HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Hatchery Program:	Methow Hatchery Spring Chinook Program
Species or Hatchery Stock:	Upper Columbia River Spring Chinook (*Oncorhynchus tshawytscha*)
Agency/Operator:	Douglas PUD, owner, and their current operator Washington Department of Fish and Wildlife
Watershed and Region:	Methow Sub-basin/Columbia Cascade Province
Date Submitted:	February 12, 2010
Date Last Updated:	February 12, 2010

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ACRONYM LIST

µg/L	micrograms per liter
BAMP	Biological Assessment and Management Plan
BKD	bacterial kidney disease
BY	brood year
CCT	Colville Confederated Tribes
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
CV	Coefficient of Variance
CWT	coded-wire tag
Douglas PUD	Public Utility District No. 1 of Douglas County
ELISA	enzyme-linked immunosorbent assay
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
f/r	fish per redd
FCRPS	Federal Columbia River Power System
FDA	U.S. Food and Drug Administration
FERC	Federal Energy Regulatory Commission
FH	Fish Hatchery
FL	Fork Length
fpp	fish per pound
GCFMP	Grand Coulee Fish Maintenance Project
Grant PUD	Public Utility District No. 2 of Grant County
gpm	gallons per minute
GPS	global positioning system
HxH	hatchery by hatchery
HxW	hatchery by wild
HCP	Habitat Conservation Plan
HETT	Hatchery Evaluation Technical Team
HGMP	Hatchery Genetic Management Plan
HOB	hatchery-origin broodstock
HOR	hatchery-origin recruit
HOS	hatchery-origin spawner
HRR	hatchery replacement rate
HSRG	Hatchery Scientific Review Group
ICTRT	Interior Columbia Basin Technical Recovery Team
IHNV	Infectious Hematopoietic Necrosis Virus
IHOT	Integrated Hatchery Operations Team
INAD	Investigational New Animal Drug
IPNV	Infectious Pancreatic Necrosis Virus
ISEMP	Integrated Status and Effectiveness Monitoring Project
ITS	Incidental Take Statement
JFP	Joint Fisheries Parties
M&E	Monitoring and Evaluation

MaSA	major spawning area
mg/L	milligrams per liter
MGD	millions of gallons per day
ml/L	milliliters per liter
mm	millimeter
MOA	Memorandum of Agreement
MPG	major population group
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NNI	No Net Impact
NOAA	National Oceanic and Atmospheric Administration
NOB	natural-origin broodstock
NOR	natural-origin recruit
NOS	natural-origin spawner
NPDES	National Pollutant Discharge Elimination System
NRR	natural replacement rate
NTTOC	non-target taxa of concern
O&M	operation and maintenance
OD	optical density
OLAFT	Off-Ladder Adult Fish Trap
PFMC	Pacific Fisheries Management Council
pHOS	percent hatchery-origin spawners
pNOB	percent natural-origin broodstock
POH	Posterior Orbit (to) Hypural (plate)
PIT	passive integrated transponder
PNFHPC	Pacific Northwest Fish Health Protection Committee
PNI	Proportionate Natural Influence
PRCC	Priest Rapids Coordinating Committee
PRCC	Priest Rapids Coordinating Committee Hatchery Subcommittee
PRD	Priest Rapids Dam
RCW	Revised Code of Washington
Recovery Plan	Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan
Rkm	river kilometer
RMIS	Regional Mark Information System
Rs	*Renibacterium salmoninarum*
RSRF	Ringold Springs Rearing Pond
S/S	spawner to spawner
SAR	smolt to adult returns
SFH	State Fish Hatchery
SIWG	Species Interaction Work Group
SSA	Salmon and Steelhead Agreement
TL	Total Length
TU	temperature units
UCR	Upper Columbia River
UCRTT	Upper Columbia Regional Technical Team
UCSRB	Upper Columbia Salmon Recovery Board

USFS	U.S. Forest Service
USFWS	U.S Fish and Wildlife Service
USGS	U.S. Geological Survey
VIE	visual implant elastomer
VSP	Viable Salmonid Populations
WxW	wild by wild
WDFW	Washington Department of Fish and Wildlife
Wells HCP	Wells Hydroelectric Project Anadromous Fish Agreement and Habitat Conservation Plan
WRIA	Water Resource Inventory Area
YN	Yakama Nation

SUMMARY

This document is the Hatchery Genetic Management Plan (HGMP) for the Methow Hatchery spring Chinook program funded by Public Utility District No 1 of Douglas County (Douglas PUD), and is submitted as a requirement to support Endangered Species Act (ESA) compliance for the operation of the program. This document includes details about the program facilities and operation, as well as information on the potential effects of the program on ESA-listed fish species and measures to avoid, minimize, or eliminate those various effects. The document is organized as follows:

- Section 1 describes the program, including contact information, justification for the program, and performance standards.
- Section 2 provides information on expected and potential effects on ESA-listed salmonid populations from the program.
- Section 3 relates the program to other management objectives for the species.
- Sections 4 through 10 describe details of fish handling, rearing, collection, and release.
- Section 11 discusses the monitoring and evaluation necessary to maintain the program.
- Section 12 summarizes ongoing or future research related to the program.

The Methow Hatchery spring Chinook program receives long-term ESA coverage under Incidental Take Permits associated with the Wells Hydroelectric Project Anadromous Fish Agreement and Habitat Conservation Plan (HCP) (DCPUD 2002). The decision-making body for hatchery issues under the Wells HCP is the Wells HCP Hatchery Committee, which provides oversight and recommendations for the program as part of the HCP implementation process. Thus, this HGMP is reflective of HCP Hatchery Committee decisions and resultant actions as deemed appropriate and consistent with the Wells HCP. The Hatchery Committee has developed the program described in this HGMP to support the current biological, agency, and program goals. Decisions made by the Hatchery Committee are dynamic and adaptive; thus future updates to this HGMP may be necessary during the ongoing implementation of the HCP.

The goal of the program is the restoration of naturally reproducing populations of spring Chinook in their native habitats using locally adapted broodstock, while maintaining genetic and ecologic integrity, and supporting harvest. The purpose is to meet No Net Impact (NNI) mitigation goals established in the Wells, Rocky Reach, and Rock Island HCPs, and the Priest Rapids Salmon and Steelhead Agreement in a manner consistent with overall objectives of rebuilding natural populations.

Natural and hatchery run-escapement numbers for spring Chinook to the Methow Basin in return years 1996 through 2008 (return years for Methow Hatchery releases) are given in the table below. The estimated run escapement of spring Chinook to the Methow Basin has averaged (geometric means) 681 total (range 31 to 10,971), 436 hatchery-origin (range 12 to 9,139), and 174 natural-origin (range 19 to 1,832) for return years 1992 to 2008. During that period, the proportion of hatchery-origin recruits in the run has increased, while the proportion of natural-origin recruits has declined.

Spring Chinook hatchery- and natural-origin run sizes to the Methow Basin for return years 1996-2008. Data from Snow et al. (2009).

Return Year	HORs	HOR Fraction	NORs	NOR Fraction	Run Size
1996	12	0.387	19	0.613	31
1997	78	0.225	269	0.775	347
1998	21	0.512	20	0.488	41
1999	71	0.612	45	0.388	116
2000	861	0.880	117	0.12	978
2001	9,139	0.833	1,832	0.167	10,971
2002	2,292	0.869	345	0.131	2,637
2003	1,080	0.949	58	0.051	1,138
2004	1,009	0.674	488	0.326	1,497
2005	849	0.617	527	0.383	1,376
2006	1,420	0.812	328	0.188	1,748
2007	813	0.753	266	0.247	1,079
2008	760	0.718	298	0.282	1,058
12-Yr Geomean:	436	0.64	174	0.26	681

The Methow Hatchery spring Chinook program is presented as a two-component program releasing up to 550,000 smolts annually to the Methow Basin as compensation for up to 7% unavoidable passage losses at up to five mid-Columbia hydroelectric facilities (currently Wells is at 3.8% unavoidable loss requiring 61,000 smolts released, Rocky Reach/Rock Island are at 7% requiring 288,000 smolts, and Priest Rapids/Wanapum are at 7% requiring 201,000 smolts). The 550,000 smolts would be released from acclimation facilities on the Twisp River (up to 100,000 Twisp-origin smolts), and Chewuch and Methow rivers (approximately 225,000 each, Methow/Chewuch-origin smolts). The anticipated returns from these releases are as follows:

Program Component (numbers of smolts released)	Anticipated Number of Adults Returned		
	Minimum SAR	Mean SAR	Maximum SAR
Methow/Chewuch (450,000)	100	1,170	2,376
Twisp (100,000)	23	140	362

Broodstock collection for the program will occur at existing traps at Wells Dam, the Twisp River weir, Methow Hatchery outfall, and Winthrop National Fish Hatchery (WNFH) outfall (and elsewhere and by other methods, such as hook-and-line angling and beach seining, as deemed appropriate by the HCP Hatchery Committee); annual total collection is projected at 348 adults (maximum 360), but this number will fluctuate over time with changes in the rate of over-collection for the management of Bacterial Kidney Disease (BKD; see Section 1.8.2.1). The program is separated into two components—the Twisp and the Methow/Chewuch—in recognition of the genetic distinctions between the Twisp-origin and Methow/Chewuch-origin spring Chinook, as well as the presence of a weir on the Twisp River that facilitates management of that component. The 348 (up to 360) broodstock collected for the program includes 63 (up to 64) adults for the Twisp component.

The proposed management of the program components is based on the principles embodied in the recommendations from the Hatchery Scientific Review Group (HSRG 2009). In general, both components of the program will be managed to improve over time the proportionate natural influence (PNI) of the natural population and integrated hatchery program. However, as noted by the HSRG (2009), due to the preponderance of hatchery-origin recruits (HORs) to the Methow Basin and the chronic paucity of natural-origin recruits (NORs), the PNI objectives for a "Primary Population" (PNI ≥ 0.67, proportion hatchery-origin spawners [pHOS] < 0.30) are unattainable in the Methow Basin with current hatchery production until the habitat capacity has improved. Thus, the proposed management promotes systematic improvement in PNI in the Methow/Chewuch component, while emphasizing dramatic improvement in PNI in the Twisp component where the weir affords options for controlling pHOS.

The following management rules will apply to the Twisp program component (see Section 1.8.2.4):

- Escapement of NORs will never be restricted.
- Minimum spawner escapement = 50 adults of any origin (NORs preferred), based on ICTRT (2007) quasi-extinction threshold.
- The NOR extraction rate for broodstock will not exceed 0.33 of the resultant natural-origin spawners (NOSs). This rule is intended to increase NOSs, facilitating the management of pHOS, especially when run sizes are too low to allow adult management.
- pNOB will always be ≥ 0.50, in accordance with the HSRG principles of maintaining the dominance of natural influence. Consequently, production from the Twisp component of the program will be limited by NOB such that the total broodstock number will never exceed twice the number of the NOB. Increased Methow/Chewuch production will compensate for shortfalls in Twisp production.
- The pHOS target will be a moving-average ≤ 0.50 except when insufficient NOSs are available to achieve 50 total spawners.
- Adult management will be used to constrain pHOS when run sizes allow the achievment of a spawner escapement of at least 200 adults. Adult management may also be necessary when spawner escapement is < 200 adults to achieve a moving-average pHOS ≤ 0.50.
- NOR extraction rates would be reduced as necessary for run sizes where utilizing the full extraction rate of 0.33 of the NOSs, would cause the total spawner escapement to fall below the minimum of 50 adults. For run sizes where a reduction in the NOR extraction rate would no longer prevent the total spawner escapement from falling below 50 adults, broodstock collection should be terminated to maximize natural production. In such cases the HCP Hatchery Committee must consider all relevant VSP data and provide a recommendation to the JFP regarding the decision to collect Twisp broodstock for that brood year; the JFP will make the final decision.

The following management rules will apply to the Methow/Chewuch program component (Section 1.8.2.4):

- Minimum escapement should not fall below 500 spawners.
- The rate of extraction of natural-origin broodstock by all hatchery programs should never exceed 0.33 of the NORs to the Methow Basin.

- Maximize pNOB in years when spawning escapement will exceed 500 NOSs to the extent that it does not result in increasing pHOS above 0.50.
- Escapement of NORs will never be restricted
- Apply measures for adult management to control pHOS when appropriate. When the natural-origin spawning escapment to the Methow is ≥ 1,140 then the escapement of HORs to the Methow should be minimized (allowing for escapement of broodstock, etc.) and pNOB will be maximized. In run years when the total spawning escapement (including both hatchery and natural origin) is between 500 and 1,140, habitat seeding and genetic concerns must be balanced in the determination by the HCP Hatchery Committee of adult-management measures.

Performance standards, indicators, and monitoring details for the program will follow objectives and goals of the Douglas PUD hatchery Monitoring and Evaluation Plan (M&E Plan; HCP HC 2007) developed (and subject to periodic updates) by the HCP Hatchery Committee.

Roles and responsibilities for the program are as follows: The HCP Hatchery Committee is responsible for determining program adjustments, considering the methodology described in the M&E Plan (HCP HC 2007; Appendix A) and a companion document, the "Analytical Framework" (Hays et al. 2007; Appendix B); approving yearly M&E implementation plans for Douglas PUD (Appendix C); and, assisting the Washington Department of Fish and Wildlife (WDFW) in developing annual broodstock collection protocols and approving those protocols (Appendix D). Douglas PUD funds the following: facility improvements, changes to artificial production programs, monitoring and evaluation of programs as identified in the M&E Plan and the yearly M&E implementation plans, permit(s), and implementation of the HCP. Douglas PUD's designated agent(s) and joint permit holder(s) (currently WDFW) implements the M&E Plan and operates the hatchery facilities at the direction of Douglas PUD and according to the terms of the Wells HCP Section 8 "Hatchery Compensation Plan," the ESA Section 10 permit(s), in consultation with the National Marine Fisheries Service (NMFS), and in coordination with the Rocky Reach and Rock Island HCP Hatchery Committees as necessary. The Public Utility District No. 1 of Chelan County (Chelan PUD) and the Public Utility District No. 2 of Grant County (Grant PUD) are currently co-funders of the hatchery program and also joint permit holders.

Douglas PUD will provide one FTE for adult-management activities (for both steelhead and spring Chinook hatchery programs) associated with Douglas PUD's NNI hatchery compensation. WDFW is responsible for the management of adult spring Chinook returning that exceed program needs or are strays from segregated programs into priority habitats. In addition to funding the removal of excess adults beyond the one FTE that will be provided by Douglas PUD, WDFW shall also be responsible for all adult returns from the point at which fish are placed in a holding container when manually removed or for a conservation fishery (not part of this program or explicitly included in this HGMP). The Co-Managers will determine the disposition of the fish placed in the holding container.

1.0 GENERAL PROGRAM DESCRIPTION

1.1 Name of Hatchery or Program.

Methow Hatchery Spring Chinook Program

1.2 Species and Population (or Stock) under Propagation, and ESA Status

Upper Columbia River Spring Chinook (*Oncorhynchus tshawytscha*)
ESA Status: Endangered

1.3 Responsible Organization and Individuals

Name (and title): William C. Dobbins, General Manager
Agency or Tribe: Public Utility District No. 1 of Douglas County (Douglas PUD)
Address: 1151 Valley Mall Parkway, East Wenatchee, WA 98802
Telephone: (509) 884-7191
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Name (and title): Phil Anderson, Director
Agency or Tribe: Washington Department of Fish and Wildlife (WDFW)
Address: (main office) Natural Resources Building, 1111 Washington Street, SE, Olympia, WA 98501-2200; (mailing address) 600 Capitol Way N., Olympia, WA, 98501-1091
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Email: Philip.anderson@dfw.wa.gov

Douglas PUD (as the owner of the Methow Hatchery and a funder of hatchery facilities, operation and maintenance [O&M] and hatchery program monitoring and evaluation [M&E]) and WDFW (as Douglas PUD's current hatchery operator and implementing contractor for the M&E Plan) are joint permit holders for the Methow Hatchery Spring Chinook Program. Future contractors for Douglas PUD, whether for operating Methow Hatchery or for implementing Douglas PUD's hatchery M&E program would also jointly hold the permit with Douglas PUD. Chelan and Grant PUDs are also joint permit holders because a substantial proportion (currently 89%) of the spring Chinook at the Methow Hatchery is produced specifically to cover the mitigation responsibilities for Chelan and Grant PUDs (who currently co-fund the program generally in proportion to their use of the Methow Hatchery).

Other agencies, tribes, co-operators, or organizations involved, including contractors, and extent of involvement in the program:

- National Marine Fisheries Service: Co-manager; HCP Hatchery Committee representative; Administration of the Endangered Species Act
- U.S. Fish and Wildlife Service: Co-manager; HCP Hatchery Committee representative; Administration of the Endangered Species Act
- Washington Department of Fish and Wildlife: Co-manager; HCP Hatchery Committee representative; current contracted hatchery operator
- Confederated Tribes of the Colville Reservation: Co-manager; HCP Hatchery Committee representative
- Confederated Tribes and Bands of the Yakama Nation: Co-manager; HCP Hatchery Committee representative
- Public Utility District No. 1 of Chelan County: current co-funder of hatchery program
- Public Utility District No. 2 of Grant County: current co-funder of hatchery program

1.4 Funding Source, Staffing Level, and Annual Hatchery Program Operational Costs

The funding source is Douglas PUD; Grant and Chelan PUDs currently reimburse Douglas PUD in proportion to the respective numbers of fish reared for each PUD (as adjusted for species trades with Chelan PUD). The staffing level at Methow Hatchery is 6.3 full-time-equivalent staff. For fiscal year 2009/2010 the budgeted operational, maintenance and study related costs for the Methow Program are $2,485,600. This total includes facility upgrades, repairs, and rehabilitation costs budgeted at $694,000 and contracted spring Chinook M&E activities for spring Chinook budgeted at $447,200.

1.5 Location(s) of Hatchery and Associated Facilities

Table 1-1. Hatchery facility locations associated with the Methow Hatchery spring Chinook program (located in Water Resource Inventory Area [WRIA] 48).

Activity	Facility
Broodstock[1] collection	Wells Dam, Twisp Weir, Methow Hatchery and Winthrop NFH outfalls[2]
Adult holding	Methow, Wells and Winthrop Hatcheries
Spawning	Methow Hatchery
Incubation	Methow Hatchery
Rearing	Methow Hatchery
Acclimation	Twisp, Methow, and Chewuch acclimation facilities, and Methow Hatchery[2]

[1]Broodstock source is as follows:
- Methow/Chewuch spring Chinook Composite (of both hatchery and natural origin)
- Twisp spring Chinook (primarily natural origin, but hatchery origin as necessary)

[2]Other locations as approved by the HCP Hatchery Committees

1.6 Type of Program

This HGMP addresses an Integrated Recovery Program.

1.7 Goal and Purpose of Program

1.7.1 Goal

The goal of the program is the rebuilding of naturally reproducing populations of Methow River spring Chinook in their native habitats using locally adapted broodstock, while maintaining genetic and ecologic integrity, and supporting harvest where and when consistent with recovery objectives.

1.7.2 Purpose

The purpose of this hatchery program is to meet the HCP NNI passage-loss mitigation goals established in the Wells HCP in a manner consistent with overall HCP objectives of rebuilding natural populations. In addition to providing mitigation for passage losses at Wells Dam the Methow Hatchery spring Chinook program also provides NNI mitigation for the Rocky Reach and Rock Island HCPs and for the Priest Rapids Salmon and Steelhead Agreement (SSA). With respect to Douglas PUD, the purpose of this hatchery program is to satisfy the hatchery-compensation terms of the Wells HCP[1], which was executed pursuant to Section 10 of the ESA as a vehicle to permit Douglas PUD to carry out its functions in a manner consistent with the ESA.

1.8 Justification for the Program

The UCR spring Chinook (*Oncorhynchus tshawytscha)* Evolutionarily Significant Unit (ESU) was listed as endangered on March 24, 1999 (50 CFR 14308). The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids. In the UCR Region, habitat destruction (e.g., stream channelization, bank armoring, and floodplain disconnection; migration barriers; unscreened diversions; land-use practices), past over-harvest in fisheries, hydropower facilities, and some hatchery practices are the major causes of population declines. Poor ocean conditions prior to 2000 suppressed fish survival, and vastly increased avian predation in the Columbia River estuary further affecting the basin's spring Chinook populations.

[1] Douglas PUD's ESA authorizations consist of two regulatory approval tiers: (1) the general ESA approval of all District operations, which consists of the Section 10 incidental take permits ("ITPs") issued for the District's HCP, and (2) the specific approvals (Section 10(a)(1)(A) permits) issued for each of the District's hatchery programs (such as Permit No. 1196). An overarching adaptive-management framework is relevant to both tiers of Douglas PUD's ESA approval. Under this adaptive-management framework, the HCP Hatchery Committees are required to develop M&E plans and to make relevant management decisions on an ongoing basis (these functions are described in more detail in Section 1.8.1 below). The adaptive-management framework is relevant to the HCP/ITPs because the HCPs specifically establish the terms of the HCP Hatchery Committees' responsibilities. The adaptive-management framework is also relevant to the hatchery permits because, through the HCPs, the HCP Hatchery Committees are charged with incorporating adaptive management into the hatchery-related activities authorized by the hatchery permits. This adaptive-management framework allows for flexible management of hatchery operations under the terms of the HCPs and the Section 10 permits.

The Methow Hatchery spring Chinook program specifically addresses the unavoidable losses of juvenile spring Chinook associated with the operation of Wells Dam, and a portion of the unavoidable losses associated with operation of Rocky Reach, Rock Island, Wanapum and Priest Rapids dams. The program has the potential to contribute to the long-term persistence of ESA-listed UCR spring Chinook through increases in their abundance within the ESU, and is likely necessary to prevent the extinction of the Methow independent population of the ESU until factors limiting the productivity of naturally produced spring Chinook in the region can be improved.

1.8.1 Legal Agreements & Requirements

This HGMP includes actions required of Douglas PUD pursuant to its Wells HCP (and Chelan and Grant PUDs pursuant to their HCPs and SSA, respectively), as well as other adult-management[2] actions that are beyond HCP and settlement agreement obligations of the respective PUDs, but represent important fishery-management activities that may be implemented by WDFW and the other JFPs. This section is intended to provide background and context to aid in the interpretation and application of the terms and obligations of this HGMP. Specifically, this section (1) identifies and describes the purposes and objectives of the Wells HCP relevant to this HGMP, (2) outlines certain responsibilities and obligations of Douglas PUD based on the commitments and assurances provided in the Wells HCP; and (3) describes certain obligations and responsibilities under the terms of this HGMP.

1.8.1.1 Douglas PUD's Wells HCP

Included in the license for the Wells Project (Federal Energy Regulatory Commission [FERC] No. 2149) is an Anadromous Fish Agreement and HCP detailing the long-term adaptive management of Plan Species and their habitat as affected by the Project. Parties to this agreement include the NMFS, the U.S. Fish and Wildlife Service (USFWS), WDFW, and the Confederated Tribes of the Colville Reservation (CCT), the Confederated Tribes and Bands of the Yakama Nation (YN), Douglas PUD and the four Wells Project power purchasers. The overriding goal of the Wells HCP—developed in accordance with the ESA's goals of conserving and facilitating the recovery of natural populations—is to achieve NNI for anadromous salmonids migrating through the Wells Hydroelectric Project. Under the terms of the Wells HCP, the hatchery-compensation component of NNI consists of providing funding and facilities required to provide up to 7-percent hatchery compensation for all Permit Species subjected to unavoidable passage losses at the Wells Hydroelectric Project (compensation for Douglas PUD is currently 3.8 percent as adjusted per the 96.2-percent survival of yearling Chinook and steelhead measured by 3 years of survival studies conducted in 1998, 1999, and 2000). Section 8 of the Wells HCP details the objectives, responsibilities, and requirements of hatchery programs required as mitigation for the operation of the Wells Project, as follows:

[2] The term "Adult Management," as used throughout this document, is defined as the selective removal of excess hatchery-origin spring Chinook by means of harvest, translocation, culling, or other method of physical removal of returning adult fish for purposes other than broodstock collection or HCP Hatchery Committee-approved monitoring and evaluation activities

8.1 Hatchery Objectives[3]

8.1.1 The District shall provide hatchery compensation for all of the Permit Species including; a) spring chinook salmon, b) summer/fall chinook salmon, c) sockeye salmon d) summer steelhead as further described in Section 8 [of the Wells HCP] *(Hatchery Compensation Plan)….*

8.1.2 The District shall implement the specific elements of the hatchery program consistent with overall objectives of rebuilding natural populations, and achieving NNI. Species specific hatchery program objectives developed by the JFP may include contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest. This compensation may include Measures to increase the off-site survival of naturally spawning fish or their progeny….

1.8.1.2 Adaptive Management and Section 10 Permits

As detailed in Footnote 1 above, Douglas PUD's spring Chinook hatchery program obligations under the HCP are implemented through an adaptive-management process set forth in the HCP and under the direction of the HCP Hatchery Committee. Specifically, the HCP Hatchery Committee may periodically adjust Douglas PUD's hatchery-production levels (see HCP at Sections 8.4.4 and 8.4.5) and make program modifications to achieve program objectives, including changes to facilities, release methods, and rearing strategies necessary to achieve and maintain NNI pursuant to the HCPs (see HCP at Section 8.6). The adaptive-management processes in the HCP are integral to the spring Chinook program described in this HGMP.

Any updated Section 10 permit and associated environmental reviews should incorporate, rely on, and anticipate compliance with the adaptive-management provisions of the HCP as described above. This practice will minimize the need for future modification of the Section 10 permit for normal, ongoing program-oversight decisions of the HCP Hatchery Committee, recognizing that NMFS will play an integral role in determining any future program modifications as a member of the HCP Hatchery Committee.

Douglas PUD HGMP Actions Implementing the HCP

Within this HGMP, the following are Douglas PUD obligations intended to implement the requirement of the HCP. These obligations include the potential need to provide up to 7-percent hatchery compensation for unavoidable passage losses (currently 3.8 percent as adjusted per the 96.2-percent survival of yearling Chinook measured by 3 years of survival studies conducted in 1998, 1999, and 2000, and subject to readjustment):

- Provide water sources and implement risk-aversion measures as described or similar to those described in Section 4 "Water Source."
- Provide facility capacity to rear the fish as described in Section 5 "Facilities."
- Provide broodstock collection facilities—Wells Dam fishways, Methow Hatchery outfall, and the Twisp River weir—and funding for an operator for broodstock

[3] Taken from Page 27 of the Wells HCP.

collection as described in Section 6 “Broodstock Origin and Identity” and Section 7 “Broodstock Collection.”

- Provide funding for an operator to perform the activities described in Section 8 “Mating,” Section 9 “Incubation and Rearing,” and Section 10 “Release.”
- Provide funding for implementation of the hatchery M&E Plan as approved and modified by the HCP Hatchery Committee.
- Provide one FTE for adult-management activities (for both steelhead and spring Chinook hatchery programs) associated with Douglas PUD’s NNI hatchery compensation.
- Under the terms of this HGMP, Douglas PUD via their hatchery operator and/or M&E contractor (currently WDFW) is also obligated to complete and submit all hatchery Section 10 permit reporting associated with Douglas PUD’s hatchery obligations.

<u>WDFW HGMP Actions</u>

WDFW is the funding source for elements of the hatchery program that are not Douglas, Chelan, or Grant PUDs’ obligations under the HCPs or respective hydroelectric licenses. In particular, WDFW is responsible for the management of adults returning that exceed program needs or are strays from segregated programs into priority habitats. In addition to funding the removal of excess adults beyond the one FTE that will be provided by Douglas PUD, WDFW shall also be responsible for all adult returns from the point at which fish are placed in a holding container when manually removed or for a conservation fishery (not part of this program or explicitly included in this HGMP). The Co-Managers will determine the disposition of the fish placed in the holding container.

1.8.2 Program Description

The Methow Hatchery spring Chinook program is described in the subsequent subsections and includes (1) broodstock collection and program size; (2) spawning, incubation, rearing, and release of juvenile spring Chinook; (3) escapement and management of returning adults; (4) annual decision-making regarding broodstock collection and escapement; and (5) monitoring and evaluation.

The Methow Hatchery spring Chinook program is a conservation program intended to rebuild the natural population using a fully integrated broodstock-collection protocol and consists of two components, Twisp River and Methow/Chewuch rivers, that will be managed with distinct strategies. Differences in the proposed management of these two components (as described below) is necessitated by the following: 1) dissimilarity in the proportions of natural- and hatchery-origin recruits (NORs and HORs, respectively) represented in the spawning escapements to the Twisp River versus the remainder of the major spawning areas (MaSAs) within the Methow Basin, and 2) the opportunity to control the proportion of hatchery origin spawners (pHOS) in the Twisp via the Twisp weir, an option unavailable within other MaSAs in the Methow Basin. At the discretion of the HCP Hatchery Committees, the program will release up to 550,000 smolts annually (Table 1-2). A second spring Chinook program (WNFH; separate HGMP) is operated within the Methow River Basin by the USFWS, and proposes to rear up to

600,000 smolts, up to 400,000 of which would be released in the Methow Basin[4]. The proposed WNFH program would be a segregated harvest program, but would "integrate" with the Methow Hatchery spring Chinook program in that 20%-30% of the broodstock will comprise excess HORs from the Methow Hatchery, with the remainder consisting of returns directly to WNFH (WNFH program will not include natural-origin recruits). Anticipated returns from the program were estimated based on the maximum, minimum, and mean smolt-to-adult returns (SARs) from the 11 most recent, complete brood-year returns. The anticipated returns are as follows:

Program Component (numbers of smolts released)	Anticipated Number of Adults Returned		
	Minimum SAR	Mean SAR	Maximum SAR
Methow/Chewuch (450,000)	100	1,170	2,376
Twisp (100,000)	23	140	362

1.8.2.1 Broodstock Collection and Program Size

Although this HGMP is for the Methow Hatchery spring Chinook program, some details of the proposed WNFH segregated harvest program are provided because, in the past, both programs have collected broodstock for each other including swim-in collection at the WNFH and Methow Hatchery outfall, and this practice is expected to continue. Numeric goals for broodstock collection by both programs were developed based on the intended outcome of the release group (conservation or segregated harvest), average fecundity, egg-to-smolt survival, and an assumed equal sex ratio. It is the intent of the co-managers to collect broodstock for the Methow Hatchery spring Chinook program in a manner that achieves mitigation needs and contributes to an increased proportionate natural influence (PNI)[5]. The maximum extraction rate of natural-origin fish collected for broodstock will not exceed 33 percent of the NORs to the Methow Basin or to the Twisp River. In years when natural-origin run size allows a 100% percent natural-origin broodstock (pNOB of 1.0) the actual extraction rate will be lower than 33 percent of the NORs.

The proposed smolt-release numbers (up to 550,000) for the Methow Hatchery spring Chinook program requires the collection of up to 360 adults, which would include a slight over-collection specifically for BKD management. BKD prevalence necessitates collection of additional hatchery-origin fish to allow for culling of gametes from high-titer hatchery-origin females (high-titer defined as enzyme-linked immunosorbent assay [ELISA] optical density [OD] ≥0.12). The most recent Broodstock Collection Protocols (2009) for the existing program called for 359 adults for the Methow Hatchery program, which included 12-percent over-collection to account for BKD-related culling (12 percent was the 5-year [2004-2008] rolling average of the proportion of females in the broodstock with ELISA OD values ≥0.12). However, analyses in

[4] Subject to NMFS approval of the program as proposed in the draft HGMP submitted in July of 2009.
[5] Mathematically, PNI = pNOB /(pHOS + pNOB), where pNOB is the proportion of natural-origin fish in the hatchery broodstock and pHOS is the proportion of hatchery-origin fish on the spawning grounds. Biologically, PNI is an approximation of the relative influences of the natural and hatchery environments on the genetic constitution and mean phenotypic values of hatchery and wild fish when gene flow occurs between them.

support of this HGMP assumed adult collection of 348 adults based on the inclusion of the 2009 ELISA values into the rolling average (now 8.2 percent rather than 12 percent) used to determine rates of over-collection. Finally, in addition to the adult collected for the Methow Hatchery spring Chinook Program an additioanl 360 hatchery-origin adults (some of which would be collected at the Methow Hatchery outfall trap) would be necessary to support the proposed WNFH spring Chinook program (the USFWS draft HGMP for the WNFH program specifies a total of 360, including up to 276 adults to provide eggs for within-basin releases and 84 adults to provide eggs for out-of-basin releases, with a not-to-exceed total of 400; see USFWS [2009]).

Table 1-2. Total Methow Basin broodstock collection necessary to meet production targets for the Methow Hatchery spring Chinook conservation program (assuming 8.2% over-collection) and the proposed Winthrop National Fish Hatchery spring Chinook segregated harvest program.

Program	Release Location	Smolt Objective	Approx. Brood
Methow Hatchery Conservation	Methow	225,000	142[a,b]
	Chewuch	225,000	142[a,b]
	Twisp	100,000	64[a,c]
	Methow Hatchery Total	**550,000**	**348**
WNFH[d] Segregated	Methow (plus out of basin)[d]	400,000 (600,000)[d]	276 (360)[d]

a – All values based on a current, mean Age-4 fecundity of 4,000, an egg-to-smolt survival of 0.90, an 8.2% over-collection allowance for BKD management, a 1:1 male:female ratio, and 95% pre-spawn adult survival.
b –Methow/Chewuch composite origin, preferrably wild-by-wild (WxW) or hatchery-by-wild (HxW) crosses, but could be hatchery-by-hatchery (HxH) crosses, depending on the availability of natural-origin fish.
c – Entirely Twisp-origin broodstock, WxW (preferred) or HxW crosses.
d – USFWS program is not associated with Douglas PUD obligations and is not covered under this HGMP. Numbers in parentheses represent total numbers when including broodstock and smolts necessary for planned out-of-basin releases.

The current (2009) Methow Hatchery spring Chinook program collects both natural- and hatchery-origin broodstock at the Twisp weir, Methow Hatchery and WNFH outfalls, and Wells Dam (Twisp-origin adults collected at Wells Dam are genetically differentiated from Methow/Chewuch spring Chinook). The proposed program would continue to collect natural-origin and/or hatchery-origin broodstock at the locations described above, and may also collect broodstock by other methods such as angling or seining. Methow Hatchery-origin adults that voluntarily enter the WNFH will be transferred to Methow Hatchery until the broodstock-collection goals for the Methow Hatchery program have been satisfied, after which WNFH will retain Methow Hatchery-origin adults for use in their segregated program or for removal to control pHOS. Additionally, Methow Hatchery-origin returns to the Methow Hatchery that exceed broodstock and spawner-escapement needs will be provided to the WNFH for their use as broodstock, until their broodstock needs are met (WNFH target for Methow Hatchery fish is 20%-30% of their broodstock total).

WDFW will annually develop site-based broodstock-collection protocols approved by the HCP Hatchery Committee. These objectives and protocols may be adjusted in season to meet changes in the abundance, composition, and location of adult returns, and to minimize impacts on non-target fish. The protocol described below will be used to facilitate the collection of hatchery broodstock throughout the run while achieving the target extraction rate and ensuring full broodstock collection.

1. Based on forecasted run size, the HCP Hatchery Committee will identify target PNI levels and associated pHOS, pNOB values, and overall broodstock targets for both the Methow/Chewuch and Twisp components of the program. Based on the target PNI levels and broodstock numbers, WDFW will develop weekly broodstock-collection goals. WDFW and the HCP Hatchery Committee will use in-season data (dam counts, PIT-tag detections, PBT to verify pre-season estimates of run size and composition to ensure that the selected PNI, pHOS, and broodstock goals are appropriate, and will modify those goals in-season as necessary.
2. Weekly collection goals will target the collection of broodstock distributed throughout the run.

When in operation, trap facilities will be checked and emptied daily, with broodstock transported to a hatchery facility for holding and spawning, and all other fish either released upstream of the trap(s) or removed to control pHOS.

The following procedures will be employed to minimize potential adverse impacts on spring Chinook associated with broodstock-collection activities:

- All species will be held for a minimal duration in the traps (less than 24 hours).
- Traps and holding areas will be locked or secured against tampering or vandalism.
- All natural-origin spring Chinook in excess of broodstock goals will be released upstream immediately without harm, consistent with run-escapement objectives.
- Spring Chinook will be transferred using water-to-water techniques.
- Hook-and-line collections (if any) will be conducted by, and/or under strict management oversight by WDFW staff.

1.8.2.2 Spawning, Incubation, Rearing and Release of Juvenile Spring Chinook

Spawning will occur at the Methow Hatchery. The spawning facilities are integrated into the broodstock-holding facilities, allowing the sorting of broodstock for sexual maturity followed immediately by spawning. Fertilization, incubation, and rearing also occur at the Methow Hatchery.

A portion of the up to 550,000 pre-smolts from the Methow Hatchery spring Chinook program will be transferred to the Twisp (only Twisp-origin fish; up to 100,000) and Chewuch River (approximately 225,000 non-Twisp fish) acclimation ponds in the spring when air and water temperatures allow (typically mid-March), and be volitionally released as smolts in late April to early May. The balance of the non-Twisp pre-smotls (approximately 225,000) will be acclimated on-site on Methow River water and released as smolts from the Methow Hatchery. In the future, the HCP Hatchery Committees may elect to acclimate in and release fish from additional acclimation sites developed by others, provided that Douglas PUD relinquishes responsibility for and receives mitigation credit (as appropriate) for those fish when they leave Douglas PUD facilities. Examples of such additional acclimation sites are those proposed by the

Yakama Nation in the floodplains of the upper Methow and Twisp rivers (draft proposal submitted for comments to the HCP Hatchery Committees in October 2009).

