Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Redfish Lake Sockeye Salmon Captive Broodstock Rearing And Research

Bonneville project number, if an ongoing project 9204000

Business name of agency, institution or organization requesting funding
National Marine Fisheries Service

Business acronym (if appropriate) NMFS

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N/A			

NPPC Program Measure Number(s) which this project addresses.
7.5A (1-3)

NMFS Biological Opinion Number(s) which this project addresses.

Other planning document references.
Proposed Recovery Plan for Snake River Salmon (4.1.a., 4.1.c: Schmitten et al. 1995; Chapter 7: Schmitten et al. 1997

Subbasin.

Salmon River, Stanley Basin

Short description.
Incubate and rear Redfish Lake sockeye salmon captive broodstocks. Provide pre-spawning adults, eyed eggs, and juveniles to aid recovery of this ESA-listed endangered stock in Idaho.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction		Watershed
	Resident fish		O & M		Biodiversity/genetics
	Wildlife	X	Production		Population dynamics
	Oceans/estuaries	+	Research		Ecosystems
	Climate		Monitoring/eval.		Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.	X	Supplementation
			Enforcement		Wildlife habitat en-hancement/restoration
			Acquisitions		

Other keywords.
Endangered Species Act, recovery program

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
9107200	Redfish Lake sockeye captive broodstock program	Idaho Department of Fish and Game is also maintaining captive broodstocks for Snake River sockeye salmon to avoid catastrophic loss of the gene pool and for rebuilding efforts
9107100	Snake River sockeye salmon habitat	The Shoshone-Bannock Tribe of Idaho is conducting habitat and limnological research for rebuilding efforts for Snake River sockeye salmon
9009300	Genetic analysis of Oncorhynchus nerke (ESA)	The University of Idaho has been conducting genetic analyses of Snake River sockeye salmon
9305600	Assessment of captive broodstock technology	Refinement of captive broodstock technology is necessary to maximize potential of captive broodstock

		recovery programs for ESA-listed stocks of Pacific salmon in the Columbia River Basin

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	ESA-listed endangered Snake River sockeye salmon captive broodstock F1 generation rearing	a	Redfish Lake stocks
2	ESA-listed endangered Snake River sockeye salmon captive broodstock F2 generation rearing	b	Redfish Lake stocks

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	9/1992	11/2001	75.00%
2	9/1992	11/2001	25.00%
			TOTAL 100.00%

Schedule constraints.
Schedule may be constrained by population viability of ESA-listed stocks in this recovery program. If population numbers are still low by the year 2001, then captive broodstocks may have to be continued to protect the gene pools.

Completion date.
2001, or beyond (see schedule constraints above)

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel		$146,200
Fringe benefits		$47,100
Supplies, materials, non-expendable property		$125,400
Operations & maintenance		$ 0
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		$ 0
PIT tags	# of tags:	$ 0
Travel		$20,800
Indirect costs		$80,200
Subcontracts	included contract employees	$80,300
Other		$ 0
TOTAL		$500,000

Outyear costs

Outyear costs	FY2000	FY01	FY02	FY03
Total budget	$500,000	$500,000	$500,000	$500,000
O&M as % of total	0.00%	0.00%	0.00%	0.00%

Section 6. Abstract

The National Marine Fisheries Service is maintaining captive broodstocks of endangered Redfish Lake sockeye salmon. Captive broodstock programs are a form of artificial propagation where fish are cultured in captivity for most or all of their life cycle. Implementation and refinement of captive broodstocks for the recovery of Snake River sockeye salmon are identified as priorities in the NWPPC Columbia Basin Fish and Wildlife Program (7.4A.1-3) and the NMFS proposed Recovery Plan for Snake River salmon (4.1a, 4.1c--Schmitten et al. 1995; Chapter 7--Schmitten et al. 1997). The NMFS captive broodstocks are complementary to those reared by the Idaho Department of Fish and Game (IDFG) and are intended to reduce the risk of catastrophic loss of this valuable gene pool. Since 1991, only 15 sockeye salmon adults (zero to eight individuals per year) have returned to Redfish Lake. NMFS has captive broodstocks for 1991-, 1993-, 1994-, and 1996-broods (no females returned in 1992, 1995, and 1997) and has has spawned Redfish Lake sockeye salmon captive broodstock yearly since 1994. The fish are reared to full term adults in fresh well water, or from smolt to adult in a pumped,

filtered, and UV-sterilized seawater system. Pre-spawning adults, eyed eggs, and juveniles are returned to Idaho to aid recovery efforts. Over 600,000 viable eggs have been produced by the program for use in recovery efforts. This captive broodstock egg production translates to a direct yearly amplification of 47-250 times the endangered species gametes taken into protective culture. The relatively high juvenile survival of first and second generation captive broodstock currently being held in protective culture should result in continued production of up to 200,000 eggs yearly in upcoming years. It is virtually certain that without the boost provided by these captive broodstocks, Redfish Lake sockeye salmon would soon be extinct.

Section 7. Project description

a. Technical and/or scientific background.

In December 1991, the National Marine Fisheries Service (NMFS) listed Snake River sockeye salmon (*Oncorhynchus nerka*) as endangered under the U.S. Endangered Species Act (ESA) (Waples et al. 1991a). Snake River sockeye salmon are a prime example of a species on the threshold of extinction. The last known remnants of this stock return to Redfish Lake, Idaho. Since 1991, only 15 sockeye salmon adults (zero to eight individuals per year) have returned to Redfish Lake. On the basis of these critically low population numbers, NMFS, in cooperation with the Idaho Department of Fish and Game (IDFG), the Bonneville Power Administration (BPA), the Shoshone-Bannock Tribe, and others, implemented a captive broodstock project as an emergency measure to save Redfish Lake sockeye salmon (Flagg 1993; Johnson 1993; Kline 1993; Spaulding 1993; Flagg and McAuley 1994; Flagg et al. 1994; Teuscher et al. 1994; Flagg et al. 1995; Kline and Younk 1995; Johnson and Pravecek 1995, 1996; Teuscher et al. 1995; Flagg et al. 1996; Teuscher and Taki 1996; Kline and Lamansky 1997; Pravecek and Johnson 1997; Taki and Mikkelsen 1997). The Redfish Lake project is intended as a stop-gap measure until migration and rearing habitat improvements can be implemented to increase survival.

