂ (12 ♀'s, 30 ♂'s)

Lineage: ANBY91 F_2 ♀'s x AN98 ♂ (from NMFS)
ANBY96 ♀'s x AN98 ♂
ANBY96 ♀'s x ANBY96 ♂'s
ANBY96 ♀'s x OMBY93 Cryo ♂'s

Note: ANBY91 F_2 = AN91 ♀ x AN91 ♂'s (3)
ANBY96 = AN96 ♀ x ANBY93 F_1 ♂'s
AN96 ♀ x OMBY93 F_1 ♂'s
AN96 ♀ x AN92 Cryo ♂

Note: ANBY96 females identified in the above crosses were age-2 at spawning. Approximately 27% of this brood group matured at age-2 in 1998 (highest age-2 maturation observed to date). The 42 age-2 fish maturing this year are progeny of this broodstock.

Appendix A. Year 2000 spawning matrix memo (continued).

Proposed 2000 Sockeye Salmon Spawning Design (Desirability Matrix)

Females		Males			Comments
		First Preference Cross	Second Preference Cross	Third Preference Cross	
ANH00	X	BY97			1
ANH00	X	CRYO			2
ANH00	X		BY98		3
ANH00	X		ANH00		4
ANH00	X			BY96	5
ANH00	X			ANH00	6
BY97	X	ANH00			1
BY97	X	BY96			1
BY97	X	CRYO			2
BY97	X		BY98		7
BY97	X		BY97		8
BY98	X		BY96		3
BY98	X		CRY0		9
BY98	X		ANH00		3
BY98	X		BY97		7
BY98	X			BY98	10

1) All crosses avoid inbreeding.
2) Inbreeding avoided. Possibility of developing unique crosses using cryo milt.
3) Some inbreeding risk (ANH00, BY96, and BY98 share AN93 genetics). Also raises issue of precocial maturation linked to the AN 96 female and BY98 broodstock group.
4) Second preference desirability if crosses based on genetic dissimilarity (inbreeding risk).
5) Third preference desirability (ANH00 and BY96 share AN93 genetics).
6) Third preference desirability if crosses conducted randomly (inbreeding risk).
7) Negligible inbreeding risk. Second preference desirability due to risk associated with precocial maturation linked to BY98.
8) Based on known lineage, crosses can be conducted to avoid or minimize inbreeding.
9) Second preference desirability due to risk associated with precocial maturation linked to BY98. Possibility of unique crosses using cryo milt.
10) Based on known lineage, crosses can be conducted to avoid or minimize inbreeding. Third preference desirability due to risk associated with precocial maturation linked to BY98.

Submitted by:

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