Any acclimation sites considered by the HCP Hatchery Committees shall meet the minimum flow and density indices, and predator-protection criteria of the HCP Hatchery Committees, and shall be non-consumptive users of water. Additionally, the HCP Hatchery Committees will assess on a case-by-case basis the magnitude of the withdrawal or diversion for each acclimation facility (as appropriate) relative to the instantaneous discharge of the water course to which it is appurtenant, and may reject any facility or condition its use for spring Chinook based upon their assessment of the impacts of that water withdrawal or diversion on Plan Species or non-target taxa of concern. Acclimation sites which by default have a natural flow through design and no means to artificially divert water will not be subject to such an assessment. It is anticipated that a portion of the spring Chinook produced by Douglas PUD at Methow Hatchery for Grant PUD may soon be acclimated at Goat Wall and Biddle ponds; permit coverage for that acclimation will be obtained by Grant PUD via their Methow River Spring Chinook Artificial Propagation Plan. Future acclimation may include other sites described in the Mid-Columbia Coho Restoration Master Plan.

1.8.2.3 Escapement Goals for Natural Spawning Areas

The Methow Hatchery spring Chinook program is intended to increase the number of adults on the spawning grounds to fully seed available habitat. Theoretically, fully seeded habitat should increase the number of naturally produced juvenile fish that migrate to the ocean, thereby increasing the number of adults that return to spawn. However, escapement of hatchery fish to the spawing grounds in excess of biologically sound escapement goals serves no useful purpose and can result in negative impacts on the natural population through density-dependent, ecological, and genetic effects. To achieve the positive benefit of increasing the number of natural spawners without adversely affecting the fitness of the natural population, it will be necessary to manage both the total number of natural-origin spawners (NOSs) and pHOS in the spawning escapement, and the pNOB of the hatchery broodstock.

The ICTRT (2007) classification of the Methow spring Chinook population as “Very Large” is based (in general) on intrinsic habitat potential, and requires a minimum abundance value of 2,000 natural-origin spawners for the Methow Basin in order to be considered a “viable” “Very Large” population. Pre-spawn mortality for Methow Basin spring Chinook has averaged 24% over the last six years (2003-2008; C. Snow, personal communication). An upward adjustment of the spawning-escapement goal by 24 percent to accommodate potential pre-spawn mortality requires a run-escapement goal of 2,480 natural-origin adults. However, the application of the coarse-scale ICTRT abundance threshold to the Methow does not consider any basin-specific analysis that may provide a more accurate estimate of production capacity. Existing data sets report estimates of run escapement to the Methow beginning in 1981 (see Table 1-12 in Section 1.12), and since that time run escapements for NORs have never achieved the goal of 2,480 (maximum of 1,832 in 2001), and even including HORs, the goal has been achieved only twice (10,971 in 2001, and 2,637 in 2002), suggesting that the ICTRT target overestimates basin capacity. Additionally, estimates of the natural replacement rates (NRR) for the years 1992-2002 (see Table 1-14 in Section 1.12) are generally highest during the years with low escapement numbers and lowest in years when escapement was highest, supporting a conclusion that density dependence may render unachievable an abundance target of 2,000 NOSs.

The Hatchery Scientific Review Group (HSRG 2009) provided a capacity estimate for the Methow Basin based on the EDT modeling from the development of the Methow Sub-basin Plan in 2004, and this estimate (NOSs = 240 Twisp and 900 for the remainder of the basin; 1,140 total) provides a better match with existing escapement data. The HSRG goal of 1,140 NOSs has been achieved six times since 1981, and when including HORs, it has been achieved eleven times over that same period (see Table 1-12 in Section 1.12). Empirical observation of spawning habitat utilization in the Methow Basin by Douglas PUD hatchery M&E investigators from WDFW's Twisp Field Office (Charlie Snow and Charles Frady, personal communications) and the relative attainability of run sizes sufficient to meet the basin spawning goal supported the decision to select the HSRG capacity estimate of 1,140 as an interim escapement target (Table 1-3) rather than the ICTRT (2007) target. This goal will be revised as reliable spawner/recruit relationships are developed for each MaSA in the Methow River Basin. The Methow Basin M&E investigators recommended an adjustment in the distribution of the spawner escapement in the basin (based on observed spawner distributions), reducing the Twisp capacity estimate from 240 to 200 (representing ~18% of the spawners) and increasing the capacity for the remainder of the basin from 900 to 940.

Combining pre-spawn mortality (0.24) and broodstock needs for the Methow Hatchery program (348, with 8.2% over-collection) with the HSRG capacity estimates for the Methow (1,140) yields a desired minimum run-escapement value of 1,848. Finally, the WNFH program would require an additional 360 adults, increasing the total run escapement of spring Chinook to the Methow Basin to 2,122 (see Table 1-3).

While the 1,140 HSRG spawner-escapement goal is for natural-origin fish, numbers of NORs in the Methow Basin are inadequate to meet these goals in all but the largest of run sizes. Thus, the targets in Table 1-3 include both NORs and HORs, and will serve as management thresholds beyond which control of HOR abundance may be necessary, and below which control of HOR abundance may preclude full seeding of available habitat. Note that estimates of spawner distribution by MaSA will vary annually and over greater time scales as survival, habitat capacity, and productivity conditions within and outside the Methow basin fluctuate, estimates of pre-spawning mortality are refined, and stock-recruitment models are updated.

Table 1-3. The estimate of habitat capacity for Methow Basin spring Chinook from the HSRG (2009) applied as the minimum spawning escapement, and apportioned to MaSA by the observed distribution of spawners (2001-2009; C. Snow and C. Frady, personal communication). Run-escapement targets assume broodstock collection in the Methow Basin rather than Wells Dam.

Major Spawning Area	Spawning Escapement Target[a]	Run Escapement Target[b]
Methow River	470	1,227[c]
Chewuch River	470	583
Twisp River	200	312[d]
Total Methow Basin	1,140	2,122

[a] NOR escapement will be unrestricted at all run sizes. In some years total escapement may be lower than the listed value so that PNI targets can be achieved. As NOR run sizes increase, pHOS will approach 0.00.
[b] Run escapement is 24% greater than spawning escapement to allow for pre-spawn mortality, straying, etc.
[c] Run escapement to the Methow includes 284 Methow/Chewuch-origin brood for the Methow Hatchery and 360 for the WNFH assuming all of which would be collected from the outfalls for those hatcheries. Collection of brood at Wells Dam would reduce the necessary total run escapement to the Methow and Twisp.
[d] Run escapement to the Twisp includes the 64 brood for the Twisp component of the Methow Hatchery program.

1.8.2.4 Annual Decision-making Regarding Broodstock Collection and Spawning Escapement

The Methow Hatchery spring Chinook program is intended to support the rebuilding of the spring Chinook population in the Methow Basin while also providing mitigation for five Columbia River hydroelectric projects. The spring Chinook population in the Methow Basin is essential to the recovery of the Upper Columbia River spring Chinook ESU, and, as such, it was designated as a "Primary" population by managers during the HSRG (2009) review of hatchery programs in the Columbia Basin. The HSRG established management guidelines for PNI, pHOS, and pNOB to minimize genetic risks of hatchery programs to naturally spawning populations, and for those programs designated as "Primary." The HSRG recommended that pHOS should be < 0.30, and that pNOB exceed pHOS by at least a factor of two, corresponding to a PNI ≥ 0.67. However, for the Methow Basin achievement of the HSRG-recommended PNI, pNOB, and pHOS values is precluded in most years—whether or not broodstock is collected for hatchery production—because NOR abundance is insufficient and the ratio of HORs to NORs too skewed toward HORs (see Table 1-10 in Section 1.12). Even in the Twisp River where historically the ratio of HORs to NORs has been relatively balanced and a weir permits the control of pHOS, achievement of the HSRG management guidelines for a Primary population is possible only in approximatley 20 percent of the historic run sizes (see Table 1-4). The HSRG (2009) acknowledged this challenge, conceding that despite examining a variety of hatchery scenarios with the current programs in place in the Methow Basin, they had been unable to "significantly increase natural-origin spawning under current habitat conditions" through their modeling efforts. Further, they stated that there were too few NORs in the Methow Basin "to properly integrate the current Winthrop and Methow combined production."

The HSRG was unable to provide discrete management recommendations for the Methow Hatchery spring Chinook program other than the implementation of a variable "sliding scale" for pNOB and pHOS that floats with variations in NOR abundance. Nevertheless, decisions on the management of Twisp and non-Twisp components of the program should focus on minimizing the genetic risk of the hatchery program while also minimizing the demographic risk to the population. Therefore, we propose management of the Methow Hatchery spring Chinook program according to the genetic principles upon which the HSRG guidelines are based within the context of meeting production objectives and providing demographic buffering (i.e., seeding the habitat). Those prinicples, for an integrated program and especially one intended to contribute to the recovery of an ESA-listed population, can be summarized as follows: to manage the hatchery program to minimize the loss of triats that optimize the fitness of natural-origin fish, or in other words, maximizing the "wildness" of fish produced in both the natural and hatchery environments. In the case of hatchery broodstock, natural influence can only predominate if pNOB exceeds 0.50; in the natural environment, pHOS cannot exceed 0.50 if natural influence is to predominate. In a natural population wherein operates an integrated hatchery program, PNI will never fall below 0.50 when pNOB $\geq$ 0.50 and pHOS $\leq$ 0.50. Holding each of these values at 0.50 would maintain the status quo of the existing phenotypic values and genetic constitution of an integrated hatchery program/natural target population. Long-term, systematic achievement of these targets in the Methow Basin would represent a substantial increase in PNI over the current conditions.

In the existing context of the Methow Basin, where annual returns are dominated by HORs, and escapement targets may not be met in years with poor returns (regardless of whether or not hatchery brood are collected), even the PNI targets of pNOB $\geq$ 0.50 and pHOS $\leq$ 0.50 will often be unachievable. The Twisp component of the Methow Hatchery spring Chinook program offers the best opportunity to achieve and even improve on these status-quo PNI targets (see Table 1-4), provided that hatchery-production targets are flexible and secondary to PNI in priority. Therefore the Twisp and the Methow/Chewuch program components will be managed differently, with the focus for the Twisp component on improving PNI at the expense of hatchery production, with any shortfall in production from the Twisp component shifted to the Methow/Chewuch component commensurate with the shortfall. For both program components, improving PNI will be an objective with the ultimate goal to achieve the PNI objective for a Primary population (0.67) as a moving average over time. Additionally for both program components, the annual forecast (and in-season adjustments) of run size and composition will be the basis for the determination by the HCP Hatchery Committees of the annual targets for broodstock numbers, PNI, pNOB, and pHOS.

The HCP Hatchery Committee will periodically evaluate whether or not the implemented management decisions have been effective at attaining the stated objectives (both PNI and production) of the two hatchery program components. Future adjustment of the objectives and/or management decision rules for the respective program components may be necessary as a result of improved estimates of basin capacity, changes in out-of-basin and/or within-basin factors influencing productivity, failure of the decision rules to achieve PNI and/or production objectives, or changes in production obligations (such as in 2013 to reflect the results of completed survival studies).

Twisp Component Decision Rules

As described above, 200 spawners (from the 1,140 HSRG capacity estimate) will constitute the spawner escapment target for the Twisp. As a target for minimum spawning escapement, the ICTRT (2007) quasi-extinction threshold (50 spawners) was selected. Finally, the broodstock target for the Twisp component is a maximum of 64 (used 63 for this analysis) adults. Within the context of these target parameters, the following management rules will apply to the Twisp program component:

- Escapement of NORs will not be restricted.
- The NOR extraction rate for broodstock will not exceed 0.33 of the resultant natural-origin spawners (NOSs). This rule will maximize NOSs, facilitating the management of pHOS, especially when run sizes are too low to allow adult management. Application of this rule to historic data sets yielded a NOR extraction rate of approximately 0.20 for most run sizes capable of supporting hatchery production (see Table 1-4).
- pNOB will always be ≥ 0.50, in accordance with the HSRG principles of maintaining the dominance of natural influence. Consequently, production from the Twisp component of the program will be limited by NOB such that the total broodstock number will never exceed twice the number of the NOB. Increased Methow/Chewuch production will compensate for shortfalls in Twisp production.
- The pHOS target will be a moving-average ≤ 0.50
- Adult management will be used to constrain pHOS when run sizes allow the achievment of a spawner escapement of at least 200 adults. Adult management may also be necessary when spawner escapement is < 200 adults to achieve a moving-average pHOS ≤ 0.50.
- NOR extraction rates would be reduced as necessary for run sizes where utilizing the full extraction rate of 0.33 of the NOSs, would cause the total spawner escapement to fall below the minimum of 50 adults. For run sizes where a reduction in the NOR extraction rate would no longer prevent the total spawner escapement from falling below 50 adults, broodstock collection should be terminated to maximize natural production. In such cases the HCP Hatchery Committee must consider all relevant VSP data and provide a recommendation to the JFP regarding the decision to collect Twisp broodstock for that brood year; the JFP will make the final decision.

Application of these rules to the spawner escapement data for the Twisp River for the 1992-2008 return years generated average pNOB values of 0.62, pHOS of 0.37, and PNI of 0.61 (Table 1-4). Despite the nearly equal proportions of HORs and NORs historically in the Twisp data, pHOS values exceeded the 0.50 maximum for several of the run-size percentiles, illustrating the difficulty of achieving even the relatively liberal genetic priniciples enforced in this exercise. Achieving the HSRG-recommended target of pHOS ≤ 0.30 was only possible via adult management in relatively extreme run sizes.

Table 1-4. Application of the "Twisp Component Decision Rules" to the ranked percentiles of historic, annual estimates of spawning escapement to the Twisp River (1992-2008) (from Snow et al. 2009)

Example - Twisp River Spawning Escapement and Brood Composition Based on Escapement Estimates from 1992-2008

Run-size percentiles (1999-2008)	NORs to Twisp	HORs to Twisp	NOR extraction rate	HOR extraction Rate	NOB[a]	HOB	Total brood	NOS[b]	HOS before pHOS control[c]	HORs removed for pHOS control	HOS after pHOS control	Total Spawners (200 target; 50 min)	pNOB	pHOS	pNOS	PNI	Egg Take pre-culling[d]	Smolts produced w/o culling	Smolt produced w/ culling (8.2%)	Naturally produced eggs
>95%	540	384	0.12	0.00	63	0	63	363	292	292	0	363	1.00	0.00	1.00	1.00	120,000	108,000	99,815	726,000
95%	416	309	0.15	0.00	63	0	63	268	235	235	0	269	1.00	0.00	1.00	1.00	120,000	108,000	99,815	538,000
90%	291	235	0.20	0.03	57	6	63	178	174	152	22	200	0.90	0.11	0.89	0.89	120,000	108,000	99,815	400,000
85%	236	181	0.20	0.09	47	16	63	144	125	70	55	200	0.75	0.28	0.72	0.73	120,000	108,000	99,815	400,000
80%	181	126	0.20	0.21	36	27	63	110	75	0	75	186	0.57	0.40	0.59	0.59	120,000	108,000	99,815	372,000
75%	138	113	0.20	0.24	27	27	54	84	65	0	65	150	0.50	0.44	0.56	0.53	104,000	93,600	86,506	300,000
70%	94	100	0.20	0.19	19	19	38	57	62	0	62	119	0.50	0.52	0.48	0.49	74,000	66,600	61,553	238,000
65%	81	99	0.20	0.16	16	16	32	49	63	0	63	113	0.50	0.56	0.44	0.47	62,000	55,800	51,571	226,000
60%	67	98	0.20	0.14	14	14	28	40	64	0	64	105	0.50	0.61	0.38	0.45	54,000	48,600	44,917	210,000
55%	66	81	0.20	0.16	13	13	26	40	52	0	52	92	0.50	0.56	0.44	0.47	50,000	45,000	41,590	184,000
50%	65	65	0.20	0.19	13	13	26	40	40	0	40	80	0.50	0.49	0.49	0.50	50,000	45,000	41,590	160,000
45%	59	63	0.20	0.18	12	12	24	36	39	0	39	75	0.50	0.52	0.48	0.49	46,000	41,400	38,262	150,000
40%	52	60	0.19	0.16	10	10	20	32	38	0	38	70	0.50	0.54	0.46	0.48	38,000	34,200	31,608	140,000
35%	48	47	0.15	0.15	8	8	16	30	30	0	30	61	0.50	0.49	0.50	0.51	32,000	28,800	26,617	122,000
30%	44	34	0.13	0.16	6	6	12	29	22	0	22	51	0.51	0.42	0.57	0.54	24,000	21,600	19,963	102,000
25%	40	26	0.00	0.00	0	0	0	30	20	0	20	51	0.00	0.39	0.60	0.00	0	0	0	102,000
20%	35	18	0.00	0.00	0	0	0	27	14	0	14	41	0.00	0.33	0.65	0.00	0	0	0	82,000
15%	35	15	0.00	0.00	0	0	0	27	11	0	11	38	0.00	0.30	0.70	0.00	0	0	0	76,000
10%	35	12	0.00	0.00	0	0	0	27	9	0	9	36	0.00	0.25	0.74	0.00	0	0	0	72,000
5%	29	6	0.00	0.00	0	0	0	22	5	0	5	27	0.00	0.17	0.82	0.00	0	0	0	54,000
												Averages	**0.62**	**0.37**	**0.62**	**0.61**				

a - NOB never exceeds 33% of NOS

b - NORs minus broodstock and 24% pre-spawn mortality

c - HORs minus broodstock and 24% pre-spawn mortality

d - Assumptions: survival = 95% pre-spawn, 90% egg-to-release; 4,000 fecundity; 1:1 male:female.

No shading = runs of sufficient size to fill program, achieve spawner-escapement (200), pHOS (< 0.3), pNOB (> pHOS and ≥ 0.5), and PNI (> 0.67) targets (with adult management).

Blue shading = run of sufficient size to achieve the spawning-escapement target (200), but to do so would require a substantial reduction in hatchery production.

Gray shading = run sizes where spawn escapement < 200 target ≥ 50 (ICTRT [2007] quasi-extinction threshold), and brood collection maximized within extraction and pNOB limitations.

Yellow shading = run sizes where run escapement cannot support a hatchery program and provide a minimum total spawning escapement of ≥50.

Methow/Chewuch Component Decision Rules

As described above for the Methow/Chewuch program component, the dissproportionately hatchery-origin composition of the run escapement and the lack of within-basin collection opportunities for controlling pHOS complicates the achievement of acceptable values of spawning escapement, pNOB, pHOS, and PNI, while also achieving production targets. Efforts to develop rules such as those proposed above for management of the Twisp program component have been unsuccessful at systematically achieving all of those management targets. Indeed, for most run sizes, simultaneously achieving more than two of those targets proved difficult. Thus, we do not offer a proposal for a management scheme for the Methow/Chewuch component, but instead recommend that the HCP Hatchery Committees agree on a management regime annually during the development of the annual broodstock collection protocol as described above in Section 1.8.2.1. The following rules should apply to the annual development of broodstock, pHOS, pNOB, PNI, and spawning-escapement targets:

- Minimum escapement should not fall below 500 spawners. Under the ICTRT (2007) viability criteria, no populations are considered viable with fewer than 500 spawners. Hatchery production should be secondary in priority to achieving a spawning escapement of at least 500 spawners.
- The rate of extraction of natural-origin broodstock from all hatchery programs should never exceed 0.33 of the NORs to the Methow Basin.
- Maximize pNOB in years when spawning escapement will exceed 500 NOSs to the extent that it does not result in increasing pHOS above 0.50. Note that in populations where escapement is dominated by HORs and pHOS generally exceeds 0.30, increasing pNOB above 0.50 is relatively ineffective at maintaining PNI > 0.5 compared with reductions in pHOS.
- Escapement of NORs will not be restricted
- Apply measures for adult management to control pHOS when appropriate. When the natural-origin spawning escapement is ≥ 1,140 then the escapment of HORs to the Methow should be minimized (allowing for escapement of broodstock, etc.) and pNOB will be maximized. In return years when the total spawning escapement (including both hatchery and natural origin) is between 500 and 1,140, habitat seeding and genetic concerns must be balanced by the HCP Hatchery Committee in their determination of adult-management measures.

Marking Strategy

All smolts will be marked according to a coordinated marking scheme for spring Chinook releases above Wells Dam, to be determined by the HCP Hatchery Committee, to distinguish specific hatchery crosses and release locations, and to facilitate removal of hatchery-origin fish. See Section 10.1.7 for additional details.

Management of Excess Hatchery Fish

The Methow Hatchery spring Chinook program is critical to the maintenance of the natural population until factors limiting the productivity of natural populations are corrected. However, excess spawning escapement of hatchery fish in relation to wild spawners and habitat capacity pose genetic and ecological risks to the natural population. Ultimately, the most repsonsible and practical means to manage over-escapement of hatchery fish is to reduce hatchery production, but interannual variability in return rates from any given broodyear complicates *a priori* determinations of appropriate hatchery production for future return years. Thus, management of adult returns is necessary to achieve PNI objectives. Escapement of hatchery fish to the Methow basin will be balanced with the goal of adequately seeding available habitat to improve PNI over time and to achieve a moving-average PNI in the Twisp of no less than 0.50, with an ultimate goal of 0.67 or greater over time. In the remainder of the Methow Basin the deisred PNI goals are the same as for the Twisp, but in actuallity, an increasing trend in PNI over time is the first-order objective. To achieve any improvement in PNI will require limitations on the escapement of hatchery fish of Methow Basin origin above Wells Dam, over the Twisp weir, and past hatchery outfalls. Natural-origin spawning escapement will never be limited, and when it meets or exceeds 1,140 (or future improved capacity estimates) in the Methow, the escapement of HORs to the Methow will be reduced to to the lowest extent practicable (considering broodstock needs, etc.).

The HCP Hatchery Committee will annually decide on the magnitude of and methods for the removal of excess hatchery fish based on pre-season natural and hatchery run-size estimates, as adjusted in-season from fishway counts at Columbia River dams. Besides monitoring counts at downstream dams, and especially detections at those dams of PIT-tagged fish originating above Wells Dam, the in-season adjustment of forecasted returns to programs above Wells Dam will be facilitated by the implementation of the Parental Based Tagging (PBT) approach to management of Wenatchee River spring Chinook. Provided the processing of genetic samples is sufficiently rapid, the PIT tagging and genetic sampling of untagged spring Chinook at Priest Rapids Dam should increase the number of known-origin adults traversing the ladders at Wells.

The allowable escapement of hatchery fish will be based on attaining a minimum spawning escapement of 500 spring Chinook (hatchery and natural-origin combined) to the Methow basin to minimize abundance-based extinction risk, and a habitat-seeding spawning escapement of 1,140. The HCP Hatchery Committee will modify this 1,140 spawning-escapment target in response to improved estimates of habitat capacity. When spawning escapements (hatchery + wild) are forecast between 500 and 1,140, the temptation to increase the escapement of hatchery fish must be tempered by genetic concerns that low PNI over time will reduce fitness and reduce the likelihood of recovery. To balance the need to increase escapement while also protecting genetic integrity, pNOB will be ≥ 0.50 for the Twisp component and the number of NOB will not exceed 0.33 of the natural-origin spawners. Additionally, pHOS in the Twisp will not exceed 0.50 except to maintain a minimum spawning escapement of 50 adults. Other than managing HORs at Wells Dam and controlling the number of smolts released, there is no proximate control over pHOS in the remainder of the Methow Basin besides removal of HORs at hatchery outfalls (or a conservation fishery [by others]). Thus, annual trapping in the outfalls of Methow Hatchery and WNFH will continue throughout the spring Chinook run for adult management.

Should improved productivity and abundance of natural-origin spring Chinook result from implementation of the PNI-enhancing management actions in the Twisp River, a greater reduction in the Methow basin escapement of hatchery fish should be implemented. This may temporarily reduce the spawner escapement below the objective of 1,140, but will improve PNI for the entire Methow spring Chinoook population at lower levels of natural-origin spawners.

Wells Dam provides an opportunity to control escapement of hatchery spring Chinook to the Methow, but adult management here also presents several problems: 1) The size of the wild run expected to pass Wells Dam must be estimated in real-time. 2) The proportions of wild fish that will home to the Methow and Okanogan must be estimated to determine the necessary magnitude of adult-management actions. 3) Hatchery fish must be differentially marked for each release location in order to allow escapement of appropriate numbers of hatchery fish specific to each basin. Furthermore, escapement above Wells Dam must account for pre-spawn mortality, fishing mortality, and subsequent broodstock collection removals to achieve desired spawner escapements. Given these challenges, adult management at Wells Dam will require a considerable effort to estimate required information, mark fish, and operate the Wells ladder traps throughout the spring Chinook run. Thus, the initial preferred option for managing excess hatchery-origin adults will be removal at weirs and hatchery volunteer traps (and other locations and methods [e.g., seining] as approved annually by the HCP Hatchery Committee), and removal from the ladders at Wells Dam will be implemented in the future only if these other methods prove unsuccessful and hatchery fish are differentially marked by release location.

Hatchery spring Chinook removed at locations and by methods described above will be provided to WDFW, and WDFW will assume responsibility for their disposition. Options under consideration for these fish include providing harvest opportunities elsewhere, distribution to tribes and public entities, or use for nutrient enhancement in tributaries. Douglas PUD will provide one FTE for adult-management activities (for both steelhead and spring Chinook hatchery programs) associated with Douglas PUD's NNI hatchery compensation.

WDFW is responsible for funding manual adult management activities from the point at which fish are placed in a holding container when manually removed, or for a conservation fishery.

Permit Holder: Although Douglas PUD, as a funder, and WDFW, as a contract operator/implementer, are joint permit holders for the Methow Hatchery spring Chinook program, Douglas PUD is not a fish-management agency with authority over fisheries, or for determining the disposition of fish surplus to program needs, and thus cannot hold a permit for such activities. Thus, WDFW will obtain and hold the necessary permit(s) for manual adult management activities beyond the point at which spring Chinook are removed at Wells Dam, Methow Hatchery, the Twisp River weir, or other Douglas PUD facility where removal of spring Chinook might occur, and placed in holding containers or transport vessels.

Agent: WDFW is designated as the authorized agent under a current contract between Douglas PUD and WDFW and until this contract expires and is not renewed or renegotiated.

Terminal Conservation Fisheries (by others; not included in this HGMP) to Reduce the Proportion of Hatchery Fish on the Spawning Grounds

A conservation fishery is not a component of the proposed modifications to the Methow Hatchery spring Chinook program, and thus is not explicitly included as part of this HGMP. Nevertheless, WDFW has expressed their desire to implement selective harvest through conservation fisheries as a tool to assist in the management of pHOS levels toward improving PNI in the Methow Basin. Adult spring Chinook of hatchery origin returning to the Methow Basin in excess of escapement and broodstock needs may be removed through selective conservation fisheries (implemented by others; not part of this HGMP) as determined on a yearly basis by the JFP. WDFW, in consultation with the JFP, will be responsible for the authorization of non-Tribal fisheries to remove excess hatchery spring Chinook. WDFW intends this management strategy will support recovery and build public support for salmon-recovery efforts in the Methow Basin and other UCR watersheds. While a WDFW conservation fishery may provide a mechanism for the removal of excess HORs, it will also inevitably result in the incidental take of NORs.

In addition to determining annual broodstock, PNI, pHOS, and pNOB targets, pre-season estimates (forecasts) of tributary run size will be used to determine if numbers of HORs are likely to exceed numbers necessary to support recovery of the natural population. In-season updates based on counts at dams, traps, and/or other monitoring locations (e.g., PIT tag detectors), will be used to refine pre-season forecasts. This refinement will be important for determining the disposition of the fish once they reach Wells Dam, and determining the opportunity for a conservation fishery (by others) to remove excess HORs.

WDFW is responsible for funding and conducting the management activities related to terminal and in-river fisheries described above. Accordingly, WDFW will be the permit holder for the harvest activities described above in this sub-section.

Permit Holder: Although Douglas PUD, as a funder, and WDFW, as a contract operator/implementer, are joint permit holders for the Methow Hatchery spring Chinook program, Douglas PUD is not a fish-management agency with authority over fisheries or for determining the disposition of fish surplus to program needs, and thus cannot hold a permit for such activities. Thus, WDFW will obtain and hold the necessary permit(s) for manual adult management activities beyond the point at which spring Chinook are removed at Wells Dam, Methow Hatchery, the Twisp River weir, or other Douglas PUD facility where removal of steelhead might occur, and placed in holding containers or transport vessels.

1.8.2.5 Monitoring and Evaluation

Monitoring and evaluation plays an important role in measuring program results and determining potential future modifications (adaptive management). M&E information is collected directly from, or derived from spawning-ground surveys, broodstock sampling, stock-composition sampling (stock assessment), hatchery juvenile sampling, smolt trapping, passive integrated transponder (PIT) tagging, adipose clipping, genetic sampling, disease sampling, and snorkeling. M&E objectives for this program are detailed in Section 11.1; typical specific actions are detailed in HCP HC (2007) and Hays et al. (2007), and risk aversion measures are detailed in Section 11.2.

Douglas PUD funds (and Chelan and Grant PUDs proportionally co-fund) the M&E activities for this program as agreed to by the HCP Hatchery Committee in accordance with the processes outlined in the HCP, and WDFW is Douglas PUD’s current contractor for those activities.

1.9 List of Program “Performance Standards”

See Tables 1-5 and 1-6 in Section 1.10.

1.10 List of Program “Performance Indicators”, Designated by "Benefits" and "Risks"

1.10.1 “Performance Indicators” Addressing Benefits

The performance indicators in Table 1-5 are from the M&E Plan for Douglas PUD programs developed and approved by the HCP Hatchery Committees, titled Conceptual Approach to Monitoring and Evaluation for Hatchery Programs funded by Douglas PUD (HCP-HC 2007).

Table 1-5. Performance Indicators Addressing Benefits.

Performance Standards	Performance Indicators	Monitoring and Evaluation
1. Increase the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population and the changes in the natural replacement rate (NRR) of the supplemented population (reference population) are similar to that of the non-supplemented population.	Natural Replacement Rate (NRR). Ho: Δ Total spawners $_{\text{Supplemented population}}$ > Δ Total spawners $_{\text{Non-supplemented population}}$ Ho: Δ NOR $_{\text{Supplemented population}} \geq \Delta$ NOR $_{\text{Non-supplemented population}}$ Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$	Spawning escapement and spawning origin composition of supplemented and non-supplemented (reference) populations.
2. Maintain run timing, spawn timing, and spawning distribution of endemic populations.	Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$ Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$ Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$	Monitor and evaluate supplemented and non supplemented (reference) population run-timing, spawn timing and redd distribution.
3. Maintain endemic population genetic diversity, population structure, and effective population size. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.	Ho: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop.}}$ Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$ Ho: Δ Spawning Population = Δ Effective Spawning Population Ho: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$ Ho: Size at Maturity $_{\text{Hatchery}}$ = Size at Maturity $_{\text{Naturally produced}}$	Periodic (every 5 years) genetic analysis of hatchery and naturally produced adult and juvenile fish in the supplemented population. Monitor and evaluate run timing, spawn timing, redd distribution, size and age at maturity, and effective population size of hatchery- and natural-origin fish.
4. Achieve/maintain adult-to-adult survival (i.e., hatchery replacement rate) that is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific HRR expected value based on survival rates listed in the BAMP (1998).	Ho: HRR $_{\text{Year x}} \geq$ NRR $_{\text{Year x}}$ Ho: HRR $\geq$ Expected value per assumptions in BAMP (note that the BAMP is not a definitive standard for comparison)	Monitor and evaluate hatchery and natural adult-to-adult replacement rate in the supplemented populations.

Performance Standards	Performance Indicators	Monitoring and Evaluation
5. Maintain the stray rate of hatchery fish below the acceptable levels to maintain genetic variation between stocks.	Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% of total brood return Ho: Stray hatchery fish < 5% of spawning escapement of other independent populations. Ho: Stray hatchery fish < 10% of spawning escapement of any non-target streams within independent population.	Monitor and evaluate hatchery stray rates and proportional contribution to natural spawning aggregates.
6. Provide release of hatchery fish consistent with programmed size and number.	Ho: Hatchery fish $_{\text{Size}}$ = +/- 10% of Programmed $_{\text{Size}}$ Ho: Hatchery fish $_{\text{Number}}$ = +/- 10% of Programmed $_{\text{Number}}$	Monitor fish size and number at release.
7. Maintain the proportion of hatchery fish on the spawning grounds at a levels that minimize negative affects to freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams with similar adult seeding levels.	Ho: Δ smolts/redd $_{\text{Supplemented population}}$ > Δ smolts/redd $_{\text{Non-supplemented population.}}$	Monitor and evaluate annual smolt production in supplemented and non-supplemented populations. Monitor and evaluate redd deposition in supplemented and non-supplemented populations.
8. Objective 8 of the M&E Plan is not applicable to the Methow Hatchery spring Chinook program	NA	NA
9. Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.	Ho: Rearing density has no effect on survival rates of hatchery fish. Ho: Antigen level has no effect on survival rates of hatchery fish. Ho: Interaction between antigen level and rearing density has no effect on survival rates of hatchery fish. Ho: Rs infection is not transferred from hatchery effluent to study fish	This is a regional objective, the implementation of which requires collaboration among all parties to the Wells HCP. Although the HCP Hatchery Committees have reviewed a draft study design, the logistics of implementing the study are sufficiently complicated as to render the study infeasible at present.
10. Minimize adverse impacts to non-target taxa of concern (NTTOC).	Ho: NTTOC abundance $_{\text{Year x through y}}$ = NTTOC abundance $_{\text{Year y through z}}$ Ho: NTTOC distribution $_{\text{Year x through y}}$ = NTTOC distribution $_{\text{Year y through z}}$ Ho: NTTOC size $_{\text{Year x through y}}$ = NTTOC size $_{\text{Year y through z}}$	This is a regional objective, the implementation of which requires collaboration among all parties to the Wells HCP. This collaboration has been initiated, including the complicated process for determining the potential for and magnitude of impacts of target species on NTTOC.

1.10.2 “Performance Indicators” Addressing Risks

Table 1-6. Performance Indicators Addressing Risks.

Performance Standards	Performance Indicators	Monitoring and Evaluation
1. Artificial propagation activities comply with ESA responsibilities to minimize impacts and/or interactions to ESA listed fish	Program complies with Section 10 permit conditions including juveniles are raised to smolt-size (approximately 15 fish/lb) and released from the hatchery at a time that fosters rapid migration downstream. 100% mass mark and CWT fish to identify them from naturally produced fish.	As identified in the HGMP: Monitor size, number, date of release and mass mark quality. Additional monitoring metrics include, straying, instream evaluations of juvenile and adult behaviors, NOR/HOR ratio on the spawning grounds, fish health documented. Required data are generated through the M & E plan and provided to NOAA Fisheries as required per annual report compliance.
2. Ensure hatchery operations comply with state and federal water quality and quantity standards through proper environmental monitoring.	All facilities meet WDFW water-right permit compliance and National Pollution Discharge Elimination System (NPDES) requirements (NPDES permit No.WAG-5011).	Flow and discharge reported in monthly NPDES reports. Environmental monitoring of total suspended solids, settle-able solids, in-hatchery water temperatures, in-hatchery dissolved oxygen, nitrogen, ammonia, and pH will be conducted and reported as per permit conditions.
3. Water intake systems minimize impacts to listed wild salmonids and their habitats.	<u>Intake screens</u> – designed and operated to assure approach velocities and operating conditions provide protection to wild salmonid species.	Intake system designed to deliver permitted flows. Operators monitor and report as required Hatcheries participating in the programs will maintain all screens associated with water intakes in surface water areas to prevent impingement, injury, or mortality to listed salmonids.
4. Hatchery operations comply with all ESA permit requirements.	Section 10 annual reports are submitted in compliance with permits.	Section 10 annual reports are submitted in compliance with permits.
5. Artificial production facilities are operated in compliance with all applicable fish health guidelines, facility operation standards and protocols including IHOT, Co-managers Fish Health Policy and drug usage mandates from the Federal Food and Drug Administration.	Hatchery goal is to prevent the introduction, amplification or spread of fish pathogens that might negatively affect the health of both hatchery and naturally reproducing stocks and to produce healthy smolts that will contribute to the goals of this facility.	Pathologists from WDFW’s Fish Health Section monitor program monthly. Exams performed at each life stage may include tests for virus, bacteria, parasites and/or pathological changes, as needed.

Performance Standards	Performance Indicators	Monitoring and Evaluation
6. The risk of catastrophic fish loss due to hatchery facility or operation failure is minimized.	Staffing allows for rapid response for protection of fish from risk sources (water loss, power loss, etc.). Backup generators to provide an alternative source of power to supply water during power outages. Protocols in place to test standby generator and all alarm systems on a routine basis. Alarm systems installed and operating at each rearing vessel to detect loss of or reduced flow and reduced operating head in rearing vessels. Densities at minimum to reduce risk of loss to disease. Sanitation – all equipment is disinfected between uses on different lots of fish including nets, crowders, boots, raingear, etc.	Hatchery engineering design and construction accommodate security measures. Operational funding accommodates security measures. Training in proper fish handling, rearing, and biological sampling for all staff. Staff are trained to respond to alarms and operate all emergency equipment on station. Maintenance is conducted as per manufacturer's requirements and according to hatchery maintenance schedules.
7. Broodstock collection and juvenile hatchery releases minimize ecological effects on listed wild fish.	Hatchery spring Chinook reared to sufficient size such that smoltification occurs within nearly the entire population, reducing residence time in streams after release (CV length ≤ 10%, condition factor 0.9 – 1.0). 2. Smolts acclimated and imprinted on surface water from the natal steam to enhance smoltification and reduce residence time in the tributaries and mainstem migration corridors. All spring Chinook encountered in hatchery broodstock collection operations will be held for a minimal duration in the traps; generally less than 24 hrs and follow permit protocols. Spring Chinook trapped in excess of broodstock collection goals will be released upstream or returned to natal streams immediately.	Fish culture and evaluation staff monitor behavior, coefficient of variation in length, and condition. Fish health specialists will certify all hatchery fish before release. Up to three downstream juvenile smolt traps will be used to monitor the outmigration of hatchery and wild fish. Outmigration may also be monitored through PIT tag detection systems at mainstem passage facilities. Broodstock collection protocols developed each season and reviewed by the HCP Hatchery committees.

