Appendix E
HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Washington Department Fish and Wildlife

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of Program

Lake Wenatchee Sockeye Salmon Supplementation Program - Rock Island Fish Hatchery Complex

1.2) Population (or stock) and species

Little Wenatchee River and White River sockeye salmon (*Oncorhynchus nerka*)

1.3) Responsible organization and individual:

Name(and title): Washington Department Fish and Wildlife
Organization: " "
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Other organizations involved, and extent of involvement in the program:

The sockeye supplementation program is funded by Public Utility District Number 1 of Chelan County for the purpose of mitigation for lost fish production associated with hydroelectric power system development in the region. The program is authorized under the Mid-Columbia Mainstem Conservation Plan (BAMP 1998), and the parties to this plan are therefore involved in short and long-term production planning.

1.4) Location(s) of hatchery and associated facilities:

Broodstock Capture: Tumwater Dam Trap - Wenatchee River Basin (WRIA 45- 0030), Washington. Located at the top of Tumwater Dam on the Wenatchee River at Rkm 52.0.
Broodstock Holding to Maturity: Lake Wenatchee net-pens - Wenatchee River Basin (WRIA 45-0030), Washington. Located in Lake Wenatchee (Rkm 91.0) near the mouths of the Little Wenatchee and White rivers.
Fish Spawning, Incubation, Rearing: Eastbank Hatchery - Columbia River Basin, Washington. Located on the east side of the Columbia River near Rocky Reach Dam, 7 miles north of Wenatchee, Washington.
Rearing to release: Lake Wenatchee net-pens - Wenatchee River Basin (WRIA 45-0030), Washington. Located in Lake Wenatchee (Rkm 91.0) near the mouths of the Little Wenatchee and White rivers.

1.5) Type of program:

The Lake Wenatchee sockeye operation is an "integrated harvest" program.

1.6) Purpose (Goal) of program:

The goal of this program is to mitigate for the loss of sockeye salmon that would have been produced in the Wenatchee River system in the absence of hydroelectric dam development in the Columbia Basin. This goal can be met through the use of the artificial environment of fish rearing facilities to increase the overall productivity of the population by increasing survival at life-history stages where competitive or environmental bottlenecks occur. Concurrently, a release strategy for artificial production is employed that will not create a new bottleneck in productivity through competition with the naturally produced component of the population.

1.7) Specific performance objective(s) of program:

(1) increase hatchery production incrementally over several salmon generations, while closely monitoring the distribution, demographics, and abundance of natural fish in the region,
(2) determine the levels of hatchery production that are consistent with the objective of maintaining sustainable natural productivity using criteria set forth in the MCMCP (BAMP 1998),
(3) defer increases in hatchery production if the natural escapement is not increasing in proportion to the total run,
(4) clearly identify the factors limiting production, and design artificial propagation strategies that circumvent these limitations, and
(5) use release strategies that minimize impacts to juvenile natural fish

1.8) List of Performance Indicators designated by "benefits" and "risks":

Benefits:
(1) the pre-release egg-to-parr survival rate of hatchery-reared juvenile sockeye salmon,
(2) the post-release growth of hatchery-reared juvenile sockeye,
(3) populations sizes for hatchery and wild juvenile sockeye emigrating from Lake Wenatchee, and
4) smolt-to-adult survival rate of Lake Wenatchee sockeye through extensive spawning surveys.
Risks:
(1) the release strategy for net pen reared sockeye salmon,
(2) the extent of predation/mortality during the release period,
(3) physical characteristics of Lake Wenatchee and the Wenatchee River that initiate emigration,
(4) annual and long-term changes in the spawning distribution of the donor population.
(5) hatchery adults spawning within the established spawning area of the donor population to replace adults taken for broodstock,
(6) effective reproduction by hatchery-reared adults in terms of distribution with the naturally produced spawners, timing, and habitat use.
(7) difference in the spawn timing of wild and hatchery fish.

1.9) Expected size of program:

Expected releases:
The program was initiated in 1989 with an annual production objective of 200,000 smolts. Smolt release totals for the 1989 through 1993 brood years have been as follows:

Table 1. Lake Wenatchee Sockeye Salmon supplementation program smolt release numbers.

Brood Year	Number of Sockeye Released
1989	260,400
1990	372,102
1991	167,523
1992	340,557
1993	190,443

Future increases in the number of sockeye produced each year through this program are proposed within the MCMCP (1998). To increase production of sockeye salmon in the Wenatchee River in future years, the net pens at Lake Wenatchee may be enlarged by 225% to acclimate and release an additional 450,000 sockeye salmon. Seventeen net pens would be required to meet the total production goal (650,000 yearling pre-smolts). As an alternative, one or both of the following strategies could be used in lieu of some of the proposed future net pen production:

1) A small acclimation unit could be built on White River (near the Sears Creek confluence), to be used for sockeye salmon. The pond would acclimate and release 75,000 sub-yearling sockeye salmon in fall.
2) Eastbank FH could incubate and early rear, and Turtle Rock Hatchery will overwinter 150,000 sockeye salmon to a yearling stage for a March release into upper Lake Wenatchee.

Adult fish produced/harvested:
The most recent five-year average annual escapement for Wenatchee Basin sockeye salmon is either 9,000 (Gustafson et al. 1997) or 26,000 (MCMCP 1998). Smolt to adult survival for sockeye produced in the Lake Wenatchee program has been estimated as 0.4 % to about 2 % (Chapman et al. 1995), with an historic baseline survival rate of 0.7 % (MCMCP 1998). Brood year 1989 sockeye produced through the program were estimated to have an overall survival rate (fishery harvest plus escapement) of 2.3 % (Chapman et al. 1995)

Escapement goal:
The program requires the capture and spawning of 300 adults each year to meet current program production objectives. The WDFW escapement goal for Wenatchee River sockeye upstream of Tumwater Dam is 23,000 (Eltrich et al. 1995). A baseline adult production objective for the sockeye salmon population reaching Rocky Reach Dam is

30,293 (MCMCP 1998).

1.10) Date program started or is expected to start:

The program was started in 1989.

1.11) Expected duration of program:

The supplementation program will continue with the objective of mitigating the loss of sockeye salmon productivity caused by hydroelectric dams in the Columbia River Basin.

1.12) Watersheds targeted by program:

Sockeye salmon propagated through the program originated from broodstock indigenous to the Little Wenatchee and White river systems. Both of these rivers are tributary to Lake Wenatchee, which outlets as the Wenatchee River (WRIA 45-0030) at Rkm 89.5.