These interim recovery efforts are being coordinated through the Stanley Basin Sockeye Technical Oversight Committee (SBSTOC). Membership on the committee includes representatives from NMFS, IDFG, BPA, the Shoshone-Bannock Tribe, other state and federal agencies, and private groups interested in sockeye salmon restoration in Idaho.

In 1992, the NMFS Northwest Fisheries Science Center entered into a cooperative project with BPA (Project 92-40, Contract DE-AI79-92BP41841) for involvement in the Redfish Lake captive broodstock project. Historically, captive broodstock fish propagation for Redfish Lake sockeye salmon was conducted under ESA Section 10 Propagation Permit 795 issued to IDFG. However, in 1996, NMFS Northwest Fisheries Science Center, was issued ESA Permit 1005 for NMFS's portion of Redfish Lake sockeye salmon captive broodstock propagation.

Implementation and refinement of captive broodstocks for the recovery of Snake River sockeye salmon are identified as priorities in the NWPPC Columbia Basin Fish and Wildlife Program (7.5A1-3: CBFWP 1994) and the NMFS proposed Recovery Plan for Snake River salmon (4.1a, 4.1c: Schmitten et al. 1995; Chapter 7-P. 99-100: Schmitten et al. 1997). Restoration mandates by the ESA are focused on natural populations and the ecosystems upon which they depend. Nevertheless, the ESA recognizes that conservation of listed species may be facilitated by artificial means while factors impeding population recovery are rectified (Hard et al. 1992). Frequently, restoration of severely depleted populations will be hindered for lack of suitable numbers of juveniles for effective supplementation (i.e., release of hatchery-propagated fish to increase natural production), even if factors impeding recovery could be corrected (Flagg et al. 1995a). For restoration of these populations to occur in a timely fashion, the full reproductive potential of Pacific salmon must be harnessed in the short-term to produce large numbers of juveniles. Often the only reasonable avenue to build populations quickly enough to avoid extinction will be through captive broodstock technology (Flagg and Mahnken 1995).

Captive propagation of animals to maximize their survival and reproductive potential has won acceptance in endangered species restoration (Gipps 1991, Johnson and Jensen 1991, DeBlieu 1993, Olney et al. 1994, Flagg and Mahnken 1995). Currently, over 105 species of mammals, 40 species of birds, 12 species of reptiles, 29 species of fish, and 14 species of invertebrates are being maintained or enhanced through forms of captive breeding (CBSG 1991). These efforts range from establishment of free-roaming breeding colonies on localized preserves to full-term captive rearing (Gipps 1991, Johnson and Jensen 1991, DeBlieu 1993, Olney et al. 1994, Flagg et al. 1995b). Full-term rearing of captive broodstocks maximizes potential production of juveniles for enhancement. The relatively short generation time of Pacific salmon and their potential to produce large numbers of offspring make them suitable for captive broodstock rearing. Survival advantages offered through protective culture can be significant. Theoretically, survival of fish reared in protective captive broodstock culture can exceed wild survival by many 100-to-1,000 fold (Flagg et al. 1995b). The substantial survival advantage for captive-reared fish provides potential to produce large numbers of juveniles to amplify the natural population during the second generation.

Even though captive broodstock theory is promising, artificial propagation and captive broodstock technologies are not without risks. There is limited data regarding the effects of broodstock manipulations (e.g., sourcing, mating, rearing, feeding, and release strategies) on the health, physiology, or genetic stability of the population, or, most importantly, on reproductive performance (Flagg and Mahnken 1995). The potential hazards of using captive culture (inbreeding, genetic drift, domestication, selection, behavioral conditioning, and exposure to disease) and the negative interactions of hatchery and wild fish have been well documented (Hynes et al. 1981, Krueger et al. 1981, Kincaid 1983, Allendorf and Ryman 1987, Kapunscinski and Jacobson 1987, Waples 1991b). However, waiting for restoration of natural production is often a more dangerous risk because the entire population is threatened. The continued decline in population size risks additional loss of genetic variability and possible extinction of the population (Kincaid 1993).

Two captive broodstock approaches are being applied to salmon recovery in the Pacific Northwest. One strategy involves capturing wild prespawning adults, fertilized eggs, or juveniles from their native habitats, and rearing the populations to maturity in hatcheries. The first or second generation offspring are then stocked into ancestral lakes or streams at one or more juvenile life stages (e.g., fry, parr, smolt). Another strategy involves rearing the broodstock in captivity to adulthood, then releasing the adults back into their natal habitats to spawn naturally. Both strategies require extended culture to adulthood.

Captive broodstock survival to adulthood can vary from low to high. Past broodstock survivals have ranged 0-90% (Flagg et al. 1995b). The major disease problem noted in most captive broodstock programs has been bacterial kidney disease, caused by *Renibacterium salmoninarum*. Disease problems can be reduced considerably when fish are cultured in water with low concentrations of pathogens (e.g., fresh well water or filtered and sterilized seawater) rather than in seawater net-pens (Flagg et al. 1995b). Using optimum culture techniques (e.g., pathogen free water and low density culture), fishery managers can currently anticipate survivals of 50-80% in captive broodstocks (Schiewe et al. 1997).

The dramatic difference between the natural environments experienced by wild Pacific salmon and the artificial environments experienced by captively-reared fish appears to create a number of differences in their relative reproductive potential. In general, captively-reared Pacific salmon appear less reproductively fit than their wild cohorts. The size and age of maturity of captively-reared adults are generally less than wild cohorts (Flagg et al. 1995b, Schiewe et al. 1997). Part of this size discrepancy can be attributed to early maturity of captively-reared fish. However, even in cases where age at maturity of captively-reared fish mimicked wild fish, their size was generally 20-50% less than wild stock (Flagg et al. 1995b, Schiewe et al. 1997). Average viability of eggs from captively-reared spawners (30-70%) is also commonly lower than the 75-95% viability of similar strains of hatchery-spawned wild fish (Flagg et al. 1995b, Schiewe et al. 1997). Behavioral studies indicate that captively-reared coho salmon released to spawn in streams may also have lower breeding success than commingling wild coho salmon (Berejikian et al. in press).