1.11 Expected Size of Program

1.11.1 Proposed Annual Broodstock Collection Level (maximum number of adult fish)

Broodstock collection will occur at Wells Dam, the Twisp River weir, Methow Hatchery outfall, Winthrop NFH outfall, and potentially from future collection facilities located on the Chewuch and/or Methow rivers, or by other methods such as angling or seining; annual total collection will be up to 360 adults (348 expected) for the combined components of the program: up to 64 for the Twisp component (expect 63), and 296 for Methow/Chewuch releases (expect 285). Additionally, Methow Hatchery-origin returns to the Methow Hatchery that exceed broodstock and spawner-escapement needs will be provided to the WNFH for their use as broodstock, until their broodstock needs are met (WNFH target for Methow Hatchery fish is 20%-30% of 360 adults).

1.11.2 Proposed Annual Fish Release Levels (maximum number) by Life Stage and Location

Table 1-7. Proposed Annual Fish Release Levels by Life Stage and Location. The 100,000 smolts is the maximum for the Twisp River releases.

Life Stage	Release Location	Annual Release Level*
Yearling Smolts	Twisp River	100,000
	Methow River	225,000
	Chewuch River	225,000

*Release levels may be adjusted downward by the HCP Committees to meet specific program objectives on an annual basis. Increased release numbers to the Chewuch and/or Methow rivers may be necessary to compensate for potential shortfalls in the Twisp program.

The current program has generally released fewer than the present 550,000 smolt target[6] during most years since 1994 (Table 1-8). For the 1996 to 2006 brood years, the average number of smolts released per year has been 396,074 (range 248,183 [BY1999] to 493,547 [BY 2002]).

[6] Note that prior to 1996 there was not a targeted number of smolts for annual releases.

Table 1-8. Aggregate number of spring Chinook smolts planted into the Twisp, Chewuch, and Methow Rivers, brood years 2000-2006.

Brood Year	Release Year	Number of Smolts
1992	1994	76,734
1993	1995	611,763
1994	1996	36,166
1995	1997	28,878
1996	1998	371,306
1997	1999	491,957
1998	2000	451,140
1999	2001	248,183
2000	2002	342,096
2001	2003	449,542
2002	2004	493,547
2003	2005	313,443
2004	2006	366,513
2005	2007	417,102
2006	2008	411,990
Mean		396,074

1.12 Current Program Performance, including Estimated Smolt-to-Adult Survival Rates, Adult Production Levels, and Escapement Levels. Indicate the Source of these Data

1.12.1 In-hatchery Survival Measures

Table 1-9. Developmental stage survivals in the hatchery environment for Methow and Twisp Rivers spring Chinook, brood years 2003-2007 (Snow et al. 2008).

Brood year	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
Methow Average 2003-07	99.0	99.1	96.9	96.9	99.6	99.5	90.4	99.6	87.7
Twisp Average 2003-07	100.0	100.0	95.7	98.2	99.6	99.5	99.2	99.9	93.2
Standard	**90.0**	**85.0**	**92.0**	**98.0**	**97.0**	**93.0**	**90.0**	**95.0**	**81.0**

1.12.2 Run Sizes and Escapement

Table 1-10. Spring Chinook hatchery- and natural-origin run sizes to the Methow River Basin for return years 1981-2008. Data from Snow et al. (2008) and Charlie Snow (WDFW unpublished data).

Return Year	HORs	HOR Fraction	NORs	NOR Fraction	Run Size
1981	0	0	476	1	476
1982	0	0	607	1	607
1983	0	0	949	1	949
1984	0	0	891	1	891
1985	0	0	1,303	1	1,303
1986	0	0	897	1	897
1987	0	0	1,545	1	1,545
1988	32	0.02	1,633	0.98	1,665
1989	3	0	1,192	1	1,195
1990	287	0.26	825	0.74	1,111
1991	0	0	620	1	620
1992	337	0.203	1,325	0.797	1,662
1993	423	0.309	947	0.691	1,370
1994	63	0.204	246	0.796	309
1995	10	0.222	35	0.778	45
1996	12	0.387	19	0.613	31
1997	78	0.225	269	0.775	347
1998	21	0.512	20	0.488	41
1999	71	0.612	45	0.388	116
2000	861	0.880	117	0.12	978
2001	9,139	0.833	1,832	0.167	10,971
2002	2,292	0.869	345	0.131	2,637
2003	1,080	0.949	58	0.051	1,138
2004	1,009	0.674	488	0.326	1,497
2005	849	0.617	527	0.383	1,376
2006	1,420	0.812	328	0.188	1,748
2007	813	0.753	266	0.247	1,079
2008	760	0.718	298	0.282	1,058
12-Yr Geomean:	588	0.667	209	0.237	881

1.12.3 Hatchery and Natural Replacement Rates (HRR, NRR) and Smolt-to-Adult Returns (SARs)

Table 1-11. Number of spring Chinook broodstock spawned (including pre-spawn mortalities), smolts released, adult returns, SARs, smolts/adult, and hatchery replacement rate (HRR) by brood year (1993-2002) for the Methow River releases from Methow Hatchery.

Brood year	Number of broodstock	Smolts released	Adult returns	SAR (%)	# Smolts/ adult	HRR
1993	91	210,849	192	0.091	1,098	2.1
1994	2	4,477	1	0.022	4,477	0.5
1995	12	28,878	122	0.422	237	10.2
1996	103	202,947	500	0.246	406	4.9
1997	187	332,484	945	0.284	352	5.1
1998[a]	161	435,670	2,300	0.528	189	14.3
1999	90	180,775	145	0.080	1,247	1.6
2000[a]	147	266,392	852	0.320	313	5.8
2001	69	130,787	508	0.388	257	7.4
2002	81	181,235	599	0.331	303	7.4
Geometric mean	**59**	**124,776**	**250**	**0.200**	**499**	**4.25**

[a]Mixed MetComp group

Table 1-12. Number of spring Chinook broodstock spawned (including pre-spawn mortalities), smolts released, adult returns, SARs, smolts/adult, and hatchery replacement rate (HRR) by brood year (1992-2002) for the Chewuch River releases from Methow Hatchery.

Brood year	Number of broodstock	Smolts released	Adult returns	SAR (%)	# Smolts/ adult	HRR
1992	21	40,881	39	0.095	1,048	1.9
1993	103	284,165	116	0.041	2,450	1.1
1994	12	11,854	2	0.017	5,927	0.2
1995	-	-	-	-	-	-
1996	64	91,672	37	0.040	2,478	0.6
1997	64	132,759	360	0.271	369	5.6
2001	85	261,284	711	0.272	367	8.4
2002	123	254,238	630	0.248	404	5.1
Geometric mean	**53**	**101,545**	**92**	**0.090**	**1,109**	**1.80**

Table 1-13. **Number of broodstock spawned (including pre-spawn mortalities), smolts released, adult returns, SARs, smolts/adult, and hatchery replacement rate (HRR) by brood year (1992-2002) for the Twisp River releases from Methow Hatchery.**

Brood year	Number of broodstock	Smolts released	Adult returns	SAR (%)	# Smolts/ adult	HRR
1992	18	35,853	21	0.059	1,707	1.2
1993	42	116,749	27	0.023	4,324	0.6
1994	5	19,835	5	0.025	3,967	1.0
1995	-	-	-	-	-	-
1996	43	76,687	278	0.363	276	6.5
1997	15	26,714	67	0.251	399	4.5
1998	10	15,470	23	0.149	673	2.3
1999	32	67,408	61	0.090	1,105	1.9
2000	64	75,704	145	0.192	522	2.3
2001	30	57,471	43	0.075	1,337	1.4
2002	9	20,377	120	0.589	170	13.3
Geometric mean	**21**	**41,654**	**47**	**0.113**	**882**	**2.3**

Table 1-14. Natural Replacement Rate (NRR) summary by Methow River subbasin for brood years 1992 through 2002.

Parent brood	Est. spawning escapement	Return age 1.1	Return age 1.2	Return age 1.3	Total expanded recruits (NOR)	NRR
Chewuch River						
1992	422	0	28	14	45	0.11
1993	184	3	69	21	95	0.52
1994	63	0	15	3	19	0.30
1995	6	1	12	19	34	5.53
1996	8	0	13	86	102	12.75
1997	123	1	662	55	1,563	12.68
1998	7	11	23	19	89	12.66
1999	21	0	2	0	2	0.11
2000	83	6	47	13	91	1.10
2001	2,493	0	205	49	321	0.13
2002	666	2	91	60	214	0.32
Geomeans	**77**	**0**	**36**	**6**	**76**	**1.00**
Methow River						
1992	924	0	47	43	55	0.10
1993	760	5	79	37	125	0.17
1994	172	0	26	7	34	0.20
1995	27	1	54	18	78	2.83
1996	15	1	30	230	268	17.89
1997	152	21	348	50	912	5.98
1998	23	16	34	2	86	3.73
1999	70	3	2	0	5	0.07
2000	639	5	197	39	333	0.52
2001	7,588	3	183	36	280	0.04
2002	1,730	0	96	93	264	0.15
Geomeans	**231**	**0**	**55**	**6**	**115**	**0.53**
Twisp River						
1992	316	0	54	37	96	0.30
1993	426	5	27	20	53	0.13
1994	74	0	15	9	25	0.34
1995	12	0	26	12	39	3.23
1996	8	0	11	56	69	8.64
1997	72	0	460	109	1,237	17.25
1998	11	24	72	21	195	17.75
1999	25	0	7	0	8	0.31
2000	256	37	264	17	441	1.72
2001	890	27	77	20	156	0.18
2002	241	0	47	35	115	0.48
Geomeans	**81**	**0**	**45**	**5**	**94**	**1.16**

1.13 Date Program Started (years in operation) or is Expected to Start

The first year of operation for the Methow Hatchery was 1992. The UCR spring Chinook salmon ESU was listed as endangered on March 24, 1999 (NMFS 1999) with supplementation activities as conditioned by Section 10 permit No. 1196 starting at Methow Hatchery with brood year 2000 fish. The proposed program as described in this HGMP would commence with brood year 2010, pending approval by NMFS.

1.14 Expected Duration of Program

The program is intended to continue for the 50-year term of the Wells HCP, which was accepted by the FERC in 2004. The Wells HCP also stipulates that the production target for artificial propagation will remain constant for 10 years at which time the programs will be reviewed and modified as needed. HCP Hatchery Committee review of the HCP hatchery programs is scheduled for 2013 with any resultant changes implemented thereafter.

1.15 Watersheds Targeted by Program

Methow Sub-basin/Columbia Cascade Province, WRIA 48.

1.16 Indicate Alternative Actions Considered for Attaining Program Goals, and Reasons Why those Actions are not being Proposed

This hatchery program is adaptively managed by the Wells HCP Hatchery Committee, which has agreed to the collective goal of recovery and sustainability of the population within the context of meeting the HCP standard of NNI. The Wells HCP Hatchery Committee therefore aims for a program of adequate size and characteristics to meet this goal. During the development and implementation of the HCP, many alternatives were, and will continue to be considered for this program. The Wells HCP Hatchery Committee has concluded that a larger program would not be consistent with the HSRG's recommendations (HSRG 2009) to reduce artificial production in the Methow Basin, while a smaller or non-existent program may fail to support recovery as described in the Recovery Plan (UCSRB 2007). Thus, the HCP Hatchery Committee developed the program described in this HGMP to meet the current biological, agency, and HCP goals.

2.0 PROGRAM EFFECTS ON NMFS ESA-LISTED SALMONID POPULATIONS

(USFWS ESA-Listed Salmonid Species and Non-Salmonid Species are addressed in Addendum A)

2.1 List All ESA Permits or Authorizations In Hand for the Hatchery Program.

2.1.1 Section 10(a)(1)(B) Permit Number 1196 Permit Type

Scientific Research/Enhancement: Artificial production of UCR spring Chinook. Expires Dec 31, 2007 but was amended on January 20, 2004 and expires January 20, 2014. Activities described in the application for this permit have been authorized under terms and conditions of the Biological Opinion on Artificial Propagation in the Columbia River Basin (NMFS 1999). WDFW submits annual reports as conditioned by Section 10 permit No. 1196 covering the period from January 1 to December 31 each year. Broodstock retained may be used in the USFWS's Winthrop NFH Methow River programs. Methow Hatchery activities are coordinated with the USFWS spring Chinook program at the Winthrop NFH (ESA Section 10 Permit No.1300).

2.1.2 Wells Habitat Conservation Plan

In 2002, the Wells HCP was signed by WDFW, USFWS, NOAA National Marine Fisheries Service, and the Colville Confederated Tribes, and approved by FERC in June of 2004. The Yakama Nation signed the HCP in March of 2005. The overriding goal of the HCP is to achieve NNI on anadromous salmonids as they pass Wells Dam. One of the main objectives of the hatchery component of NNI is to provide species-specific hatchery programs that may include contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest.

The Wells HCP is intended to be a comprehensive 50-year adaptive management plan for anadromous salmonids and their habitat as affected by the Wells Project. The Wells HCP was designed to address Douglas PUD requirements for relicensing and as such included all of the parties terms, conditions and recommended measures related to regulatory requirements to conserve, protect and mitigate plan species pursuant to ESA, the FPA, the Fish and Wildlife Coordination Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Pacific Northwest Electric Power Planning and Conservation Act and Title 77 RCW of the State of Washington. The HCP also obligates the parties to work together to address water quality issues.

2.2 Provide Descriptions, Status, and Projected Take Actions and Levels for NMFS ESA-Listed Natural Populations in the Target Area

2.2.1 Description of NMFS ESA-listed Salmonid Population(s) Affected by the Program

2.2.1.1 Adult Age Class

Methow Spring Chinook MPG

Most Columbia River adult spring Chinook spend 2 years in the ocean before migrating back to their natal streams (Mullan 1987; Fryer et al. 1992; Chapman et al. 1995; Snow et al. 2008). Both female and male adults sampled from UCR tributaries predominantly spend two years in the ocean, and are four years old. The estimates of age of adult spring Chinook sampled in the UCR comport well with those for fish sampled at Bonneville Dam and other Columbia basin tributaries. These data suggest that more than 50 percent of spring Chinook in the Columbia River basin spend 1 year in fresh water and 2 in salt water (1.2), and from 20 to 40 percent spend 3 years in saltwater before returning to the river. Most stream-type Chinook throughout their geographic range average approximately 4 years of age, except those from the Yukon River, Alaska.

In the Methow River basin, the average age class for naturally produced adults since 2001 has been approximately 7 percent age 3, 56 percent age 4, and 37 percent age 5 (Table 2-1). Age structure does not appear to vary much between major spawning areas, ranging between approximately 3 to 10 percent for age 3, 53 to 57 percent for age 4, and 37 to 40 percent for age 5 (Table 2-1).

Table 2-1. **Age structure of Methow Basin spring Chinook salmon per major spawning area (based on Chapter 5 Appendices D-J, Snow et al. 2008).**

	Number				Percent		
Subbasin/year	**1.1**	**1.2**	**1.3**	**Total**	**1.1**	**1.2**	**1.3**
Methow							
2001	16	286	292	594	2.7	48.1	49.2
2002	1	21	64	86	1.2	24.4	74.4
2003	5	1	2	8	62.5	12.5	25.0
2004	3	196	0	199	1.5	98.5	0.0
2005	0	182	39	221	0.0	82.4	17.6
2006	0	101	27	128	0.0	78.9	21.1
2007	6	42	104	152	3.9	27.6	68.4
Average	**4**	**118**	**75**	**198**	**10.3**	**53.2**	**36.5**
Chewuch							
2001	8	641	83	732	1.1	87.6	11.3
2002	0	23	55	78	0.0	29.5	70.5
2003	4	2	19	25	16.0	8.0	76.0
2004	0	46	0	46	0.0	100.0	0.0
2005	2	206	11	219	0.9	94.1	5.0
2006	0	86	49	135	0.0	63.7	36.3
2007	1	14	59	74	1.4	18.9	79.7
Average	**2**	**145**	**39**	**187**	**2.8**	**57.4**	**39.8**
Twisp							
2001	18	439	49	506	3.6	86.8	9.7
2002	66	115	181	362	18.2	31.8	50.0
2003	6	4	15	25	24.0	16.0	60.0
2004	16	227	0	243	6.6	93.4	0.0
2005	0	73	14	87	0.0	83.9	16.1
2006	0	45	20	65	0.0	69.2	30.8
2007	2	0	38	40	5.0	0.0	95.0
Average	**15**	**129**	**45**	**190**	**8.2**	**54.4**	**37.4**
Total Basin							
2001	42	1366	424	1832	2.3	74.6	23.1
2002	67	159	300	526	12.7	30.2	57.0
2003	15	7	36	58	25.9	12.1	62.1
2004	19	469	0	488	3.9	96.1	0.0
2005	2	461	64	527	0.4	87.5	12.1
2006	0	232	96	328	0.0	70.7	29.3
2007	9	56	201	266	3.4	21.1	75.6
Average	**22**	**393**	**160**	**575**	**6.9**	**56.0**	**37.0**

Methow Summer Steelhead MPG

Chapman et al. (1994) summarized information for 459 naturally produced adult steelhead collected at Wells Dam, Wells Reservoir, and the Methow River between 1987 and 1993 (Table 2-2). They found that the majority of both males and females had spent 2 years in the ocean (Table 2-2; Figure 2-1). Between 1997 and 2006, 478 naturally produced fish were sampled at Wells Dam. The majority of these fish had spent 1 year in the ocean (see Table 2-2, Figure 2-1). It is uncertain why this inconsistency exists, although saltwater ageing was estimated from otoliths between 1987 and 1993, and with scales between 1997 and 2006.[7] In addition, sample sizes were small in many of the years.

In previous summaries of hatchery-origin age structure (Mullan et al. 1992a; Chapman et al. 1994), most hatchery-origin fish were designated as 1-salt. While this still appears to be true for males, females appear to have shifted to more 2-salt, which is more similar to wild fish between 1987 and 1993 (Table 2-3).

[7] It is unlikely that saltwater age estimation would be affected by the differing methods. However, freshwater age estimation may be underestimated using scales for steelhead (Peven 1990, Mullan et al. 1992a).

Table 2-2. The number and percentage of steelhead by saltwater age and sex from Chapman et al. (1994) for years 1987-1993, and Snow et al. (2008) for years 1997-2006.

Brood year	Male				Female				Total
	1-salt		2-salt		1-salt		2-salt		
	#	%	#	%	#	%	#	%	
1987	12	16.9	8	11.3	16	22.5	35	49.3	71
1988	9	13.4	12	17.9	9	13.4	37	55.2	67
1989	16	18.2	25	28.4	16	18.2	31	35.2	88
1990	5	5.7	24	27.3	12	13.6	47	53.4	88
1991	16	22.5	9	12.7	28	39.4	18	25.4	71
1992	2	5.9	8	23.5	1	2.9	23	67.6	34
1993	5	12.5	13	32.5	3	7.5	19	47.5	40
Total	**65**	**14.2**	**99**	**21.6**	**85**	**18.5**	**210**	**45.8**	**459**
1997	18	31.6	10	17.5	14	24.6	15	26.3	57
1998	5	41.7		0.0	4	33.3	3	25.0	12
1999	5	18.5	4	14.8	5	18.5	13	48.1	27
2000	13	31.7	4	9.8	13	31.7	11	26.8	41
2001	14	53.8	2	7.7	7	26.9	3	11.5	26
2002	3	16.7	1	5.6	5	27.8	9	50.0	18
2003		0.0	9	33.3		0.0	18	66.7	27
2004	53	45.3		0.0	55	47.0	9	7.7	117
2005	15	22.7	9	13.6	15	22.7	27	40.9	66
2006	21	24.1	16	18.4	8	9.2	42	48.3	87
Total	**147**	**30.8**	**55**	**11.5**	**126**	**26.4**	**150**	**31.4**	**478**

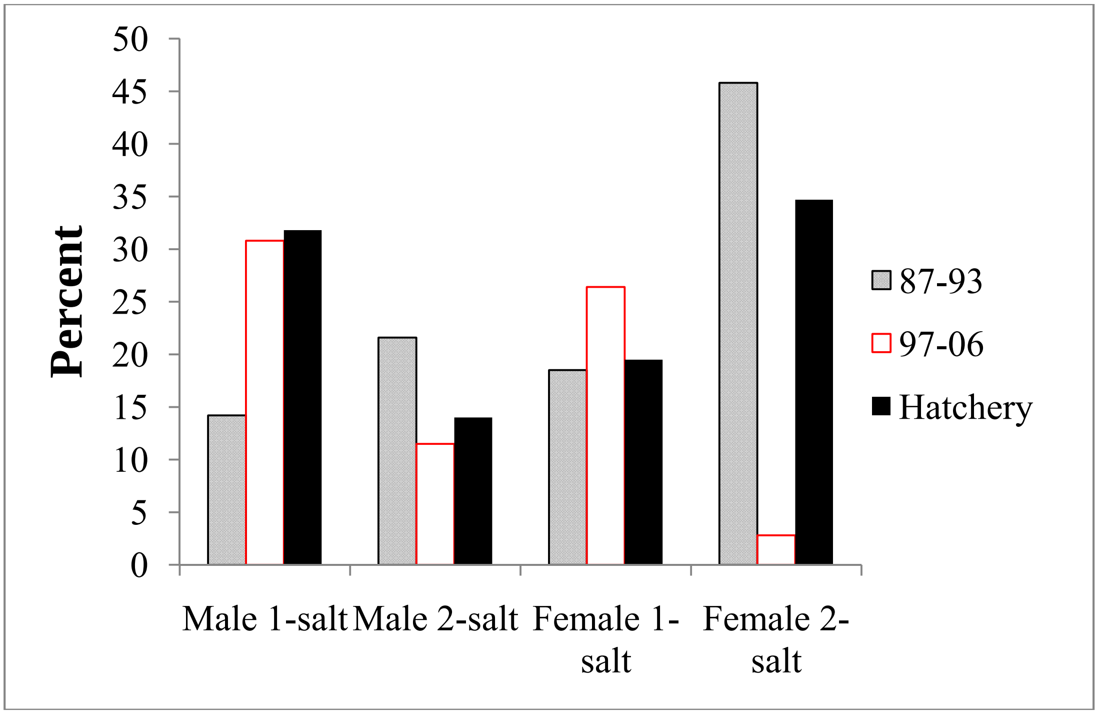

Figure 2-1. **Comparison of saltwater age structure of naturally produced steelhead sampled between1997-2006 and naturally produced and hatchery-origin fish between 1987-1993, based on Table 2 and 3.**

Table 2-3. **Numbers and percentages of steelhead by sex, saltwater age, and origin sampled at Wells Dam between 1997 and 2006 (based on Appendix C, Chapter 1 of Snow et al. 2008).**

Brood year	Male				Female				Total
	1-salt		2-salt		1-salt		2-salt		
	#	%	#	%	#	%	#	%	
1997	145	46.5	20	6.4	94	30.1	53	17.0	312
1998	122	28.2	64	14.8	78	18.0	169	39.0	433
1999	123	33.2	41	11.1	66	17.8	141	38.0	371
2000	113	34.7	28	8.6	87	26.7	98	30.1	326
2001	12	5.7	27	12.8	66	31.3	106	50.2	211
2002	106	28.3	68	18.2	50	13.4	150	40.1	374
2003	30	11.2	89	33.1	17	6.3	133	49.4	269
2004	183	59.0	3	1.0	118	38.1	6	1.9	310
2005	93	29.5	53	16.8	31	9.8	138	43.8	315
2006	98	32.6	58	19.3	22	7.3	123	40.9	301
Total	**1,025**	**31.8**	**451**	**14.0**	**629**	**19.5**	**1,117**	**34.7**	**3,222**

Methow Core Area Bull Trout

Mullan et al. 1992a reported some populations that did not mature until 9 years of age in the Methow Basin. They found that headwater male bull trout (potentially non-migratory ecotype) in the Methow River began to mature at age 5, and were all mature by age 6. Females from the same area began to mature at age 7 and were all mature by age 9. The bull trout that Mullan et al. (1992a) found that did not mature until 9 years of age are the oldest (at first maturity) reported within the literature. The oldest bull trout sampled in the Methow River was 12 years (Mullan et al. 1992a).

2.2.1.2 Sex Ratio

Methow Spring Chinook MPG

Mullan (1987) presented data compiled from Howell et al. (1985) on the number of returning male and female hatchery spring Chinook in the mid-Columbia. From those data, we calculated the sex ratios for Leavenworth, Entiat, and Winthrop populations. The range (female to male) for the three stocks was 1.27:1 to 1.86:1.

Sampling at Wells Dam in 2007 and 2008, estimates of sex ratio ranged (males to females) from 1.5:1 to 1.9:1 for hatchery fish and 1.1:1 to 1.5:1 for wild fish (C. Snow, pers. comm). It is important to note that determining sex of fish from Wells Dam months prior to sexual maturity is not considered accurate for spring Chinook, which may explain the difference between these data and those described above from Chapman et al. (1994).

Methow Summer Steelhead MPG

Based on the most recent information available (Appendix C, Chapter 1 of Snow et al. 2008), the female to male ratio for hatchery-origin and naturally produced fish is 1.2:1 and 1.3:1, respectively. This is similar to what has been reported previously (Mullan et al. 1992a; Chapman et al. 1994).

Methow Core Area Bull Trout

In Mullan et al. (1992a), the overall female to male ratio was 1.11:1, but for mature fish, they found almost twice the percentage of the population of males was mature (14.6 percent of the females and 24.3 percent of the males).

2.2.1.3 Fecundity

Methow Spring Chinook MPG

Fecundity from wild and hatchery spring Chinook salmon has been measured in recent years as part of the hatchery supplementation evaluation program. In the Methow River basin, fecundity (hand-counted) averaged 5,100 (range: 2,600 to 8,100) between 1992 and 1994 (Chapman et al. 1995). Since 2000, four-year-old wild females averaged 4,000 eggs, while 5-year-old wild fish averaged 4,800 eggs (Table 2-4). For hatchery fish, 4-year-old fish averaged 3,800 eggs, and 5-year-old fish averaged 4,400 (Table 2-4). As shown in Table 2-4, there are gaps between years, primarily for wild fish, especially 5-year-olds.

Table 2-4. Fecundity of Methow Basin spring Chinook (from Chapter 1, Appendix D of Snow et al. 2008).

	Age 4		Age 5	
Stock/year	**Wild**	**Hatchery**	**Wild**	**Hatchery**
Met Comp				
2000		3,759		
2001	3,753	3,949		
2002		3,905		3,318
2003		3,795		4,839
2004	3,565	3,510		3,510
2005	3,823	3,475		3,261
Average	3,714	3,732		3,732
Twisp				
2000		3,820		5,292
2001	4,720	3,922	4,941	4,469
2002		4,653		
2003		3,195		5,867
2004	3,811	3,496		
2005	4,216		4,745	4,745
Average	4,249	3,817	4,843	5,093
Average for Basin				
	3,981	3,771	4,843	4,413

Methow Summer Steelhead MPG

For fish sampled at Wells Dam between 2000 and 2006, 1-salt naturally produced fish average fecundity was higher than 1-salt hatchery-origin fish, while for 2-salt fish, hatchery-origin fish had slightly higher fecundity (Table 2-5).

Table 2-5. Mean fecundity by salt-age and origin of 2006 brood summer steelhead sampled at Wells Complex hatchery facilities (Appendix D, Chapter 1 from Snow et al. 2008).

	1-salt		2-salt	
Year	**H**	**W**	**H**	**W**
2000	4,837	5,760	6,049	
2001	4,356	3,865	6,624	6,714
2002	4,786	4,721	6,744	6,586
2003	4,241		6,545	6,954
2004	4,543	4,517	5,865	4,832
2005	4,547	5,370	6,575	6,627
2006	4,652	4,203	6,858	6,397
Average	**4,566**	**4,739**	**6,466**	**6,352**

Methow Core Area Bull Trout

Fecundity of bull trout varies with size. Fraley and Shepard (1989) found that fecundity averaged almost 5,500 eggs (up to over 12,000 in one individual) for migratory bull trout from the Flathead River. Martin et al. (1992) noted females between 271 and 620 millimeters (mm) long produced 380 to over 3,000 eggs in southeastern Washington streams. Mullan et al. (1992a) found one bull trout that was 300 mm in the Methow Basin had a fecundity of fewer than 200 eggs.

2.2.1.4 Size Range

Methow Spring Chinook MPG

Juveniles

In 2007, wild smolt length averaged just over 100 mm fork length (FL) (Table 6). Wild parr (fall-run) averaged almost 91 mm FL. Little variation occurs between years in smolt length (C. Snow, pers. comm.).

Table 2-6. Summary of length and weight of migrating Chinook juveniles in the Methow River in 2007 (from Chapter 3, Table 1 Snow et al. 2008).

Brood	Origin/stage	Fork length (mm)			Weight (g)			K-factor
		Mean	*N*	SD	Mean	*N*	SD	
2005	Wild smolt	100.7	395	8.6	11.6	393	2.9	1.1
2005	Hatchery smolt	129.9	186	17.5	27.8	186	11.2	1.3
2006	Wild fall parr	90.7	67	10.8	8.9	67	3.1	1.2

Adults

Length measurements (fork length) from wild and hatchery spring Chinook salmon have been measured in recent years as part of the hatchery evaluation program (Table 2-7). There appears to be little difference between streams or between wild and hatchery fish (Table 2-7).

Table 2-7. Mean fork length by age, sex and brood of spring Chinook collected for the Methow Hatchery program, 1998-2005 (from Chapter 1, Appendix C of Snow et al. 2008).

	Age - 3		Age - 4		Age - 5	
Stock/sex/year	**H**	**W**	**H**	**W**	**H**	**W**
Met Comp - male						
1998	54.0	52.0	79.0	74.9	94.0	92.7
1999	52.0		78.0	76.4		100.0
2000	52.1		73.3			
2001	60.0		80.6			
2002	48.3		79.0		100.0	
2003	49.0	51.0			96.7	
2004	48.3		72.0			
2005	52.1		72.3			
Average	*52.0*	*51.5*	*76.3*	*75.7*	*96.9*	*96.4*
Met Comp - female						
1998			76.3	76.1	87.2	89.0
1999			78.0	77.6		86.5
2000			74.5			
2001			76.9			
2002			76.3		87.3	
2003			75.3			
2004			73.4	75.0	76.0	
2005			74.3	71.0	81.0	
Average			*75.6*	*74.9*	*82.9*	*87.8*
Twisp - male						
1998			79.5		87.0	
1999	50.8					
2000	52.0	45.0	71.0			98.0
2001	63.0	52.5	79.3	75.3		
2002	46.3					
2003	50.7	50.0		67.0		
2004	49.0	45.7	72.2	71.6		
2005	49.6			82.0		
Average	*51.6*	*48.3*	*75.5*	*74.0*	*87.0*	*98.0*
Twisp - female						
1998			77.0		90.5	
1999				78.5		89.3
2000			75.1			91.0

Stock/sex/year	Age - 3 H	Age - 3 W	Age - 4 H	Age - 4 W	Age - 5 H	Age - 5 W
2001			76.9	79.6	92.5	88.0
2002			75.0			
2003			70.7			93.4
2004			73.0	75.8		
2005				81.0		88.5
Average			*74.6*	*78.7*	*91.5*	*90.0*
Total Basin Average - male						
1998	54.0	52.0	79.3	74.9	90.5	92.7
1999	51.4		78.0	76.4		100.0
2000	52.1	45.0	72.2			98.0
2001	61.5	52.5	80.0	75.3		
2002	47.3		79.0		100.0	
2003	49.9	50.5		67.0	96.7	
2004	48.7	45.7	72.1	71.6		
2005	50.9		72.3	82.0		
Average	*52.0*	*49.1*	*76.1*	*74.5*	*95.7*	*96.9*
Total Basin Average - female						
1998			76.7	76.1	88.9	89.0
1999			78.0	78.1		87.9
2000			74.8			91.0
2001			76.9	79.6	92.5	88.0
2002			75.7		87.3	
2003			73.0			93.4
2004			73.2	75.4	76.0	
2005			74.3	76.0	81.0	88.5
Average			*75.3*	*77.0*	*85.1*	*89.6*

Methow Summer Steelhead MPG

Juveniles

In the Upper Columbia Basin, naturally produced steelhead smolts sampled at Rock Island Dam have averaged between 163-188 mm FL (Peven and Hays 1989; Peven et al.1994). In the Methow Basin, smolt trapping has been ongoing since the mid 1990s, and in general length frequency of juveniles does not vary greatly between years (C. Snow, pers. comm.), and averages between from approximately 130 to 180 mm FL (this includes “transitional” juveniles that may or may not be smolting; Table 2-8).

Table 2-8. Mean length and weight at migration age of wild transition and smolt summer steelhead captured at the Methow (A) and Twisp (B) smolt traps in 2007 (Tables 2 and 4, respectively, from Chapter 3 of Snow et al. 2008).

A

Age	*N* (%)	Fork (mm)			Weight (g)			K-factor
		Mean	*N*	SD	Mean	*N*	SD	
1	6 (4.3)	138.7	6	17.8	32.6	6	14.4	1.2
2	122 (86.5)	175.2	122	20.1	55.3	117	20.1	1.0
3	12 (8.5)	181.5	12	22.4	58.4	10	22.7	1.0
4	1 (0.7)	174.0	1	- -	51.3	1	- -	0.9

B

Age	*N* (%)	Fork (mm)			Weight (g)			K-factor
		Mean	*N*	SD	Mean	*N*	SD	
1	7 (2.4)	128.6	7	14.6	24.3	6	7.8	1.1
2	231 (80.8)	162.2	229	17.4	42.7	226	12.9	1.0
3	43 (15.0)	180.6	43	20.5	58.6	43	17.7	1.0
4	5 (1.7)	177.2	5	9.6	56.8	5	11.1	1.0

Adults

Chapman et al. (1994) reported that female steelhead sampled at Wells from 1982 to 1992 ranged from 57 to 81 centimeters (cm) and 67 to 75 cm for fish spending 1 and 2 years in the ocean, respectively. Males ranged from 59 to 66 cm and 69 to 77 for 1 and 2 ocean fish.

The length frequency of broodstock captured in 2006 for the Wells steelhead program comports well with previous sampling at Wells Dam above (Table 2-9). In general, hatchery-origin fish are similar in size to naturally produced fish.

Table 2-9. Mean fork length (cm) by saltwater age, sex, and origin for broodstock sampled at Wells Hatchery Complex facilities, 1997-2006 (Chapter 1, Appendix C from Snow et al. 2008).

	Male				Female			
Brood	**1-salt**		**2-salt**		**1-salt**		**2-salt**	
year	**H**	**W**	**H**	**W**	**H**	**W**	**H**	**W**
1997	64.2	63.8	76.6	74.5	62.3	61.6	71.9	74.3
1998	64.8	65.6	79.3		62.1	64.0	75.3	74.3
1999	63.3	64.0	80.0	80.8	62.3	61.8	74.3	73.8
2000	63.4	62.9	77.8	76.0	61.4	62.5	73.8	76.8
2001	61.2	60.9	76.1	82.5	60.2	59.4	72.9	73.3
2002	64.3	63.7	78.3	76.0	62.9	63.8	73.6	74.7
2003	61.9		78.6	81.6	60.4		74.7	75.8
2004	60.9	64.2	73.0		60.1	62.2	67.5	73.4
2005	60.4	62.1	74.0	75.6	59.4	62.5	71.8	73.4
2006	60.3	65.2	75.6	77.4	59.7	61.4	70.9	72.7
Average	**62.5**	**63.6**	**76.9**	**78.1**	**61.1**	**62.1**	**72.7**	**74.3**

<u>Methow Core Area Bull Trout</u>

Juveniles

Length at age of bull trout found in Methow River tributaries by Mullan et al. (1992a) were the shortest by age group of any other lengths reported in the literature (Goetz 1989; Wydoski and Whitney 2003). Table 2-10 shows the age range of all bull trout sampled by Mullan et al. (1992a) in the 1980s. Considering that males began maturing at age 5 and females by age 7 (see above), all lengths shown in Table 2-10 for fish aged 5 and younger can be considered juveniles, and all of those older than that may be juveniles or adults (assume that older than age 8 would be adults). Juvenile mean length ranged from and averaged between 51 and 195 mm FL.

Table 2-10. Mean fork length[8] (mm) of bull trout sampled in the Methow Basin (Mullan et al. 1992a).

	Age											
Stream	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Methow R				188.	257.							
Gold Cr					230.							
Wolf Cr	58.	86.		168.	199.		229.	250.				
Early Winters	52.	89.	124.	136.	174.	198.	200.	186.	210.	188.		205.
Lake Cr	49.				152.							
WF Methow R	50.	82.			190.		207.					
Chewuch R						255.						
EF Buttermilk	48.	87.	112.	130.	204.	231.				324.		
Monument Cr	42.				179.							
Lost Cr				195.								
Cedar Cr	51.				172.							
Twisp R	58.	97.	120.	163.								
South Cr			116.									
Average	*51.*	*88.*	*118.*	*163.*	*195.*	*228.*	*212.*	*218.*	*210.*	*256.*		*205.*

Adults

BioAnalysts (2002) compared a sample of resident and fluvial fish from the Methow subbasin and found that the fluvial fish were two to three times larger than resident fish of the same age. BioAnalysts (2004) tagged adult migratory bull trout at Rock Island, Rocky Reach, and Wells Dam in 2001 to 2003. For fish tagged in 2002 at Wells Dam, bull trout averaged 57.3 cm FL. Most of the fish tagged at Wells Dam eventually headed to the Methow River basin (some fish tagged at both Rocky Reach and Rock Island also headed in some years to the Methow Basin).

2.2.1.5 Migration Timing

<u>Methow Spring Chinook MPG</u>

Mainstem Columbia River

Adult spring Chinook destined for areas upstream from Bonneville Dam (upriver runs) enter the Columbia River beginning in March and reach peak abundance (in the lower river) in April and early May (WDF and ODFW 1994). Fifty percent of the spring Chinook run passes Priest Rapids and Rock Island dams by mid-May, while most pass Wells Dam somewhat later (Howell et al. 1985; Chelan and Douglas PUD, unpublished data). Chinook that pass Rock Island Dam are considered "spring-run" fish from the beginning of counting (mid-April) through approximately the third week of June (French and Wahle 1965; Mullan 1987).

[8] Mullan et al. (1992a) reported bull trout length in Appendix K (their Table 4) by temperature units, so there may be multiple measurements per age class per stream. This table combined (averaged) each age class per stream.