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SECTION 2. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

2.1) List all existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which program operates. Indicate whether this HGMP is consistent with these plans and commitments, and explain any discrepancies.

The supplementation program, and the HGMP describing it, are consistent with the following agreements or plans:

- The Mid-Columbia Mainstem Conservation Plan - Hatchery Plan (BAMP 1998).
- The Rock Island Settlement Agreement (RISA 1989) between Chelan Public Utilities District, their power purchasers, and the joint fishery parties represented by Washington Department of fish and Wildlife and other state and federal fishery agencies and tribes.

2.2) Status of natural populations in target area.

Sockeye (target populations) -

The natural populations targeted for supplementation include sockeye spawning in the Little Wenatchee and White rivers. The recent 5-year escapement for this ESU was about 26,000 adult sockeye salmon and the recent (1985-1994) abundance trend has been declining about 4% per year, with a single low abundance in 1994. The long-term (1961-1994) abundance trend shows an increase of about 1% per year (Gustafson et al. 1997). Competition for food may play a role in the mortality of juvenile sockeye (Mullan 1986). Predation also limits production of sockeye salmon (Beauchamp et al. 1995; Wahle et al. 1979; Thompson and Tufts 1967). Chapman et al. (1994b) suggest that the low productivity of Lake Wenatchee may increase the vulnerability of juvenile sockeye salmon to predation.

WDF et al. (1993) classified Lake Wenatchee sockeye as of mixed origin, wild production, and healthy status. In the 1997 "Status Review of Sockeye Salmon from Washington and Oregon", NMFS indicated that Lake Wenatchee sockeye were not in danger of extinction, nor were they likely to become so in the foreseeable future (Gustafson et al. 1997).

Other salmonid species -
Several salmonid species in the target area are listed as "endangered" or "threatened" under the ESA. Upper Columbia River ESU steelhead and Upper Columbia River ESU spring chinook are listed as "endangered", and Columbia River population segment bull trout are listed as "threatened". Summer/fall chinook salmon in the region were judged as neither in danger of extinction or likely to become so in the foreseeable future by NMFS in the west coast chinook salmon species status review (Myers et al. 1998). Other ESA-listed species of significance to the sockeye salmon supplementation program include those that originate in other watersheds within the Columbia River Basin: Middle Columbia River ESU steelhead - "threatened"; Snake River ESU sockeye - "endangered"; Snake River ESU spring chinook - "threatened"; Snake River ESU fall chinook - "threatened"; Snake River ESU steelhead - "threatened"; Lower Columbia River ESU chinook - "threatened"; Lower Columbia River ESU chum - "threatened"; Lower Columbia River ESU steelhead - "threatened"; and Lower Columbia/Southwest Washington ESU coastal cutthroat - "threatened".

2.2.1) Geographic and temporal spawning distribution.

Wenatchee sockeye salmon spawn primarily in the White River and secondarily in the Little Wenatchee River (French and Wahle 1959; Wahle et al. 1979). Wenatchee sockeye broodstock enter freshwater from mid-June through mid-August (Gustafson et al. 1997) and are collected at Tumwater Dam between the second and fourth week in July (WDFW 1997). Wenatchee sockeye spawn in the tributaries during the last two weeks of September and early October, with peak spawning occurring during the last week of September (Gustafson et al. 1997; Chapman et al. 1995).

2.2.2) Annual spawning abundance for as many years as available.

Table 2. Lake Wenatchee Sockeye Salmon spawning abundance estimates from Tumwater Dam counts (1988-1994) (Chapman et al. 1995).

Return Year	Tumwater Dam Sockeye Count

Return Year	Tumwater Dam Sockeye Count
1988	7,530
1989	20,077
1990	32,033
1991	19,799
1992	16,756
1993	14,817
1994	6,033

2.2.3) Progeny-to-parent ratios, survival data by life-stage, or other measures of productivity for as many brood years as available.

Progeny to parent survival rates:

Smolt to adult survival for sockeye produced in the Lake Wenatchee supplementation program has been estimated as 0.4 % to about 2 % (Chapman et al. 1995), with an historic baseline survival rate of 0.7 % (MCMCP 1998). Brood year 1989 sockeye produced through the program were estimated to have an overall survival rate (fishery harvest plus escapement) of 2.3 % (Chapman et al. 1995). Table 3 presents survival data by life stage for the sockeye supplementation program (from Eltrich et al. 1995 and Petersen et al. 1997).

Table 3. Lake Wenatchee sockeye salmon supplementation program survival summary by life stage (1989-1993 brood years).

Percent survival by life stage	Brood Year				
	1989	1990	1991	1992	1993
Adult (holding)	56.0	96.4	91.0	94.2	67.4
Egg	85.6	88.3	79.2	92.3	89.2
Fry	94.4	96.3	94.8	97.3	98.3
Rearing	98.1	97.4	96.4	98.8	93.8
Overall (fertilization to release)	**79.3**	**82.8**	**72.4**	**89.2**	**82.2**

2.2.4) Annual proportions of hatchery and natural fish on natural spawning grounds for as many years as possible.

Returns of 1989 brood hatchery-origin sockeye in 1993 and 1994 were estimated at 4,133 in the Wenatchee Basin (Chapman et al. 1995). The estimated total number of sockeye passing Tumwater Dam in 1993 and 1994 was 20,850 (Chapman et al. 1995). For those two return years, hatchery-origin sockeye comprised 19.0 % of the total estimated escapement into the Basin.

2.2.5) Status of natural population relative to critical and viable population thresholds.

The natural Lake Wenatchee sockeye salmon population is healthy in status (WDF et al. 1993) and has been judged as not warranting listing under ESA protective provisions (Gustafson et al. 1997).

2.3) Relationship to harvest objectives:

The sockeye supplementation program is a component of the *Mid-Columbia Hatchery Program*, a part of an application for a 50-year multi-species Habitat Conservation Plan (HCP) and relicensing agreement for the PUDs. This plan has two objectives: (1) to help recover natural populations throughout the Mid-Columbia Region so that they can be self-sustaining and harvestable, while maintaining their genetic and ecologic integrity; and (2) to compensate for a 7% mortality rate at each of the five PUD-owned mid-Columbia River mainstem dams (Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids) in a manner that is consistent with the first objective. Through the regional hatchery plan, the sockeye artificial production program has been integrated with harvest management objectives to provide run size enhancement and fishery benefits. Biological risks to listed species in the Columbia Basin posed by hatchery sockeye releases, including predation, competition, and disease transfer, are expected to be minimal.