The reasons for the generally poorer reproductive performance of artificially propagated captively-reared fish compared to ocean ranched and wild cohorts are not well understood. Most captive broodstock programs use spawners collected from the wild population. Therefore, it seems intuitive that much of the poor performance, at least in first-generation offspring, can be attributed to the effects of artificial culture environments. However, the effects of genetic change in the captively-reared populations as a basis for reduced spawner size, egg viability, and reproductive behavior fish remain a possibility. Ongoing research being conducted under BPA Project 9305600 to refine captive broodstock technology should provide methodologies to improve broodstock performance in the future.

Although in many cases, viability of captive broodstocks have not entirely met expectations, they still are fulfilling most supplementation goals. In the case of Redfish Lake sockeye salmon, the NMFS captive broodstock efforts for this endangered species (BPA Project 9204000) has already resulted in over 600,000 viable eggs produced and returned to Idaho for use in recovery efforts; a direct amplification of over 175 times the endangered species gametes taken into protective culture (T. A. Flagg, NMFS, unpubl. data). Similarly, White River captive broodstocks (Appleby and Keown 1995) are now producing almost a million eggs a year for enhancement (K. Keown, Washington State Department of Fisheries and Wildlife, pers. commun., 1997).

Captive broodstock technology for salmonids, although still in its initial development stages, appears sufficiently advanced to allow carefully planned programs to proceed. Viability of captively-reared spawners may be less than wild fish. Nevertheless, captive broodstock programs have the potential to provide the amplification necessary to both reduce extinction risk and begin recovery measures for depleted stocks. It is clear that captive broodstocks cannot be a substitute for restoring fish in the habitat. However, it appears unrealistic to rely solely on habitat improvements and harvest restrictions to affect recovery, especially when populations have reached critically low numbers. For severely depleted populations, captive broodstocks will often be the only method to rebuild numbers quickly enough to reduce inbreeding or avoid extinction.

b. Proposal objectives.

The proposal objectives for BPA Project 9204000 are to: (1) Rear Snake River sockeye salmon captive broodstocks from Redfish Lake (Idaho) and, (2) Provide prespawning adults, eyed eggs, and juveniles to aid recovery of this ESA-listed stock in Idaho.

Testable hypotheses include:

1. Endangered Redfish Lake sockeye salmon grown to maturity in freshwater have similar growth, survival, and reproductive success as fish grown in seawater. Ho: no difference. H1: difference.

2. Snake River sockeye salmon captive broodstocks will produce prespawning adults and gametes in sufficient numbers and of sufficient quality to aid recovery efforts. Ho: no prespawning adults or eggs produced. H1: prespawning adults and eggs will be produced in sufficient numbers and quality. H2: prespawning adults and eggs will be produced, but in insufficient numbers and quality.

The alternate approach to captive broodstock intervention for Snake River sockeye salmon may be extinction of this ESA-listed stock.

Critical uncertainties include: (1) Whether Snake River sockeye salmon captive broodstocks will produce prespawning adults and gametes in sufficient numbers and of sufficient quality to aid recovery efforts; and (2) If habitat improvements in nursery areas and in the migration corridor will occur to allow natural long-term increases in population replacement rate.

Expected products include: (1) The captive broodstock programs should provide hundreds of adults and hundreds of thousands of eggs for use in recovery efforts; (2) Maintaining geographically separate captive brood populations (at the IDFG Eagle and NMFS Manchester Marine Experimental Station) will help reduce the risk of catastrophic loss of gene pools from mechanical failure, human error, or disease; (3) Annual progress reports to BPA; (4) In addition, information from projects related to recovery efforts for ESA-listed Snake River sockeye salmon are being coordinated through the BPA-chaired Stanley Basin Sockeye Technical Oversight Committee (SBSTOC). Membership on the committee includes representatives from NMFS, IDFG, BPA, the Shoshone-Bannock Tribe, other state and federal agencies, and private groups interested in sockeye salmon restoration in Idaho.

c. Rationale and significance to Regional Programs.

Snake River sockeye salmon (*Oncorhynchus nerka*) are listed as endangered under the U.S. Endangered Species Act (ESA) (Waples et al. 1991a). For restoration of these populations to occur in a timely fashion, the full reproductive potential of Pacific salmon must be harnessed in the short term to produce large numbers of juveniles. Often the only reasonable avenue to build populations quickly enough to avoid extinction will be through captive broodstock technology (Flagg and Mahnken 1995). The objectives for BPA Project 9204000 follow the priority guidelines for implementation and refinement of captive broodstocks for the recovery of Snake River sockeye salmon identified in the NWPPC Columbia Basin Fish and Wildlife Program (7.5A.1-3: CBFWP 1994) and the NMFS proposed Recovery Plan for Snake River salmon (4.1a, 4.1c: Schmitten et al. 1995; Chapter 7-P. 99-100: Schmitten et al. 1997).

Captive broodstock programs are a form of artificial propagation where fish are cultured in captivity for most or all of their life cycle. The relatively high fecundity of anadromous Pacific salmon, coupled with potentially high survival in protective culture, should allow captive broodstocks to produce large numbers of adults and juveniles to help "jumpstart" depleted populations. Maintaining geographically separate captive brood populations (at the IDFG Eagle Hatchery: BPA Project 9107200 and NMFS Manchester Marine Experimental Station: BPA Project 9204000) will help reduce the risk of catastrophic loss of gene pools from mechanical failure, human error, or disease. Research to refine captive broodstock technology (BPA Project 9305600) should help improve broodstock performance and maximize their contribution to recovery goals. In upcoming years, the captive broodstock programs should provide hundreds of adults and hundreds of thousands of eggs for use in recovery efforts in Idaho.

NMFS is coordinating captive broodstock rearing activities for Redfish Lake sockeye salmon through the BPA chaired Stanley Basin Sockeye Technical Oversight Committee (SBSTOC). Membership on the committee includes representatives from NMFS, IDFG, BPA, the Shoshone-Bannock Tribe, other state and federal agencies, and private groups interested in sockeye salmon restoration in Idaho.

d. Project history

1. Project numbers - BPA Project 9204000 (unchanged)

2. Project reports:

Flagg, T. A. 1993. Redfish Lake sockeye salmon captive broodstock rearing and research, 1991-1992. Report to Bonneville Power Administration, Contract DE-AI79-92BP41841. 16 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112.)