Methow River

The Methow basin spring Chinook migrate past Wells Dam and enter the sub-basin in May and June, peaking after mid-May. Differences in migration timing have been observed between, but not within, age classes. Hatchery 3-year-olds migrated to Wells Dam later than hatchery 4- and 5-year-olds, as well as wild 5-year-olds (Snow et al. 2008), which has likely contributed to a decline in 5-year-old returns because the fishery below Bonneville Dam routinely commences during the earliest part of the run.

<u>Methow Summer Steelhead MPG</u>

Mainstem Columbia River

Adults return to the Columbia River in the late summer and early fall. A portion of the returning run over-winters in the mainstem reservoirs, passing over the UCR dams in April and May of the following year.

In 2006, naturally produced fish began their migration earlier than hatchery-origin fish (Table 2-11). The run timing observed in 2006 followed a typical beginning (July) and ending (October) for a calendar year. However, it is important to reiterate that a portion of the fish that spawned upstream of Wells Dam pass the dam in the following spring after over-wintering in the mainstem Columbia River.

Table 2-11. Migration of hatchery and wild steelhead to Wells Dam between 31 July and 26 October, 2006 (Table 6, Chapter 4 from Snow et al. 2008).

Origin	*N*	Cumulative migration date			
		25%	50%	75%	100%
Hatchery	6,002	7-Sept	19-Sept	28-Sept	26-Oct
Wild	489	27-Aug	11-Sept	28-Sept	26-Oct

Methow River

There is no Methow-specific information on run timing, but steelhead are known to enter the river in late summer (August), through the following May, based on observations from trout and steelhead fisheries and radio telemetry studies (English et al. 2001, 2003).

<u>Methow Core Area Bull Trout</u>

The focus of this discussion is migratory (not resident) bull trout.

Bull trout were tagged by BioAnalysts (2004) between May 1 and the first week of June in this 3-year study. Most bull trout entered the Methow by the end of June and were found in possible spawning locations (usually in August) well before the initiation of spawning. Most tagged trout left tributary streams by late November.

During the study period (2001 to 2003) bull trout entered Mid-Columbia tributaries from April to September but most (94 percent) entered tributaries during May, June, and July. At the time bull trout entered tributary streams, the mean daily temperatures in the mainstem Columbia River varied from 5.4°C to 19.6°C. Similarly, tributary mean daily temperatures ranged from 7.5°C to 17.2°C. Most bull trout (92.3 percent) entered tributaries before the Columbia River reached a mean temperature of 15°C.

2.2.1.6 Spawning Range

Methow Spring Chinook MPG

Methow Basin spring Chinook spawn primarily in the upper reaches of the Chewuch, Twisp, and Methow rivers, including the Lost River, Early Winters, and Wolf Creek tributaries; in order of decreasing redd numbers: the mainstem Methow, Twisp, Chewuch, Lost Rivers, and Early Winters Creek. No significant differences have been detected in the distribution of hatchery and wild carcasses (females) within each subbasin (Snow et al. 2008).

Methow Summer Steelhead MPG

In the Methow River, steelhead currently spawn in the Twisp River, mainstem Methow River, Early Winters Creek, Lost River, Chewuch River, Beaver Creek, Black Canyon Creek, Lost River, Buttermilk, Boulder, Eight-Mile, Suspension, and Little Suspension, and Lake Creeks (Snow et al. 2008).

Methow Core Area Bull Trout

Bull trout are currently known to spawn in Lost, Chewuch, West Fork Methow, and Twisp Rivers, Little Bridge, Early Winters, Goat, Wolf, East Fork Buttermilk, Blue Buck (in Beaver Creek watershed), Gold, and Lake Creeks (Gene Shull, pers. comm.).

2.2.1.7 Spawning Timing

Methow Spring Chinook MPG

Spawning occurs late July through mid-September. There have been no significant differences in spawn timing between hatchery and wild fish (females) within or among sub-basins, although it appears hatchery fish spawn earlier than wild fish (Snow et al. 2008).

Methow Summer Steelhead MPG

Spawning occurs in the late spring of the calendar year following entry into the river, and usually ranges from mid-late March through May. Spawn timing within the index areas shows that the peak spawn timing in 2007 in the Chewuch sub-basin occurred during the week of April 15. Peak spawning in the remaining three sub-basins all occurred between April 15 and 30. Differences in spawn timing between hatchery and wild fish has not been assessed because many hatchery fish do not possess an externally visible mark (i.e., ad-clip[9]), thus confounding the surveyors ability to determine the origin of spawning adults (Snow et al. 2008).

Methow Core Area Bull Trout

Bull trout are strongly influenced by water temperature during all life stages and for all ecotypes. Most bull trout spawn from mid-September through October, with timing related to declining water temperatures. Spawning sites are commonly found in areas of ground water interchange, both from the subsurface to the river, and from the river to the subsurface. Association with areas of ground water interchange can promote oxygen exchange and mitigate severe winter temperatures including the formation of anchor ice.

Within the Methow Basin, spawning begins in headwater streams in late September and continues through October, with commencement closely tied to water temperature between 9 and 11°C (Brown 1992). After spawning, fluvial and adfluvial kelts return to their more moderate environments, while resident forms seek winter refuge. In Methow drainage tributaries, bull trout spawning and early rearing is confined to streams cold enough (less than 1,600°C annual temperature units) to support them in areas below barrier falls (Mullan et al. 1992a). In most cases, such reaches are very short (less than 5 miles).

2.2.1.8 Juvenile Life History Strategy

Methow Spring Chinook MPG

Fry emerge the spring following spawning, and are assumed to smolt as yearlings, although fall parr migrations from upper reaches have been observed (Hubble 1993; Hubble and Harper 1999; Snow et al. 2008), although where these fall migrants rear prior to smolting the next spring is still unknown.

Fryer et al. (1992) summarized age information of spring Chinook sampled at Bonneville Dam from 1987 through 1991. They found no adult scales with two stream annuli (2.x), although in every year there were some fish estimated to have entered the ocean in their first year of life (0.x; probably from the Snake River basin). Adults sampled in the UCR tributaries have shown no 0.x or 2.x life histories.

Individuals that never migrated to the sea make up some portion of the spawning population (Healey 1991; Mullan et al. 1992a). Mullan et al. (1992a) indicate that precocious maturation of male spring Chinook is common in the mid-Columbia basin and is characteristic of both hatchery and wild stocks. Generally the largest males show evidence of early maturity (Rich 1920). This may explain why large numbers of hatchery fish mature precociously, since they are typically larger at age than their wild counterparts.

[9] All hatchery-origin fish are externally marked, but a portion have only elastomer tags, which would not be readily visible to surveyors. It is also important to note that since steelhead are iteroparous, and they spawn during a period of increasing stream discharge, examination of carcasses, as in the case of spring Chinook salmon, is not possible.

The proportion of males that mature precociously is mostly unknown. Mullan et al. (1992a) examined 20,000 wild juvenile Chinook in tributaries of the mid-Columbia River during 1983 to 1988 and found that precocious males made up about 1 percent of the sample. However, if jacks (age-2 males that return after 1 year in the ocean) are included, the percentage of males that mature precociously would be much greater than 10 percent.

The extent that precocious males contribute to reproduction is unknown. In the Upper Columbia Basin, males that mature in freshwater during their first or second summer may contribute to reproduction, and may contribute more than jacks under certain conditions. For example, Leman (1968) and Mullan et al. (1992b) observed only precocious males attending large female Chinook in small headwater streams that were accessible only at high water. In Marsh Creek and Elk Creek, Idaho, precocious males occurred most frequently where there was active spawning (Gebhards 1960). These fish usually lay within the depression of the redd with an adult female, or male and female pair. Gebhards (1960) reports seeing between 4 and 30 precocious males within redds. Apparently these fish frequent spawning areas to reproduce, not to forage on eggs. Gebhards (1960) analyzed the stomach contents of several precocious males and found that only 5 percent had consumed eggs. Furthermore, most (85.1 percent) of the dead precocious males that he found were partly or completely spent.

The mechanism that dictates the life history tactic of Chinook is not well understood (Gross 1991), however, recent studies have indicated that growth rate can be a large factor determining the incidence of precocial and residualism rates in hatchery fish (Larsen et al. 2004, 2006; Sharpe et al. 2007). In the wild, juvenile size is determined by many variables, such as genotype, egg size, time of hatching, water flow, water temperature, territory quality, stream productivity, predation pressure, and population density. Changes in these variables may therefore affect the life history of Chinook.

Precocious males may play a significant role in reproduction in the Upper Columbia Basin, spawning successfully not only as "sneakers" in the presence of older males, but as the sole male present in some areas and in some years when spawner numbers are very low. They probably play a greater role in spawning in years such as 1994 and 1995, when numbers of spawners were so low that adult females were widely dispersed.

<u>Methow Summer Steelhead MPG</u>

The life-history pattern of steelhead in the Upper Columbia Basin is complex (Chapman et al. 1994). In the Upper Columbia region, Peven et al. (1994) observed smolt ages ranging from 1 to 7 years, with the highest percentages at ages 2 and 3. Female smolts (63 percent of fish sampled) were older and larger for most age classes than males.

Steelhead can residualize in tributaries and never migrate to sea, thereby becoming resident rainbow trout. Conversely, progeny of resident rainbow trout can migrate to the sea and thereby become steelhead. This dynamic expression of life-history characteristics makes *O. mykiss* very challenging to understand and manage. It is difficult to summarize one life history strategy (anadromy) without due recognition of the other (non-migratory). The two strategies co-mingle on some continuum with certain stream residency at one end, and certain anadromy on the other.

Upstream distribution is limited by low heat budgets (about 1,600 temperature units) (Mullan et al 1992a). The response of steelhead/rainbow complex in these cold temperatures is residualism, presumably because growth is too slow within the time window for smoltification. However, these headwater rainbow trout contribute to anadromy via emigration and displacement to lower reaches, where warmer water improves growth rate and subsequent opportunity for smoltification.

Methow Core Area Bull Trout

Migratory juveniles usually rear in natal streams for 1-4 years before emigration (Goetz 1989; Fraley and Shepard 1989; Pratt 1992). Methow Subbasin juvenile bull trout rear in the coldest headwater locations until they reach a size that allows them to compete with other fish (75 to 100 mm; Mullan et al. 1992a). Non-migratory forms above barrier falls probably contribute a limited amount of recruitment downstream, nevertheless, this recruitment contributes to fluvial and adfluvial productivity. The fluvial forms migrate to the warmer mainstem Methow and Columbia rivers (e.g., Twisp River, Wolf Creek), while the adfluvial populations (e.g., Lake Creek, Cougar Lake) migrate to nearby lakes.

2.2.1.9 Smolt Emigration Timing

Methow Spring Chinook MPG

Smolt trapping has occurred in the Methow Basin since the mid 1990s as part of the hatchery evaluation program. In general, yearling spring Chinook (smolts) migrate down the Methow River between early March and the end of May to early June. The peak of the migration in 2007 appeared later in the Twisp River compared to the Methow River site (Figures 2-2 and 2-3), although trap efficiencies and periods when traps are inoperable may influence the absolute numbers of fish caught on a given date.

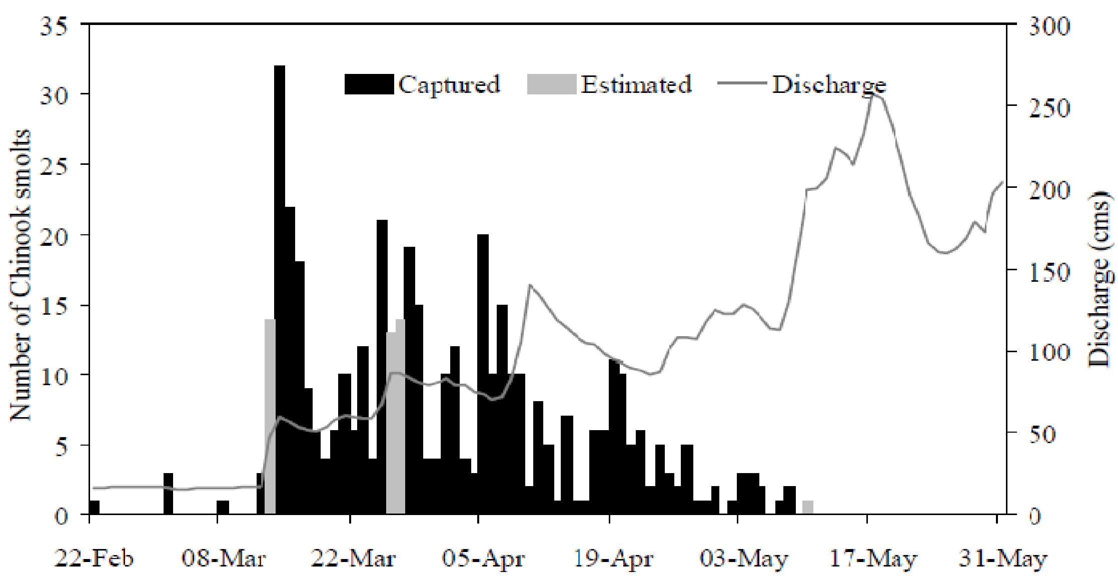

Figure 2-2. Daily capture of wild Chinook salmon smolts from the Methow River trap in 2007 (Figure 3, Chapter 3 from Snow et al. 2008).

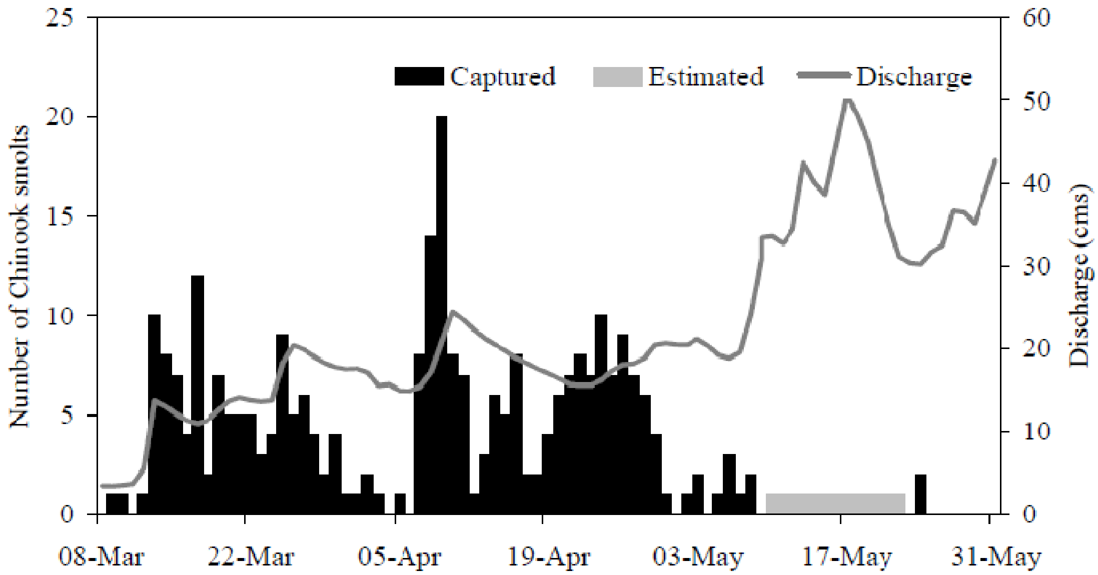

Figure 2-3. **Daily capture of wild Chinook salmon smolts from the Twisp River trap in 2007 (Figure 6, Chapter 3 from Snow et al. 2008).**

As previously stated, a substantial parr migration occurs within the Methow Basin, and appears in two main phases—throughout the summer and then again in the fall (Figure 2-4).

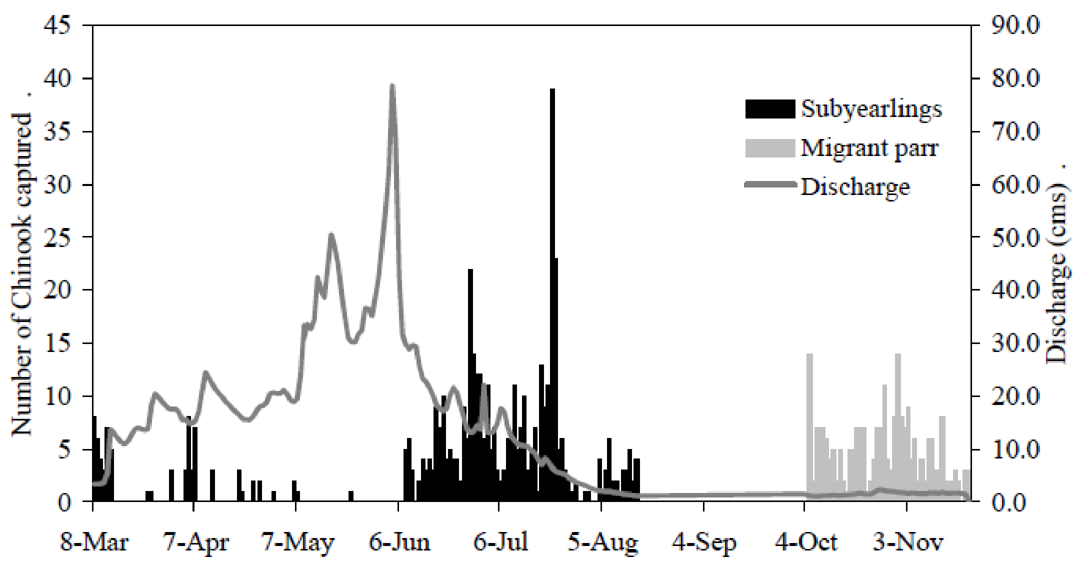

Figure 2-4. **Daily capture of sub-yearling wild spring Chinook and migrant parr at the Twisp River trap in 2007 (Figure 7, Chapter 3 from Snow et al. 2008).**

Methow Summer Steelhead MPG

Smolt trapping has occurred in the Methow Basin since the mid 1990s as part of the hatchery evaluation program. In general, *O. mykiss* juveniles[10] migrate down the Methow River between early March and the end of May to early June. The peak of the migration in 2007 appeared later in the Twisp River compared to the Methow River site (Figures 2-5 and 2-6), although trap efficiencies and periods when traps are inoperable may influence the absolute numbers of fish caught on a given date.

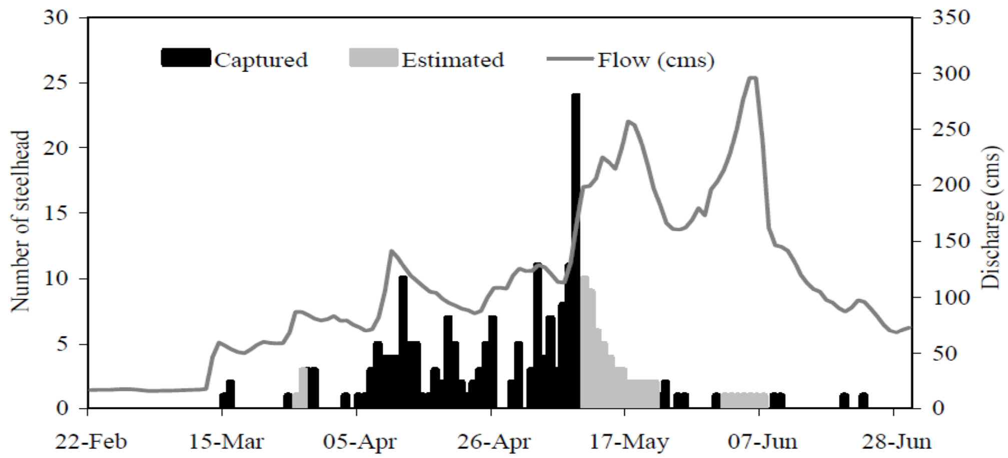

Figure 2-5. **Daily capture of wild steelhead smolts and transitional parr from the Methow River trap in 2007 (Figure 5, Chapter 3 from Snow et al. 2008).**

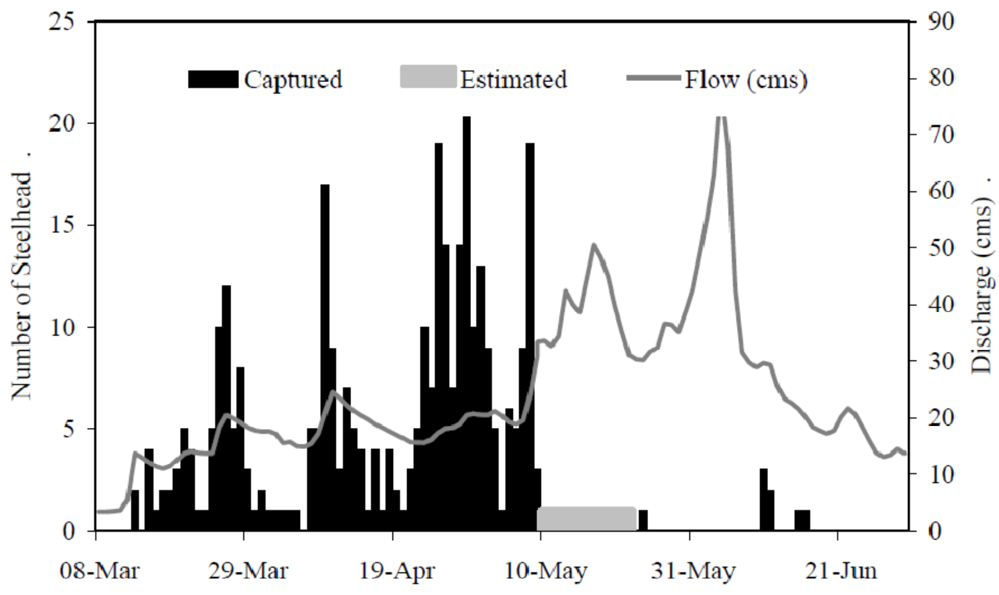

Figure 2-6. **Daily capture of wild steelhead smolts and transitional parr from the Twisp River trap in 2007 (Figure 8, Chapter 3 from Snow et al. 2008).**

[10] Because it is not possible to determine whether juvenile *O. mykiss* are "trout" or "steelhead", we refer to them by their scientific nomenclature.

As previously stated, a substantial parr migration occurs within the Methow Basin, and appears in two main phases—throughout the summer and then again in the fall (Figure 2-7).

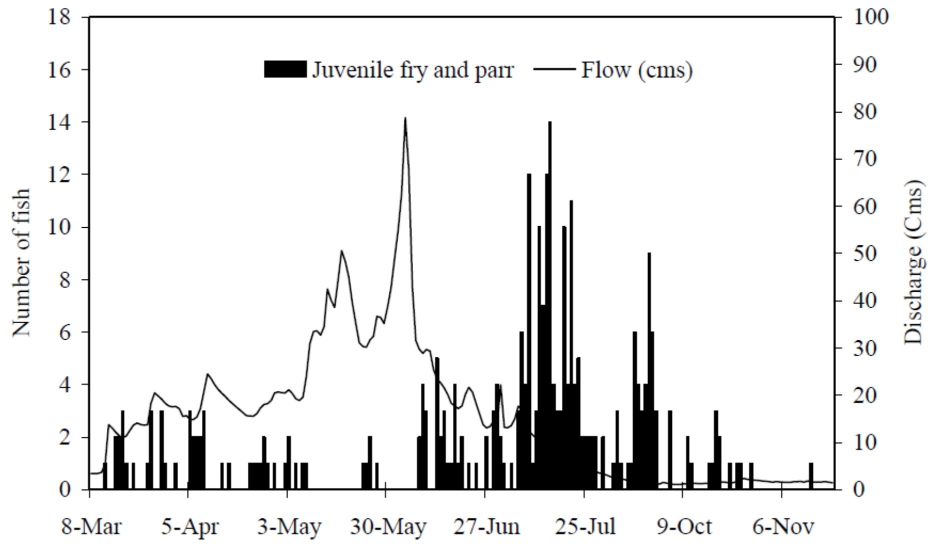

Figure 2-7. Daily capture of natural-origin steelhead fry and parr at the Twisp River trap in 2007 (Figure 9, Chapter 3 from Snow et al. 2008).

Methow Core Area Bull Trout

All of the fish that BioAnalysts (2004) tagged in their 3-year study appeared to have spent at least three years in their natal stream prior to migrating to the Columbia River.

2.2.1.10 Spatial And Temporal Distribution of Spawners in Relation to Fish Release Location

Methow Spring Chinook MPG

Snow et al. (2008) found no significant differences in spawn timing between hatchery and natural-origin fish (females) within or among sub-basins. However, hatchery fish tended to spawn earlier than naturally produced fish, except in the Twisp River (which had the lowest proportion of hatchery-origin spawners).

Snow et al. (2008) found no significant differences were detected in the distribution of hatchery and natural-origin carcasses (females) within each major spawning area either). However, hatchery fish tended to spawn lower in each of the spawning areas than naturally produced fish.

Methow Hatchery spring Chinook salmon are typically released in three locations in the Methow River basin. All of the acclimation sites use surface water for rearing prior to release to increase homing fidelity. Despite this, an estimated 49 percent of the Twisp-released fish spawning in the Methow Basin spawned in areas other than the Twisp River. However, because abundance of

Twisp-stock fish is relatively low, their prevalence typically comprises a small proportion of the escapement within other spawning areas (i.e., Methow and Chewuch rivers). Similarly, an estimated 60 percent of the Chewuch-released fish spawned in areas other than the Chewuch River, but because release numbers are much greater, contribution of these fish to other spawning areas can be high. Conversely, an estimated 28 percent of Methow-released fish spawned in areas other than the Methow River (Snow et al. 2008).

Methow Summer Steelhead MPG

Because there is currently no way to differentiate steelhead by origin on the spawning grounds, there is no information to fill in for this subheading. The lack of this ability (to determine origin on the spawning grounds) has been identified by the Upper Columbia Regional Technical Team as an important data gap.

Methow Core Area Bull Trout

There are currently no hatchery programs for bull trout in the Methow River.

2.2.1.11 Identify the NMFS ESA-listed Population(s) that will be Directly Affected by the Program

Methow Spring Chinook MPG

Common Name	Endangered Species Act	Natural population targeted for integration
Spring Chinook salmon (UCR)	Endangered	Methow spring Chinook

Methow Summer Steelhead MPG

Common Name	Endangered Species Act	Natural population targeted for integration
Steelhead trout (UCR)	Threatened	Methow River summer steelhead

Methow Core Area Bull Trout

There are currently no hatchery programs for bull trout in the Methow River.

2.2.1.12 Identify the NMFS ESA-listed Population(s) that may be Incidentally Affected by the Program

Methow Spring Chinook MPG

Common Name	Endangered Species Act
Spring Chinook salmon (UCR)	Endangered
Steelhead trout (UCR)	Threatened
Bull trout (Columbia River)	Threatened

Methow Summer Steelhead MPG

Common Name	Endangered Species Act
Spring Chinook salmon (UCR)	Endangered
Steelhead trout (UCR)	Threatened
Bull trout (Columbia River)	Threatened

Methow Core Area Bull Trout

There are currently no hatchery programs for bull trout in the Methow River.

2.2.2 Status of NMFS ESA-listed Salmonid Population(s) Affected by the Program

2.2.2.1 Describe the Status of the Listed Natural Population(S) Relative to "Critical" and "Viable" Population Thresholds (see definitions in "Attachment 1")

Methow Spring Chinook MPG

The ICTRT (2007) has classified the Methow River spring Chinook as a "Very Large" population in size based on its historic habitat potential. A "Very Large" population is one that requires a minimum abundance of 2,000 natural-origin spawners and an intrinsic productivity of greater than 1.75 spawner to spawner (S/S) to be viable. The Recovery Plan (UCSRB 2007) incorporated the abundance goal of 2,000 naturally produced spawners (geometric mean over 12 years), but incorporated an earlier recommendation from the ICTRT of an intrinsic productivity of 1.2.

Regardless of which productivity metric is used, the Methow spring Chinook currently are considered to have a greater than 25 percent chance of becoming extinct within 100 years.

Methow Summer Steelhead MPG

The ICTRT (2007) has classified the Methow River summer steelhead as an "Intermediate" population in size based on its historic habitat potential. An "Intermediate" population is one that requires a minimum abundance of 1,000 natural-origin spawners and an intrinsic productivity of greater than 1.1 S/S to be viable. The Recovery Plan (UCSRB 2007) incorporated the abundance goal of 1,000 naturally produced spawners (geometric mean over 12 years) and an intrinsic productivity of 1.1.

Methow summer steelhead are currently considered to have a greater than 25 percent chance of becoming extinct within 100 years.

Methow Core Area Bull Trout

Because of a lack of detailed information on the population dynamics of bull trout in the Upper Columbia Basin, a different approach was used to estimate Viable Salmonid Population (VSP) parameters for bull trout in UCSRB (2007). Bull trout abundance was estimated as the number of redds times 2.0 to 2.8 fish per redd. This approach provided a range of abundance estimates for bull trout within each core area (USFWS 2004, 2005). Productivity was based on trends in redd counts, while diversity was based on general life-history characteristics of bull trout (resident, fluvial, and adfluvial) within each core area. Although these parameters were less rigorous than the parameters used to estimate status of spring Chinook and steelhead, they provide relative indices of abundance, productivity, and diversity.

In the final listing rule (63 FR 31647), USFWS identified eight bull trout sub-populations in the Entiat, Wenatchee, and Methow River basins (USFWS 1998). USFWS identified eight sub-populations within this recovery unit: Lake Wenatchee, Ingalls Creek, Icicle Creek, Entiat system, Methow River, Goat Creek, Early Winters Creek, and Lost River. USFWS considered half of these to be “at risk of stochastic extirpation” due to: a) their inability to be re-founded, b) presence of a single life history form, c) limited spawning areas, and c) relatively low abundance.

In the 5-year review (USFWS 2008), the USFWS determined that the Methow core area was at high risk of extinction.

2.2.2.2 Provide the Most Recent 12 Year (e.g., 1988-Present) Progeny-to-Parent Ratios, Survival Data by Life-Stage, or Other Measures of Productivity for the Listed Population. Indicate the Source of these Data.

Methow Spring Chinook MPG

During the period 1960 to 1999, returns per spawner for spring Chinook in the Methow sub-basin ranged from 0.05 to 5.21 (UCSRB 2007). The 12-year geometric mean of returns per spawner during this period ranged from 0.41 to 1.02. The geometric mean at the time of listing (1999) was 0.51.

Since 1999, the natural replacement rate (the number of recruits from successive return years that originated from the same brood year, and dividing the sum by the number of spawners for that brood year) has varied, but remains low, especially in the Methow River spawning area (Table 2-12). The most recent geometric mean of productivity remains near 0.51, which it was at the time of listing for the Chewuch and Twisp spawning areas, but approximately half that amount in the Methow spawning area, which coincidentally has the highest proportion of hatchery-origin spawners.

Table 2-12. The natural replacement rate of Methow River basin spring Chinook between the 1992 and 2001 brood years (data from Chapter 5, Appendix A from Snow et al. 2008).

	NRR		
Year	**Chewuch**	**Methow**	**Twisp**
1992	0.11	0.10	0.30
1993	0.52	0.17	0.13
1994	0.30	0.20	0.34
1995	5.53	2.83	3.23
1996	12.75	17.89	8.64
1997	12.68	5.98	17.25
1998	12.66	3.73	17.75
1999	0.11	0.07	0.31
2000	1.10	0.52	1.72
2001	0.13	0.04	0.18
2002	0.32	0.15	0.48
Geometric mean	*1.00*	*0.53*	*1.16*

Methow Summer Steelhead MPG

In UCSRB (2007), the returns per spawner were expressed as either a hatchery spawner effectiveness of 100 percent or 0 percent. The geometric mean of returns per spawner is 0.09 if hatchery spawner effectiveness was 100 percent, and 0.84 if hatchery spawner effectiveness was 0 percent up to the 1996 brood.

More recently, Snow et al. (2008) estimated that the total (not accounting for hatchery spawner effectiveness) average return per spawner as 0.30 for brood years 1996 to 2001 (Table 2-13). This value is in between the two reported in UCSRB (2007).

Table 2-13. The natural replacement rate of Methow River basin steelhead between the 1996 and 2001 brood years (data from Chapter 4, Table 16 from Snow et al. 2008).

Parent Brood	Recruits	NRR
1996	315	0.56
1997	684	0.28
1998	730	0.30
1999	167	0.11
2000	848	0.40
2001	595	0.16
Average	***557***	***0.30***

Methow Core Area Bull Trout

Numbers of redds counted in the Methow sub-basin appear to have increased since the mid-1990s. This reflects both an actual increase in redds and an artifact of improved survey methods. Looking at recent years (2000 to 2007), when survey methods were similar, there is an increasing trend in redds, ranging from 147 in 2000 to 231 in 2007 (see below).

2.2.2.3 Provide the Most Recent 12 Year (e.g., 1988-1999) Annual Spawning Abundance Estimates, or any Other Abundance Information. Indicate the Source of these Data.

Methow Spring Chinook MPG

From 1960 to 2003, abundance of age 3+ naturally produced spring Chinook in the Methow sub-basin ranged from 33 to 9,904 adults. During this period the 12-year geometric mean of spawners in the sub-basin ranged from 480 to 2,231 adults. The 12-year geometric mean at the time of listing (1999) was 480 spawners (UCSRB 2007).

More recently (1992-2008), the estimated escapement of naturally produced spring Chinook has ranged from approximately 58 (2003) to 1,832 fish (2001), with a geometric mean of 363 (Table 2-14).

Table 2-14. Estimated escapement of spring Chinook in the Methow River, 1992-2007 (based on Appendices A and D, Chapter 5, from Snow et al. 2008 and unpublished 2009 WDFW data).

Return Year	Estimated Escapement							
	Chewuch		Methow		Twisp		Total	
	H	W	H	W	H	W	H	W
1992		422		924		316		1,662
1993		184		537		426		1,147
1994		63		172		74		309
1995		6		27		12		45
1996								
1997		123		155		72		350
1998								
1999		21		70		25		116
2000	52	83	546	611	235	256	833	950
2001	1,761	732	6,994	594	384	506	9,139	1,832
2002	588	78	1,644	86	60	181	2,292	345
2003	465	25	597	8	18	25	1,080	58
2004	289	46	622	199	98	243	1,009	488
2005	289	219	526	221	34	87	849	527
2006	378	135	942	128	100	65	1,420	328
2007	203	74	545	152	65	40	813	266
2008	166	86	468	172	126	40	760	298
Geometric mean	***310***	***84***	***873***	***158***	***86***	***92***	***1,342***	***363***

Methow Summer Steelhead MPG

Between 1988 and 2007, the run of naturally produced steelhead returning to the Methow River has ranged from 66 (1995) to 669 (2004). The most recent 12-year average (1996 to 2007) geometric mean is estimated at 329 fish (Table 2-15).

Table 2-15. Estimated return of naturally produced steelhead to the Methow River, 1988-2009. Information based on UCSRB (2007) and Snow et al. (2008) and unpublished WDFW data.

Return year	Estimated naturally produced return	12-year running geometric mean of return
1988	316	116
1989	401	126
1990	315	160
1991	552	184
1992	252	242
1993	130	240
1994	165	275
1995	128	250
1996	222	247
1997	96	224
1998	186	221
1999	350	229
2000	436	236
2001	702	247
2002	651	262
2003	847	272
2004	638	294
2005	558	331
2006	472	362
2007	762	420
2008	898	472

Methow Core Area Bull Trout

Bull trout redd surveys in the Methow sub-basin began in the early 1990s. Total numbers of redds within the sub-basin have ranged from 4 to 231 (Table 2-16). Following the UCSRB (2007), using 2.0 and 2.8 fish per redd equates to a range of abundance between 22 and 647 fish per year in the Methow Basin (Table 2-17).

Table 2-16. Bull trout redds from the Methow Basin between 1992 and 2007 (pers. comm., Barb Kelly and Gene Shull, USFWS and USFS, respectively).

Stream/ watershed	Methow River Basin															
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Lower Methow watershed					2	2	1	0		0	1	0		14	4	4
Twisp watershed	4	5	4	25	0	2	86	101	105	76	93	86	101	87	89	108
Chewuch watershed				22	13	9	8	0	18	31	22	20	10	43	54	46
Upper Methow watershed	7			28	29	18	40	30	42	47	79	21	58	71	63	73
Redd Total:	**11**	**5**	**4**	**75**	**44**	**31**	**135**	**131**	**165**	**154**	**195**	**127**	**169**	**215**	**210**	**231**
Miles Surveyed Total:				**18.7**	**25.6**	**20.2**	**26.7**	**27.8**	**22.9**	**42.5**	**28.7**	**30.6**	**30.7**	**33.3**	**32.3**	**32.8**

Note: Not all bull trout redd counts were complete, and length of stream surveyed has varied between some surveys, in many cases with new survey reaches being added in recent years. Please refer to the annual spawning survey reports for more complete information.

Lower Methow includes Crater Creek; Middle Methow includes Wolf and Goat Creeks; and Upper Methow includes the upper mainstem basin, Early Winters basin, and lower Lost River basin.

Table 2-17. The number of bull trout estimated to spawn in the Methow Basin between 1992 and 2007, based on Table 2-16 and using either 2.0 fish per redd (f/r) or 2.8.

Year	Total Redds	Fish @ 2.0 f/r	Fish @ 2.8 f/r
1992	11	22	31
1993	5	10	14
1994	4	8	11
1995	75	150	210
1996	44	88	123
1997	31	62	87
1998	135	270	378
1999	131	262	367
2000	165	330	462
2001	154	308	431
2002	195	390	546
2003	127	254	356
2004	169	338	473
2005	215	430	602
2006	210	420	588
2007	231	462	647

2.2.2.4 Provide the Most Recent 12 Year (e.g., 1988-1999) Estimates of Annual Proportions of Direct Hatchery-Origin and Listed Natural-Origin Fish on Natural Spawning Grounds, if Known

Methow Spring Chinook MPG

The percentage of hatchery-origin fish on the spawning grounds has been rising since 2001, and in particular in the Chewuch and Methow spawning areas since 2005 (Table 2-18). Except for 2007, the percentage of hatchery-origin fish spawning in the Twisp has remained consistently below 30 percent (Table 2-18).