Lake Wenatchee sockeye have been harvested incidentally in lower Columbia River fisheries directed at other species. Directed sport fisheries in Lake Wenatchee have also been allowed in years where the escapement goal of 23,000 was expected to be met or exceeded. Past harvest rates for Lake Wenatchee can be estimated as follows: total sockeye run size estimates for fish passing Bonneville Dam and lower river sockeye harvest estimates can be used estimate lower river sockeye exploitation rates; and Tumwater Dam sockeye counts can be compared with Lake Wenatchee sport catch estimates to estimate terminal area harvest rates. Table 4 presents lower river, terminal area, and total harvest rate estimates for the total Lake Wenatchee sockeye run. Hatchery origin fish may comprise 20 % of the total number of sockeye harvested, with natural-origin fish making up the balance.

Table 4. Lake Wenatchee Sockeye Salmon harvest rate estimates - 1988-1994 (data from Chapman et al. 1995).

Return Year	Lower River Harvest Rate	Tumwater Dam Sockeye Count	Lk Wenatchee Sport Catch	Terminal Harvest Rate	Total Basin Harvest Rate
1988	79.8	7,530	0	0	79.8
1989	4.9	20,077	0	0	4.9
1990	5.2	32,033	6,523	20.4	25.6
1991	4.6	19,799	6,311	31.8	36.4
1992	2.8	16,756	3,565	21.3	24.1
1993	0.8	14,817	7,039	47.5	48.3
1994	0.8	6,033	0	0	0.8

Given low run sizes for this population in recent years, and fishery protection measures implemented in lower river and Wenatchee Basin areas to protect ESA-listed salmonid populations, future harvest rates (if any) on fish propagated by the program and on natural populations in the target area are expected to be lower than the average rate observed for the 1988-94 period, and likely below five percent.

2.4) Relationship to habitat protection and recovery strategies.

Production of Wenatchee sockeye salmon is primarily limited by oligotrophic conditions in Lake Wenatchee (the sole rearing lake) (BAMP 1998). Lake Wenatchee is reported to be one of the least productive sockeye rearing lakes in North America (Allen and Meekin 1980), yet habitat and migration conditions are generally considered fair to good in this basin (Mullan 1986; BAMP 1998). NMFS expressed concerns about the effects of hydropower development in the Columbia River on the health of Lake Wenatchee sockeye (Gustafson et al. 1997). The main fresh-water habitat problem presently facing this ESU is hydropower dams in the mainstem Columbia River, which have probably reduced returns of sockeye salmon (Chapman et al. 1995). Measures taken by the Mid-Columbia PUDs to improve natural production of anadromous fish in the region will compensate for mortality in project and reservoir passage. Two strategies will be used: (1) habitat protection and restoration, and (2) hatchery production of affected species in the mainstem mid-Columbia River and in the four major tributaries, including the Wenatchee River.

Bugert et al. (1997a) maintain that the spawning habitat for the Wenatchee population is highly susceptible to degradation or loss. This may greatly affect the viability of naturally produced sockeye salmon. In the Wenatchee Watershed, most sockeye salmon spawn in the lower 15 km of the White River, which is vulnerable to housing development. Bugert et al. (1997a) identified this as the single most important habitat to protect in the Wenatchee Watershed.

The supplementation program for Wenatchee River sockeye salmon is based on the premise that current stock productivity has a major limiting factor because of low spring zooplankton production in Lake Wenatchee (BAMP 1998). Mullan (1986) hypothesized that low zooplankton densities limited growth and survival of sockeye fry in Lake Wenatchee from fry emergence through early summer, particularly in years with high snow accumulations and resultant nutrient flushing from the lake. The existing production and proposed additional production is designed to circumvent this bottleneck by providing rearing in net pens until fall or late summer, when zooplankton densities are much higher. This strategy is based on the concept that release of juveniles in late summer to fall will not reduce survival of naturally produced sockeye rearing in the lake because food is abundant in late summer and winter survival is probably not density dependent.

Habitat protection efforts, combined with production from the sockeye supplementation program, are expected to benefit natural sockeye production over the short-term and long-term. Improvements in dam passage survival rates, and circumvention of bottlenecks to productivity afforded by the sockeye supplementation program will be used to boost the populations to a level approaching or exceeding 32,000.

2.5) Ecological interactions

Salmonid and non-salmonid fishes or other species that could:
(1) negatively impact program;
Most sockeye salmon emigrate from Lake Wenatchee as smolts in spring (French and Wahle 1959; Mullan 1986). Competition for food may play a role in the mortality of juvenile sockeye (Mullan 1986). Predation also limits production of sockeye salmon (Beauchamp et al. 1995; Wahle et al. 1979; Thompson and Tufts 1967). Chapman et al. (1994) suggest that the low productivity of Lake Wenatchee may increase the vulnerability of juvenile sockeye salmon to predation.

Wild-origin bull trout indigenous to the Wenatchee Basin pose a predation risk to natural and hatchery-origin sockeye (BAMP 1998). Due to their relatively large size, natural and hatchery-origin steelhead, spring chinook, and coho salmon yearlings may also pose a predation risk to rearing and migration sockeye juveniles, in the Wenatchee Basin and in the Columbia mainstem. SIWG (1984) reported a high risk that freshwater predation by coho, chinook, cutthroat trout, steelhead, and bull trout will have a significant negative impact on the productivity of enhanced sockeye populations. A high predation risk ranking was also assigned for northern pike minnow, coastrange sculpin, and prickly sculpin (SIWG 1984). Threespine stickleback were determined to pose a high risk of adverse competitive effects on enhanced sockeye.

(2) be negatively impacted by program;
SIWG (1984) reported that there is a low risk that enhanced sockeye populations would

negatively effect the productivity of any wild salmonid species through predation or competition. Large concentrations of migrating hatchery sockeye may attract predators (birds, fish, and seals) and consequently contribute indirectly to predation of listed wild fish (Steward and Bjornn 1990). The presence of large numbers of hatchery fish may also alter wild sockeye behavioral patterns, potentially influencing their vulnerability and susceptibility to predation.

(3) positively impact program;
Increased numbers of spring chinook, steelhead, and bull trout that escape to spawn in tributaries to Lake Wenatchee may contribute nutrients to the lake upon dying that would benefit sockeye productivity.

(4) be positively impacted by program.
Sockeye released from the Wenatchee net-pens may benefit co-occurring salmonid populations. A mass of hatchery fish migrating through an area may overwhelm established predator populations, providing a beneficial, protective effect to co-occurring wild fish.