Flagg, T. A., K. A. Johnson, and J. C. Gislason. 1994. Redfish Lake sockeye salmon broodstock programs. In Proceedings of the 1993 Alaska Department of Fish and Game Sockeye Culture Workshop. Cooper Landing, Alaska. 10 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112.)

Flagg, T. A., and W. C. McAuley. 1994. Redfish Lake sockeye salmon captive broodstock rearing and research, 1991-1993. Report to Bonneville Power Administration, Contract DE-AI79-92BP41841. 99 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112.)

Flagg, T. A., C. V. W. Mahnken, and K. A. Johnson. 1995. Captive broodstocks for recovery of depleted populations of Pacific salmon. Amer. Fish. Soc. Symp. 15:81-90

Flagg, T. A., W. C. McAuley, M. R. Wastel, D. A. Frost, and C. V. W. Mahnken. 1996. Redfish Lake sockeye salmon captive broodstock rearing and research, 1991-1994. Report to Bonneville Power Administration, Contract DE-AI79-92BP41841. 98 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112.)

3. Summary of major results achieved: In 1992, the NMFS Northwest Fisheries Science Center entered into a cooperative project with BPA (Project 9204000, Contract DE-AI79-92BP41841) for involvement in the Redfish Lake captive broodstock project. The NMFS captive broodstocks are complementary to those reared by the Idaho Department of Fish and Game (IDFG) and are intended to reduce the risk of catastrophic loss of this valuable

gene pool. Historically, captive broodstock fish propagation for Redfish Lake sockeye salmon was conducted under ESA Section 10 Propagation Permit 795 issued to IDFG. However, in 1996, NMFS Northwest Fisheries Science Center, was issued ESA Permit 1005 for NMFS's portion of Redfish Lake sockeye salmon captive broodstock propagation.

The source of NMFS captive broodstocks are juvenile and adult fish captured, held, and spawned by IDFG. Since 1991, only 15 sockeye salmon adults (zero to eight individuals per year) have returned to Redfish Lake. NMFS has captive broodstocks for 1991-, 1993-, 1994-, and 1996-broods (no females returned in 1992, 1995, and 1997). The fish are reared to adult either full term in fresh well water or from smolt to adult in a pumped, filtered, and UV-sterilized seawater system. Pre-spawning adults, eyed eggs, and juveniles are returned to Idaho to aid recovery efforts. Fry to adult survival of 1991-brood fish was about 14% and eyed egg viability of spawners in fall 1994 was about 60%. This spawning produced about 46,500 viable eggs; a direct amplification of about 47 times the 991 1991-brood eggs taken by NMFS into protective culture. Fry to adult survival of 1993-brood fish was about 72% and eyed-egg viability of spawners was about 50-60% in fall 1996-1997. These spawnings produced almost 500,000 viable eggs; a direct amplification of about 250 times the 1,939 1993-brood eggs taken into protective culture. Fry to adult survival of 1994-brood fish was about 55% and eyed-egg viability of spawners was about 75% in fall 1997. This spawning produced almost 70,000 viable eggs; a direct amplification of about 150 times the 461 1994-brood eggs taken into protective culture. The relatively high juvenile survival of other 1994-brood (58%) and 1996-brood (70-77%) in protective culture should result in continued production of up to 400,000 eggs yearly at fish maturity in 1998-2000. It is virtually certain that without the boost provided by these captive broodstocks, Redfish Lake sockeye salmon would soon be extinct.

4. Adaptive management implications: For severely depleted populations, captive broodstocks will often be the only method to rebuild numbers quickly enough to reduce inbreeding or avoid extinction.

5. Years underway: since 1992.

6. Past costs: FY 1993 - $425,700; FY 1994 - $460,000; FY 1995 - $459,300; FY 1996 - $496,000; FY 1997 - $499,000

e. Methods.

The captive broodstock concept differs from that used in conventional hatcheries in that fish of wild origin are maintained in captivity throughout their life. Offspring from captive broodstocks are released to supplement wild populations. The high fecundity of Pacific salmon, coupled with potentially high survival in protective culture, affords an opportunity for captive broodstocks to produce large numbers of juveniles in a single generation for supplementation. The relatively stable egg supply provided through a captive broodstock program should help ensure success of supplementation efforts for depleted stocks.

NMFS is rearing Redfish Lake captive broodstock in circular tanks supplied with fresh well water at the NMFS facility at the University of Washington's Big Beef Creek (BBC) Research Station near Seabeck, Washington and in circular tanks supplied with filtered and ultraviolet light (UV) treated seawater at the NMFS Manchester Marine Experimental Station near Manchester, Washington. Because these fish are listed as endangered under ESA, husbandry research has been deemed infeasible and the fish are not routinely handled during rearing. This precludes documentation of parameters such as growth except as an endpoint measurement. Therefore, survival and primary causes of death are usually the only data documented for these fish.

Historically, captive broodstock fish propagation for Redfish Lake sockeye salmon was conducted under ESA Section 10 Propagation Permit 795 issued to IDFG. However, in 1996, NMFS Northwest Fisheries Science Center, was issued ESA Permit 1005 for NMFS's portion of Redfish Lake sockeye salmon captive broodstock propagation. NMFS provides daily staffing for protective culture of fish, with constant electronic security and facilities monitoring. Staffing during some weekends and holidays may be covered by drop-in site inspections. The fish are reared using standard fish culture practices and approved therapeutics (for an overview of standard methods see Piper et al. 1982, Leitritz and Lewis 1976, Rinne et al. 1986). Generally, juvenile-to-adult rearing density in the tanks will be maintained at under 8 kg/m^3 (0.5 lbs/ft^3) during most of the culture period; however, fish density may range to 15 kg/m^3 (1.0 lbs/ft^3) at maturity. Fish are fed a commercial ration (e.g., Biodiet). Appropriate prophylactic drugs are administered under supervision of a veterinarian during fish rearing. For instance, the diet is modified under FDA New Investigational Animal Drug (INAD) 4333 to contain 0.45% erythromycin and fed at 2% of body weight/day for 28 d on a quarterly basis during rearing as a prophylatic for bacterial pathogens. Mortalities are examined by a fish pathologist to determine cause of death. Select mortalities are frozen or preserved as appropriate for genetic or other analyses. Specimens not vital to analysis or restoration are incinerated or buried. Appropriate statistical analysis will be conducted to compare growth, survival, and reproductive success of stocks of fish.