Table 2-18. Percentages of hatchery-origin spring Chinook spawners in the Methow Basin, based on Table 2-14.

	Percentages							
	Chewuch		Methow		Twisp		Total	
Return Year	H	W	H	W	H	W	H	W
2001	41.4	58.6	48.0	52.0	30.1	69.9	42.1	57.9
2002	46.9	53.1	48.7	51.3	24.9	75.1	45.7	54.3
2003	48.7	51.3	49.7	50.3	29.5	70.5	51.4	48.6
2004	46.9	53.1	48.7	51.3	19.9	80.1	43.0	57.0
2005	56.9	43.1	70.4	29.6	28.1	71.9	61.7	38.3
2006	86.3	13.7	75.8	24.2	28.7	71.3	65.4	34.6
2007	73.3	26.7	78.1	21.9	61.9	38.1	69.5	30.5
2008	65.9	34.1	73.1	26.9	75.9	24.1	71.8	28.2
Average	*58.3*	*41.7*	*61.6*	*38.4*	*37.4*	*62.6*	*56.3*	*43.7*

Methow Summer Steelhead MPG

Using the percentage of natural-origin fish sampled at Wells Dam as a surrogate for the percentage of natural-origin fish on the spawning grounds shows that the percentage of hatchery steelhead on the spawning grounds is typically greater than 90 percent (Figure 2-8). The long-term average percentage of naturally produced fish sampled at Wells Dam is approximately 8 percent (Figure 2-8).

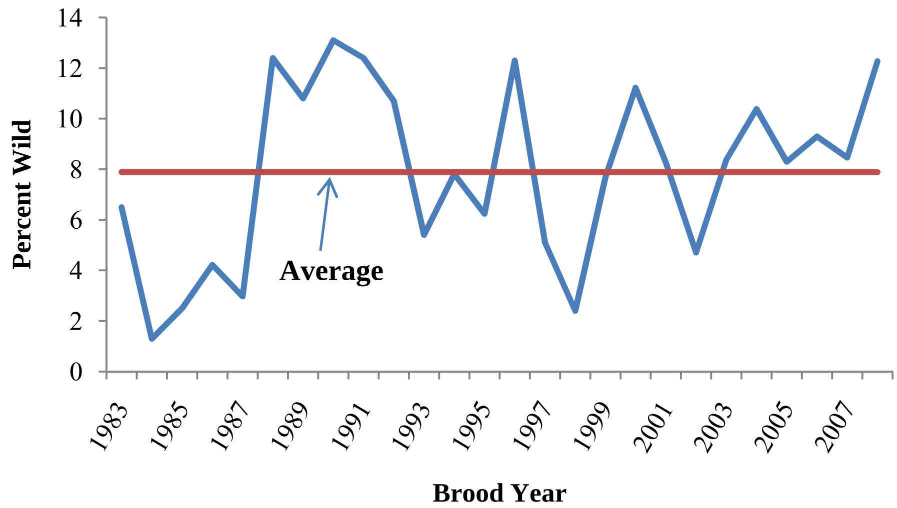

Figure 2-8. **Percent of naturally-produced steelhead sampled in the run at large at Wells Dam for the 1983-2008 brood years. Data from UCSRB (2007) and C. Snow, pers. comm.**

Methow Core Area Bull Trout

There are currently no hatchery programs in the Methow Basin.

2.2.3 Describe Hatchery Activities, Including Associated Monitoring, Evaluation and Research Programs, that May Lead to the Take of ESA Listed Fish in the Target Area, and Provide Estimated Annual Levels of Take

See Tables 2-19 and 2-20 for estimated levels of annual take.

2.2.3.1 Hatchery Program Activities

Hatchery program activities include:

- Collection of broodstock (up to 360 adults, includes up to 64 Twisp-origin) through trap operations at Wells Dam, the Twisp River weir, Methow Hatchery outfall, Winthrop NFH outfall, and potentially from future collection facilities located on the Chewuch, Twisp, and/or Methow rivers, or by other methods such as angling or seining (as approved by the HCP Hatchery Committees) for Methow River Basin-origin spring Chinook salmon. See Sections 1.8.2.1 and 1.11.1.
- Transfer of hatchery-origin adults and fertilized eggs between the Methow Hatchery and the Winthrop NFH; holding and artificial spawning of collected adults at the Methow Hatchery.
- Incubation and propagation from the fertilized egg through the smolt life stage at Methow Hatchery.
- Holding and artificial spawning of collected adults at the Methow Hatchery.

- Transfer of fingerlings and pre-smolts from the Methow Hatchery for rearing in acclimation facilities on the Methow, Twisp, and Chewuch rivers (and other locations as approved by the HCP Hatchery Committees; see Section 1.8.2.1 and 1.11.2).
- Release of up to 550,000 smolts into the Methow Basin (split between the Methow, Chewuch, and Twisp rivers) from the Methow Hatchery and acclimation facilities in those systems, and any future acclimation facilities as approved by the HCP Hatchery Committees.
- Monitoring of the programs in the hatchery environment using standard techniques such as growth and health sampling.
- Monitoring of the programs in the natural environment using standard techniques such as juvenile fish traps, adult spawner surveys, etc., as described in detail in the M&E Plan (Appendix A), Analytical Framework (Appendix B), and annual M&E Implementation plans (Appendix C, current version). Each of these documents is subject to periodic (or annual) revisions by the HCP Hatchery Committees.

Adult Management Activities

Take of hatchery and natural origin spring Chinook may also occur as a result of adult management of hatchery spring Chinook to meet spawn escapement objectives (abundance and hatchery/origin composition on the spawning grounds).

Responsibilities

The funding, permit holder, and agent for the activities discussed in this section are as follows:

Harvest

Funding: WDFW

Permit Holder WDFW

Agent: WDFW

Adult Removal at Trapping Facilities

Funding: Douglas PUD will provide funding for one FTE (for both steelhead and spring Chinook hatchery programs) for adult management activities associated with Douglas PUD's NNI hatchery compensation. This funding includes manual adult management activities up to the point at which spring Chinook are removed at Douglas PUD's trapping facilities and placed in holding containers.

WDFW is responsible for coordinating the funding for manual adult management activities from the point at which fish are placed in holding containers when manually removed and/or for a conservation fishery. The Co-managers will determine the disposition of the fish placed in the holding containers.

Permit Holder: Douglas, Chelan, and Grant PUDs and WDFW will be co-permit holders for manual adult management activities up to the point at which spring Chinook are removed at from Douglas PUD's trapping facilities and placed in holding containers. WDFW will be the permit holder for manual adult management activities, including any conservation fishery, from the point at which fish are placed in holding containers.

Agent: For Douglas PUD's permit, WDFW is designated as the authorized agent under a current contract between Douglas PUD and WDFW and until this contract expires and is not renewed or renegotiated.

Table 2-19. Estimated levels of take of UCR Spring Chinook by hatchery activity.

Listed species affected: UCR Spring Chinook ESU/Population: Methow Population Activity: Implement Hatchery Program				
Location of hatchery activity: **Methow Hatchery, Twisp and Chewuch Acclimation Ponds, Wells Dam, Twisp & Methow screw traps and other M&E activities/locations** **Dates of activity:** **Broodstock collection: May-August; screw traps spring thaw to ice up.** **Hatchery program operator:** **Currently WDFW**				
Type of Take	**Annual Take of Listed Fish By Life Stage (*Number of Fish*)**			
	Egg/Fry	Juvenile/Smolt	Adult	Carcass
Observe or harass a)			Up to 100%	Up to 100%
Collect for transport b)			Up to 360	
Capture, handle, and release c)		Up to 550,000 hatchery smolts		
Capture, handle, tag/mark/tissue sample, and release d)		Trap up to 20% nat. and hat. population from any tributary	Up to 100% of the natural. and hatchery returns	100%
Removal (e.g. broodstock) e)			Up to 360	
Intentional lethal take f)	Up to 12% of total egg take for BKD management		Up to 360 hat. & nat. broodstock; up to 100% hat. for pHOS control	
Unintentional lethal take g)	Up to 10%		Up to 18 (10% of broodstock)	
Other Take (specify) h)				

a. Contact with listed fish through stream surveys, carcass and mark recovery projects, or migrational delay at weirs.
b. Take associated with weir or trapping operations where listed fish are captured and transported for release.
c. Take associated with weir or trapping operations where listed fish are captured, handled and released upstream or downstream.
d. Take occurring due to tagging and/or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
e. Listed fish removed from the wild and collected for use as broodstock.
f. Intentional mortality of listed fish, usually as a result of spawning as broodstock.
g. Unintentional mortality of listed fish, including loss of fish during transport or holding prior to spawning or prior to release into the wild, or, for integrated programs, mortalities during incubation and rearing.
h. Other takes not identified above as a category.

Table 2-20. Estimated levels of take of UCR Summer Steelhead by hatchery activity.

Listed species affected: **UCR Summer Steelhead** **ESU/Population:** **Methow and Okanogan Populations** **Activity:** **Implement Hatchery Program**				
Location of hatchery activity: **Methow Hatchery, Wells Dam, Twisp and Methow rivers screw traps and other M&E activities/locations,** **Dates of activity:** **Broodstock collection: May-August; screw traps spring thaw to ice up.** **Hatchery program operator:** **Currently WDFW**				
Type of Take	**Annual Take of Listed Fish By Life Stage (*Number of Fish*)**			
	Egg/Fry	Juvenile/Smolt	Adult	Carcass
Observe or harass a)				
Collect for transport b)				
Capture, handle, and release c)			Up to 100 adults	
Capture, handle, tag/mark/tissue sample, and release d)		Trap up to 20% nat. and hat. population from any tributary	Trap up to 20% hat. & nat. population from any tributary	
Removal (e.g. broodstock) e)				
Intentional lethal take f)				
Unintentional lethal take g)			Up to 9 adults; not exceed 1% of trapped steelhead	
Other Take (specify) h)				

a. Contact with listed fish through stream surveys, carcass and mark recovery projects, or migrational delay at weirs.
b. Take associated with weir or trapping operations where listed fish are captured and transported for release.
c. Take associated with weir or trapping operations where listed fish are captured, handled and released upstream or downstream.
d. Take occurring due to tagging and/or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
e. Listed fish removed from the wild and collected for use as broodstock.
f. Intentional mortality of listed fish, usually as a result of spawning as broodstock.
g. Unintentional mortality of listed fish, including loss of fish during transport or holding prior to spawning or prior to release into the wild, or, for integrated programs, mortalities during incubation and rearing.
h. Other takes not identified above as a category.

3.0 RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1 Describe Alignment of the Hatchery Program with any ESU-Wide Hatchery Plan or other Regionally Accepted Policies. Explain any Proposed Deviations from the Plan or Policies

The objectives of the Methow Hatchery spring Chinook artificial propagation program are established in the Wells HCP and described above in Section 1. Implementation of the HCP is a cornerstone of recovery efforts for the UCR Spring Chinook and as such, has been imbedded in the Recovery Plan (UCSRB 2007). The Upper Columbia Salmon Recovery Board lead the development of the Recovery Plan which was adopted by NMFS as a final ESA recovery plan for UCR spring Chinook and steelhead on October 9, 2007. The UCSRB coordinates recovery planning in the UCR region with funding from the Washington State Governor's Salmon Recovery Office. A link to the NMFS webpage describing the plan is at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/Index.cfm.

Section 5.3.1 of the Recovery Plan describes the hatchery programs currently being implemented in the Upper Columbia ESU. Implementing Entities include CCT, YN, USFWS, WDFW, and Douglas County, Chelan County, and Grant County PUDs. Coordinating and technical bodies have been established to guide implementation of Douglas, Chelan and Grant County PUDs' hatchery programs (Coordinating Committees and Hatchery Committees), required by the PUD HCPs and by Grant County PUD's Biological Opinion (2008). The HCP and Priest Rapids coordinating and hatchery committees include participation by the relevant PUD(s) and CCT, YN, USFWS, NOAA, and WDFW. This HGMP will also be consistent with the direction provided by the HRSG on UCR spring Chinook artificial supplementation programs (HSRG 2009). Such modifications will be reflected in the program production size and duration, monitoring and evaluation, and in the artificial production strategies.

3.1.1 HSRG – Upper Columbia Review

The HSRG, as part of the Pacific Salmon Hatchery Reform Project, has completed a review of 178 hatchery programs and 351 salmonid populations in the Columbia River Basin. The project was conducted by the Columbia River HSRG, composed of 14 members, nine of whom were affiliated with agencies and tribes in the Columbia River Basin. The remaining five members were unaffiliated biologists. The objective was to produce recommendations that are based on broad policy agreements and are supported by consistent technical information about hatcheries, habitat, and harvest. The Upper Columbia Hatchery Programs Regional Review began in April 2008, and the final HSRG recommendations were published January 31, 2009 in Appendix E to the Columbia River Hatchery Reform System-Wide Report (HSRG 2009). The principles of the HSRG recommendations (specifically as elaborated in White Paper No. 1 of Appendix A of the HSRG Final Systemwide Report for the Columbia Basin) form the basis of the management decision rules proposed in Section 1.8.2.4.

3.2 List All Existing Cooperative Agreements, Memoranda of Understanding, Memoranda of Agreement, or other Management Plans or Court Orders under which the Program Operates

3.2.1 Wells Habitat Conservation Plans

In April 2002, pursuant to section 10(a)(1)(B) of the ESA, negotiations on the Anadromous Fish Agreement and Habitat Conservation Plan Wells Hydroelectric Project FERC License No. 2149 with Douglas PUD for the operation of Wells Dam (HCP, DPUD 2002) were concluded. A Biological Opinion with incidental take statements (ITSs) on the operation of the Wells Hydroelectric Project was issued consistent with the HCP (NMFS 2003a, 2003b, 2003c). The amended Incidental Take Permit No.1196 (NMFS 2004) added Douglas PUD to the permit as a joint permit holder with WDFW and Chelan PUD in accordance with Douglas PUD's HCP Agreement reached between Douglas PUD, NMFS, USFWS, WDFW, CCT, YN, and the Power Purchasers[11]. The artificial propagation activities of this program are included within Douglas PUD's HCP; see Sections 1.7 and 1.8 for more detailed information regarding the HCPs. The production levels specified in the HGMP are identical to those of the HCP; therefore this HGMP is consistent with the Wells HCP.

3.2.2 2008-2017 / United States v. Oregon / Management Agreement

The purpose of this Management Agreement is to provide a framework within which the signatory fishery co-managers can use their authorities to protect, rebuild, and enhance UCR fish runs while fairly sharing harvestable fish between Treaty and non-Treaty fisheries. The Management Agreement specifies harvest limits and artificial production measures for stocks of salmon and steelhead originating above Bonneville Dam. The hatchery production goal for the Wells Complex Methow spring Chinook facilities as shown in Appendix B Table B1 of the Management Agreement is 550,000 yearling juveniles incubated and reared at the Methow Hatchery.

These production programs are implemented and/or adjusted based on modifications to productions levels through processes established under the mid-Columbia HCPs, the Priest Rapids Salmon and Settlement Agreement, and discussions associated with Part III.H. of the Management Agreement. The current program involves the release of smolts from the Methow Hatchery, and some Methow Hatchery production is also acclimated at ponds located in the Twisp and Chewuch watersheds. The Management Agreement is entered as an order of the 7th US District Court in /*US v. Oregon*/ and, as such, its terms are binding on the parties. The mitigation production levels specified in this HGMP are identical to those of the Management Agreement; therefore this HGMP is consistent with *US v. Oregon*.

This program does not affect the management, assessment, or goals of fisheries that occur outside of the Methow River basin. Low numbers of Methow spring Chinook are harvested in ocean fisheries. Impacts of ocean fisheries are regulated under authority of the Pacific Salmon

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[11] Entities that have executed long-term power sales contracts with Douglas PUD, specifically Puget Sound Energy, Inc., Portland General Electric, PacifiCorp., and Avista Corp.

Commission and the Pacific Fishery Management Council. Fisheries under these jurisdictions have been reduced in recent years in response to ESA listings. Mainstem Columbia River fisheries are regulated under a co-management framework pursuant to litigation in *US v Oregon*. The *2008-2017 United States v Oregon Management Agreement* provides the harvest management framework for spring Chinook fisheries below McNary Dam. The harvest schedule is designed to allow some level of harvest while protecting the great majority of ESA-listed NOR adults passing through the fisheries. Allowable harvest rates are scaled to the abundance of the total run projected to pass Bonneville Dam and the abundance of NOR spring Chinook projected to enter the Snake River. The allowable harvest rates for Treaty and non-Treaty fisheries are designed to achieve a 50/50 sharing of harvestable fish in the non-selective tribal fisheries and mark-selective non-tribal fisheries in accordance with treaty fishery case-law standards. Total allowable fishery impacts in combined mainstem fisheries range from less than 5.5 percent on total runs of less than 27,000 fish to a maximum of 17 percent on runs of 488,000 fish or more. Nevertheless, lower-mainstem commercial and recreational fisheries annually commence prior to confirmation of the forecasted run-size by actual fish counts at Bonneville Dam, potentially resulting in a disproportionate harvest of the early returning component of the UC spring Chinook run, which historically comprised older, more-fecund fish (i.e., Age-5 fish).

Fisheries in the UCR basin are currently limited by the need to protect ESA-listed UCR spring Chinook salmon and UCR steelhead. Fisheries in the migration corridor and ocean are also limited to protect these populations, and to minimize harvest impacts on other listed salmon and steelhead returning to other Columbia River basin and Snake River basin areas as noted above. NMFS evaluates and authorizes annual fisheries proposed by the co-managers in the action area each year through separate Section 7 biological opinions.

Until the spring of 2000—when a relatively large run of hatchery spring Chinook salmon returned and provided a small commercial Tribal fishery in the lower Columbia River—no commercial season for spring Chinook salmon had taken place since 1977. Present Columbia River harvest rates are very low compared with those from the late 1930s through the 1960s (NMFS 2008).

Harvest actions outside the action area, such as in the ocean, mainstem Columbia River and other basin areas will be managed through the *U.S. v Oregon* and Pacific Fisheries Management Council (PFMC) planning and management processes, with guidance from NMFS. Proposed releases of spring Chinook salmon, summer Chinook salmon, sockeye salmon, and coho salmon juveniles into the UCR basin are not expected to create any substantial harvest complications with listed species. NMFS involvement with the co-managers in the PFMC and *U.S. v Oregon* fishery planning processes will adequately limit harvest effects on listed salmon and steelhead. Proposals for future fisheries will continue to be addressed by NMFS through separate Section 7 consultation processes.

3.3 Describe Fisheries Benefiting from the Program, and Indicate Harvest Levels and Rates for Program-Origin Fish for the Last Twelve Years (1998-09), if Available

There have been no recreational fisheries on Methow spring Chinook in the Methow River since the stock was listed in 1999. Neither formal creel survey nor punch card data were available to estimate total catch or effort in fisheries prior to 1999. Any future fisheries that may occur in the Methow Basin prior to spring Chinook recovery would be by others (WDFW) for conservation purposes only, specifically to assist in pHOS control when the natural-origin run could tolerate a small percentage of incidental hooking mortality. Implementation of a conservation fishery is not the purview of Douglas PUD and is thus not explicitly included in this HGMP. The ultimate goal of the hatchery program is stock recovery that would then enable annual harvest (recreational) fisheries.

3.4 Relationship to Habitat Protection and Recovery Strategies

Although habitat in much of the upper reaches of the Methow basin is in near pristine condition, habitat complexity, connectivity, water quantity, and riparian function have been compromised due to human activities in other parts of the Methow basin, including portions where the majority of spring Chinook spawn. The Recovery Plan (UCSRB 2007) details specific objectives and actions for habitat protection and restoration necessary for the recovery of UCR salmon and steelhead populations. These habitat actions are occurring at the same time as hatchery programs are supplementing natural production, while preserving important genetic resources. Douglas PUD is actively coordinating with its cooperators to ensure that hatchery actions do not impact the ability to monitor the effectiveness of habitat restoration activities.

Douglas PUD also provides funding for projects for the protection and restoration of HCP Plan Species habitat, including the Methow and Okanogan watersheds and the Columbia River watershed (from Chief Joseph Dam tailrace to Wells Dam tailrace). Douglas PUD provides this funding as a requirement of the Wells HCP to compensate for up to two percent unavoidable project mortality. This HCP requirement, combined with the survival standards and hatchery compensation, effectively mitigates for passage losses due to the operation of Wells Dam. The goal of this tributary program is to protect and restore habitat, a goal that is shared with the recently signed 10-Year Memoranda of Agreement (MOAs) between the Federal Columbia River Power System Action Agencies and four tribes that provides for habitat improvements in the Columbia basin (FCRPS/Three Treaty Tribes MOA 2008; FCRPS/CCT MOA 2008). A recovered spring Chinook population will occupy improved and re-opened habitat that will likely follow implementation and completion of these initiatives. The Wells HCP Tributary and Hatchery committees are managing both the habitat and hatchery programs so that they provide VSP benefits that will trend toward recovery of UCR spring Chinook.

3.5 Ecological Interactions

Potential effects of the Methow Hatchery spring Chinook hatchery program on salmonids and non-salmonids as well as the physical environment, and potential effects of other supplementation programs, natural-origin fish, and other species on this spring Chinook hatchery program, have been evaluated in the NMFS Biological Opinion (2004) and Environmental Assessment (NMFS 2002) for a multi-year authorization for an annual take of UCR spring Chinook salmon and UCR steelhead associated with the spring Chinook supplementation program (Permit 1196). Potential effects from the program are regulated by existing policies regarding hatchery operations, maintenance protocols, fish health practices, genetic effects, ecological interactions, and fish cultural practices, as prescribed in the 1994 Integrated Hatchery Operations Team (IHOT) annual report (IHOT 1995).

3.5.1 Populations that Could Negatively Impact the Program

Juvenile hatchery spring Chinook salmon are liberated as yearling smolts through volitional releases. Because fish are released as yearling smolts, potential predation by both native and non-native predators is thought to be reduced compared to sub-yearling releases.

Fish, mammals, and birds are the primary natural predators of spring Chinook in the Upper Columbia Basin. Several fish species may consume spring Chinook. Northern pikeminnow (*Ptychocheilus oregonensis*), walleyes (*Sander vitreus vitreus*), and smallmouth bass (*Micropterus dolomieu*) have the potential to negatively affect the abundance of juvenile Chinook (Gray and Rondorf 1986; Bennett 1991; Poe et al. 1994; Burley and Poe 1994). Adult salmonids within the Upper Columbia Basin are opportunistic feeders and are therefore capable of preying on juvenile spring Chinook. Those adult salmonids likely to have some affect on the survival of juvenile salmonids include (in order of greatest likely impact), adult bull trout, rainbow trout, cutthroat trout, brook trout, and brown trout..

Predation by piscivorous birds on juvenile salmonids may also represent a large source of mortality. The NMFS (2000) identified gulls (*Larus* spp.), cormorants (*Phalacrocorax* spp.), and Caspian terns (*Sterna caspia*) as the most important avian predators in the Columbia River Basin. In the Columbia River estuary, avian predators consumed an estimated 16.7 million smolts (range, 10-28.3 million smolts), or 18 percent (range, 11 to 30 percent), of the smolts reaching the estuary in 1998 (Collis et al. 2000). Caspian terns consumed primarily salmonids (74 percent of diet mass), followed by double-crested cormorants (*P. auritus*) (21 percent of diet mass) and gulls (8 percent of diet mass).

Predation and delayed mortality for returning adult salmon as a result of wounding by marine mammals may negatively affect spring Chinook salmon. The incidence of wounds noted at Lower Granite Dam during 1991was 20.9 percent for adult spring migrants and 9.4 percent for summer migrant salmon (Park 1993). In 1992, the numbers were 17.4 percent and 7.6 percent, respectively. Although UCR Chinook do not pass Lower Granite Dam, the losses there may be similar to losses experienced by UCR Chinook along their migration route.

Competition and potentially predation could also occur between juvenile spring Chinook and hatchery steelhead that reside in the mainstem Columbia River and in the Methow subbasin. Although the degree of steelhead residualism is unknown, it is thought to average between 5 percent and 10 percent of the number of fish released (USFWS 1994). Competition for food and space with other hatchery released fish (e.g., coho salmon) throughout the Columbia Basin may occur as hatchery spring Chinook rear in the Methow subbasin and migrate downstream through the Columbia River. Indeed, Spaulding et al. (1989) documented a habitat shift by juvenile Chinook in side channels of the Wenatchee River in response to the introduction of juvenile coho. During the feasibility phase of the YN Mid-Columbia Coho Restoration program (YN 2008), the YN completed two predation evaluations of spring Chinook juveniles by hatchery coho juveniles in the Wenatchee subbasin. Methods for both studies were similar and are detailed in Murdoch and LaRue (2002) and Murdoch et al. (2005). The two predation evaluations, both in Nason Creek, estimated predation on spring Chinook at 0.96 percent (95 percent CI 0.12 percent to 3.5 percent) of the total spring Chinook fry population in Nason Creek in 2001 and 0.14 percent (95 percent CI 0.03 percent to 0.4 percent) of the total spring Chinook fry population in Nason Creek, in 2003, respectively. For coho juveniles scattered planted as surrogates of naturally produced coho, the predation rates on spring Chinook fry were nearly double those observed by hatchery coho (Murdoch et al. 2005). This observation could be expected considering the greater temporal overlap of the scatter-planted natural-surrogate coho with newly emerging spring Chinook fry, and the observations by others (Hawkins 2002) that naturally produced coho smolts were more effective predators of Chinook fry than hatchery coho smolts. Predation rates by naturally produced coho juveniles on spring Chinook fry in the Methow or Wenatchee sub-basins cannot be accurately measured until adequate numbers of naturally produced coho become available for study. Nevertheless, using YN estimates of future natural production of coho and available spring Chinook fry in Nason Creek in 2003, and the observed predation rate by natural-surrogate coho in 2003 from Murdoch et al. (2005), calculations of potential consumption rates of natural-origin coho on spring Chinook fry equate to 9.1 percent of estimated spring Chinook fry available in Nason Creek (Kahler 2005).

Both introduced (e.g., walleye and smallmouth bass) and native predators (e.g., northern pikeminnow) consume large numbers of juvenile salmonids as they migrate through the Columbia River system (Poe et al. 1991; Rieman et al. 1991; Tabor et al. 1993). Exacerbating this impact of predation are observations that northern pikeminnow are able to rapidly adjust their diet and foraging habits to key in on the opportunity presented by the release and seaward migration of large numbers of hatchery fish (Shively et al. 1996). Furthermore, pikeminnow predation is typically concentrated downstream of mainstem hydropower facilities where juvenile fish are less dispersed than normal, and potentially disoriented and/or stressed following navigation through the hydro facility. Ongoing programs designed to control the size of predator populations and to redesign juvenile bypass facilities to avoid the aggregation of large numbers of predators below mainstem dams are attempting to minimize the impacts of predation and increase the survival of seaward migrating juvenile salmonids.

3.5.2 Populations that Could be Negatively Impacted by the Program

The potential ecological effects of Methow Hatchery spring Chinook on natural salmonid populations is broken down into three sections: A) effects associated with juvenile releases,

B) effects associated with adult returns, and C) effects associated with both juveniles and adults. Effects to non-salmonid species are unknown at this time, but will be addressed as part of Objective 10 of the Douglas PUD M&E Plan (HCP-HC 2007).

3.5.2.1 Juvenile Releases

Hatchery-origin juvenile spring Chinook from this program can potentially interact with natural-origin spring Chinook and steelhead juveniles. These species are present year round in the UCR mainstem and tributary areas. Natural-origin spring Chinook salmon in the UCR initiate seaward migration as yearling fish between March and June (Chapman et al. 1995). Natural-origin steelhead fry emerge from the gravel in the late spring through August and disperse to downstream rearing areas in the late summer and early fall. UCR steelhead begin seaward migration as age 2+ (43.2 percent) or 3+ (46.4 percent) smolts (Peven 1990) during April and May at an average size of 136 to 188 mm (Chapman et al. 1994).

After initial incubation and rearing on well water at the Methow Hatchery, up to 550,000 (15 fish per pound [fpp]) hatchery-origin yearling juvenile spring Chinook salmon will be acclimated on and released into natal waters: the Methow River (approximately 225,000 Methow/Chewuch composite stock smolts, Rkm 82.1); the Twisp River acclimation pond (up to 100,000 Twisp River stock only, Rkm 10); and the Chewuch River acclimation pond (Rkm 12.9; approximately 225,000 Methow/Chewuch composite smolts). Fish not leaving acclimation ponds volitionally will be forced out in May; historically, it has been seldom necessary to force fish. All fish released will be either externally or internally (or both) marked according to a coordinated marking scheme to be determined by the HCP Hatchery Committees. The target release size of 15 fpp for hatchery-origin spring Chinook yearlings is specified in the Wells HCP and M&E Plan. This target for release size is intended to produce rapidly migrating juveniles that, because of their rapid migration should not compete for resources with naturally produced spring Chinook or other species.

3.5.2.2 Adult Returns

Little is known about interactions between individual stocks of spring Chinook released into the Columbia River system from this hatchery program and other salmonids between the time they leave the estuary and return as adults to spawn. Available information is inferred from CWT data taken from fish harvested from sea. Based on this available data, it is assumed that ocean harvest of upriver spring Chinook will continue to be minimal (2008 – 2017 *US v. OR* Management Agreement) and for practical purposes is assumed to be zero (FCRPS 2008). These data, however, do not give us insight into fish behavior nor inter-specific interactions among stocks in the ocean. However, given the assumed zero harvest of Methow spring Chinook in ocean fisheries, the Methow spring Chinook hatchery program is not a factor in determining ocean harvest regulations and quotas that could affect listed species.

Returning adult hatchery spring Chinook that stray to natural spawning areas may compete for spawning gravel and/or breed with native fish, potentially altering genetic fitness and influencing their ability to survive in the ecosystem. Guidance on acceptable stray rates of hatchery fish is ≤5 percent of total brood return. If one ignores the fact that, due to the chronically low abundance of NORs in the Methow Basin, hatchery-origin spawners are necessary to provide an adequate number of spawners on the spawning grounds, then one might consider that straying of hatchery spring Chinook is a significant problem in the Methow Basin. Despite this reliance in the Methow Basin on hatchery-origin spawners to achieve adequate spawner escapement, strays from out-of-basin hatchery programs are undesirable. Overall, 14.5 percent of the estimated number of hatchery fish spawning in the Methow River basin in 2007 strayed from other independent populations (Entiat, Chiwawa, and Dworshak Hatchery releases). These fish comprised 26.6 percent of the hatchery fish spawning in the Chewuch River basin, and 17.2 percent of those spawning in the upper Methow; no out-of-basin strays were recovered in the Twisp River (Snow et al. 2008). Methow Hatchery stocks have comprised less than 5 percent of the estimated spawning escapement in the Entiat River between run years 1997 to 2006 (Snow et al. 2008).

The concept of within-basin straying in the Methow Basin is controversial because hatchery spring Chinook of Methow/Chewuch-composite origin are assigned arbitrarily to release location, either directly from the Methow Hatchery or from the Chewuch acclimation pond, with the intention that greater than 5% of them will return to the spawning grounds, rather than to the hatchery. Nevertheless, any fish recovered by the hatchery M&E staff is classified as a within-basin stray if it is not within the stream in which it was released, regardless of the origin of its parents or length of acclimation at the release site. According to this practice, of the expanded CWT hatchery fish recovered on Methow Basin spawning grounds in 2007 ($N = 639$), 21.9 percent were classified as strays from the Methow Hatchery. Of the 2001 brood spring Chinook released in the Twisp and Chewuch rivers, greater than 5 percent of the adult returns strayed to non-target spawning areas. Stray rates of Twisp and Chewuch hatchery spring Chinook salmon were high for the 1998 and 2000 broods examined. Releases in both these watersheds were accomplished through the use of acclimation ponds, but both ponds relied on local irrigation withdrawal for their water supply. Stray rates may decrease with a longer acclimation time, but longer acclimation at the current facilities may not be possible without acquisition of ground water to prevent freezing in the ponds (Snow et al. 2008). Annual monitoring and evaluation, as required in the HCP, will be used to direct or assess future hatchery program operations to avoid exceeding the acceptable levels of strays from this hatchery program. Assuming that extended acclimation would translate into reduced straying, the addition of well water to extend the acclimation period for both the Twisp and Chewuch ponds may be necessary; the current 30-day rearing period (if not zero days due to debris or ice) is apparently not adequate to control stray rates from these sub-basins (C. Snow, WDFW, pers. comm.). However, stray rates are not known for natural-origin fish in the Methow Basin; thus, we are uncertain whether or not the rates of straying observed for fish originating from the Methow Hatchery differ from the rates within the natural population.

Potential adverse impacts to steelhead and bull trout during spring Chinook broodstock collection are negligible; WDFW has established specific procedures for handling non-target species to reduce negative effects (NMFS 2002). In addition, impacts to bull trout from the supplementation of spring Chinook are expected to be negligible (NMFS 2002).

3.5.2.3 Both Juveniles and Adults

Negative effects to other species that may result from the Methow Hatchery spring Chinook program could occur from impacts to water quantity and water quality. To limit impacts to water quantity the program complies with water-right permits established for the hatchery to prevent over appropriation of surface water. Hatchery surface water intakes are screened to current criteria. Water quality will be affected by effluent from the hatchery, but the hatchery facility is required to operate under National Pollutant Discharge Elimination System (NPDES) permits issued by Washington Department of Ecology. Hatchery effluent standards and state criteria for point-source discharge are set forth in the permit to protect aquatic life, and the habitat in the area below the discharge point. Considering that the effluent produced from the hatchery facility complies with Environmental Protection Agency standards, coupled with the low percentage of effluent to discharge (dilution factor), there is probably minimal impacts to other species.

Hatchery-raised fish may be a source of pathogen transmission to natural-origin fish in the natural environment. This impact may occur from release sites in headwater spawning and/or rearing areas and throughout the entire migration corridor (BAMP 1998; HCP-HC 2007). Pathogens responsible for diseases are present in both hatchery and natural populations, although hatchery fish are probably more susceptible to disease pathogens because of the high rearing densities and resultant stress. The HCP Hatchery Committee approved broodstock protocols that allow culling of eggs from hatchery-origin females with ELISA OD levels greater than 0.12, and the culling of eggs from natural-origin females with ELISA OD values considered by WDFW Fish Health to be a substantial risk to the program. This action alleviated the capacity constraints associated with the current WDFW BKD rearing strategy and is consistent with Objective 9 of the Hatchery M&E Plan which requires an evaluation of whether management of BKD in the hatchery program lowers the prevalence of BKD in the hatchery environment. It is also consistent with the HSRG recommendations to cull high-ELISA (high BKD) spring Chinook from broodstocks when programs are not broodstock-limited (HSRG 2009). In years where BKD titers do not exceed management thresholds (e.g., >0.12 optical density), culling of excess eggs from hatchery-origin females will be necessary to prevent exceedance of the permitted smolt-production target. Also see Section 9.1.2.

3.5.3 Populations that have a Positive Impact on the Program

Chinook, steelhead, and coho carcasses of both hatchery and natural-origin deposited within the Methow sub-basin are likely to have a positive influence on nutrient levels within the basin. Increased nutrient levels are likely to provide a more productive environment within which the natural-origin and hatchery spring Chinook can rear and migrate. Marine-derived nutrients brought to the Methow Basin by adult spring Chinook should benefit all species there (Stockner 2003).

3.5.4 Populations Positively Impacted by the Program

The Methow Basin native fish assemblage is expected to benefit from nutrients derived from carcasses of returning adult Methow Hatchery spring Chinook at dispersed locations throughout the sub-basin (Stockner 2003). This hatchery program is designed to promote natural spawning of spring Chinook salmon in a more widely dispersed manner (relative to the un-supplemented condition) consistent with available spawning habitat in the Twisp, Chewuch, and upper Methow

River sub-watersheds. The dispersed spawning will likely have a positive effect on bull trout, resident rainbow trout, and westslope cutthroat trout populations scattered throughout the Methow sub-basin because these salmonids will consume salmon eggs, fry, and parr (and flesh from carcasses).

4.0 WATER SOURCE

4.1 Provide a Quantitative and Narrative Description of the Water Source (spring, well, surface), Water Quality Profile, and Natural Limitations to Production Attributable to the Water Source

Methow Hatchery has both groundwater and surface water supplies. The facility was built with four wells capable of producing the full groundwater right of 10 cubic feet per second (cfs) (4,500 gallons per minute [gpm]). Groundwater temperatures are steady at 8.9°C year round. Maintenance on the four wells in 1995 and 1996 revealed that the total output of the wells had declined to 8.8 cfs (4,000 gpm). Thus, a fifth well was added in 1999, and a sixth well in 2007, restoring groundwater production capacity to 4,500 gpm. Methow Hatchery also has senior uninterruptible rights to 7 cfs (3,142 gpm) of surface water and 18 cfs of junior interruptible water rights, both diverted from Foghorn Irrigation Ditch. This water is used primarily for final rearing, but can be used for any rearing stage after incubation. The 7 cfs surface-water right is held by USFWS, but granted to Douglas PUD by USFWS under the terms of a Memorandum of Understanding in exchange for improvements to the intake structure of the Foghorn Ditch plus improvements to the ladder at Foghorn Dam.

Methow Hatchery also has two acclimation ponds: one each on the Twisp and Chewuch rivers. Both ponds are used for final rearing and acclimation of smolts to these drainages. The water right for each pond is 6 cfs during the period of February 1 through May 31. Water for the Twisp Pond is diverted from the Twisp Valley Power and Irrigation Company ditch, and water for the Chewuch Pond is diverted from the Chewuch Canal Company irrigation ditch. The easements from both canal companies are for delivery of water from February 1 through May 1. Neither site is suitable for late-summer rearing because (1) low flow conditions persist in both the Twisp and Chewuch rivers in late summer, and (2) existing water demands on the irrigation ditches would compete with acclimation use.