SECTION 3. WATER SOURCE

Adult sockeye used as broodstock in the supplementation program are captured at Tumwater Dam on the Wenatchee River, which is the home water source for the target population. Captured adult fish, and fingerling fish reared to smolt size for release, are held in net-pens in Lake Wenatchee, which is the sole waterbody used for adult holding and juvenile rearing by the natural sockeye population. There are no differences between the water used for these portions of the supplementation program and water used by the naturally spawning population. Incubation to swim-up stage occurs at Eastbank Hatchery. Eastbank Hatchery uses well water at a volume of up to 10 cfs for the salmon rearing operation. The quality of well water used by the hatchery is high, and adequate to ensure the health of salmonids propagated.

SECTION 4. FACILITIES

Descriptions of the physical plants listed in this section -
Attached as Figures 1 and 2 are plan views of the Eastbank Hatchery and Lake Wenatchee net-pen facilities (from IHOT 1995). The Tumwater Dam trap is operated to collect sockeye salmon broodstock, and to assess the status of Lake Wenatchee sockeye salmon returns.

For programs that directly take listed fish for use as brood stock, provide detailed information on catastrophe management, including safeguards against equipment failure, water loss, flooding, disease transmission, or other events that could lead to

a high mortality of listed fish -
As a run-of-the-river operation, the Tumwater Dam sockeye trapping program may lead to the direct take of co-migrating listed species, including Upper Columbia River ESU steelhead and spring chinook, and Columbia River population segment bull trout. Direct takes of these listed species at the Tumwater Dam trap are authorized through Section 10 direct take permits #1094 (steelhead) and # 1196 (spring chinook), and under a Section 6 cooperative management agreement with the USFWS (bull trout). Risk aversion measures associated with the trapping operations are detailed in WDFW permit applications for these authorizations and within the permits themselves. No other portions of the sockeye program are expected to lead to the direct take of listed fish.

The trap will be operated three days per week from June 9 through November 14 each year, with sockeye trapping concentrated in the mid and later portion of July only. The trap will be in active operation 16 hours per day during the three days per week that it will be open. Downstream migrating fish can pass the trapping operation freely. Frequent monitoring and operation of the trap minimizes the risk of fish loss. Water loss is not a potential risk factor, as the ladder where the fish are trapped is supplied directly by the Wenatchee River at the head of Tumwater Dam.

Describe any instance where construction or operation of the physical plant results in destruction or adverse modification of critical habitat designated for the listed species -
No circumstances where the construction or operation of the sockeye supplementation program results in adverse impacts to listed fish critical habitat are envisioned. The sockeye supplementation program complies with NPDES permit effluent discharge conditions, which act to protect the quality of receiving waters adjacent to Eastbank Hatchery and Lake Wenatchee.

Describe any inconsistencies with standards and guidelines provided in any ESU-wide hatchery plan approved by the co-managers and NMFS -
The sockeye supplementation program is fully consistent with standards and guidelines set forth in the MCMCP's "Mid-Columbia Hatchery Plan". The plan presents hatchery programs that have been jointly agreed to by the parties to the MCMCP, which includes WDFW, NMFS, USFWS, Chelan and Douglas PUDs, and the Tribes.

4.1) Brood stock collection
The Tumwater Dam trap is situated at the top of the fish ladder circumventing Tumwater Dam on the left bank of the Wenatchee River. Fish are trapped through closure of a gate at the top of the trap, which prevents upstream passage, maintaining the fish in a 10' x 50' x 8' deep holding pond. The pond lacks a "V" entry, and fish are therefore not prevented from returning to downstream areas. The trap is actively run, with fish allowed to exit the pond upstream via a *Denil* ladder shunted into a 4' x 4' holding box for immediate loading into a tanker truck for transport to the Wenatchee net-pens. The fish may also be passed

into the dam forebay in this manner. Collected fish will be identified by species and as of wild or hatchery-origin if visible marks enable such distinguishment.

4.2) Spawning

Sockeye trapped at Tumwater Dam are held in the Wenatchee net-pens until maturity, and spawned at the net-pen site. The pens are located on the west end of the lake near the mouths of Little Wenatchee and White rivers. After the sockeye are spawned at the net-pen site, unfertilized gametes are transported to Eastbank Hatchery for fertilization and incubation. Plan views of both facilities are attached as Figures 1 and 2.

4.3) Incubation

Eastbank Hatchery consists of one raceway, two 0.5 acre ponds, and a hatchery building with 4 fiberglass troughs and 16 vertical incubator stacks (IHOT 1995).

4.4) Rearing

Sockeye salmon fry are transported from Eastbank Hatchery and reared in four to six floating net pens on Lake Wenatchee (Figure 2). These pens are adjacent to the two pens used to hold adult sockeye for spawning.

4.5) Acclimation/release

Fry are acclimated and reared to smolt size in the Lake Wenatchee net-pens (Figure 2).

4.6) Other

No other physical plants associated with sockeye supplementation are used.

SECTION 5. ORIGIN AND IDENTITY OF BROOD STOCK

5.1) Source

Broodstock used in the program are trapped from the run at large reaching Tumwater Dam. These fish originated from Little Wenatchee or White River sockeye broodstock of natural or hatchery-origin, and represent the indigenous population.

5.2) Supporting information

5.2.1) History

Broodstock used in the supplementation program since 1989 originated from natural spawners from the White and Little Wenatchee rivers. Sockeye salmon originating in these two rivers are likely the descendants of stock manipulations during the Grand Coulee Fish Maintenance Program, since Lake Wenatchee sockeye were extremely depressed in number prior to the construction of Grand Coulee Dam (Gustafson et al. 1997) . The status of the natural populations relative to critical and viable population thresholds is indicated in section 2.2.5. The existing hatchery program was founded in 1989 through the collection of returning sockeye from the run at large at Tumwater Dam to supplement

the natural Lake Wenatchee population. No other broodstock sources have been used since that time.

5.2.2) Annual size

The current annual program broodstock collection goal is 300 fish, equally divided by sex. Actual collection figures are presented in Table 5. Future production alternatives specified in the Mid-Columbia Hatchery Plan (BAMP 1998) will necessitate the annual collection of approximately 950 fish (1:1 sex ratio) to meet sockeye smolt production objectives.

The collection of only 300 sockeye from the run at large for use as broodstock is not expected to adversely affect the population status of the natural population relative to critical and viable thresholds. The supplementation program is designed to increase the population size to counter natural bottlenecks to the productivity of the natural Lake Wenatchee sockeye run.

5.2.3) Past and proposed level of natural fish in brood stock.