The NMFS captive broodstocks are complementary to those reared IDFG (BPA Project 9107200) and are intended to reduce the risk of catastrophic loss of this valuable gene pool. Redfish Lake sockeye salmon are reared to maturity at NMFS Manchester and BBC facilities. Prespawning adults, spawn, and juveniles are returned to Idaho for use in recovery programs for Snake River sockeye salmon. Spawners are analyzed for common bacterial and viral pathogens, e.g., bacterial kidney disease (BKD), infectious hematopoietic necrosis virus, etc. NMFS obtains appropriate permits for interstate transport of eggs, fish, and progeny. NMFS coordinates captive broodstock rearing activities through the BPA chaired Stanley Basin Sockeye Technical Oversight

Committee (SBSTOC). Membership on the committee includes representatives from NMFS, IDFG, BPA, the Shoshone-Bannock Tribe, other state and federal agencies, and private groups interested in sockeye salmon restoration in Idaho.

f. Facilities and equipment.

BPA Project 9204000 is being conducted at the NMFS Manchester Marine Experimental Station. The Station is situated on Clam Bay, a small bay adjoining the central basin of Puget Sound. The station is located on 9 hectares of land surplused from the U.S. Navy to NMFS in the late 1960s. The main building at the Manchester Station contains three laboratories, seven offices, and computer and conference rooms. Adjoining the main building is a smaller disease diagnostic laboratory containing a pathology lab, a bioassay lab, and two offices. A new land-based seawater captive broodstock rearing complex at the Station contains three offices, and wet and dry labs, and 400 m^2 of floor space for fish rearing tanks in one building and 1,280 m^2 in another.

A major advantage of the site is the excellent seawater quality. Clam Bay is a major tidal mixing zone between Sinclair and Dyes Inlets to the west and waters of central Puget Sound to the east. Annual seawater temperature at the site normally ranges from 7-13^{o}C and salinity ranges between about 26-29 ppt. The high quality seawater environment, combined with a 250-m pier made available to the station by the EPA Region X Laboratory, make the Manchester Station an excellent site for experimentation/culture of a variety of finfish and shellfish.

A 700-m-long pipeline from the end of the pier supplies about 6,000 L/min (1,500 gpm) of pumped seawater to the Station’s land-base facilities. Water is pumped via 50-hp centrifugal pumps. The system is outfitted with 50-hp backup pumps in case of primary pump failure. An alarm system monitors the pumps and electrical supply and is tied into an automatic dialer system linked to pagers and home and office telephones. Redundant emergency generators are automatically serially activated in the event of a power failure.

The 400 m^2 seawater laboratory contains six 4.1-m and three 1.8-m diameter circular fiberglass tanks and was built especially for sockeye salmon captive broodstock rearing for BPA Project 9204000. The seawater supplied to these tanks is processed to ensure quality. Filtering consists of primary sand filters containing number 20-grade sand; this filters out all organic and inorganic material more than 20 microns in diameter. Water exiting the sand filters immediately enters a secondary cartridge filter system capable of filtering out all material more than 5 microns in diameter. The water then passes through ultraviolet (UV)-sterilizers to inactivate remaining organic material. Flow and pressure sensors monitor flow through the seawater filtration/sterilization system.

Before entering fish rearing tanks, the processed seawater is passed through packed column degassers to strip out any excess nitrogen and to boost dissolved oxygen levels.

Any interruption in water flow activates an emergency oxygen supply to all rearing containers. The Station complies with Washington State quarantine certification standards and all water exiting captive broodstock rearing areas is depuratied.

A freshwater satellite facility for the NMFS Manchester Marine Experimental Station is located at the University of Washington's Big Beef Creek (BBC) Fisheries Research Station near Seabeck, WA (approximately 35 minutes from Manchester). The NMFS fresh water hatchery at BBC was designed as a protective rearing facility for salmonid captive broodstocks. The facility includes a 425-m^2 building and a 600- m^2 outside chain-link fence enclosed fish holding area. The protected rearing building contains 6 4.1-m, and 19 1.8-m diameter tanks. The outside chain-link enclosed rearing area contains, 6 4.1-m and 6 2.1-m diameter circular tanks. A separate hatchery room accommodates down-well incubators for isolated egg incubation. All of the large tanks in the protected rearing areas at BBC are currently dedicated for protected rearing of endangered Redfish Lake sockeye salmon.

The hatchery is supplied with about 500 L/min of creek water and about 2,500 L/min of high-quality 10^{o}C artesian well water. Before entering fish rearing tanks, water is passed through 120-cm-long by 20-cm-diameter packed column degassers which are located at each pool to strip out any excess nitrogen and to boost dissolved oxygen levels. Water flow, fire, and intruder alarms are monitored through a security system linked to pagers and home and office telephones. Any interruption in water flow activates an emergency oxygen supply to all rearing containers. Effluent from the hatchery is depurated through a settling basin and UV-sterilization system. An emergency generator is automatically activated in the event of a power failure.

The unique seawater and freshwater rearing facilities and staff expertise make the NMFS Manchester Station an ideal facility for conducting captive broodstock rearing and research projects.

g. References.

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Schmitten, R., W. Stelle, Jr., and R. P. Jones. 1995. Proposed Recovery Plan for Snake River Salmon. 347 p., plus appendices. (Available from National Marine Fisheries Service, 525 N.E. Oregon, Suite 500, Portland, OR 97232-2737.)

Schmitten, R., W. Stelle, Jr., and R. P. Jones. 1997. Draft Proposed Recovery Plan for Snake River Salmon. (Available from National Marine Fisheries Service, 525 N.E. Oregon, Suite 500, Portland, OR 97232-2737.)

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Teuscher, D., D. Taki, W. A. Wurtsbaugh, C. Luke, P. Budy, H. P. Gross, and G. Steinhart. 1994. Snake River sockeye salmon habitat and limnological research, 1993. Report to Bonneville Power Administration, Contract DE-BI79-91BP22548, 136 p. (Available from Bonneville Power Administration, P.O. Box 3621, Portland, OR.)