4.2 Indicate Risk Aversion Measures that will Be Applied to Minimize the Likelihood for the Take of Listed Natural Fish as a Result of Hatchery Water Withdrawal, Screening, or Effluent Discharge

Water withdrawal for use in hatcheries is monitored through the Washington State Department of Ecology and the Washington State chapter 90.03 Revised Code of Washington (RCW) water code. None of the hatchery facilities employed to carry out the proposed artificial propagation programs de-water river reaches used by listed fish for migration, spawning, or rearing. Water intakes into artificial propagation facilities shall be screened in compliance with 1995 NMFS screening criteria and as per the 1996 addendum to those criteria (NMFS 1996). As an alternative, they will comply with transitional criteria set forth by NMFS in 2000 for juvenile fish screens constructed prior to the establishment of the 1995 criteria, to minimize risks to listed salmon and steelhead. WDFW shall inspect and monitor the water intake screen structures at their hatchery facilities to determine if listed salmon and steelhead are being drawn into the facility.

All WDFW hatcheries monitor their discharge in accordance with the NPDES permit. This permit is administered in Washington by the Washington Department of Ecology under agreement with the United States Environmental Protection Agency. The permit was renewed effective June 1, 2005 and will expire June 1, 2010. Hatchery wastewater discharge is monitored monthly at each of the spring Chinook production facilities in the Upper Columbia Basin. The WDFW-operated facilities covered under this permit include Methow Hatchery. No violations of the NPDES permit limits occurred during the reporting period June 1, 2008 through May 31, 2009.

Facilities are exempted from sampling during any month that pounds of fish on hand fall below 20,000 lbs and pounds of feed used fall below 5,000 lbs, with the exception of offline settling basin discharges which are to be monitored once per month when ponds are in use and discharging to receiving waters.

Sampling at permitted facilities includes the following parameters:

FLOW	Measured in millions of gallons per day (MGD) discharge.
SS EFF	Average net settleable solids in the hatchery effluent, measured in milliliters per liter (ml/L).
TSS COMP	Average net total suspended solids, composite sample (6 times per day) of the hatchery effluent, measured in milligrams per liter (mg/L).
TSS MAX	Maximum daily net total suspended solids, composite sample (6 times per day) of the hatchery effluent, measured in mg/L.
SS PA	Maximum settleable solids discharge from the pollution abatement pond, measured in ml/L.
SS %	Removal of settleable solids within the pollution abatement pond from inlet to outlet, measured as a percent. This is no longer required under permit effective June 1, 2000.
TSS PA	Maximum total suspended solids effluent grab from the pollution abatement pond discharge, measured in mg/L.
TSS %	Removal of suspended solids within the pollution abatement pond from inlet to outlet, measured as a percent. This is no longer required under permit effective June 1, 2000.
SS DD	Settleable solids discharged during drawdown for fish release. One sample per pond drawdown, measured in ml/L.
TRC	Total residual chlorine discharge after rearing vessel disinfection and after neutralization with sodium thiosulfate. One sample per disinfection, measured in micrograms per liter (µg/L).

5.0 FACILITIES

5.1 Broodstock Collection Facilities (or methods)

The Methow Hatchery spring Chinook program uses returning spring Chinook adults collected at Wells Dam, weirs located within the Methow Basin, and volitional returns to adult capture facilities, including the Methow Hatchery outflow channel and trap (Methow River at Rkm 82.1); the WNFH volunteer ladder (Methow River at Rkm 81.1), the Twisp River weir and trap (Twisp River at Rkm 10); and the Wells Dam east and west bank fishway traps (Columbia River at Rkm 830). Broodstock may also be collected via hook-and-line angling and seining. (See Section 1.5 for hatchery facility locations and Section 7.2 for more details on broodstock collection.)

5.2 Fish Transportation Equipment (description of pen, tank truck, or container used)

IHOT guidelines for transportation are followed.

Table 5-1. Fish Transportation Equipment.

Equipment Type	Capacity (gallons)	Suppl. Oxygen (Y/N)	Temp. Control (Y/N)	Normal Transit Time (minutes)	Chemical(s) Used	Dosage (ppm)
Truck with Tank	500	Y	N	30-60	MS-222 and NaCl	10 ppm and 0.8% solution
Tanker Truck	800	Y	N	45-90	MS 222 and NaCl	10 ppm and 0.8% solution

5.3 Broodstock Holding and Spawning Facilities

IHOT adult holding guidelines are followed for adult holding, density, water quality, alarm systems and predator control measures to provide the necessary security for the broodstock. Broodstock are held in covered, concrete raceways and adults are seined, sorted, killed and spawned at spawning facilities integrated into the concrete raceways (Table 5-2).

Table 5-2. Broodstock Holding and Spawning Facilities.

Ponds (No.)	Pond Type	Volume (cu. ft)	Length (ft)	Width (ft)	Depth (ft)	Available Flow (gpm)
3	Concrete Raceways	2560	80	8.0	4.0	320

5.4 Incubation Facilities

Methow Hatchery has three separate incubation rooms with 16 Heath stacks per room to accommodate the segregation of progeny from the three primary Methow Basin spawning drainages: Twisp, Chewuch, and upper Methow.

Table 5-3. Incubation Facilities.

Incubator Type	Units (number)	Flow (gpm)	Volume (cu. ft)	Loading-Eyeing (eggs/unit)	Loading-Hatching (eggs/unit)
Iso-Buckets	300	0.5	-	3500-5000	
Heath Vertical Tray Stack Units (8 trays per stack)	48	3-4	-	-	3500-5000

5.5 Rearing Facilities

See Section 5.6 below.

5.6 Acclimation/Release Facilities.

Table 5-4. Acclimation/Release Facilities.

Ponds (No.)	Pond Type	Volume (cu. ft)	Length (ft)	Width (ft)	Depth (ft)	Flow (gpm)	Max. Flow Index	Max. Density Index
24	Intermediate Fiberglass Deep Troughs	112	15	2.5	3.0	20	0.9	0.11
12	Concrete Raceways	2560	80	8.0	4.0	320	0.9	0.11
10	Circular Start Tanks	25	--	4	2	20	0.9	0.11
1	Hypalon-Lined Pond - Methow Acclimation Satellite	28000	175	40	4.0	2700	0.9	0.11
1	Hypalon-Lined Pond - Twisp Acclimation Satellite	28000	175	40	4.0	2700	0.9	0.11
1	Hypalon-Lined Pond - Chewuch Acclimation Satellite	24000	150	40	4.0	2700	0.9	0.11

5.7 Describe Operational Difficulties or Disasters that led to Significant Fish Mortality

During high water in April 2002, a malfunction of a float alarm and/or dialer at the Twisp River acclimation pond prevented a call to the on-duty person, and 80,000 fish were lost. On March 10, 2009, the generator failed to restart a well pump, and the auto dialer failed to call out the alarm. As a result, 8,000 spring Chinook smolts were lost. The auto dialer has since been replaced, and the connection from the generator to the restart controls has been repaired. Additionally, alarm annunciators have been installed in hatchery housing to eliminate dependence on the auto-dialer and phone service.

5.8 Indicate Available Back-Up Systems, and Risk Aversion Measures that will be Applied, that Minimize the Likelihood for the Take of Listed Natural Fish that may Result from Equipment Failure, Water Loss, Flooding, Disease Transmission, or other Events that could Lead to Injury or Mortality

Fish are reared in multiple facilities or with redundant systems to reduce the risk of catastrophic loss. The Methow Hatchery and existing acclimation facilities are sited so as to minimize the risk of catastrophic fish loss from flooding. Water flow alarms monitor flow, and back-up portable pumps are available for short term usage. Staff reside on-station and the facilities are continuously staffed and monitored to assure the security of fish stocks on-site. The programs implement the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and Co-managers 1998) and Pacific Northwest Fish Health Protection Committee (PNFHPC 1989) guidelines to minimize the risk of fish disease amplification and transfer, and to ensure that artificially propagated fish would be released in good health.

To prevent catastrophic mortality or to reduce the preponderance of chronic disease, variance from the smolts-only release requirement may be pursued after agreement of the HCP Hatchery Committees and NMFS. Conditions such as flooding, water loss to raceways, or vandalism may warrant early release into appropriate environments after review by the HCP Committees and NMFS. Any emergency release of UCR spring Chinook salmon would be reported immediately to the NMFS Salmon Recovery Division in Portland, Oregon.

Flow reductions, flooding, and poor fish-culture practices may all cause hatchery facility failure or the catastrophic loss of listed fish under propagation. To protect endangered spring Chinook, all efforts should be made to ensure the survival of adult spring Chinook held for broodstock at the hatchery facility. WDFW, as Douglas PUD's current contract operator of the Methow Hatchery proposes a variety of measures to address risks associated with operation failures, including:

- Staffing hatchery facilities and fish weirs full time during their operation, providing for the protection of fish from vandalism and predation, and allowing for rapid response in the event of power and water loss or freezing;

- Equipping hatchery facilities with back-up generators to provide an alternative source of power to supply water to rearing fish during power outages; Methow Hatchery is equipped with an auto-start backup generator that is tested every week. It is run, under load, for one hour weekly;
- Equipping the operator housing at the Methow Hatchery with alarm annunciators to eliminate dependence on the auto-dialer and phone service during power outages;
- Rearing progeny of low-ELISA females at lower pond-loading densities to minimize the risk of loss due to disease at all facilities where spring Chinook are held; and
- Ensuring staff are adequately trained in proper fish handling, rearing, and biological sampling techniques, and that all activities will be conducted in accordance with the WDFW Fish Health Manual (WDFW 1996) and/or Pacific Northwest Fish Health Protection Committee (PNFHPC 1989) disease prevention and control standards.

6.0 BROODSTOCK ORIGIN AND IDENTITY

6.1 Describe the Origin and Identity of Broodstock Used in the Program, Its ESA-Listing Status, Annual Collection Goals, and Relationship to Natural-Origin Fish of the Same Species/Population

6.1.1 Source

The broodstock selected represents natural populations native or adapted to the watersheds in which hatchery fish will be released. Spring Chinook returning to the Methow River and its major tributaries are used in both the Twisp and Methow/Chewuch program components.

6.1.2 Supporting Information

6.1.2.1 History

Natural-origin spring Chinook broodstock collections began in the early 1990s, generally in 1992 as shown in Table 6-1. Native (natural) Methow spring Chinook were ESA-listed in 1999. In recent years the ability to collect natural-origin adults in each MaSA (Twisp, Methow, Chewuch) has been compromised, particularly by the loss of the Fulton Dam on the lower Chewuch River. The Twisp weir has had periods during which it was not functional due to flood damage; it was rebuilt in 2007-08 restoring full function in the spring of 2008. Currently the collection of natural-origin adults directly from their MaSA of origin is only possible at the Twisp weir; natural-origin fish collected as volunteers to the Methow Hatchery and WNFH outfalls are presumed to be of Methow River origin, but could include adults of Chewuch or Twisp sub-basin parentage as well.

Table 6-1. Collection sites and history for Methow River Basin spring Chinook broodstocks.

Broodstock Source	Origin	Year(s) Used	
		Begin	End
Chewuch River spring Chinook	Natural/hatchery	1992	2007[a]
Twisp River spring Chinook	Natural/hatchery	1992	Ongoing
Methow River spring Chinook (Foghorn Dam)	Natural/hatchery	1993	Ongoing
UCR spring Chinook composite (collected @ Wells Dam) (protocol varies annually as to H:W proportion taken at Wells)	Natural / Hatchery	1996	Ongoing
Methow River spring Chinook composite (Methow, Twisp, & Chewuch hatchery stocks collected @ MSFH outfall)	Natural / Hatchery	1998	Ongoing
Methow River spring Chinook composite (Methow, Twisp, & Chewuch hatchery stocks collected @ WNF Hatchery outfall – gametes given to MSFH)	Hatchery	1998	Ongoing

[a]Upkeep of the Fulton rock weir was terminated in 2007, and the weir was replaced with a "roughened channel" to facilitate fish passage at the Fulton diversion.

Besides collection at the Twisp Weir, the ladder traps at Wells Dam are used to collect broodstock to support the genetically distinct Twisp component of the program. Twisp-origin fish are differentiated from Methow/Chewuch fish using genetic analysis.

Natural-origin adults collected at the upper-basin hatchery outfalls or by other methods currently are a mixture of progeny of earlier collections that included natural-origin fish that could have been derived from either the Methow or Chewuch MaSAs. Until collection capability is established in the Chewuch and Methow rivers (e.g., at the Foghorn diversion or Chewuch Dam), the MaSA of origin for natural-origin adults collected in those rivers will be unknown, and likely a mixture of Methow and Chewuch origins.

Adipose fin clipping has not been performed on 100% of the smolts from the Methow and Winthrop Nation Fish hatcheries. Therefore, it is not yet possible to distinguish the origin of returning Methow/Chewuch hatchery adults at Wells Dam or Twisp weir.

6.1.2.2 Annual Size

Broodstock numbers have been limited by low run sizes and the requirement that natural-origin fish compose at least 30 percent of the broodstock, but no greater than 33 percent of the natural-origin run to any tributary sub-population can be taken for broodstock. Under the current 550,000 smolt program, up to 360 fish will be collected for broodstock, with up to 64 of those Twisp-origin fish for the Twisp River component. Historic broodstock collection is summarized in Table 6-2. The sex ratio of broodstock is expected to be close to 1:1.

Table 6-2. Numbers of wild and hatchery spring Chinook collected for Methow Basin program broodstock, numbers that died before spawning, and numbers of spring Chinook spawned, 1994-2005. Unknown origin fish (i.e., undetermined by scale analysis; no elastomer, CWT, or fin clips; and no external evidence of hatchery residence) were considered naturally produced (in part from Snow et al. 2008).

Brood year	Wild spring Chinook					Hatchery spring Chinook					Total number spawned
	Number collected[1]	Pre-spawn loss	Mortality[2]	Number spawned	Number Not Used	Number collected[1]	Pre-spawn loss	Mortality[2]	Number spawned	Number Not Used	
1994	16	0	0	16	0	2	0	0	2	0	18
1995	0	0	0	0	0	11	0	0	11	0	11
1996	117	0	0	117	0	95	4	0	86	5	203
1997	12	0	0	12	0	272	0	0	270	2	282
1998	94	0	0	94	0	88	2	0	79	7	173
1999	49	0	0	49	0	141	14	0	115	12	164
2000	6	0	0	6	0	339	23	0	306	10	312
2001	52	2	0	49	1	357	10	0	228	119	277
2002	0	0	0	0	0	438	21	0	367	50	367
2003	42	1	0	41	0	218	9	0	166	43	207
2004	50	5	0	45	0	304	4	0	299	1	344
2005	9	0	0	9	0	281	2	0	265	14	274
2006	9	1	0	8	0	342	13	0	320	9	328
2007	23	0	0	23	0	204	2	0	169	33	192
2008	56	2	0	52	2	327	4	0	308	15	360
Avg.	***36***	***1***	***0***	***35***	***0.2***	***228***	***7***	***0***	***199***	***21***	***234***

[1]The sum of broodstock collected at all sites.
[2]Mortality includes fish that died of natural causes typically near the end of spawning and were not needed for the program or were immature fish killed at spawning.

6.1.2.3 Past and Proposed Level of Natural Fish in Broodstock

Based on CWT and scale analysis on Brood Years 1994 through 2005, 15.9 percent of the 1,581 spring Chinook trapped for the Methow basin program were natural-origin, and 84.1 percent were hatchery-origin (Snow et al. 2008). Annual broodstock contribution from natural-origin fish ranged from 0 to 58 percent during this period. See Section 1.8.2.1 and 1.11.1 for proposed broodstock composition. See Table 6-2 for the historical natural and hatchery composition of past overall combined broodstock collections. For the proposed program, natural-origin fish may comprise 100% of the hatchery broodstock, provided that collection of NORs for broodstock does not exceed 33% of the NORs to the Methow Basin. Specifically for the Twisp component of the program, pNOB will be ≥ 0.5 and extraction of natural-origin broodstock will not exceed 33% of the NOSs above the Twisp weir, with production floating according to the available number of NOSs above the Twisp Weir.

6.1.2.4 Genetic or Ecological Differences

Small et al. (2007) provide a recent review of the genetic characteristics of Methow River basin spring Chinook. Fish samples from 1992 through 2006 were obtained from the Winthrop NFH, and both natural and hatchery-origin fish from the Methow, Twisp, and Chewuch Rivers. Twisp hatchery and natural-origin collections formed a discrete group distinct from a Methow-Chewuch-WNFH group. Methow River fish were very similar to the WNFH collections, and also differentiated from Chewuch River fish collected in 1992-93. The Methow and Chewuch Rivers fish became more similar after developing the broodstock that combines the Methow and Chewuch River fish. Assignment tests indicated that if natural-origin fish were collected at Wells Dam for broodstock and assigned with a moderate probability threshold (10 times more likely to have come from one collection as from another), there is low risk of incorrectly identifying a Methow-Chewuch fish as a Twisp fish, and even lower risk of incorrectly identifying a Twisp fish as a Methow-Chewuch fish.

In addition to genetic similarity, the broodstocks chosen display morphological and life history traits similar to the natural populations.

The annual adult broodstock collection protocol is keyed on target numbers at various collection sites, currently operated by WDFW, that provide broodstock for Mid-Columbia PUD mitigation program facilities. This adult broodstock collection protocol is an interim and dynamic hatchery broodstock collection plan, which may be altered following HCP Hatchery Committee discussions. As such, there may be significant in-season changes in broodstock numbers, locations, or collection times, brought about through continuing co-manager consultation and in-season monitoring of the anadromous fish runs to the Columbia River above Priest Rapids Dam. Depending on the TAC forecast for UCR spring Chinook, collection protocols will target specific populations of fish in the Methow Basin through broodstock collections in tributary locations in addition to collections at Wells Dam.

Consistent with the BAMP (1998), the draft Biological Opinion released by NMFS and the NWPPC Methow River Sub-basin Summary, broodstock will be collected in a manner that reduces the possibilities of collecting Winthrop NFH Carson-lineage fish to be consistent with the development of local tributary attributes. Recent Methow spring Chinook broodstock collections have occurred at Wells Dam, Twisp River weir, Methow Hatchery, and Winthrop NFH. Limited on-station release of smolts from the Methow Hatchery, absence of a trapping facility on the Chewuch River, and poor trapping success at Foghorn Dam on the mainstem Methow River reduce reasonable certainty of meeting adult collection requirements via tributary and Methow Hatchery outfall collections. The aforementioned limitations are the principle reasons for the inclusion of broodstock collection at Wells Dam and Winthrop NFH.

6.1.2.5 Reasons for Choosing

The goal of the program is to rebuild and recover listed UCR Spring Chinook in the Methow River basin. Multiple sub-basins have contributed to the UCR Spring Chinook genetic makeup. The sources for collection at the Twisp and Methow Rivers provide broodstock from distinguishable stocks for rebuilding and recovery of the listed UCR Spring Chinook in the Methow.

6.2 Indicate Risk Aversion Measures that will be Applied to Minimize the Likelihood for Adverse Genetic or Ecological Effects to Listed Natural Fish that may Occur as a Result of Broodstock Selection Practices

The broodstock protocols were designed to mitigate for potential genetic effects from hatchery domestication and to avoid introgression with fish from other spawning aggregates.

7.0 BROODSTOCK COLLECTION

7.1 Life-history Stage to be Collected (adults, eggs, or juveniles)

Adults are trapped at a number of locations in the Methow system; see Sections 1.8.2.1, 1.11.1, and 2.2.3 and below. Primary collection locations are Wells Dam, Methow Hatchery outfall, WNFH volunteer ladder, and the Twisp River weir.

7.2 Collection or Sampling Design

7.2.1 General Broodstock Collection Methods

Methow spring Chinook broodstock collection will generally occur at Wells Dam fishways, the Twisp River weir, and the Methow Hatchery and Winthrop NFH outfalls. Limited on-station release of smolts from the Methow Hatchery, absence of a trapping facility on the Chewuch River, and poor trapping success at Foghorn Dam on the mainstem Methow River reduce reasonable certainty of meeting adult collection requirements via tributary and Methow Hatchery outfall collections. The aforementioned limitations are the principle reasons for the inclusion of broodstock collection at Wells Dam and Winthrop NFH as a general practice.

Inclusion of natural-origin fish into the broodstock will be a priority, with natural-origin fish specifically targeted. Natural-origin fish collections will not exceed 33 percent of the Methow Basin NOR escapement to Wells Dam, and ideally should not exceed 33 percent of the NOS escapement to the either the Methow Basin or Twisp River, respectively. Recent WDFW genetic assessment of natural-origin Methow spring Chinook (Small et al. 2007) indicates that Twisp natural-origin spring Chinook can be identified with sufficient confidence that natural-origin collections can occur at Wells Dam, thereby facilitating natural-origin inclusion in the broodstock, while maintaining the ability to manage separately the Twisp origin spring Chinook spawning aggregate. Although Twisp natural-origin fish can be assigned to the Twisp population with confidence, some gene flow between the Twisp and Methow/Chewuch composite spawning aggregates are anticipated as a result of collecting natural-origin broodstock at Wells Dam.

Trapping at Wells Dam generally occurs at the east and west ladder traps beginning in early May, or at such time as the first spring Chinook are observed passing Wells Dam, and continues through about the third week of June. Access to the east ladder trap must be coordinated with staff at Wells Dam due to a rotor-rewind project continuing through approximately 2018. The trapping schedule consists of 3 days/week (Monday-Wednesday), and up to 16 hours/day. Two of the three trapping days will be concurrent with the stock-assessment sampling activities authorized through the 2010 Douglas PUD Hatchery M&E Implementation Plan (and as revised in the future by the HCP Hatchery Committee). Natural-origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quotas). Once the weekly quota target is reached, broodstock collection will cease until the beginning of the next week. If a shortfall occurs in the weekly trapping quota, the shortfall will carry forward to the collection quota for the following week. All natural-origin spring Chinook collected at Wells Dam for broodstock will be held at the Methow Hatchery.

To meet Methow Hatchery broodstock collection needs for hatchery-origin Methow/Chewuch composite and Twisp River stocks, adipose-present CWT hatchery fish (future marking schemes will also facilitate differentiation by program and release location) are generally collected at Methow Hatchery, Winthrop NFH and the Twisp River weir beginning in May, or at such time as spring Chinook arrive at those locations, and continuing through about the third week of August. Natural-origin spring Chinook are retained from the Twisp weir as necessary to bolster the Twisp program production so long as the aggregate collection at Wells Dam and Twisp River weir does not exceed 33 percent of the estimated Twisp River NORs past Wells Dam. All hatchery and natural-origin fish collected at Methow Hatchery, Twisp Weir and Winthrop NFH for broodstock will be held at the Methow Hatchery.

7.2.2 Genetic Issues

Based on the projected proportion of natural-origin broodstock (pNOB) composition for Twisp and Methow/Chewuch composite programs (31 percent and 30 percent, respectively for the 2009 brood year) and composite brood year assignment errors for natural-origin Twisp and Methow/Chewuch composite spring Chinook provided in Snow et al. (2007), the projected non-source fish contributions to the Twisp and Methow/Chewuch composite hatchery programs are 1.6 percent and 1.5 percent, respectively in 2009. In this instance, percent non-source fish contribution may be considered a gene flow estimate between the two program production elements (Twisp and Methow/Chewuch composite) and is an unavoidable consequence associated with natural-origin broodstock collection at Wells Dam. Although gene flow between the two hatchery production components is likely, it is expected to be relatively low in most years, and supports an objective of the hatchery broodstock collection program to infuse natural-origin fish into the hatchery program to maintain/improve genetic diversity and reduced domestication. For a more complete discussion regarding Methow spring Chinook genetic monitoring and evaluation, see Snow et al. (2007).

Non-lethal tissue samples (fin clips) for genetic analysis and scale samples will be obtained from adipose present, non-CWT, non-ventral clipped spring Chinook (suspected natural-origin spring Chinook) collected at Wells Dam for origin analysis. Natural-origin fish retained for broodstock will be tagged with a PIT tag (dorsal sinus) for cross-referencing with tissue sample/genetic analysis. Tissue samples will be preserved and sent to WDFW genetics lab in Olympia Washington (or other genetics lab approved by the HCP Hatchery Committee) for genetic/stock analysis. The spring Chinook sampled will be retained at Methow Hatchery and will be sorted as Twisp or non-Twisp natural-origin fish prior to spawning. The number of natural-origin Twisp and Methow/Chewuch composite (non-Twisp) spring Chinook retained will be dependent upon the number of natural-origin adults returning and the collection objective limiting extraction to no greater than 33 percent of the natural-origin spring Chinook return past Wells Dam. Based on the broodstock collection schedule (3-day/week, 16 hours/day at Wells Dam), natural-origin spring Chinook extraction is expected to be approximately 33 percent or less of the spring Chinook passing Wells Dam.

7.2.3 Run-Size Adjustment

Weekly estimates of passage of natural-origin spring Chinook past Wells Dam will be provided through stock assessment and broodstock collection activities, and will provide the opportunity to adjust, in-season, the extraction of natural-origin spring Chinook to maintain no greater than 33 percent extraction of Twisp and Methow/Chewuch composite natural-origin components, while maximizing the opportunity for the inclusion of natural-origin spring Chinook in the broodstock. In additional, in-season estimates of Twisp and Methow/Chewuch composite natural-origin escapement past Wells Dam provides the opportunity to utilize both Wells Dam and the Twisp River weir as natural-origin collection sites for the Twisp production component, thereby providing additional flexibility to account for differences between projected and actual returns of Twisp and Methow/Chewuch composite natural-origin fish. Twisp and Methow/Chewuch composite hatchery-origin spring Chinook will be captured at the Twisp weir and the Methow Hatchery outfall. Trapping at the Winthrop NFH will also provide broodstock for the Methow Hatchery program. Likewise, excess Methow Hatchery-origin returns to the Methow Hatchery will be provided to the WNFH for their use as broodstock, until their broodstock needs are met (WNFH target for Methow Hatchery fish is 20%-30% of 360 adults).

The Methow Hatchery rears spring Chinook salmon for three acclimation/release sites in the Methow River Basin, including: (1) Methow River (Methow Hatchery); (2) Twisp River (Twisp acclimation pond); and (3) Chewuch River (Chewuch acclimation pond). The total production target is up to 550,000 smolts divided as follows: 225,000 each in the Methow and Chewuch releases, and up to 100,000 in the Twisp River release. Reductions in the Twisp production resulting from insufficient NORs to the Twisp River may preclude the achievement of the 100,000-smolt production target. In such cases, there may be increases in the production numbers in the Methow and/or Chewuch rivers commensurate with the shortfall in Twisp production. The Chewuch acclimation pond and Methow Hatchery releases will typically include progeny of broodstock identified as natural non-Twisp origin, and known Methow/Chewuch composite hatchery-origin fish (WxH), but may utilize HxH crosses of Methow/Chewuch composite fish.

7.2.4 Broodstock Collection Biocriteria

Methow Hatchery spring Chinook program assumptions:

Production Objective:	550,000 yearling smolts, at 30g/fish
Propagation survival:	90 percent fertilization to release
Fecundity:	4,000 eggs/female
Sex ratio:	1: 1
Pre-spawn survival	95 percent
ELISA cull rate	12 percent
Maximum broodstock required	360

7.3 Identity

For hatchery-origin fish, CWTs are read prior to fertilization to determine origin and to facilitate genetic crossing at the hatchery. Non-lethal tissue samples (fin clips) for genetic analysis and scale samples will be obtained from adipose present, non-CWT, non-ventral clipped spring Chinook (suspected natural-origin spring Chinook) collected at Wells Dam for origin analysis. Natural-origin fish retained for broodstock will be tagged with a PIT tag (dorsal sinus) for cross-referencing with tissue sample/genetic analysis. Tissue samples will be preserved and sent to WDFW genetics lab in Olympia Washington for genetic/stock analysis. The spring Chinook sampled will be retained at Methow Hatchery and will be sorted as Twisp or non-Twisp natural-origin fish prior to spawning. Ongoing broodstock collections will be made at the Twisp River weir, and hook-and-line or seining collections of natural-origin adults in selected areas of the Methow and Chewuch Rivers, and natural-origin fish obtained from these efforts will be assumed to originate from those terminal locations. The 2008 Methow hatchery broodstock was comprised of 78.3% known ESA-listed, hatchery-origin, UCR spring Chinook; 7.1% unknown hatchery-origin spring Chinook; and 14.6 percent natural-origin ESA-listed UCR spring Chinook.

7.4 Proposed Number to be Collected

7.4.1 Program Goal (assuming 1:1 sex ratio for adults)

The Methow Hatchery spring Chinook program requires up to 360 adults, which includes collection of additional fish (up to 12-percent over-collection) to facilitate achievement of production targets while culling of gametes from high-ELISA hatchery-origin females for BKD control. See Section 1.8.2.1 for a more thorough discussion of over-collection for BKD management.

7.4.2 Broodstock Collection Levels for the Last Twelve Years (e.g., 1988-99), or for Most Recent Years Available

Table 7-1. Natural and hatchery-origin broodstock collected at Methow River basin traps, brood years 1992-2008.

Brood Year	Chewuch River		Methow River		Twisp River	
	Naturals	Hatchery	Naturals	Hatchery	Naturals	Hatchery
1992	25	5	0	0	20	0
1993	91	9	26	55	30	1
1994	11	1	0	1	5	0
1995	0	0	0	11	0	0
1996	21	45	74	25	22	25
1997	1	66	11	191	0	15
1998	0	0	93	77	1	11
1999	0	0	33	117	16	24
2000	0	0	0	276	6	63
2001	18	73	0	250	34	34
2002	0	126	0	297	0	15
2003	2	60	0	126	40	32
2004	1	134	0	145	49	25
2005	2	134	0	130	7	17
2006	1	125	8	189	0	28
2007	0	0	19	168	4	36
2008	0	0	44	296	12	31

7.5 Disposition of Hatchery-origin Fish Collected Surplus to Broodstock Needs

See Section 7.4, depending on annual returns. The level of fish collected has been determined by the WDFW and the HCP Hatchery Committees. Adult and jack endangered UCR spring Chinook salmon not retained for broodstock are released unharmed above the respective trapping facility for natural spawning immediately after being enumerated.

7.6 Fish Transportation and Holding Methods and Holding of Fish, Especially if Captured Unripe or as Juveniles. Include Length of Time in Transit

Table 7-2. Fish Transportation Equipment.

Equipment Type	Capacity (gallons)	Suppl. Oxygen (Y/N)	Temp. Control (Y/N)	Normal Transit Time (minutes)	Chemical(s) Used	Dosage (ppm)
Truck with Tank	300	Y	N		MS-222 and NaCl	10 ppm and 0.8% solution
Tanker Truck	700	Y	N		MS 222 and NaCl	10 ppm and 0.8% solution

Table 7-3. **Broodstock Holding and Spawning Facilities.**

Ponds (No.)	Pond Type	Volume (cu. ft)	Length (ft)	Width (ft)	Depth (ft)	Available Flow (gpm)
3	Concrete Raceways	2560	80	8.0	4.0	320

7.7 Describe Fish Health Maintenance and Sanitation Procedures Applied

For all production programs under the Mid-Columbia Hatchery Program, standard fish-health monitoring will be conducted (monthly checks of salmon and steelhead) by fish-health specialist, with intensified efforts to monitor presence of specific pathogens that are known to occur in the donor populations. Significant fish mortality attributed to an unknown cause(s) will be sampled for histopathological study. Fish-health maintenance strategies are described in IHOT (1995). Incidence of viral pathogens in salmon and steelhead broodstock will be determined by sampling fish at spawning in accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Populations of particular concern may be sampled at the 100-percent level and may require segregation of eggs/progeny in early incubation or rearing, and/or culling. Specifically, incidence of *Renibacterium salmoninarum* (Rs, causative agent of BKD) in salmon broodstock will be determined by sampling fish at spawning by ELISA. Hatchery staff will segregate eggs/progeny based on levels of Rs antigen, protecting negative or low-ELISA progeny from the potential horizontal transmission of Rs bacteria from high-ELISA progeny. Progeny of any segregation study will also be tested by ELISA; at a minimum each segregation group would be sampled at release. Necropsy-based condition assessments (based on organosomatic indices) will be used to assess condition of hatchery-reared salmon smolts at release, and natural-origin salmon during outmigration. If needed, condition assessments will be performed at other key times during hatchery rearing.

7.8 Disposition of Carcasses

IHOT, PNFHPC, state or tribal guidelines are followed for broodstock fish health inspection, transfer of eggs or adults and broodstock holding and disposal of carcasses. Carcasses of the ESA-listed fish spawned in captivity may be outplanted in the Methow River watershed for nutrient enrichment if disease protocols as determined by the co-managers fish-health specialists are met, donated for educational purposes, incinerated, buried on-station after completion of spawning or disposed of at waste disposal facilities.

7.9 Indicate Risk Aversion Measures that will be Applied to Minimize the Likelihood for Adverse Genetic or Ecological Effects to Listed Natural Fish Resulting from the Broodstock Collection Program

In an effort to minimize adverse impacts to ESA-listed spring Chinook and ESA-listed UCR steelhead, WDFW trapping locations, dates and frequency are consistent with the Year 2009 UCR Salmon and Steelhead Broodstock Objectives and Site-Based Broodstock Collection Protocols (and future annual broodstock collection protocols). Adult Chinook are trapped and transferred to Methow Hatchery. Holding facilities at Methow Hatchery include covered raceways and surface water spray to minimize disturbance, provide shade, and reduce jumping by adults. Traps are checked at least once daily and no out-of-water transfers occur during transfer from trap site to holding sites. Twisp weir trapping includes on-site security to minimize potential impact to steelhead kelts, bull trout, and spring Chinook. While trapping and handling procedures for adult Chinook are implemented to minimize potential adverse affects to listed stocks, some mortality could occur.

If water temperatures at adult trapping sites exceed 69.8°F (21°C), trapping will cease pending further consultation with NMFS to determine if continued trap operations poses substantial risk to ESA-listed species.

8.0 MATING

8.1 Describe Fish Mating Procedures that will be Used, including those Applied to Meet Performance Indicators Identified Previously

8.1.1 Selection Method

All males and females collected for broodstock will be examined weekly during the spawning season to determine ripeness, and all fish will be spawned when ripe. Spawning activities for ESA-listed spring Chinook retained from the Methow basin will normally occur from mid-August to mid-September. *In-situ* stock separation of ESA-listed spring Chinook, Carson origin, and out-of basin stray fish is accomplished through scale sample and CWT analysis; only natural-origin and Methow Hatchery origin adults will be spawned. Only WxW and HxW parental crosses will be made (no HxH crosses) for the Twisp component; though not preferred, some HxH crosses may be necessary for the Methow/Chewuch component in some years with very low escapement.

8.1.2 Males

Males may be live-spawned on the first spawning day as necessary to make up for a naturally occurring low male-to-female ratio. However, inclusion of jack Chinook in the run-at-large broodstock collections helps to alleviate occasional low adult-male occurrence.

Jacks are collected in similar proportion to the run-at-large. Inclusion of about 10 percent jack Chinook in the broodstock collections helps to alleviate occasional low adult male occurrence. The hatchery broodstock remains genetically similar to, and representative of the spring Chinook populations. Back-up males are used in the spawning protocol.

8.1.3 Fertilization

Spawning protocols reflect the need to maintain genetic diversity of the separate summer Chinook populations. A 1:1 spawning ratio is employed, and each female's eggs are divided into two buckets (a and b) and each bucket is fertilized with a separate male. Thus, when two females are spawned with two males, four separate genetic crosses result: female 1a x male1; female 1b x male2; female 2a x male 1; female 2b x male2. In some cases, not enough females, males, or fish of the necessary stock/origin are available on an individual spawn day, and a standard one-male-to-one-female strategy is employed. After fertilization, the eggs are combined and incubated as individual female lots.

8.1.4 Cryopreserved gametes

Cryopreserved gametes are not used.

8.2 Indicate Risk Aversion Measures that will be Applied to Minimize the Likelihood for Adverse Genetic or Ecological Effects to Listed Natural Fish Resulting from the Mating Scheme

- A 1:1 mating scheme is employed.
- Collect jacks in similar proportion to the run-at-large. Inclusion of jack Chinook in the run-at-large broodstock collections helps to alleviate occasional low adult male occurrence. The hatchery broodstock remains genetically similar to, and representative of, the up-river spring Chinook populations.
- Fish health procedures used for disease prevention include biological sampling of spawners. Generally, kidney/spleen samples are collected from all female spawners to test for the presence of viral pathogens. The ELISA is conducted on kidney samples from all females. This assay detects the antigen for Renibacterium salmoninarium, the causative agent of BKD.

9.0 INCUBATION AND REARING

9.1 Specify any Management Goals (e.g., "egg to smolt survival") that the Hatchery is Currently Operating under for the Hatchery Stock in the Appropriate Sections Below. Provide Data on the Success of Meeting the Desired Hatchery Goals

9.1.1 Incubation

9.1.1.1 Number of Eggs Taken and Survival Rates to Eye-up and/or Ponding.

Egg-take goals will vary annually dependent upon the necessary level of over-collection for BKD management. Currently, over-collection rate is determined annually based on the average of high-titer (ELISA OD $\geq$ 0.12) females from the previous five brood years; for 2009, the over-collection rate was 12 percent. Using the 12-percent over-collection rate, egg-take goals are estimated at approximately 280,000 each for the Chewuch and Methow Rivers, and approximately 124,000 for the Twisp River.

Table 9-1. Hatchery life stage survival rate standards and level achieved (%) by stock and brood year for Met-Comp spring Chinook, brood years 1999-2008. Standards are in parentheses.

Brood Year	Unfertilized egg to eyed (92.0)	Eyed egg to ponding (98.0)	30 d after ponding (97.0)	100 d after ponding (93.0)	Ponding to release (90.0)	Transport to release (95.0)	Unfertilized egg to release (81.0)
1999	95.4	100.0	99.5	99.5	99.2	---	94.6
2000	96.5	100.0	99.6	99.4	99.0	99.9	92.7
2001	93.2	100.0	99.3	99.1	97.0	99.8	90.8
2002	96.0	100.0	98.6	98.6	96.5	98.5	92.7
2003	90.0	100.0	98.8	98.3	93.0	99.8	77.9
2004	94.8	96.2	99.2	99.2	96.6	99.8	84.6
2005	96.9	96.9	99.6	99.5	90.4	99.6	87.7
2006	93.9	95.0	89.4	89.4	76.5	96.2	68.2
2007	92.9	94.8	99.6	99.3	95.7	99.1	84.2

Table 9-2. Hatchery life stage survival rate standards and level achieved (%) by stock and brood year for Twisp River spring Chinook, brood years 1999-2008.