Broodstock used in the sockeye supplementation program are secured from the run-at-large encountered through trapping in the Wenatchee River at Tumwater Dam. Beginning with the 1990 brood, all sockeye released through the program were externally marked, allowing for differentiation between natural and hatchery origin adults. Initially, only natural-origin fish were incorporated into the broodstock annually. Since 1997, sockeye broodstock are collected randomly from the run at large, including hatchery produced adults. The broodstock will include less than 10% hatchery fish in any one year, and less than 10% of the overall run will be collected for broodstock (BAMP 1998). In the event the projected run size is below 3,000 fish, the broodstock goal will be reduced proportionately.

Table 5. Lake Wenatchee sockeye salmon supplementation program broodstock collection data - 1989-1993 (data from Eltrich et al. 1995 and Petersen et al. 1997).

Brood Year	Program Goal	Actual Number Collected	Percent of Program	Sex Ratio M:F
1989	300	299	99.6	1.12 : 1.00
1990	300	333	111.0	1.13 : 1.00
1991	300	357	119.0	2.68 : 1.00
1992	300	362	120.1	0.99 : 1.00
1993	300	320	106.7	0.73 : 1.00

5.2.4) Genetic or ecological differences

There are no known genotypic, phenotypic, or behavioral differences between the hatchery stocks and natural stocks in the target area.

5.2.5) Reasons for choosing

Sockeye collected as adults and spawned, and the progeny propagated through the program, represent the indigenous Wenatchee Basin sockeye population, which is the target of the supplementation program.

5.3) Unknowns

Broodstock collected at Tumwater Falls Dam represent the indigenous Wenatchee Basin sockeye population. There are therefore no known circumstances where a lack of data leads to uncertainties about the choice of brood stock.

SECTION 6. BROOD STOCK COLLECTION

Describe any inconsistencies with standards and guidelines provided in any ESU-wide hatchery plan approved by the co-managers and NMFS.

6.1) Prioritized goals

The protocol for this stock allows for the collection of up to 300 run at large adults to provide gametes for a release of 200,000 sub-yearlings into Lake Wenatchee. The protocol includes the following guidelines:

a. Trap all fish from the middle 80th percentile of the run at large;
b. Begin trapping a minimum of eight days after the peak passage of sockeye is recorded at Rock Island Dam or after July 15, which ever comes first; and

c. Randomly collect up to 300 adult sockeye during the peak of passage to ensure proportional representation of the age and size structure of the returning population. Broodstock collections will not exceed 10% of the expected run.

d. Marked (hatchery-origin) sockeye salmon will not exceed 10% of the broodstock.

These broodstock collection goals are consistent with standards and guidelines presented in the Mid-Columbia Hatchery Plan (BAMP 1998), which is the ESU-wide hatchery plan approved by the co-managers, the PUDs, and NMFS.

6.2) Supporting information

6.2.1) Proposed number of each sex.
The broodstock collection objective is to remove equal numbers of males and females.

6.2.2) Life-history stage to be collected (e.g., eggs, adults, etc.)
Adult sockeye salmon are to be collected at Tumwater Dam for use as broodstock.

6.2.3) Collection or sampling design.
Sockeye salmon broodstock are collected each year from the run at large reaching Tumwater Dam, located at Rkm 52.0 on the Wenatchee River during the months of July and early August. Fish are collected using a trap positioned at the top of the fish ladder, which is located on the left bank of the river. The trap will be operated three days per week during the sockeye collection period each year. The trap will be in active operation 16 hours per day during the three days per week that it will be open. Fish are trapped through closure of a gate at the top of the trap, which prevents upstream passage, maintaining the fish in a 10' x 50' x 8' deep holding pond. The pond lacks a "V" entry, and fish are therefore not prevented from returning to downstream areas. The trap is actively run, with fish allowed to exit the pond upstream via a *Denil* ladder shunted into a 4' x 4' holding box for immediate loading into a tanker truck. The fish may also be passed into the dam forebay in this manner. Collected fish will be identified by species and as of wild or hatchery-origin.

When operating, the trap is able to collect 100 % of the sockeye migration arriving at Tumwater Dam. The sockeye have no alternatives to bypass the dam other than the fish ladder. The collection of approximately 300 adult sockeye each year for use as broodstock leads to the removal of 0.9 % to 2.16 % (mean = 1.29 %, s.d. = 0.51 %) of the total estimated run arriving at Tumwater Falls (1989-93 brood year collection data from Eltrich et al. 1995 and Petersen et al. 1997). Measures to reduce sources of bias that could lead to a non-representative sample of the desired brood stock source include trapping all fish from the middle 80^{th} percentile of the run at large and collection of fish randomly during the peak of passage to ensure proportional representation of the age and size structure of the returning population. Based upon a comparison of age composition of sockeye collected for broodstock in 1989 and 1990 with those studied on the spawning grounds, it appears that fish collected at Tumwater Dam are representative of the age structure of the population (Eltrich et al. 1995). An additional measure employed to reduce the risk of adverse genetic effects to the population is the 10% ceiling on inclusion of marked (hatchery-origin) sockeye in the broodstock.

Adverse effects on the sockeye population, and on listed fish that may be encountered incidentally during trapping, including injury during handling, behavior modification, stress, or mortality, are minimized through the following measures:
a. The trap is actively operated 16 hours per day on a three day per week schedule between early June and mid-November to directly and continuously monitor fish captures.
b. The trap is monitored continuously when it is in operation.

c. All fish passed upstream are enumerated by species.
d. All listed and non-listed fish not needed for authorized supplementation programs are delayed for a minimal duration to determine mark occurrence and released upstream without harm.
e. The capture of adult salmon at Tumwater Dam does not rely on a fish weir, and all downstream migrating fish can pass the collection site freely year-round.

6.2.4) Identity

(a) The target population is the Lake Wenatchee sockeye ESU. No other sockeye population is present in the project area.
(b) Broodstock are collected from the run at large. Beginning with the 1990 brood, all sockeye released from the program have external marks, enabling recognition of adults upon return as of hatchery or natural origin.

6.2.5) Holding

Sockeye broodstock colleted at Tumwater Dam are held to maturity in two net-pens in Lake Wenatchee, the natural production area for the population. No takes of listed fish occur through the sockeye broodstock holding operation.

6.2.6) Disposition of carcasses

Carcasses of sockeye spawned through the program are seeded into Lake Wenatchee for nutrient enrichment and lake productivity enhancement purposes.

6.3) Unknowns

The effects of the broodstock collection program on the timing of spawning of the target population and the on the composition of the spawning population (e.g. hatchery versus wild origin, age class distribution, sex ratios) are unknown.