Teuscher, D., D. Taki, W. A. Wurtsbaugh, C. Luke, P. Budy, and G. Steinhart. 1995. Snake River sockeye salmon habitat and limnological research, 1994. Report to Bonneville Power Administration, Contract DE-BI79-91BP22548, 137 p. (Available from Bonneville Power Administration, P.O. Box 3621, Portland, OR.)

Teuscher, D., and D. Taki. 1996. Snake River sockeye salmon habitat and limnological research, 1995. Report to Bonneville Power Administration, Contract DE-BI79-91BP22548, 85 p. (Available from Bonneville Power Administration, P.O. Box 3621, Portland, OR.)

Waples, R. S., O. W. Johnson, and R. P. Jones Jr. 1991a. Status review for Snake River sockeye salmon. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS F/NWC-195, 23 p.

Waples, R. S. 1991b. Genetic interactions between wild and hatchery salmonids: lessons from the Pacific Northwest. Can. J. Fish. Aquat. Sci. 48 (Supplement 1):124-133.

Section 8. Relationships to other projects

In December 1991, the National Marine Fisheries Service (NMFS) listed Snake River sockeye salmon (*Oncorhynchus nerka*) as endangered under the U.S. Endangered Species Act (ESA) (Waples et al. 1991a). Snake River sockeye salmon are a prime example of a species on the threshold of extinction. The last known remnants of this stock return to Redfish Lake, Idaho. Since 1991, only 15 sockeye salmon adults (zero to eight individuals per year) have returned to Redfish Lake. On the basis of these critically low population numbers, NMFS, in cooperation with the Idaho Department of Fish and Game (IDFG), the Bonneville Power Administration (BPA), the Shoshone-Bannock Tribe, and others, implemented a captive broodstock project as an emergency measure to save Redfish Lake sockeye salmon. The Redfish Lake project is intended as a stop-gap measure until migration and rearing habitat improvements can be implemented to increase survival.

The NMFS captive broodstocks (BPA Project 9204000) are complementary to those reared IDFG (BPA Project 9107200) and are intended to reduce the risk of catastrophic loss of this valuable gene pool. The program interconnections are multifaceted. In addition to population amplification through the NMFS and IDFG captive broodstock programs, necessary habitat improvements are being undertaken by the Shoshone-Bannock Tribe (BPA Project 9107100), and genetic monitoring is being conducted by the University of Idaho (BPA Project 9009300). Research to refine captive broodstock technology (BPA Project 9305600) should help improve broodstock performance and maximize their contribution to recovery goals. In upcoming years, the captive broodstock programs should provide hundreds of adults and hundreds of thousands of eggs for use in recovery efforts in Idaho.

NMFS is coordinating captive broodstock rearing activities for Redfish Lake sockeye salmon through the BPA chaired Stanley Basin Sockeye Technical Oversight Committee (SBSTOC). Membership on the committee includes representatives from NMFS, IDFG, BPA, the Shoshone-Bannock Tribe, other state and federal agencies, and private groups interested in sockeye salmon restoration in Idaho.

Section 9. Key personnel

1. Mr. Thomas A. Flagg, Fisheries Research Biologist. Principal Investigator @ 50% FTE. Duties include internal project oversight; project coordination with IDFG, Stanley Basin Sockeye Technical Oversight Committee, and others; Data analysis and report writing; etc. [See attached resume for qualifications.]

2. Mr. Wm. Carlin McAuley, Endangered Species Biologist. Hatchery Manager @ 67% FTE. Duties include all phases of fish husbandry and hatchery oversight/coordination. [See attached resume for qualifications.]

3. Mr. Michael R. Wastel, Fisheries Biological Technical. Hatchery support staff @ 67% FTE. Duties include fish husbandry. [See attached resume for qualifications.]

4. Ms. Deborah Frost, Fisheries Biologist. Hatchery biologist @ 100% FTE. Duties include fish husbandry at the BBC hatchery. [See attached resume for qualifications.]

5. Dr. Lee W. Harrell, Veterinarian. Fish Pathologist @ 15% FTE. Duties include oversight of fish health issues. [See attached resume for qualifications.]

CURRICULUM VITAE--**THOMAS ALVIN FLAGG**

Education: B.S. (Fisheries Biology), University of Washington, Seattle, WA; 1976.
M.S. (Fisheries Biology), University of Washington, Seattle, WA; 1981.

Employer: National Marine Fisheries Service, Northwest Fisheries Science Center, Resource Enhancement & Utilization Technologies Division.

Position: Fisheries Research Biologist, NMFS employee since 1978.

Present assignment: Team Leader, Salmon Enhancement Projects. Responsibilities include: development of captive broodstock programs to conserve depleted gene pools of salmonids; development of supplementation techniques for restoration of depleted stocks of salmonids to their native habitats; and development of fish husbandry technology to produce wild-type juvenile salmon for release from hatcheries.

Previous research/expertise: Included research associated with: determination of status of depleted stocks of fish including those proposed for listing as threatened or endangered under the Endangered Species Act; development of the passive integrated transponder (PIT) tagging system for salmonids; development of freshwater and seawater net-pen aquaculture husbandry and captive broodstock techniques for Atlantic and Pacific salmon (including research in the areas of aquaculture systems design and development, stock rearing strategies, nutrition, disease investigations, maturation and spawning, hormonal sex reversal, smoltification, and stock performance); investigation of fish-collection and transportation related mortalities in juvenile salmonids in the Columbia River system; evaluation of the impact of the 1980 Mt. St. Helens eruption on juvenile salmonids in the Columbia River system; and investigation of the relationship between swimming behavior, smoltification status, and seawater survival for coho salmon.

Mr. Flagg has participated in a number of captive broodstock programs for Pacific and Atlantic salmon. He has written a number of articles on captive broodstocks, including:

Flagg, T. A., and C. V. W. Mahnken (editors). 1995. An assessment of captive broodstock technology for Pacific salmon. Report to Bonneville Power Administration, Contract DE-AI79 93BP55064. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Flagg, T. A., C. V. W. Mahnken, and K. A. Johnson. 1995. Captive broodstocks for recovery of depleted populations of Pacific salmon. Am. Fish. Soc. Symp. 15:81-90.