Brood Year	Unfertilized egg to eyed (92.0)	Eyed egg to ponding (98.0)	30 d after ponding (97.0)	100 d after ponding (93.0)	Ponding to release (90.0)	Transport to release (95.0)	Unfertilized egg to release (81.0)
1999	94.2	100.0	99.5	99.5	98.0	99.7	92.3
2000	97.1	100.0	99.6	99.5	48.0	23.9	46.6
2001	90.1	100.0	98.8	95.2	90.1	100.0	81.2
2002	97.9	100.0	99.3	99.1	98.5	99.9	96.4
2003	91.8	99.8	99.2	98.6	95.9	100.0	86.4
2004	95.4	97.8	99.1	98.8	78.7	99.5	73.3
2005	95.7	98.2	99.6	99.5	99.2	99.9	93.2
2006	95.9	99.6	99.7	99.6	94.6	99.7	90.4
2007	92.4	95.4	99.5	98.8	89.1	99.7	78.6

9.1.1.2 Cause for, and Disposition of Surplus Egg Takes

Permit conditions specify a maximum number of broodstock that can be collected as determined by expected pre-spawning survival of broodstock, fecundity, and survival-to-release of progeny. To facilitate achievement of the production target of 550,000 smolts while anticipating the need to cull progeny of high-ELISA females, annual protocols for broodstock collection include collection of up to 12-percent additional broodstock above that necessary for the production target. Given the deliberate over-collection for BKD management, culling of hatchery-origin eggs may occur as required to manage BKD and/or maintain production at no more than 550,000 yearling smolts. Under any circumstances, culling will be selective for hatchery-origin egg lots with the highest ELISA OD values. Culling of eggs from natural-origin females will not occur unless their ELISA levels are determined by WDFW Fish Health to be a substantial risk to the program.

9.1.1.3 Loading Densities Applied During Incubation

IHOT species-specific incubation recommendations will be followed for water quality, flows, temperature, substrate, and incubator capacities. Fertilized eggs from each female are incubated in individual iso-buckets to the eyed-egg stage to segregate for ELISA (BKD) values, and are then transferred to Heath stack incubators, with the progeny of one female per Heath tray (approximately 4,000 eggs/tray). Incubation conditions are based on loading densities recommended by Piper et al. (1982).

9.1.1.4 Incubation Conditions

Eggs are incubated full-term (green egg to emergence) at the Methow Hatchery.

9.1.1.5 Ponding

Spring Chinook fry are transferred from Heath trays for ponding upon button-up and swim-up. Ponding generally occurs after the accumulation of 1,650 to 1,750 temperature units. Unfed fry are transferred to the rearing ponds from early May through early June. The normal weight for fry initially ponded at the Methow Hatchery for brood years 1989-95 was 0.45 grams (1000 fish per pound). The fry fork length recorded for the same brood years was 36 to 40 mm. More recently fry have been ponded at between 1200 and 3000/lb.

9.1.1.6 Fish Health Maintenance and Monitoring

Eggs are examined daily by hatchery personnel. Prophylactic treatment of eggs for the control of fungus is prescribed by fish-health specialists, and may include treatment with formalin or other accepted fungicides. Non-viable eggs and sac-fry are removed by bulb-syringe. Adherence to WDFW, Pacific Northwest Fish Health Protection Committee, and IHOT (1995) fish disease-control policies reduces the incidence of diseases in fish produced and released from the Methow Hatchery. All lots are monitored for BKD; no eggs will be retained from hatchery-origin females with ELISA OD values ≥ 0.12. Culling of eggs from natural-origin females will not occur, unless their ELISA levels are determined by WDFW Fish Health to be a substantial risk to the program. Juveniles from natural-origin females with ELISA levels ≥ 0.12 will be differentially tagged for evaluation purposes. If the program is under the 550,000 goal some low-ELISA fish may be reared at lower densities.

9.1.1.7 Indicate Risk Aversion Measures that will be Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish During Incubation

All eggs brought to the facility will be surface-disinfected with iodophor (as per disease policy). All equipment (nets tank and rain gear) is disinfected with iodophor between different fish/egg lots. Different fish/egg lots will be physically isolated from each other by separate ponds or incubation units. The intent of these activities is to prevent the horizontal spread of pathogens by splashing water. Tank trucks are disinfected between the hauling of different fish lots. Foot baths containing iodophor are strategically located on the hatchery grounds (i.e., entrance to “clean” or isolated areas of the incubation room) to prevent spread of pathogens. Formalin drips are applied to prevent fungal spread from dead eggs. Flow, D.O. and temperature units (TU) are monitored per IHOT or program guidelines.

Regarding BKD, the following will occur:

- Hatchery-origin eggs/progeny with high ELISA titers (O.D. ≥ 0.12) will be culled.
-
- Wild-origin eggs/progeny with high ELISA titers (O.D. ≥ 0.12) will be raised at lower density of 0.06.
-
- Culling very high titer progeny: All hatchery- and natural-origin eggs/progeny with very high ELISA titers (O.D. >0.19) will be culled from the program.
-
- At the first signs of infection with BKD, juvenile spring Chinook will be treated with orally administered erythromycin (100 mg/kg fish) for 28 days. The treatment should be repeated if there is evidence that the BKD agent has persisted in the hatchlings.

9.1.2 Rearing

9.1.2.1 Provide Survival Rate Data (average program performance) by Hatchery Life Stage (fry to fingerling; fingerling to smolt) for the Most Recent Twelve Years (1988-99), or for Years Dependable Data are Available

Tables are provided in Section 9.1.1.1.

9.1.2.2 Density and Loading Criteria (goals and actual levels)

Include density targets (lbs fish/gpm, lbs fish/ft3 rearing volume, etc).

The following table represents current density and loading criteria. The HCP Hatchery Committee may adjust criteria as deemed necessary.

Table 9-3. Density and fish loading criteria for spring Chinook.

Rearing Criteria	**Spring Chinook**	
Rearing Criteria	ELISA ≤0.119[1]	ELISA ≥0.12
Density index (lbs/cf-in)	0.12	0.06
Flow index (lbs/gpm-in)	0.75	0.60
Acclimation Criteria		
Density index (lbs/cf-in)	0.10	0.06
Flow index (lbs/gpm-in)	1.00	0.60

[1] The 0.119 threshold was developed jointly by the USFWS and WDFW. Fish with an ELISA >0.19 will be culled.

9.1.2.3 Fish Rearing Conditions

Fish are reared on a combination of well and river water. Methow River water is added beginning in late November. Rearing is on 100 percent river water by late February prior to transfer of pre-smolts to acclimation ponds. Temperature, dissolved oxygen and pond turnover rate are monitored. IHOT standards are followed for: water quality, alarm systems, predator control measures (netting) to provide the necessary security for the cultured stock, loading and density. Settleable solids, unused feed and feces are removed regularly to ensure proper cleanliness of rearing containers. All ponds are vacuumed weekly for the yearlings. Ponds are pressure washed between broods. Temperature and dissolved oxygen are monitored and recorded daily during fish rearing. Temperatures during the rearing cycle range from a high of 55°F to a low of 33°F.

9.1.2.4 Indicate Biweekly or Monthly Fish Growth Information (average program performance), including Length, Weight, and Condition Factor Data Collected During Rearing, if Available

These data are not collected monthly at the Methow Hatchery.

9.1.2.5 Indicate Monthly Fish Growth Rate and Energy Reserve Data (average program performance), if Available

These data are unavailable at the Methow Hatchery.

9.1.2.6 Indicate Food Type Used, Daily Application Schedule, Feeding Rate Range (e.g., % B.W./Day and Lbs/Gpm Inflow), and Estimates of Total Food Conversion Efficiency During Rearing (average program performance)

Table 9-4. Food Type Information.

Rearing Period	Food Type	Application Schedule (#feedings/day)	Feeding Rate Range (%B.W./day)	Lbs. Fed Per gpm of Inflow	Food Conversion During Period
December-January	BioDiet Starter	3-4	1.0-3.0	0.025	0.8
February-March	BioDiet Starter	2-3	1.0-2.0	0.02	1.0
April-May	BioVita	2	1.0-2.0	0.02	1.0
June-September	BioVita	1-2	1.0-1.5	0.02	1.0
October-April	BioVita	1	1.0	0.02	1.0

9.1.2.7 Fish Health Monitoring, Disease Treatment, and Sanitation Procedures

Standard fish-health monitoring will be conducted by a fish-health specialist at frequencies appropriate to the life stage and susceptibility to disease. Significant fish mortality attributable to unknown cause(s) will be sampled appropriately for study (i.e., viral assay, bacterial culture, and histopathology). Fish health maintenance strategies are described in IHOT (1995). Incidence of viral pathogens in spring Chinook broodstock will be determined by sampling fish at spawning in accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Populations of particular concern may be sampled at the 100 percent level and may require segregation of eggs/progeny in early incubation or rearing.

Fish are monitored daily by staff during rearing for signs of disease, through observations of feeding behavior and monitoring of daily mortality trends. A fish-health specialist will monitor fish health often as determined necessary. More frequent care will be provided as needed if disease is noted. Hatchery Specialists under the direction of the Fish Health Specialist will provide treatment for disease. Sanitation will consist of raceway cleaning as necessary by brushing, and disinfecting equipment. Fish-health examinations are performed on all spring Chinook production lots throughout the rearing period and pre-release.

All equipment (nets, tanks, boots, etc.) is disinfected with iodophor between different fish/egg lots. Tank trucks are disinfected between the hauling of adult and juvenile fish. Foot baths containing disinfectant are strategically located on the hatchery grounds to prevent spread of pathogens.

The general policy is to bury dead juvenile fish and eggs to minimize the risk of disease transmission to natural fish. Adult spring Chinook carcasses will be buried or disposed of in an approved landfill if individuals have been treated with antibiotics and died within the withdrawal period identified by the FDA. All adults injected with maturation accelerating hormones (such as sGnRHa implants) will be disposed of in an approved landfill, consistent with INAD requirements.

9.1.2.8 Smolt Development Indices (e.g., gill ATPase activity), if Applicable

Degree of smoltification is monitored through monthly collection of data indicating average condition factor (Kfl) of the populations. Gill ATPase levels have been monitored in the past to attempt to indicate degree of smoltification. However, this index has not been found to be a useful tool for determining when to begin releases, due to the delay in obtaining results from sampling, and the finding that ATPase levels do not actually increase until the smolts are actively migrating in the Columbia River (Petersen et al. 1999b). Organosomatic Index analysis of Methow Composite fish in 2004 provided a normality index of 97.5 percent.

9.1.2.9 Indicate the Use of "Natural" Rearing Methods as Applied in the Program

Currently, natural rearing methods are approached through the transfer of most Chinook smolts to acclimation ponds at release locations. The trapezoidal, Hypalon-lined acclimation ponds provide lower density rearing vessels for the fish on their natal water prior to release. Any changes to current rearing approaches must be approved by the HCP Hatchery Committee. Additionally, dispersed acclimation of a portion of the spring Chinook from the Methow Hatchery may occur at the discretion of the Hatchery Committee following the development of natural rearing sites in the Methow Basin by others (e.g., the Yakama Nation, Methow Salmon Recovery Foundation, etc.), provided that Douglas PUD relinquishes responsibility for and receives credit for the production of spring Chinook acclimated in those locations at the time they are released from the custody of Douglas PUD.

9.1.2.10 Indicate Risk Aversion Measures that will be Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish Under Propagation

- Marked fish from outside of the Mid-Columbia Region will be excluded from the Methow broodstock. Progeny from adults captured at Wells Dam that are from the Entiat or Wenatchee programs will be returned to their hatchery of origin, if this action is consistent with fish-health protocols. This will require reading of CWTs during spawning.
- Adults may be PIT tagged (or individually marked by some means) to identify them by time of arrival. If too many adults are collected because the actual run size differs substantially from the prediction, adults may be selected for return to the river for natural spawning or, alternatively, removed for control of pHOS. This will be performed in a manner that allows an adequate representation of the gene pool, and is consistent with ongoing disease prophylaxis treatments. Origins of late arriving adults will be investigated through in-situ scale pattern analysis and maturation timing to help ensure that ocean-type Chinook salmon are not inadvertently included in the broodstock.
- In-situ stock separation of Methow/Chewuch composite, Twisp, Carson-based Winthrop stock and stray fish via scale analysis, PIT-tag identification, and reading of CWTs during spawning operations will continue.

10.0 RELEASE

10.1 Describe Fish Release Levels, and Release Practices Applied Through the Hatchery Program

10.1.1 Proposed Fish Release Levels

Table 10-1. Approximate size and number targets for production of spring Chinook smolts from the Methow Hatchery spring Chinook program. Targets are subject to change at the discretion of the HCP Hatchery Committees, and may fluctuate dependent upon availability of NORs at the Twisp Weir and PUD obligations as determined through survival studies (as described in the pertinent HCPs and Grant PUD's Settlement Agreement).

Age Class	Maximum Number	Size (fpp)	Release Date	Location
Eggs	None	NA	NA	NA
Unfed Fry	None	NA	NA	NA
Fry	None	NA	NA	NA
Fingerling	None	NA	NA	NA
Yearling	225,000	15	April – May	Chewuch River
Yearling	225,000	15	April – May	Methow River
Yearling	100,000	15	April - May	Twisp River

Up to 550,000 smolts will be produced per Douglas, Chelan, and Grant PUD obligations. The numbers planted to each system will depend on the availability of composite stock and identification of fish from Chewuch or Twisp populations. Currently, Douglas PUD's obligation is for 61,071 yearling UCR spring Chinook, Chelan PUD's obligation is for 288,000 yearling UCR spring Chinook, and 201,000 yearling UCR spring Chinook are produced for Grant PUD. These production proportions will remain until modified by the HCP Hatchery Committees (Douglas and Chelan PUDs) and/or the Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC; Grant PUD).

10.1.2 Specific Location(S) of Proposed Release(S)

Stream, river, or watercourse:
Release point:
Major watershed:
Basin or Region:

Fish are released on station from the Methow Hatchery to the Methow River at RKm 82.1.
Fish are released from an acclimation pond on the Twisp River at RKm 10.
Fish are released from an acclimation pond on the Chewuch River at RKm 12.9.

All sites are in the (Upper) Columbia River watershed, and the Methow River sub-basin (WRIA 48). Future acclimation facilities within the Methow Basin may be developed by others and may receive releases of spring Chinook from the Methow Hatchery spring Chinook program at the discretion of the HCP Hatchery Committees (and the PRCC HSC, when applicable).

10.1.3 Actual Numbers and Sizes of Fish Released by Age Class through the Program

Table 10-2. Methow River Basin yearling spring Chinook smolt releases, 1994-2005.

Release Year	Methow River			Chewuch River			Twisp River		
	No.	Date (MM/DD)	Avg Size (fpp)	No.	Date (MM/DD)	Avg Size (fpp)	No.	Date (MM/DD)	Avg Size (fpp)
1994	-	-	-	40,881	4/18	15.1	35,853	4/15	15.1
1995	210,849	4/15	15.9	284,165	4/17	16.4	116,749	4/17	15.2
1996	4,477	4/22	14.5	11,854	4/21	12.7	19,835	4/21	14.4
1997	28,878	4/15	14.1	-	-	-	-	-	-
1998	202,947	4/15	18.1	91,672	4/15	20	76,687	4/15	14.8
1999	332,484	4/15	18.3	132,759	4/19	16.2	26,714	4/15	16.1
2000	218,499	4/17	16	217,171	4/17	18.4	15,470	4/17	15.0
2001	180,775	4/17	11.0	-	-	-	67,408	4/17	9.5
2002	66,454	4/16	16.9	199,938	4/16	16.9	75,704	4/15-23	16.7
2003	130,787	4/21	16.0	261,284	4/21-23	15.0	57,471	4/21	21.0
2004	181,235	4/2-14	15.8	254,238	4/14	12.9	58,074	4/13	15.0
2005	48,831	4/18	16.0	127,614	4/18	16.4	136,998	4/18-25	16.1

Data source: Snow et al. (2008), and WDFW unpublished data.

10.1.4 Actual Dates of Release and Description of Release Protocols

See Section 10.3 (Table 10-2) for recent release dates. Releases from the acclimation ponds at the beginning of the release period in April are volitional for approximately 20 days with the remaining fish forced out by mid-May.

10.1.5 Fish Transportation Procedures, if Applicable

Pre-smolts are transported from the hatchery to the Chewuch and Twisp acclimation ponds in March by tanker truck (Table 10-3). Current fish-transport procedures include crowding and loading into distribution tucks via a fish pump. Distribution trucks are reliable and safe and water is tempered as appropriate. Fish are tempered to within 3°C of the receiving water prior to release into the ponds. Loading densities are from 0.3 to 0.5 pounds of fish per gallon of water. Fish are volitionally released directly from the ponds to the river and do not require additional transportation.

Table 10-3. Fish Transportation Equipment.

Equipment Type	Capacity (gallons)	Suppl. Oxygen (Y/N)	Temp. Control (Y/N)	Normal Transit Time (minutes)	Chemical(s) Used	Dosage (ppm)
Truck with Tank	300	Y	N	30 minutes	MS-222 and NaCl	10 ppm and 0.8% solution
Tanker Truck	700	Y	N	30 minutes	MS 222 and NaCl	10 ppm and 0.8% solution

10.1.6 Acclimation Procedures (methods applied and length of time)

On or about March 15th, pre-smolts are transferred from Methow Hatchery to Twisp and Chewuch acclimation ponds where fish are acclimated for approximately 30 days. Fish are provided a volitional release, and typically migrate quickly from the acclimation facilities.

10.1.7 Marks Applied, and Proportions of the Total Hatchery Population Marked, to Identify Hatchery Adults

All juveniles in the current program (through 2009) are 100 percent CWT marked but not adipose fin clipped, and are segregated into rearing vessels based on ELISA (BKD) values and stock (Twisp and Methow/Chewuch composite). Segregation by stock and ELISA category will continue, and all smolts will be marked to distinguish specific hatchery crosses and to facilitate removal of hatchery-origin fish in selective fisheries. The HCP Hatchery Committee will determine the marking scheme that will be coordinated among all releases of spring Chinook above Wells Dam.

10.1.8 Disposition Plans for Fish Identified at the Time of Release as Surplus to Programmed or Approved Levels

Broodstock and egg collections are designed to minimize the potential for egg surpluses. Egg surpluses, if any, will be culled (see Section 9.1.2). Thus, surplus smolts are not expected.

10.1.9 Fish Health Certification Procedures Applied Pre-Release

Fish health and disease condition are continuously monitored in compliance with the requirements of the "Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State" (Co-managers 1998), requirements of the Section 10 ESA permit issued and guidelines of IHOT (1995). Spring Chinook are monitored daily by staff during rearing for signs of disease, through observations of feeding behavior, and monitoring of daily mortality trends. A fish health specialist monitors fish health as least monthly; these inspections must adhere to the disease prevention and control guidelines established by the Pacific Northwest Fish Health Protection Committee. More frequent care will be provided as needed if disease is noted. Prior to release, the population health and condition is established by the Area Fish Health Specialist. This is commonly done 1-3 weeks pre-release, and up to 6 weeks on systems with pathogen free water and little or no history of disease.

10.1.10 Emergency Release Procedures in Response to Flooding or Water System Failure

Emergency releases shall be allowed in the event of flooding, water loss to raceways, or vandalism that necessitates early release of ESA-listed spring Chinook to prevent catastrophic mortality. Any emergency releases made by the hatchery operators will be reported immediately to the NMFS Salmon Recovery Division in Portland, OR.

In the event of a water-system failure, screens will be pulled to allow fish to exit the ponds, or in some cases they will be transferred into other rearing vessels to prevent an emergency release. Upon permission, fish would be force-released into the Methow River by pulling the screens/outlets of rearing units. Outlet screens/stop logs of the ponds would be pulled, and fish would be forced out, or allowed to volitionally move into the Methow. This would only occur if the program were in jeopardy. WDFW also has emergency response procedures for providing back-up pumps, transport trucks, etc. in cases of emergency. In cases of severe flooding the screens will not be pulled because flood waters rise to the point where they breach the ponds. Every effort will be made to avoid pre-programmed releases including transfer to alternate facilities. Emergency releases, if necessary and authorized, would be managed by removal of outlet screens and pull sumps of the rearing units. If possible, staff would set up portable pumps to use river water to flush the fish.

10.1.11 Indicate Risk Aversion Measures that will be Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish Resulting from Fish Releases

The risk of ecological hazards to listed species resulting from liberations of hatchery-origin spring Chinook will be minimized through the following measures:

- Hatchery spring Chinook will be reared to sufficient size such that smoltification occurs within nearly the entire population, reducing residence time in the streams after release and promoting rapid seaward migration.
- Spring Chinook smolt releases will be timed with releases from Columbia River dams to further accelerate seaward migration, to improve survival at mainstem dams, and to reduce the duration of interactions with wild fish.
- Acclimation in natal stream water will contribute to smoltification, reducing the residence time in the rivers and mainstem corridors.
- Hatchery spring Chinook smolts will be released when environmental conditions exist that promote rapid emigration.
- Total number of smolts released with expected adult contribution to natural spawning will be managed with consideration of both the HCP obligations and the tributary carrying capacity.
- All artificially propagated UCR spring juveniles shall be externally or internally marked prior to release, according to the coordinated marking scheme under development by the HCP Hatchery Committee.

Variance from this smolts-only release requirement shall only be allowed in the event of an emergency, such as flooding, water loss to raceways, or vandalism that necessitates early release of ESA-listed spring Chinook to prevent catastrophic mortality. Any emergency spring Chinook releases made by the action agencies will be reported immediately to the NMFS Salmon Recovery Division in Portland, OR.

11.0 MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

11.1 Monitoring and Evaluation of "Performance Indicators" Presented in Section 1.10

The HCP Hatchery Committee has developed a rigorous monitoring plan (M&E Plan) for the Methow Hatchery spring Chinook program (HCP HC 2007), attached as Appendix A. Douglas PUD funds an M&E program based upon that M&E Plan and a companion document, the "Analytical Framework" (Hays et al. 2007), attached as Appendix B, which describes the necessary data and analytical rules by which to assess the performance of the program relative to the specific objectives in the M&E Plan. Implementation of the M&E Plan is guided by an annual M&E Implementation Plan (Murdoch and Snow 2009; attached as Appendix C) prepared by Douglas PUD's M&E contractor (currently WDFW) and approved by the HCP Hatchery Committee. The M&E program is subject to review by the HCP Hatchery Committee at least every five years (or as needed), and it is within the purview of the HCP Hatchery Committee to modify the M&E Plan and Analytical Framework (and thus, the M&E program) at any time (adaptive management).

The M&E program monitors survival and growth within the hatchery and the effects of hatchery fish on population productivity, genetic diversity, run and spawn timing, spawning distribution, and age and size at maturity. This information is collected directly from, or is derived from spawning ground surveys, broodstock sampling, stock composition sampling (stock assessment), hatchery juvenile sampling, smolt trapping, PIT tagging, elastomer tagging, adipose clipping, genetic sampling, disease sampling, and snorkeling. The monitoring and evaluation program is consistent with the draft monitoring and evaluation plan prepared by NMFS for the Recovery Plan (see Appendix P to the Recovery Plan; UCSRB 2007) and the Ad Hoc Supplementation Monitoring and Evaluation Workgroup recommendations (Galbreath et al. 2008).

11.1.1 Describe Plans and Methods Proposed to Collect Data Necessary to Respond to Each "Performance Indicator" Identified for the Program

The M&E Plan and Analytical Framework were developed by the Hatchery Evaluation Technical Team (HETT; *ad hoc* technical subcommittee to the HCP Hatchery Committees and PRCC Hatchery Subcommittee). The objectives within the M&E Plan and Analytical Framework were developed to assess progress toward achieving the hatchery program goals defined by the JFP in the M&E Plan. The Wells HCP Hatchery Committee approved the initial 2005 M&E Plan at the July 2005 HCP Hatchery Committee meeting and approved the updated version in September of 2007. The Wells HCP Hatchery Committee may modify the M&E Plan as necessary to ensure that the program goals are being appropriately monitored.

The M&E Plan for the Methow Hatchery spring Chinook program intends to use control populations (sometimes called "reference streams") for comparative analysis (i.e., to tease out hatchery effects). Availability, feasibility, and viability of using control population are currently being evaluated by the HETT. Because of the difficulty in finding suitable control populations (spring Chinook systems similar to the Methow, but with no hatchery influence) and the ability to detect impacts, the HCP Hatchery Committee has tentatively accepted this approach while the HETT conducts the necessary analyses to identify control populations and validate the approach.

The M&E Plan and Analytical Framework (Appendices A and B) thoroughly describe the program objectives, their respective hypotheses, measured variables, derived metrics, and analyses.

11.1.2 Indicate Whether Funding, Staffing, and other Support Logistics are Available or Committed to Allow Implementation of the Monitoring and Evaluation Program

Douglas PUD funds and Chelan and Grant PUDs co-fund the M&E activities for this program. WDFW, as a contractor to Douglas PUD and co-holder of the permit, currently provides the personnel and equipment for conducting these activities. Copies of the Annual Report on M&E activities are routinely and regularly provided to NMFS through its representative on the Wells HCP Hatchery Committee.

11.2 Indicate Risk Aversion Measures that will be Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish Resulting from Monitoring and Evaluation Activities

11.2.1 Juvenile Monitoring

Injury to steelhead, spring Chinook salmon, and bull trout may occur through trapping, handling, and marking procedures. Primary injury and mortality events are associated with debris accumulation in the trap live-box, reaction to anesthesia, handling stress, over-crowding in the live-box, predation in the live-box, and increased predation post release. Injury and mortality will be minimized through diligent trap attendance. Traps will be checked a minimum of once a day in the morning or more often as needed (as determined by capture rate, debris loading, discharge, temperature, etc.). Injury and mortality associated with handling stress and post-release predation will be addressed by applying MS-222 (or other anesthetic approved by WDFW and/or NMFS) to all fish handled, and allowing full recovery of fish before release. Other risk aversion measures include:

- No more than 20 percent of the natural or hatchery emigrants may be captured.
- Lethal take may not exceed 2 percent of the natural or hatchery fish captured.
- Tissue sampling shall be minimized to the extent possible.

- Fish must be kept in water to the maximum extent possible. Adequate water circulation and replenishment of water in holding units is required.
- Fish must be moved using equipment that holds water during transfer.
- Fish must not be handled if water temperatures exceed 69.8°F (21°C) at the capture site.
- The incidence of capture, holding, and handling effects shall be minimized and monitored.
- Visual observation protocols must be used instead of intrusive sampling methods whenever possible.

The Section 10 Permits No. 1196 describes the risk aversion measures required of the current M&E activities for spring Chinook.

11.2.2 Adult Monitoring

No injury or mortalities are expected during spring Chinook spawning ground surveys. Field staff will minimize disturbance to any spawning spring Chinook by identifying spawning sites and using a land route around their location. In addition, wading is restricted to the extent practical to minimize disturbance, and extreme caution is used to avoid adults and redds when wading is required.

During sampling at Twisp Weir, Methow Hatchery, WNF Hatchery, and Wells Dam (and other collection/sampling locations and methods as approved by the HCP Hatchery Committee), injury to spring Chinook may occur through trapping, handling, and sampling procedures. Primary injury and mortality events are associated with reaction to anesthesia, handling stress, and over-crowding in collection areas. Injury and mortality will be minimized through diligent trap attendance. Traps will be checked a minimum of once a day in the morning or more often as needed. Injury and mortality associated with handling stress, anesthetizing, and sampling will be addressed by applying MS-222 (or other anesthetic approved by WDFW and/or NMFS) to all fish handled, and allowing full recovery of fish before release. Procedures and trapping equipment have been rigorously tested and refined over the last five years. Potential sources of injury have been identified and corrected by Douglas PUD and WDFW staff.

Additionally, WDFW (as Douglas PUD's current contractor) submits annual reports as conditioned by Section 10 Permit No. 1196 covering the period from January 1 – December 31 each year per permit Reporting and Annual Authorization Requirements. Specifically, the annual reports include detailed activities as per requirements including monitoring of performance indicators identified for the program. A summary documenting the M&E activities associated with the endangered UCR spring Chinook hatchery program is included in annual progress reports submitted to NMFS. Monitoring activities have already been approved by the permit. Any additional harm to listed fish beyond the permit allowances are communicated immediately to NMFS by the WDFW ESA response lead in the area for review or needed changes.

12.0 RESEARCH

Other than what data collection and analysis is encompassed within the M&E activities described in Section 11 and Appendices A, B, and C, no specific research projects are ongoing or proposed in association with the Methow Hatchery spring Chinook program. Any unanticipated, future research that may be associated with this program must be approved by the HCP Hatchery Committees.

13.0 ATTACHMENTS AND CITATIONS

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14.0 CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the information provided is complete, true and correct to the best of my knowledge and belief. I understand that the information provided in this HGMP is submitted for the purpose of receiving limits from take prohibitions specified under the Endangered Species Act of 1973 (16 U.S.C.1531-1543) and regulations promulgated thereafter for the proposed hatchery program, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or penalties provided under the Endangered Species Act of 1973."

Name, Title, and Signature of Applicant:

Name: W C Dobbins	Name: Heather Bartlett
Title: General Manager	Title: Hatcheries Division Mgr.
Date: March 9, 2010	Date: March 15, 2010

Appendix A

Conceptual Approach to Monitoring and Evaluation for Hatchery Programs

Conceptual Approach to Monitoring and Evaluation for Hatchery Programs

funded by Douglas County Public Utility District

Prepared for:
Douglas PUD Habitat Conservation Plan Hatchery Committee

Committee members:

Brian Cates (US Fish and Wildlife Service)
Rick Klinge (Douglas PUD)
Jerry Marco (Colville Tribes)
Kristine Petersen (NOAA Fisheries)
Tom Scribner (Yakama Nation)
Kirk Truscott (Washington Department of Fish and Wildlife)

Last modified: September 2007

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Abstract

Public Utility District No. 1 of Douglas County (Douglas PUD) implements hatchery programs as part of the Habitat Conservation Plan (HCP) agreement relating to the operation of the Wells Hydroelectric Project. The HCP defines the goal of achieving no net impact (NNI) to anadromous fish species affected by operation of Wells Dam. The HCP identifies general program objectives as "contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest. The HCP further establishes a Hatchery Committee charged with defining specific hatchery program objectives and developing a monitoring and evaluation (M & E) program to determine if the hatchery objectives are being met. The HCP specifies that this plan will be reevaluated and adjusted, if need be, every five years. The purpose of this plan is to provide the conceptual framework to monitor and evaluate the success of the hatchery programs. This will in turn provide information to the HCP Hatchery Committee to manage these programs.

Introduction

In April 2002, negotiations on the Wells Habitat Conservation Plan (HCP) were concluded (DPUD 2002). The HCP is a long-term agreement between Douglas PUD, National Marine Fisheries Service (NOAA Fisheries), the Washington Department of Fish and Wildlife (WDFW), the U. S. Fish and Wildlife Service (USFWS), the Confederated Tribes of the Colville Reservation (Colville Tribes) and the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) [12]. The HCP objective is to achieve No Net Impact (NNI) for each plan species (spring Chinook salmon, summer/fall Chinook salmon, sockeye salmon, steelhead, and coho salmon of upper Columbia River (UCR) Basin) affected by the hydroelectric project. NNI consists of two components: (1) 91% combined adult and juvenile project survival achieved by project passage improvements implemented within the geographic area of the Project, (2) up to 9% compensation for unavoidable project mortality provided through hatchery and tributary programs, with a maximum 7% compensation provided through hatchery programs and 2% compensation provided through tributary programs. The signatory parties intend these actions to contribute to the rebuilding of tributary habitat production capacity and basic productivity and numerical abundance of plan species. Previous artificial propagation commitments to compensate for habitat inundation are carried forth in the HCP[13].

The Joint Fisheries Parties (JFP) include fishery resource managing agencies that are signatories to the HCP agreements and responsible for developing species-specific hatchery program goals. At this time, the WDFW, the USFWS, the Colville Tribes, the Yakama Nation and NOAA Fisheries constitute the JFP in regards to the HCP agreements. The JFP has agreed that hatchery programs for anadromous salmonid tributary populations (Methow and Okanogan) will attempt to follow the concepts and

[12] The Yakama Nation signed the HCP on March 24, 2005.
[13] For further information on the HCPs, and the creation and role of the Hatchery Committees, please see the HCP (DPUD 2002).

strategies of supplementation as defined and outlined in RASP (1992) and Cuenco et al. (1993). While hatchery programs for those salmonid population(s) that are released directly into the Columbia River will follow conventional hatchery practices associated with harvest augmentation. The Entiat River has been selected as a potential reference stream (population) for hatchery evaluations purposes, and as such, no new HCP hatchery supplementation programs will be initiated in that watershed. Conversely, conventional hatchery practices will continue to be utilized for plan species released into the mainstem Columbia River. The primary goal of these hatchery programs continues to be both inundation compensation and harvest augmentation.

The HCP Hatchery Committee (HCP HC) is responsible for developing a monitoring and evaluation (M&E) plan to assess overall performance of Douglas PUD's hatchery programs in achieving the general program objective of *"contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest as well as defining and monitoring specific hatchery program objectives".* The HCP HC has developed and adopted goals for specific hatchery programs. The various goals of those programs are outlined below:

1. Support the recovery of ESA listed species[14] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

   Hatchery Programs: Methow spring Chinook; Methow steelhead; and Okanogan steelhead

2. Increase the abundance of the natural adult population of unlisted plan species, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity. In addition, provide harvest opportunities in years when **spawning escapement** is sufficient to support harvest.

   Hatchery Programs: Methow summer/fall Chinook; Okanogan sockeye[15]

3. Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural spawning populations.

   Hatchery Programs: Wells summer/fall Chinook

As previously mentioned, Douglas PUD's hatchery program encompasses two different hatchery strategies that address different goals due in part to the purpose in which the program was created. The main focus and an important goal of the hatchery program is

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[14] While the HCP is not a recovery plan into itself, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.
[15] Evaluation of the Douglas PUD Okanogan Sockeye obligation is conducted through the implementation of the Fish-Water Management Tool Program.

to increase the natural production of fish in the tributaries that will aid in the achievement of no net impact (NNI) and in the recovery of ESA listed stocks. This is accomplished through the strategy of supplementation. Simple put, supplementation uses broodstock for the hatchery program from a target stream or area, the offspring of which are reared in a hatchery and released back to the target stream or area. Fish will be reared and released in a manner that ensures appropriate spatial distribution and genetic integrity of the populations being supplemented. Subsequently, these juvenile hatchery fish will return as adults to supplement the natural spawning population with the intent of increasing the natural production of the population.
The fundamental assumption behind the theory of supplementation is that hatchery fish returning to the spawning grounds are "reproductively similar" to naturally produced fish. There is some information that suggests that this may not be true. Therefore, one of the questions that will be answered through this M&E plan is how effective are hatchery-origin salmon and steelhead at reproducing in the natural environment.

One of the important aspects of this Plan is to compare changes in productivity of a supplemented population to a non-supplemented population. Potential reference streams (e.g., Entiat) should have similar biotic and abiotic components as experimental streams. Preliminary determinations regarding the suitability of potential reference streams or areas within streams will be made based on the following criteria (these criteria are not considered all inclusive at this time):

- No recent (within last 5-10 years; two generations) hatchery releases directed at target species
- Similar information of hatchery contribution on the spawning grounds
- Similar fluvial-geomorphologic characteristics
- Similar out of subbasin effects
- Similar historic records of productivity
- Appropriate scale for comparison
- Similar in-basin biological components, based on analysis of empirical information

The question of how effective hatchery-origin salmon and steelhead are at reproducing in the natural environment will be answered in separate studies (i.e., DNA pedigree) that will eventually be added to this plan. Results from ongoing reproductive success studies (Wenatchee spring Chinook) as well as future studies (Upper Columbia steelhead) will be incorporated into the Plan on a continual basis. This plan recognizes that it is important to manage the numbers of hatchery fish spawning in the wild and the proportion of naturally produced fish in the broodstock. The further development of goals to achieve these mutual management actions will be developed by the HCP HC in the future and will be incorporated within the M&E plan at that time.

The second strategy is intended to increase harvest opportunities. This is accomplished primarily with releases of hatchery fish into the mainstem of the Columbia River or other terminal areas with the intent that the returning adults be harvested.

Additionally non harvest fish should remain segregated, from the naturally spawning populations.

Conceptual Framework of the Monitoring and Evaluation Plan

It is important that the M&E Plan has obtainable goals, and that the objectives and strategies are clearly linked to those goals. Figure 1 depicts the generalized conceptual model that this M&E Plan will follow. The hypotheses that will be tested under the objectives will be based on previous monitoring and evaluation information (i.e., key findings), and from the Biological Assessment and Management Plan (BAMP, 1998). Strategies, and the subsequent research, monitoring and evaluation, will clearly link to and provide feedback for the objectives.

The HCP specifies that the M&E Plan will be reevaluated, and revised if necessary every five years. It is important that information is collected through the evaluation plan that will enable the committee to make changes if needed. One of the challenges presented in developing the M&E Plan is to develop quantifiable metrics that support the goals of the hatchery programs. As such, it will be necessary to develop a conceptual framework for not only the M&E Plan, but for each objective to determine what types of information is required. A hierarchal approach to accomplishing the objectives would optimize data collection, analysis, and resources required to implement the Plan. Some of the data collection tasks will not need to be performed unless a data gap appears from other monitoring efforts.