SECTION 7. MATING

7.1) Selection method

Spawners are collected randomly from the run at large arriving at Tumwater Dam during the central 80th percentile of the sockeye migration. Marked (hatchery-origin) sockeye are included at a rate not to exceed 10% of the fish that are retained for use as broodstock.

7.2) Males

Sockeye are spawned in three fish pools (i.e. two males - primary and secondary per female.

7.3) Fertilization

Eggs are fertilized using two males per female. Fish health procedures used for disease prevention includes biological sampling of spawners, and (in 1992) prophylactic treatment

of spawners with an approved therapeutant. Generally, sixty ovarian fluid and kidney/spleen samples are collected from female spawners to test for the presence of viral pathogens. The enzyme-linked immunosorbent assay (ELISA) is conducted on kidney samples from 100 females. This assay detects the antigen for *Renibacterium salmonarium*, the causative agent of bacterial kidney disease (BKD).

7.4) Cryopreserved gametes

No cryopreserved gametes are used in the sockeye supplementation program.

7.5) Unknowns

The effects of the supplementation program on the within population diversity of the sockeye ESU are not known.

SECTION 8. REARING AND INCUBATION

INCUBATION:

8.1) Number of eggs taken and survival objective to ponding

The program production goal is 200,000 sockeye yearlings. Assuming a fertilization to release percent survival standard of 65.0 %, 308,000 sockeye eggs are needed each year for the program. The egg survival objective to the eyed stage is 92.0 % and from the eyed egg stage to ponding is 98.0 %.

8.2) Loading density

Heath stack incubators are used to incubate the sockeye eggs at Eastbank Hatchery. Incubation is in double stack (8 high) incubators, but only the upper 7 trays are used for sockeye eggs, at 3 females per tray (refer to Section 4.4). Lake Wenatchee sockeye eggs are normally about 4,500 eggs per pound in size.

8.3) Influent and effluent gas concentration

Influent and effluent gas concentrations, including dissolved oxygen concentrations, are within parameters optimal for salmonid egg and juvenile survival.

8.4) Ponding

Sockeye fry are transferred from Heath trays for ponding upon button-up and swim-up. Ponding generally occurs after the accumulation of about 3,200 temperature units. The fish are transferred to the Wenatchee net-pens as unfed fry in early April. Mean weights for fry transferred to the net-pens for brood years 1989 through 1992 are presented in Table 6. The mean fry fork length recorded for 1993 brood sockeye transferred to the net-pens was 40.4 mm (range = 36 - 44 mm).

8.5) Fish Health monitoring

No fish disease outbreaks have been experienced during the incubation to ponding period in the sockeye program and mortality levels have remained within program standards. Fish health is continuously monitored in compliance with Co-manager Fish Health Policy standards (WDFW and WWTIT 1998).

Table 6. Mean sockeye fry weights at transfer to the Wenatchee net-pens - 1989-92 brood years.

Brood Year	Transfer Date	Mean Weight (gms)
1989	April 5, 1990	0.25 (fed)
1990	April 3, 1991	0.13
1991	April 1, 1992	0.13
1992	April 5-6, 1993	0.12

REARING:

8.6) Number of fish ponded and survival objective to release

On average, 81 % of the sockeye eggs fertilized survive to the fry stage for ponding (1989-92 brood year data from Eltrich et al. 1995). The program survival standard from fertilization to ponding is 90.2 %. The survival objective from fertilization to release is 65.0 %.

8.7) Density and loading.

Sockeye fry are transferred from the Heath incubation trays to fiberglass rearing tanks prior to transfer to the Wenatchee net-pens. The tanks have flow through water circulation. The net-pens are open to the natural water circulation patterns in Lake Wenatchee. Net-pens containing the fry vary from 1/16 inch (starter mesh) to progressively larger mesh sizes. A typical starter configuration is a 1/16 inch mesh net measuring 20 ft x 10 ft x 10 ft deep (1,900 cu ft effective volume). The larger, grow-out pens have larger mesh sizes to facilitate circulation, with outside measurements of 20 ft x 20 ft x 20 ft depth, and approximately 7,400 cu ft effective volume. Net-pen fish rearing densities range from 0.023 lb/cu ft in early April (2 pens) at the start of the rearing period to 0.20 lb/cu ft (6 pens) just prior to the attainment of the target release size in October.

8.8) Influent and effluent gas concentrations

Influent and effluent gas concentrations in the Wenatchee net-pens, including dissolved oxygen concentrations, are within parameters optimal for juvenile salmonid production and survival.

8.9) Length, weight, and condition factor.

Table 7 presents length, weight, and condition factor data for 1993 brood sockeye reared through the Wenatchee supplementation program (from Petersen et al. 1997).

8.10) Growth rate, energy reserves

Fish health and condition is monitored seven to nine times by fish health professionals during the five to six month rearing period. Sockeye reared exhibit internal organ and body conditions that are standard for a healthy fish population.

Table 7. Length, weight, and condition factor data for 1993 brood sockeye reared through the Wenatchee supplementation program.

Date	Fork Length mm	SD	CV %	Weight (gms)	Condition Factor (Kfl)
May 29	40.4	1.9	4.7	0.6	0.96
June 29	60.9	3.4	5.6	2.2	0.97
August 7	81.1	6.5	8.1	5.9	1.10
“	81.3	6.3	7.7	5.8	1.07
“	78.0	6.8	8.7	5.0	1.05
Sept. 1	90.8	5.8	6.4	8.0	1.06
“	89.6	6.7	7.4	8.0	1.10
Sept. 2	95.5	6.6	6.9	9.4	1.08
Sept. 29	103.2	6.0	5.8	12.6	1.15
“	102.9	6.5	6.3	12.5	1.15
Oct. 17	116.0	3.3	2.8	19.1	1.22

8.11) Food type and amount fed, and estimates of feed conversion efficiency.

Commercial-grade moist or semi-moist fish feed is used in the operation, and applied at sizes appropriate for the size of the fish being fed. The daily amount fed is determined by the number of fish in the population and individual fish weight. Feed is therefore applied at a daily rate ranging from 3.0 % of the total population weight per day (fry and small fingerlings) to 1.5 % of the total population weight per day (larger fingerlings). The expected feed conversion efficiency rate is 1.2.

8.12) Health and disease monitoring.

Fish health is continuously monitored in compliance with Co-manager Fish Health Policy standards (WDFW and WWTIT 1998). Fish health and condition is monitored seven to nine times by fish health professionals during the five to six month rearing period. The results of fish health monitoring for the sockeye program are reported each year in WDFW Rock Island Fish Hatchery Complex annual reports.