Flagg, T. A., F. W. Waknitz, and C. V. W. Mahnken. 1995. The captive broodstock concept: application to Pacific salmon, pp. 1-1 - 1-60 (1995b). *In* T. A. Flagg and C. V. W. Mahnken (eds.), An assessment of captive broodstock technology for Pacific salmon. Report to Bonneville Power Administration, Contract DE-AI79 93BP55064. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.)

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Schiewe, M. H., T. A. Flagg, and B. A. Berejikian. 1997. The use of captive broodstocks for gene conservation of salmon in the western United States. Bull. Natl. Res. Inst. Aquacult., Suppl. 3:29-34.

CURRICULUM VITAE--**W. Carlin McAuley**

Education: B.S. Zoology, University of Washington, 1973.

Training: Fish Disease Control Course, Oregon State University, Marine Science Center, 80 hours, 1987.

Employer: National Marine Fisheries Service, Northwest Fisheries Science Center, Resource Enhancement & Utilization Technologies Division.

Position: Endangered Species Biologist, NMFS employee since 1991.

Present assignment: Hatchery Manager for NMFS Manchester Marine Experimental Station captive broodstock programs for recovery of ESA-listed endangered Redfish Lake sockeye salmon and threatened Snake River spring/summer chinook. Responsible for every aspect of life cycle including feed rations, disease detection and control, detailed record database, and spawning.

Previous research/expertise: Conducted research into captive broodstock programs using non endangered Lake Wenatchee sockeye salmon captive broodstock (BY 1990 and 1991) reared in three different environments. Responsible for daily care including feed, disease detection and control, detailed record database, spawning, and egg incubation. Provided support for other researchers investigating physiological developments in these same fish. Specialized skills include various fish tagging techniques (coded wire tag, PIT tag, elastomer tag, freeze branding), and Fluorescent Antibody Technique for detection of fish disease pathogens. Provided aquaculture consulting to Domsea Farms Inc. Primarily responsible for continuation of 13 year genetics breeding program for captive broodstocks of Pacific salmon at Domsea Farms. Duties consisted of management of captive breeding program of fish reared in freshwater, including collection and input of data into genetics database, tracking and maintaining separate identity of 40 families, and decision making for various program steps

Mr. McAuley has participated in a number of captive broodstock programs for Pacific salmon. He has authored or coauthored a number of articles on captive broodstocks, including:

McAuley, W. C. 1981a. DOMSEA coho broodstock program. *In* T. Nosho (editor), Salmonid broodstock maturation, p.23-24. Proceedings of the salmonid broodstock maturation workshop. University of Washington Sea Grant Pub. WSG-WO-80-1.

McAuley, W. C. 1981b. DOMSEA coho broodstock program-update. *In* T. Nosh (editor), Salmonid broodstock maturation, p.65-66. Proceedings of the salmonid broodstock maturation workshop. University of Washington Sea Grant Pub. WSG-WO-80-1.

Flagg, T. A., and W. C. McAuley. 1993. Redfish Lake sockeye salmon captive broodstock rearing and research, 1991-1993. Report to Bonneville Power Administration, Contract DE-A179-92BP41841.

Flagg, T. A., W. C. McAuley, M. R. Wastel, D. A. Frost, and C. V. W. Mahnken. 1996. Redfish Lake sockeye salmon captive broodstock rearing and research, 1994. Report to Bonneville Power Administration, Contract DE-AI79 92BP41841, 98 p.

CURRICULUM VITAE--**Michael R. Wastel**

Education: A.S. Fisheries - Peninsula College, 1977.

Training: Business College Computer Classes 1987, 1989. U.S. Fish & Wildlife Service Fish Disease Course, 1990.

Employer: National Marine Fisheries Service, Northwest Fisheries Science Center, Resource Enhancement & Utilization Technologies Division.

Position: Fisheries Biological Technician, NMFS employee since 1992.

Present assignment: Provide technician support for NMFS Manchester Marine Experimental Station captive broodstock programs for recovery of ESA-listed endangered Redfish Lake sockeye salmon and threatened Snake River spring/summer chinook. Lead contact for construction of captive broodstock research facilities for freshwater and seawater rearing at Manchester. Responsible for aspect of life cycle culture including feed rations, disease detection and control, detailed record database, and spawning.

Previous work experience/expertise: 1991-1992**--**Fisheries Technician, Steelhead Stock Assessment Program, Washington Department Fish and Wildlife, Olympia, Washington. Responsible for the collection of data on steelhead life histories for 22 Washington State rivers, all tributaries of the Columbia River. 1980-1991--Hatchery Manager, Fisheries Research Division, Domsea Farms Inc. Gorst Creek Hatchery, Gorst, Washington. Supervised and participated in all phases of hatchery operations. Responsible for all fish rearing activities. Worked on both production and broodstock programs. Supervised six employees. Assigned work schedules. Formulated fiscal budget. Produced monthly reports. Maintained hatchery systems including; wells, pumps, generators and alarm system. Expanded and upgraded hatchery incubation. Installed additional tanks. Assisted in the formation of coho salmon broodstock program which produced fish with superior growth and survival rates. As the offspring of fish from the broodstock program outperformed all other hatchery fish, the program expanded and became a major part of my responsibilities.

Mr. Wastel has participated in a number of captive broodstock projects for Pacific salmon. He has coauthored articles on fisheries and captive broodstocks, including:

Hymer, J., R. Pettit, M. Wastel, P. Hahn, and K. Hatch. 1992. Stock Summary reports for Columbia River Anadromous Salmonids, Volume 3. BPA, Division of Fish and Wildlife, Project No. 88-108.

Flagg, T. A., W. C. McAuley, M. R. Wastel, D. A. Frost, and C. V. W. Mahnken. 1996. Redfish Lake sockeye salmon captive broodstock rearing and research, 1994. Report to Bonneville Power Administration, Contract DE-AI79 92BP41841, 98 p.

CURRICULUM VITAE--**Deborah A. Frost**

Education: A.A. - Lower Columbia College, 1984.
B.S. Zoology - University of Washington, 1986.

Employer: National Marine Fisheries Service, Northwest Fisheries Science Center, Resource Enhancement & Utilization Technologies Division.