8.13) Smolt development indices, if applicable:

Pre-release condition is monitored through collection of data indicating average condition factor of the population (see Table 7). However, smolt development indices are not applicable for fall age-0 parr releases into Lake Wenatchee.

8.14) Use of "natural" rearing methods:

Sockeye are reared for the majority of the propagation period in the Wenatchee net-pens in Lake Wenatchee, which is the indigenous and sole juvenile production lake for the target population. The hatchery fish are therefore exposed to some of the same pelagic and drift food sources, environmental conditions, and limnological conditions as naturally rearing sockeye.

8.15) Unknowns

Monitoring and evaluation measures are proposed to address data gaps that lead to uncertainty in the incubation and rearing protocols. These uncertainties include whether the release of sub-smolts in the fall months is the most effective means to supplement the natural population and whether the condition factor of sub-smolts produced adequately matches the condition of natural-origin sockeye juveniles present at the same time.

SECTION 9. RELEASE

9.1) Life history stage, size, and age at release.

Sockeye are released as sub-yearlings after approximately 170 - 200 days of artificial propagation in the fall of their first year for continued rearing in Lake Wenatchee prior to emigration seaward the following spring as yearling smolts. The 1989-93 brood year average size at release was 16.6 grams (s.d. 3.85, range = 4.2 - 18.9 gms), or approximately 110 mm fl.

9.2) Life history stage, size and age of natural fish of same species in release area at time of release.

Natural sockeye present in the release area are sub-yearlings and yearlings. The size of the natural sockeye in their first year at the time the Wenatchee net-pen fish are liberated is considerably smaller than the hatchery fish, while natural yearlings tend to be more comparable. Allen and Meekin reported a mean length of 88 mm (range 81-91 mm) for sockeye smolts (all ages) captured in the spring in Lake Wenatchee.

9.3) Dates of release and release protocols.

Sockeye are force released from the Wenatchee net-pens during September and October into Lake Wenatchee.

9.4) Location(s) or release.

The sockeye are released into the west end of Lake Wenatchee near the confluence of the lake with the Little Wenatchee and White rivers (approximately Rkm 90.0 of the

Wenatchee River (WRIA 45-0030).

9.5) Acclimation procedures.

Sockeye are transferred to the Wenatchee net-pens as unfed fry in April and reared for 170 to 200 days for release in September or October. Upon release, the sockeye over-winter in the lake prior to seaward emigration the following spring. Sockeye juveniles produced through the program spend all of their post swim-up life in freshwater in the natal rearing environment, and are therefore fully acclimated to the home, Lake Wenatchee watershed.

9.6) Number of fish released:

Table 8 presents Lake Wenatchee net-pen sockeye salmon release data for brood years1989 through 1997.

Table 8. Lake Wenatchee net-pen sockeye salmon releases - 1990-98 (data from Petersen et al. 1997 and WDFW Hatcheries Program database, September 16, 1999).

Brood Year	Date(s) Planted	Number Released	Kg Released
1989	Oct. 24, 1990	260,400	4,717.3
1990	Oct. 19, 1991	372,102	5,826.4
1991	Oct. 20, 1992	167,523	3,454.1
1992	Sept. 7/Oct. 26, 1993	340,557	3,789.2
1993	Sept. 1/Oct. 17, 1994	190,443	2,733.4
1994	Sept.15/Oct. 20, 1995	252,859	3,378,6
1995	Oct. 25, 1996	150,808	2,285.0
1996	Oct. 22, 1997	284,630	4,312.7
1997	Nov. 9, 1998	197,195	4,266.8

9.7) Marks used to identify hatchery adults.

All sockeye juveniles produced through the Lake Wenatchee net-pen program have been marked with an adipose clip/coded wire tag (CWT) combination to allow for differentiation of hatchery from natural origin sockeye adults upon return and to assess brood year fishery contribution and survival rates for program releases. However, only the adipose clip has been used since the 1995 brood year. The need for the adipose/CWT combination may be reaffirmed with continuing evaluations.

9.8) Unknowns

Uncertainties pertaining to release strategies applied through the program that should be resolved to allow for adaptive management include the following: the survival rate from release to emigration of juvenile sockeye salmon in Lake Wenatchee; the population size of hatchery and wild sockeye salmon that emigrate from Lake Wenatchee; the smolt to adult survival rate for hatchery and wild sockeye salmon; the spawning distribution of hatchery adults relative to natural adults; and the release strategy for sockeye salmon that reduces predation by bull trout.

SECTION 10. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

Staffing, and other support logistics for the Wenatchee net-pen sockeye supplementation program are provided by WDFW. Funding for the program is provided by Public Utility District Number 1 of Chelan County for the purpose of mitigation for lost fish production associated with hydroelectric power system development in the region. Staffing and funding are available and committed through the Rock Island Settlement Agreement and WDFW's Rock Island Evaluations contract (Chelan Public Utility District) to allow most of the data collection, and monitoring and evaluation, described in this section. Additional funding and staff may be necessary to carry out some of the monitoring and evaluation objectives subsequently identified in the MCMCP (BAMP 1998) or as identified and prioritized through continuing evaluation work.

10.1) Marking

All sockeye produced through the Lake Wenatchee net-pen program will be marked with an adipose clip and potentially an adipose/CWT combination. No wild fish are proposed to be marked at this time.

10.2) Genetic data

The anadromous sockeye populations presently upstream from Rock Island Dam are the product of unknown interactions resulting from sockeye trans-locations, mixtures, introductions and remnant indigenous populations (Chapman et al. 1995). However, electrophoretic data indicate that the Lake Wenatchee sockeye ESU is genetically still the most distinctive population (after Redfish Lake, ID) within the contiguous United Sates (Gustafson et al. 1997). A thorough review of available genetic studies of Pacific Northwest sockeye populations, and presentation of baseline genetic data for the Lake Wenatchee sockeye population is included in the NMFS BRT sockeye salmon status review document (Gustafson et al. 1997).

10.3) Survival and fecundity

10.3.1) Average fecundity

Fecundity will be monitored through sub-sampling throughout the collection season of individual egg weights applied to the weight of green eggs taken from returning spawners

and the total number of females spawned. Sockeye from the mid-Columbia River region have some of the lowest fecundity estimates reported in the literature, with a 1937, `44-94 brood year average for Lake Wenatchee sockeye of 2,538 (Chapman et al. 1995). Fecundity for 1989-93 brood year returns for the WDFW sockeye program were 2,344, 2225, 2,598, 2,341, and 2,340 respectively. The program fecundity goal is the brood year average level observed since the program began in 1989.

10.3.2) Survival

a) Collection to spawning

Sockeye adult losses during trapping and holding will be monitored through removal and enumeration of mortalities in the Tumwater Dam trap and Wenatchee net-pens used for holding. The survival standards for the program are 80.0 % (pre-spawn) and 98.0 % (females to spawning) (Petersen et al. 1997).

b) Green eggs to eyed eggs

Egg losses during incubation monitored through removal and enumeration of green egg mortalities upon shocking from Heath trays at Eastbank Hatchery. The green to eyed egg survival standard for the program is 92.0 % (Petersen et al. 1997).

c) Eyed eggs to release

Eyed egg and juvenile fish losses during incubation and rearing at Eastbank Hatchery and the Wenatchee net-pens will be monitored through removal and enumeration of eyed egg mortalities from Heath trays upon transfer to the net-pens, and daily or weekly (as necessary) removal and enumeration of fish mortalities occurring during the 170-200 day rearing period. The following survival standards for the program will be pursued during the eyed egg to release phases of the supplementation program (taken from Petersen et al. 1997):

Table 9. Survival standards for the Wenatchee net-pen sockeye program.

Production Phase	Survival Standard (%)
Eyed egg to ponding	98.0
30 days post ponding	97.0
100 days post ponding	93.0
Ponding to smolt	72.0

d) Release to adult, to include contribution to:

(i) harvest

Contribution of supplementation program-origin sockeye to fisheries in the mainstem Columbia River and within the Wenatchee Basin will be monitored and evaluated through the regional coded wire tag recovery and evaluation program implemented by WDFW, the Tribes, and other fisheries management agencies in the Columbia Basin. All program sockeye are

marked with an adipose clip to allow for differentiation of hatchery-origin sockeye upon capture and evaluation of their origin through the existing recovery programs.

(ii) hatchery brood stock

Contribution of program-origin fish to the hatchery broodstock will be monitored and controlled through visual identification of adipose-clipped hatchery fish upon capture at Tumwater Dam. Numbers or proportions of program-origin sockeye relative to unmarked natural-origin fish arriving at Tumwater Dam will be monitored and evaluated in this manner. Video tape records of sockeye passage at Tumwater Dam will allow more precise documentation of sockeye adult wild and hatchery origin composition.

(iii) natural spawning

A carcass recovery program implemented on the White and Little Wenatchee rivers allows for the evaluation of the contribution of supplementation program-origin sockeye adults to the annual naturally spawning population. Spawning ground surveys are conducted weekly during the September-October spawning period to enumerate spawners and to identify origin of spawned-out carcasses through examination for marks.

10.4) Monitoring of performance indicators in Section 1.8

The following monitoring objectives measures are included in the Mid-Columbia Hatchery Plan (BAMP 1998) to evaluate the performance of the sockeye supplementation program. These measures are either being presently applied through the WDFW program, or in need of further funding to fully implement them. From BAMP (1998):

The following monitoring and evaluation objectives will be applied to evaluate the Wenatchee net-pen sockeye program:

(1) evaluate the release strategy for net pen reared sockeye salmon,

(2) determine the extent of predation/mortality during the release period,

(3) determine the post-release fingerling-to-smolt survival rate of hatchery-reared juvenile sockeye salmon,

(4) determine the post-release growth of hatchery-reared juvenile sockeye,

(5) estimate populations of hatchery and wild juvenile sockeye emigrating from Lake Wenatchee,

(6) describe physical characteristics of Lake Wenatchee and the Wenatchee River that initiate emigration, and

(7) determine the smolt-to-adult survival rate of Lake Wenatchee sockeye through extensive spawning surveys.

To accomplish these objectives, the following tasks will be undertaken:

- Physical characteristics of the lake and river shall be monitored and the relationship between the number of fish emigrating and temperature, discharge and

photoperiod shall be determined through regression analysis.

- Fish growth and health of hatchery sockeye smolts shall be compared to pre-release samples and wild sockeye smolts emigrating from the lake. Organosomatic indices will be determined for hatchery-reared sockeye before the release and during the emigration period.
- Spawning surveys will be conducted weekly on each river. Spent fish and carcasses will be recovered and determined to be hatchery or wild origin. In addition, scales, otoliths, and lengths (post orbital to hypural plate) will be collected to determine the age structure of the population. The scope of spawning surveys should be expanded to include and document lake shoreline spawning and carcass recovery.
- Fingerling-to-smolt survival rates of hatchery-reared sockeye will be calculated by dividing the estimated total number of hatchery sockeye emigrating from the lake by the total number released into the lake the previous fall. The fingerling-to-smolt mortality rate of hatchery sockeye salmon could be used to adjust smolt-to-adult survival estimates.
- Define annual and long-term changes in the spawning distribution of the donor population. Determine from mark recoveries if enough hatchery adults spawn within the established spawning area of the donor population to replace adults taken for broodstock. Determine if hatchery-reared adults reproduce effectively in terms of distribution with the naturally produced spawners, timing, and habitat use.
- Weekly spawning ground surveys will be done to determine if there is a difference in the spawn timing of wild and hatchery fish. Determine egg retention of marked and unmarked fish in the donor population by opening carcasses of females.
- Relate redd count to escapement in donor stream to develop adult multiplier for redds (e.g. adults per redd). Estimate proportion of carcasses of hatchery origin. Estimate numbers of marked adults that spawn in each donor stream (Hatchery Spawning Escapement = Redds X Proportion Hatchery X Redd Multiplier).
- Smolt-to-adult survival will be estimated by dividing the total number of hatchery sockeye salmon adults returning to the Columbia River by the estimated number of smolts that emigrate from Lake Wenatchee, during the respective brood year. Escapement to the Wenatchee River will be measured by counts at Tumwater Dam.

10.5) Unknowns or uncertainties identified in Sections 5 through 9

Unknowns and uncertainties identified in previous sections will be addressed through monitoring and evaluation measures proposed above in Section 10.4.

10.6) Other relevant monitoring projects

WDFW's smolt monitoring program at Rock Island Dam, and other smolt passage monitoring programs operating in the mainstem Columbia River, will contribute additional information regarding the passage timing and survival of sockeye produced each year through the supplementation program.

SECTION 11. RESEARCH

Research programs associated with this HGMP are described within the monitoring and evaluation sections above. Research will be directed at determination of supplementation program contribution rates, and the ecological and genetic effects of the program on the natural population.

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