Position: Fisheries Biologist, NMFS employee since 1990.

Present assignment: NMFS Manchester Marine Experimental Station. Duties include daily oversight of the Big Beef Creek Hatchery. Directly involved with the daily culture of captive Redfish Lake sockeye salmon through all life phases. Includes maintaining strict isolation procedures for these fish, administering medicated feed on schedule, analyzing mortalities and conducting fluorescent antibody technique (FAT) procedures for bacterial kidney disease. Organized the PIT tagging of current brood year classes of fish. Maintain daily records of feed, mortality, and water temperature for all fish.

Previous work experience/expertise: Fisheries Biologist, Manchester Field Station and Big Beef Creek Research Facility as part of the PIT tag biological feasibility program. Assisted in the development and evaluation of various passive integrated transponder (PIT) tag systems for fish. Involved with conducting captive broodstock culture and growth research on non-endangered Lake Wenatchee sockeye salmon (organized the PIT tagging of this group of fish as well as the monthly collection of growth data). Observed salmon behavior with respect to various PIT-tag interrogation passageway models in lab and stream. Conducted various comparative tagging predation and survival studies in rearing pools and in a natural stream. Involved in the initial natural feed and habitat rearing methods for the NMFS NATURES program. Involved in a study to test a model for survival estimates for juvenile chinook salmon passage through Snake River dams and reservoirs. This consisted of assembling a PIT tagging station and relocating it to different sites on the Snake River, PIT tagging chinook salmon, teaching others to PIT tag salmon and operate digitizer board, and maintaining and uploading tagging data to the database.

Ms. Frost’s publication record includes:

Maynard, D. J., D. A. Frost, F. W. Waknitz, and E. F. Prentice. 1996. Vulnerability of marked age-O Steelhead to a visual predator. Transactions of the American Fisheries Society 125:330-333.

Flagg, T. A., W. C. McAuley, M. R. Wastel, D. A. Frost, and C. V. W. Mahnken. 1996. Redfish Lake sockeye salmon captive broodstock rearing and research, 1994. Report to Bonneville Power Administration, Contract DE-AI79 92BP41841, 98 p.

Prentice, E. F., D. J. Maynard, S. L. Downing, D. A. Frost, M. S. Kellett, D. A. Bruland, P. Sparks-McConkey, F. W. Waknitz, R. N. Iwamoto, K. McIntyre, and N. Paasch. 1994. A Study to Determine the Biological Feasibility of a New Fish Tagging System (1990-93). Report to Bonneville Power Administration, Contract DE-AI79-84BP11982, 209 p. + appendices.

Iwamoto, R. N., W. D. Muir, B. P. Sandford, K. W. McIntyre, D. A. Frost, J. G. Williams, S. G. Smith, and J .R. Skalski. 1994. Survival Estimates for the Passage of Juvenile Chinook Salmon Through Snake River Dams and Reservoirs, Annual Report 1993. Report to Bonneville Power Administration, Contract DE-AI79-93BP10891, 126 p. + appendix tables.

CURRICULUM VITAE--**Lee W. Harrell**

Education:

- B.S. (Animal Husbandry). University of Florida, Gainesville, FL. 1960.
- D.V.M. (Veterinary Medicine). Auburn University, Auburn, AL. 1964.
- M.S. (Fisheries Biology). University of Washington, Seattle, WA. 1973.

Professional Certifications: Certified Fish Pathologist (AFS) #35; Washington State Veterinary practice license # 653; Florida State Veterinary license # 857.

Employer: National Marine Fisheries Service, Northwest Fisheries Science Center, Resource Enhancement & Utilization Technologies Division.

Position: Fisheries Research Biologist/Veterinarian, NMFS employee since 1973.

Present assignment: Manager of Fish Health projects, Manchester Experimental Station. Duties include fish disease diagnosis and treatment; conducting research on freshwater and marine diseases of salmonids; and involvement in broodstock restoration methods. Pathologist representative, Pacific Northwest Fish Health Protection Committee. Consulting Veterinarian, Washington State Department of Fisheries and Wildlife.

Previous research/expertise: Included: research associated with all phases of salmonid fish health and disease diagnosis and treatment; development of freshwater and seawater net-pen aquaculture husbandry; development of captive broodstock techniques for Atlantic and Pacific salmon. Dr. Harrell has authored or coauthored a number of articles on captive broodstocks and fish health, including:

Harrell, L. W., C. V. W. Mahnken, T. A. Flagg, E. F. Prentice, F. W. Waknitz, J. L. Mighell, and A. J. Novotny. 1984. Status of the NMFS/USFWS Atlantic salmon brood-stock program (Summer 1984). Annual report of research (to NMFS/NER). 16 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, Washington 98112.)

Harrell, L. W., T. A. Flagg, and F. W. Waknitz. 1987. Snake River Fall Chinook Salmon Broodstock Program, 1981-1986. Final report to Bonneville Power Administration. 24 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, Washington 98112.)

R. A. Elston, L. W. Harrell, and M. T. Wilkinson. 1986. Isolation and in vitro characteristics of chinook salmon *Oncorhynchus tshawytscha* rosette agent. Aquaculture 56:1-21.

R. A. Elston, M. L. Kent, and L. W. Harrell. 1987. An intranuclear microsporidium associated with acute anemia in the chinook salmon, *Oncorhynchus tshawytscha*. J. Protozool. 34(3):274 277.

Harrell, Lee W. 1995. Fish health aspects of broodstock restoration, pp. 5-1 - 5-14. *In* T. A. Flagg and C. V. W. Mahnken (eds.), An assessment of captive broodstock technology for Pacific salmon. Report to Bonneville Power Administration, Contract DE-AI79 93BP55064. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Section 10. Information/technology transfer

Information/technology transfer methods will include: BPA contract reports; journal publications; participation in conferences and workshops; etc. In addition, projects related to recovery efforts for ESA-listed Snake River sockeye salmon are being coordinated through the BPA chaired Stanley Basin Sockeye Technical Oversight Committee (SBSTOC). Membership on the committee includes representatives from NMFS, IDFG, BPA, the Shoshone-Bannock Tribe, other state and federal agencies, and private groups interested in sockeye salmon restoration in Idaho. Project information will be provided to SBSTOC members at SBSTOC meetings.