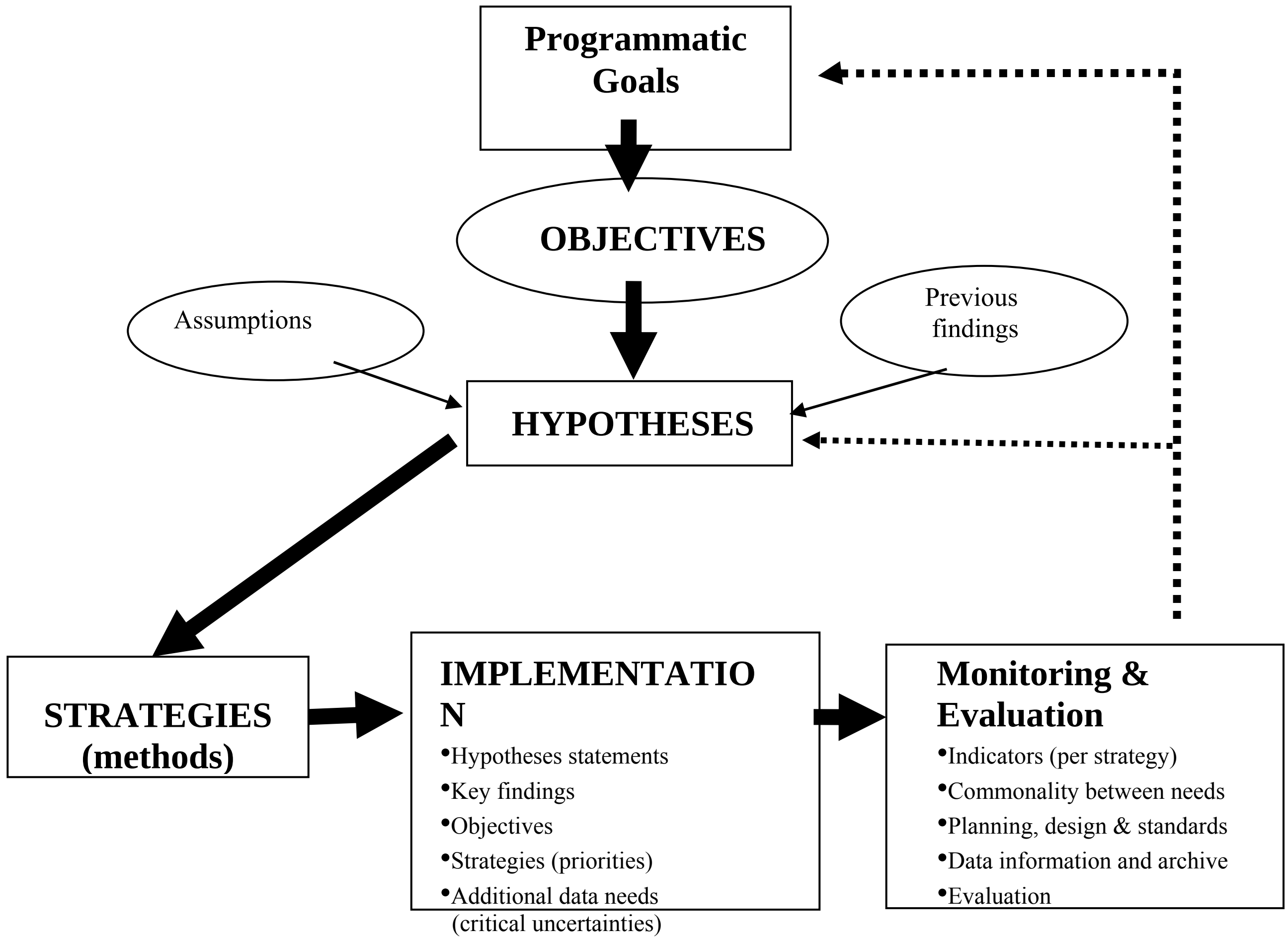

Figure 1. Conceptual model of how goals, objectives, strategies, and monitoring and research interrelate.

Monitoring and Evaluation Plan Objectives

The objectives (and subsequent hypotheses) of the Plan are generated in part from existing evaluations plans, the BAMP, and support the Hatchery Program Goals as defined by the HCP HC.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and the changes in the natural replacement rate (NRR) of the supplemented population is similar to that of the non-supplemented population.

Hypotheses:

- Ho: Δ Total spawners $_{\text{Supplemented population}}$ > Δ Total spawners $_{\text{Non-supplemented population}}$

- Ho: Δ NOR[16] $_{\text{Supplemented population}} \geq \Delta$ NOR $_{\text{Non-supplemented population}}$
- Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

<u>Objective 2:</u> Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Hypotheses:

- Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$
- Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

<u>Objective 3:</u> Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Hypotheses:

- Ho: Allele frequency $_{\text{Donor}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Hatchery}}$
- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations Structure $_{\text{Year y}}$
- Ho: Δ Spawning Population = Δ Effective Spawning Population
- Ho: Ho: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$
- Ho: Size at Maturity $_{\text{Hatchery}}$ = Size at Maturity $_{\text{Naturally produced}}$

<u>Objective 4</u>: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR)[17] is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and equal to or greater than the program specific HRR expected value (BAMP1998).

[16] Natural Origin Recruits.
[17] See Table 1 for HRR.

Hypotheses:

- Ho: $HRR_{\text{Year x}} \geq NRR_{\text{Year x}}$
- Ho: HRR ≥ Expected value per assumptions in BAMP

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

Hypotheses:

- Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% total brood return
- Ho: Stray hatchery fish < 5% of spawning escapement of other independent populations [18]
- Ho: Stray rate $_{\text{Hatchery fish}}$ < 10% total within independent populations [19]

Objective 6: Determine if hatchery fish were released at the programmed size and number.

Hypotheses:

- Ho: $\text{Hatchery fish}_{\text{Size}} = \text{Programmed}_{\text{Size}}$
- Ho: $\text{Hatchery fish}_{\text{Number}} = \text{Programmed}_{\text{Number}}$

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Hypotheses:

- Ho: $\Delta\ \text{smolts/redd}_{\text{Supplemented population}} > \Delta\ \text{smolts/redd}_{\text{Non-supplemented population}}$

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[18] This stray rate is suggested based on a literature review and recommendations by the ICTRT. It can be re-evaluated as more information on naturally-produced Upper Columbia salmonids becomes available. This will be evaluated on a species and program specific basis and decisions made by the HCP HC. It is important to understand the actual spawner composition of the population to determine the potential effect of straying.

[19] This stray rate is suggested based upon a literature review. It can be re-evaluated as more information on naturally produced Upper Columbia salmonids becomes available. The selected values will be evaluated on a species and program specific basis and decision.

Objective 8: **Determine if harvest opportunities have been provided using hatchery returning adults where appropriate.**

Hypotheses:

- Ho: Harvest rate ≤ Maximum level to meet program goals

Regional Objectives

Two additional objectives will be included within the total framework of this plan because they are related to the goals of the programs funded by Douglas PUD and other hatchery programs throughout the region. These regional objectives will be implemented at various levels into all M&E plans in the upper Columbia Basin region (Douglas PUD, Chelan PUD, Grant PUD, USFWS, and CCT). These objectives may be more suitable for a specific hatchery or subbasin, the results of which could be transferred to other locations. As such, the HCP HC should ensure that these efforts are coordinated throughout the region so resources are used efficiently. Other objectives that are deemed more regional in nature, per HCP HC, could also be included in the section.

Objective 9: Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.

Monitoring Questions:

Q1: What is the effect of BKD disease management on BKD disease prevalence?

Q2: Are study fish exposed to hatchery effluent infected to a greater extent than control fish?

Q3: Is Rs infection transferred at various life stages from hatchery fish to naturally produced fish or appropriate surrogates?[20]

Hypotheses Q1:

- Ho_1: Rearing density has no effect on survival rates of hatchery fish.
- Ha_1: Rearing density has an effect on survival rates of hatchery fish.

- Ho_2: Antigen level has no effect on survival rates of hatchery fish.
- Ha_2: Antigen level has an effect on survival rates of hatchery fish.

[20] Hypothesis statements for these monitoring questions will be developed.

- Ho_3: Interaction between antigen level and rearing density has no effect on survival rates of hatchery fish.
- Ha_3: Interaction between antigen level and rearing density has an effect on survival rates of hatchery fish.

Hypothesis Q2:

- o Ho_1: Rs infection is not transferred from hatchery effluent to study fish.
- o Ha_1: Rs infection is transferred from hatchery effluent to study fish.

<u>Objective 10</u>: Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

Hypotheses:

- Ho: NTTOC abundance $_{\text{Year x}}$ = NTTOC abundance $_{\text{Year y}}$
- Ho: NTTOC distribution $_{\text{Year x}}$ = NTTOC distribution $_{\text{Year y}}$
- Ho: NTTOC size $_{\text{Year x}}$ = NTTOC size $_{\text{Year y}}$

Detailed Objectives

Below, we detail the objectives, generate hypotheses, and describe the importance of each objective in accomplishing goals of the plan.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning adults of the target population relative to a non-supplemented population

At the core of a supplementation program is the objective of increasing the number of spawning adults (both naturally produced and hatchery fish) in order to affect a subsequent increase in the number of returning naturally produced fish or natural origin recruits (NOR). This is measured as the Natural Replacement Rate (NRR). All other objectives of the M&E Plan either directly support this objective or minimize impacts of the supplementation program to non-supplemented population. Specific hypotheses tested under this objective are:

Ho: Δ Total spawners $_{\text{Supplemented population}}$ > Δ Total spawners $_{\text{Non-supplemented population}}$

Ho: Δ NOR $_{\text{Supplemented population}}$ ≥ Δ NOR $_{\text{Non-supplemented population}}$

Ho: Δ NRR $_{\text{Supplemented population}}$ > Δ NRR $_{\text{Non-supplemented population}}$

The supplementation program should in all cases increase the number of spawning adults (i.e., hatchery origin). If the supplementation program does not increase the number of spawners, the subsequent increase in natural produced fish cannot occur. Under this scenario, poor survival or high stray rates of the hatchery fish will prevent the objectives and goals of the hatchery program from being met.

When an increase in the spawning population has been observed, the subsequent increase in naturally produced retuning adults is determined by comparing the natural replacement rate of the treatment population to a reference population (i.e., non-supplementation fish). If supplementation fish do have a similar reproductive success as naturally produced fish, then the trend of the NRR of both populations should not differ over time. Should divergence of the NRRs occur and the treatment population NRR does decline over time, the level or strategy of supplementation will be reevaluated by the HCP HC and appropriate adjustments to the program would be recommended.

If reference streams are not available for all hatchery programs or are not suitable due to 1) effects of other hatchery programs or 2) biotic or abiotic conditions are different from the treatment stream, an alternate experimental design needs to be considered to examine this important aspect of the Plan. Relative productivity of hatchery and naturally produced fish can be empirically measured using DNA pedigree approach study design. This approach may not be logistically feasible for all programs (i.e., too many fish to sample or poor trap efficiency). Alternatively, a temporal rather than a spatial reference stream can be used. This approach would involve not releasing hatchery fish in a specific stream for at least one generation and determine if a change in the NNR is observed without hatchery fish present on the spawning grounds. Regardless of the approach or experimental design used, this component of the Plan is crucial and must be examined in order to determine if supplementation will result in an increased number of naturally produced adults.

Another important comparison, with or without reference streams, can be made by looking at different parental crosses (treatments) and what affects these crosses may have on NRR and HRR.

<u>Objective 2</u>: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Supplementation is an integrated hatchery program. Hatchery and naturally produced fish are intended to spawn together and in similar locations. Run timing, spawn timing, and spawning distribution may be affected through the hatchery environment (i.e., domestication). If supplemented fish are not fully integrated into the naturally produced spawning population, the goals of supplementation may not be achieved. Hatchery adults that migrate at different times than naturally produced fish may be subject to differential survival. Hatchery adults that spawn at different times or locations than naturally produced fish would not be integrated into the naturally produced spawning population (i.e., segregated stock). Specific hypotheses tested under this objective are:

Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$

Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$

Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

Broodstock collection and spawning protocols should ensure appropriate run timing and spawn timing of the supplemented fish, respectively. Observed differences in these indicators would suggest that protocols be reevaluated. Differences in redd distributions will be evaluated based upon the location that carcasses were recovered during spawning ground surveys. However, freshets or fall floods may limit the utility of these data. If the accuracy of carcass recovery location is questionable (i.e., floods), a more precise, although more labor intensive, indicator for redd distribution would involve determining the origin of actively spawning fish.

<u>Objective 3</u>: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

The genetic component of the Plan specifically addresses the long-term fitness of supplemented populations. Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological, and behavioral components. Maintaining the long-term fitness of supplemented populations, per the HCP Hatchery Program goals, requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location and stray rates) is already addressed under other objectives.

Theoretically, a supplementation program should maintain genetic variation present in the original donor population, and as a program proceeds, genetic variability in hatchery- and naturally-produced fish in the supplemented population should be similar. Loss of within-population variation is a genetic risk of artificial production programs, and genetic divergence between hatchery and natural components of a supplemented population may lead to a loss of long-term fitness.

Differences in genetic variation among neighboring populations maintain the genetic population structure of drainages, basins, and regions. Mixing of populations in the hatchery (e.g., improper broodstock collection) or in the natural environment (e.g., excessive straying of hatchery fish) may lead to outbreeding depression and a loss of long-term fitness. Loss of between-population variation is also a genetic risk of artificial production programs, and can lead to long-term fitness loss at a scale larger than the population targeted for supplementation. Specific hypotheses tested under this objective for these issues are:

H_o: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Natural}}$ = Allele frequency $_{\text{Donor}}$

H_o: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Supplementation should increase spawning population abundance as a result of high juvenile survival in the hatchery. Associated with an increase in returning spawner abundance should be an increase in effective population size (i.e., the number of actual breeders that produce successful offspring; N_e). The relative proportion of hatchery-origin spawners that participate in natural spawning is an important factor in realizing improvements in $N_{e.}$ A disproportionate number of hatchery spawners may cause inbreeding depression if their level of relatedness is relatively high due to expected high juvenile survival. A decrease in reproductive success and thus lowered N_e is an expected result of inbreeding. Lowered genetic variability is also expected. Achieving a larger N_e in a supplemented population should improve long-term fitness. The specific hypothesis tested under this objective for this issue is:

H_o: Spawning Population Size Change = Effective Population Size Change

Results of domestication selection may be expressed through changes in life history patterns. Changes in phenotypic traits can result from inadvertent selection during artificial propagation and rearing. Persistence of selection effects will be influenced by the genetic basis of a trait. Age and size at maturity are two important phenotypic traits that have not been already addressed in the Plan. Should domestication selection be found, changes in broodstock collection protocols and hatchery operations would be required. Specific hypotheses tested under this objective for this issue are:

H_o: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$

H_o: Size at Maturity $_{\text{Hatchery}}$ = Size at Maturity $_{\text{Naturally produced}}$

<u>Objective 4:</u> Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific expected value (BAMP 1998).

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome the survival disadvantage after release (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish the program should be modified or discontinued. Production levels were initially developed using historical run sizes and smolt-to-adult survival rates (BAMP 1998). Using the stock specific NRR and the values listed in the BAMP, comparisons to actual survival rates will be made to ensure the expected level of survival has been achieved. Specific hypotheses for this objective are:

Ho: $HRR_{\text{year x}} \geq NRR_{\text{year x}}$

Ho: HRR $\geq$ Expected value per assumptions in BAMP

Using five-year mean and determining trends in survival of specific programs would address interannual variability in survival. Although annual differences among programs would still be analyzed to detect within year differences, which could explain some the variability among programs. Specific recommendations to increase survival would be provided for programs in which the HRR do not exceed the NRR or the expected values.

Table 1. The expected smolt to adult (SAR) and hatchery replacement rates (HRR) for Wells Complex programs based on assumptions provided in BAMP (1998).

Program	SAR	HRR
Methow spring Chinook	0.0030	4.5
Chewuch spring Chinook	0.0030	4.5
Twisp spring Chinook	0.0030	4.5
Wells summer Chinook (yearlings)	0.0030	4.9
Wells summer Chinook (subyearlings)	0.0012	3.0
Wells steelhead	0.0100	19.5

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks

Maintaining locally adapted traits of fish populations requires that returning hatchery fish have a high rate of site fidelity to the target stream. Hatchery practices (e.g., acclimation, release methodology and location) are the main variables that affect stray rates. Regardless of the adult returns, if adult hatchery fish do not contribute to the donor population the program will not meet the basic condition of a supplementation program. Fish that do stray to other independent populations should not comprise greater than 5% of the spawning population. Likewise, fish that stray within an independent population should not comprise greater that 10% of the spawning population. Specific hypothesis for this objective is:

Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% total brood.

Ho: Stray rate $_{\text{Hatchery fish}}$ < 10% within independent populations

Stray rates should be calculated using the estimated number of hatchery fish that spawned in a stream and CWTs were recovered. Recovery of CWT from hatchery traps or broodstock may include "wandering fish" and may not include actual fish that spawned. Special consideration will be given to fish recovered from non-target streams in which the sample rate was very low (i.e., sample rate < 10%). Expansion of strays from spawning ground surveys with low sample rates may overestimate the number of strays (i.e., random encounter).

The rate and trend in strays from hatchery programs will be used to provide recommendations that would lead to a reduction in strays. Depending on the severity, hatchery programs with fish straying out of basin will be given high priority, followed by strays among independent populations, and finally strays within an independent population.

Objective 6: Determine if hatchery fish were released at the programmed size and number.

The HCP outlines the number and size of fish that are to be released to meet NNI compensation levels. Although many factors can influence both the size and number of fish released, past experience with these stocks should assist in minimizing impacts to the program. Specific hypotheses for this objective are:

Ho: Hatchery fish $_{\text{Size}}$ = Programmed $_{\text{Size}}$

Ho: Hatchery fish $_{\text{Number}}$ = Programmed $_{\text{Number}}$

Understanding causes of not meeting programmed release size or goal is important for the continued success of the program. Systematic problems must be identified and managed properly to achieve the objective(s) and goal of the program. Annual and some stock specific issues may be addressed via changes in hatchery operations.

A review of broodstock collection protocols every five years should occur concurrently with an evaluation of the number of fish released from each hatchery. In addition, the assumptions under pinning the HCP size at release goals should be evaluated and if necessary should be adjusted based upon the best scientifically based conclusions. In the absence of such studies, the HCP size at release goal should be the target for each hatchery program.

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affect the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Out of basin effects (e.g., smolt passage and ocean productivity) have a strong influence on survival of smolts after they migrate from the tributaries. These effects introduce substantial variability into the adult-to-adult survival rates (NRR and HRR), which may mask in-basin effects (e.g., habitat quality, density related mortality, and differential reproductive success of hatchery and naturally produced fish). The objective of smolt monitoring programs in the Upper Columbia ESU is to determine the egg-to-smolt survival of target stocks. Smolt production models generated from the information obtained through these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that take into account all effects.

A critical uncertainty with the theory of supplementation is the reproductive success of hatchery fish. Given the dependence of hatchery fish to assist in achieving program and recovery goals, monitoring smolt production with respect to the proportion of hatchery fish on the spawning grounds is critical in understanding subsequent adult-to-adult survival. While some factors that affect freshwater production require years or decades to detect change in productivity (e.g., habitat quality and quantity), other factors (e.g., spawner density and number of hatchery fish) can be adjusted annually in most tributaries.

The number of smolts per redd (i.e., smolt production estimate divided by total number of redds) will be used as an index of freshwater productivity. While compensatory mortality in salmonid populations cause survival rates to decrease as the population size increases, inferences regarding the reproductive success of hatchery fish may be possible by carefully examining and understanding this relationship. Inherent differences in productivity are expected among tributaries (spatial), changes in relative differences among years (temporal) would suggest differences in spawner productivity. Negative effects could then be minimized through actions take by the management agencies. Specific hypothesis for this objective is:

Ho: Δ smolts/redd $_{\text{Supplemented pop.}}$ > Δ smolts/redd $_{\text{Non-supplemented pop.}}$

Robust smolt production models derived from basin specific data are critical to this objective. In addition, accurate estimates of the proportion of hatchery fish on the spawning grounds will be needed. Inferences regarding the freshwater productivity cannot be made until both of these requirements are satisfied. Alternatively, DNA pedigree studies can be used to assess the relative freshwater production of hatchery and naturally produced fish within a tributary.

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate.

In years when the expected returns of hatchery adults are above the level required to meet program goals (i.e., supplementation of spawning populations and/or broodstock requirements), surplus fish are available for harvest (i.e., target population). Harvest or removal of surplus hatchery fish from the spawning grounds would also assist in reducing genetic impacts to naturally produced populations (loss of genetic variation within and between populations). Specific hypotheses for this objective are:

Ho: Harvest rate ≤ Maximum level to meet program goals

A robust creel program on any fishery would provide the precision needed to ensure program goals are met. In addition, creel surveys would be used to assess impacts to non-target stocks.

Regional Objectives

Objective 9: Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.

The hatchery environment has the potential to amplify diseases that are typically found at low levels in the natural environment. Amplification could occur within the hatchery population (i.e., vertical and horizontal transmission) or indirectly from the hatchery effluent or commingling between infected and non-infected fish (i.e., horizontal transmission). Potential impacts to natural populations have not been extensively studied, but should be considered for programs in which the hatchery fish are expected to commingle with natural fish. This is particularly important for supplementation type programs. Specifically, the causative agent of bacterial kidney disease (BKD), *Renibacterium salmoninarum* (Rs), could be monitored at selected acclimation ponds, both in the water and fish, in which the risk and potential for transmission from the hatchery is highest. Although it is technologically possible to measure the amount of Rs in water or Rs DNA in smolts and adults non-lethally sampled, the biological meaning of these data are uncertain. Currently, the only metric available for M & E purposes is measuring the antigen level from kidney/spleen samples (i.e., ELISA). When available, non-lethal sampling may replace or be used in concert with lethal sampling.

Implementation of this objective will be conducted in a coordinated approach within the hatchery and natural environment. BKD management within the hatchery population (e.g., broodstock or juveniles) has the potential to reduce the prevalence of disease through various actions (e.g., culling or reduced rearing densities). BKD management must also take into account and support other relevant objectives of the M & E program (e.g., Hatchery Return Rate [HRR], number of smolts released). Hence, the goal of BKD management is to decrease the prevalence of disease and maintain hatchery production objectives (i.e., number and HRR).

As previously discussed, disease transmission from hatchery to naturally produced fish may occur at various life stages and locations. Of these, horizontal transmission from hatchery effluent, vertical transmission on the spawning grounds, and horizontal transmission in the migration corridor have been identified as disease interactions that could be examined under this objective, although others may also be relevant. Experimental designs addressing this objective may require technology not yet available, although in some instances samples may be collected, but not analyzed until a link can be established between bacteria levels in samples and disease prevalence.

Developing a complete set of questions and hypotheses statements for this objective may not be practical at this time, because there is currently no BKD Management Plan. However, while developing experimental designs for this objective, it may be feasible to incorporate both hatchery and natural environment monitoring under a single study design. Integration of the different aspects of the objective would likely result in a more robust approach into understanding the effectiveness of disease management strategies.

Monitoring Questions:

Q1: What is the effect of BKD disease management on BKD disease prevalence?

Q2: Are study fish exposed to hatchery effluent infected to a greater extent than control fish?

Q3: Is Rs infection transferred at various life stages from hatchery fish to naturally produced fish or appropriate surrogates?[21]

Target Species/Populations:

- Q1 and Q2 both apply to spring Chinook (primary focus) and summer Chinook programs.

Hypotheses Q1:

- Ho_1: Rearing density has no effect on survival rates of hatchery fish.
- Ha_1: Rearing density has an effect on survival rates of hatchery fish.

[21] Hypothesis statements for these monitoring questions will be developed.

- Ho_2: Antigen level has no effect on survival rates of hatchery fish.
- Ha_2: Antigen level has an effect on survival rates of hatchery fish.

- Ho_3: Interaction between antigen level and rearing density has no effect on survival rates of hatchery fish.
- Ha_3: Interaction between antigen level and rearing density has an effect on survival rates of hatchery fish.

Hypothesis Q2:
- o Ho_1: Rs infection is not transferred from hatchery effluent to study fish.
- o Ha_1: Rs infection is transferred from hatchery effluent to study fish.

Measured Variables:
- Hypotheses Q1:
  - o Numbers of fish (at different life stages)

- Hypothesis Q2:
  - o Numbers of Rs+ fish

Derived Variables:
- Survival rates
- SARs
- HRRs

Spatial/Temporal Scale:
- o Hypotheses Q1:
  - o Analyze annually based on brood year.
- o Hypothesis Q2:
  - o Analyze annually.

Statistical Analysis:
- Hypotheses Q1: either 2-way ANOVA or response-surface design.
- Hypothesis Q2: ANOVA.

Analytical Rules:
- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

<u>Objective 10:</u> Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

Supplementation of any stock or species will increase demand for resources and the potential of species interactions. The benefits gained from supplementation must be balanced with the ecological costs of the releasing hatchery fish into the ecosystem. Resource managers must be aware of and monitor potential impacts of supplementation related activities to non-target taxa. This is more important when supplementation activities involving more than one taxon are occurring simultaneously. For example, within the Methow Basin supplementation programs (i.e., spring Chinook, summer/fall Chinook, and steelhead), a spring Chinook harvest augmentation program and a coho reintroduction program release fish annually. At full program, the number of hatchery fish released into the Methow Basin would be approximately 2.4 million. Theoretical or realized benefits from supplementation activities may be at a cost to other taxa that are too great for the program to be deemed successful. In extreme cases, the costs of such activities may negate benefits of similar activities within the same subbasin. For example, predation by residualized hatchery steelhead may reduce the abundance of naturally produced spring Chinook fry that may subsequently result in a lower number of naturally produced adult spring Chinook.

In the Upper Columbia River ESU, a target species in one program is likely a non-target species in another program. The extent of spatial overlap is a decisive factor in determining the potential for ecological interactions and the associated risk. Consideration must be given to those fish that pose the greatest risk to NTT. Busack et al. (1997) categorized NTT into two classes. Strong interactor taxa (SIT) are those species that potentially could influence the success of the program through predation, competition, disease transmission or mutualistic relationships. Other NTT are classified as stewardship or utilization taxa (SUT), which are important ecologically or have high societal value.

Monitoring and evaluation plans concentrate efforts on the target species with little effort pertaining to the direct or indirect impacts to non-target species. In the Upper Columbia River ESU, a target species in one program is likely a non-target species in another program. There are also some stocks and species in which no artificial propagation programs have been initiated and as a result are non-target for all existing hatchery programs. While impacts to non-target taxa are often preconceived to be negative (e.g., competition, predation, behavioral, and pathogenic), positive impacts may also occur (e.g., nutrient enhancement and prey). Monitoring efforts will be concentrated on those interactions that pose the highest risk of limiting the success of the programs and deemed important for ecological reasons. Specific hypotheses for this objective are:

Ho: NTTOC abundance $_{\text{Year x}}$ = NTTOC abundance $_{\text{Year y}}$

Ho: NTTOC distribution $_{\text{Year x}}$ = NTTOC distribution $_{\text{Year y}}$

Ho: NTTOC size $_{\text{Year x}}$ = NTTOC size $_{\text{Year y}}$

If changes in abundance, distribution, and size of NTTOC occur, other information will need to be considered before attributing the changes to the hatchery program.

Strategies

The hypotheses and strategies that have been created in this plan were developed from the objectives of the hatchery program (Figure 1). As such, it is important to consider the goals and how they relate to the overall vision of the hatchery program, which is to meet NNI. The strategies outlined in this plan form the basis for how information will be collected and analyzed.

Commonalities among certain strategies and hypotheses will provide efficiencies in data collection and analysis. A detailed explanation of each strategy employed in the Plan is provided in the appendices to ensure repeatability in protocols, data collection, and analysis.

Other strategies and potentially hypotheses may be developed after information is collected and analyzed through the five-year review as specified in the HCP.

Indicators

An important function of the Plan is to define the indicators and methods used to measure the effect of hatchery fish on naturally spawning populations, guide hatchery operations and subsequent M&E activities. The indicators in the M&E Plan describe the biological data of interest. The protocols describe the strategy or methodologies used to measure or calculate the indicator. These are found in the appendices. The M&E Plan will also enable the hatchery committee to assess the progress toward meeting the goals and objectives of the hatchery program. The plan will be used to assure that the proper information is collected, and can be used to reevaluate hatchery production levels in 2013. In order to do this, each objective must have a:

- **Indicator**: A description of the biological data of interest. Each indicator must have a standardized methodology or protocol to ensure accuracy and precision are consistent spatially and temporally.

- **Baseline condition**: Each indicator must have a measurement or range of measurements (spatially and temporally) against which future conditions will be compared.

- **Target**: A scientifically defendable value that when obtained would lead to meeting the objective(s).

- **Performance Gap**: The difference in the baseline condition of an indicator and the target.

In order to refine the monitoring and evaluation plan with an appropriate detail, indicators are distributed into three categories: 1) the primary indicators that will be used initially to quantitatively assess if the objectives of the programs are being achieved (i.e., was the target reached or exceeded); 2) secondary indicators that will be used to collect information annually and may be used to calculate the primary indicator or assess whether the objectives are being reached in conjunction with the primary indicators; and 3) tertiary indicators that will be used when secondary indicators fail to explain some critical uncertainties in reaching the target. Primary indicators may reflect performance on a longer (temporal) or larger (spatial) scale where secondary and tertiary indicators are often used to drive smaller scale adjustments and refinements in operations to improve the likelihood of meeting the target.

To the extent possible, the objectives of this Plan must be quantifiable. The HC specified the capability to assess if the goals are being achieved. To assess this, indicators were developed that have targets associated with them that enable the HC to determine if the hatchery program is meeting objectives (see Tables 3 and 4).

Due to the variability in survival, monitoring and reporting will be conducted annually but evaluation of most objectives will be conducted over a five-year period. Measurements will center on the established indicators and whether the targets are being met. Trends in the primary indicators rather than simply the five-year mean will be important in determining if objectives are being achieved. Primary and secondary indicators will be calculated when needed (as dictated by the information obtained). However, in the event that these indicators fall below the agreed to target values, tertiary indicators may be required to explain the differences observed (uncertainty) and also a possible course of action.

Realistic targets for the indicators need to be identified. Targets set too low may lead to a perceived short-term success, but may ultimately result in the long-term failure of the hatchery program. Conversely, targets that are too high may lead to an unnecessary use of resources and a low cost-benefit ratio. The proposed initial targets for indicators appear in Table 3.

Supplementation is a strategy used in most of the hatchery programs (except Wells summer/fall Chinook) and will be the focus of discussion. As mentioned earlier, supplementation by definition implies that naturally spawning hatchery fish possess a similar reproductive potential as naturally produced fish. This critical uncertainty associated with the theory of supplementation is a primary focus of the M&E Plan and logically a majority of the primary indicators in this plan are related to testing this uncertainty. Thus, the targets of many of the indicators are based on measurements taken from naturally produced populations, both temporally and spatially (i.e., Before-After-Control-Impact Design or BACI). Under this statistical design, inferences can be made regarding the effectiveness of supplementation in achieving the goals of the hatchery program. Without the use of a control or reference population, changes in the indicators over time could not be attributed to the supplementation fish. Due to potential multiple treatment effects, a direct comparison of the indicators may be invalid. Instead, a comparison in the change of the indicators over time may be more appropriate. For example, if indicator A showed a 15% increase in the reference population in the first five years, a similar 15% increase in the treatment population would also be expected Thus, any decrease in the change of the treatment population relative to the reference population could be attributed to the presence or abundance supplementation fish.

All primary and a proportion of the secondary indicators have a target. Those indicators that are influenced by out of basin causes (e.g., ocean productivity) or density dependent factors (e.g., egg-to-smolt survival) do not have a target identified in this Plan because the ability to change these indicators fall outside the control of the HC. All primary and secondary indicators will be calculated on an annual basis. Tertiary indicators would only be measured or calculated when required. Most primary indicators will be analyzed at the five-year scale. All secondary and tertiary indicators would be analyzed on an annual basis. The relationship between indicators and the methods used to calculate them is listed in Table 4. A list of appendices with detailed methodologies for each strategy is listed in Table 5.

Table 2. Relationship of hypotheses and strategies (methods) used in monitoring and evaluation plan.

Methods	*Relative increase in spawners of supplemented stream is greater than non-supplemented stream*	*NRR of supplemented stream is equal to that of non-supplemented stream*	*Run timing, spawn timing, and redd distribution of supplemented fish is equal to that of naturally produced fish*	*No loss of within or between genetic variability* *Size and age at maturity of hatchery fish is equal to that of naturally produced fish*	*Effective population size of supplemented stream increases in relation to spawning population*	*HHR is greater than NRR* *HRR is equal or greater than expected value*
Spawning ground survey	X	X	X	X	X	X
Creel surveys	X	X	X	X	X	X
Broodstock sampling	X	X	X	X	X	X
Hatchery juvenile sampling				X	X	X
Smolt trapping				X	X	X
Residual sampling				X	X	X
Precocity sampling				X	X	X
PIT tagging	X		X	X	X	X
CWT tagging	X	X	X	X	X	X
Radio tagging	X	X	X			
Genetic sampling	X			X	X	
Disease sampling						
Snorkel surveys		X	X			
Redd capping		X				
	Stray rates of hatchery fish are less than 5%	*Hatchery fish are released at programmed number and size*	*Hatchery fish have not increased the prevalence of disease in the supplemented stream or hatchery and naturally produced populations*	*Impacts to NTTOC (size, abundance, and distribution) are within acceptable levels*	*Supplemented streams have equal ratio of smolts/redd than non-supplemented streams*	*Harvest of hatchery fish is at or below the desired level to meet program goals*
Spawning ground surveys	X		X		X	X
Creel surveys	X					X
Broodstock sampling	X	X	X			X
Hatchery juvenile sampling		X	X			
Smolt trapping		X	X	X	X	
Residual sampling		X	X	X	X	
Precocity sampling		X	X	X	X	
PIT tagging		X		X	X	
CWT tagging	X	X	X			
Radio tagging	X					
Genetic sampling						
Disease sampling			X	X	X	
Snorkel surveys				X	X	

Redd capping				X	X	

Table 3. A list of primary indicators and targets used in the M&E Plan (S=supplementation; H=harvest augmentation). Data will be collected annually and analyzed when required (minimum every 5 years). The HC will reevaluate objectives and results and make recommendations. See Glossary for definition of indicators.
[1] Derived from plug numbers in BAMP

Objective #	Program	Indicator	Target	Preliminary results
1	S	Natural replacement rate	≥ Non-supplemented pop.	> 10 yrs
2/3	S	Run timing	= Naturally produced run timing	5 yrs
2/3	S	Spawn timing	= Naturally produced spawn timing	5 yrs
2/3	S	Redd distribution	= Naturally produced spawning distribution	5 yrs
3	S	Genetic variation	= Donor population	5 yrs
3	S	Genetic structure	= Baseline condition	5 yrs
3	S	Effective population size	Δ Spawning population size	5 yrs
3	S	Size and age at maturity	= Naturally produced fish	5 yrs
4	S/H	Hatchery replacement rate	≥ Expected value[1]	5 yrs
5	S/H	Stray rate	< 5% of adult returns	5 yrs
6	S/H	Number and size of fish	± 10% of production level	5 yrs
7	S	Smolts/redd	≥ Non-supplemented pop.	> 10 yrs
8	H	Harvest	≤ Maximum level	5 yrs
9	S/H	Disease	< Baseline values	> 5 yrs
10	S/H	NTTOC	Various (0-40%)	> 5 yrs

Table 4. Indicators that will be used in the monitoring and evaluation plan, indicator level (primary, secondary, and tertiary), and the strategies used to calculate the indicator.

Specific Indicators	Level	Strategies														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Natural replacement rate	1	X	X	X	X					X	X					
Spawning escapement	2	X						X	X	X	X	X	X	X	X	X
Spawning composition	2	X		X	X											
Sex ratio	2	X	X	X	X											
Recruits	2	X	X	X	X					X	X					
Number of redds	2	X														
Run timing	1			X						X		X				
Spawn Timing	1	X														
Redd Distribution	1	X														
Genetics variation/structure	1	X		X	X	X	X						X			
Effective pop. Size	1	X		X	X								X			
Broodstock composition	2			X	X											
Age at maturity	1	X	X	X	X											
Size at maturity	1	X	X	X	X											
Hatchery replacement rate	1	X	X	X	X	X		X	X	X	X			X		

Table 4. Continued.

Specific indicators	LLevel	*Strategies*														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Smolt-to-adult	2	X	X	X	X	X	X	X	X	X	X			X		
Number of broodstock	2			X	X											
Precocity rates	2					X	X		X							
Residualism rates	2						X	X	X	X	X					
Stray rate	1	X	X	X	X					X		X	X			
Days of acclimation	2					X				X	X					
Number juveniles released	1			X	X	X				X				X	X	
Fecundity	2			X	X											
Broodstock survival	2			X	X											
In-hatchery survival	2					X				X	X			X		
Size of juveniles released	1			X	X	X		X	X	X	X			X	X	
Growth rates	2				X	X										
Incubation timing	3				X	X										
Disease	1					X								X		
Density index	2					X										
Flow index	2					X										

Table 4. Continued.

Specific Indicators	LLevel	*Strategies*														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Pathogen values	2					X								X		
Hatchery effluent	2					X								X		
Smolts per redd	1	X					X								X	X
Egg-to-smolt	2	X					X								X	X
Egg-to-parr	3	X					X								X	X
Parr-to-smolt	3	X					X								X	X
Smolt-to-smolt	3	X					X			X						
Egg-to-fry	3	X														X
NTTOC (A,S,D)	1						X	X	X	X					X	
Harvest rate	1	X	X	X	X						X					

Table 5. List of appendices outlining the methodologies for calculating indicators used in the M & E plan.

Appendix	Strategy	Indicator(s)	
		Primary	Secondary and/or tertiary
A	Broodstock protocols	Not applicable	Broodstock number
B	Broodstock collection	Run timing	Broodstock number, male to female ratio, run composition, run timing, trap efficiency, extraction rate
C	Hatchery evaluations	Number and size of fish released	Age at maturity, length at maturity, spawn timing, fecundity, broodstock survival, juvenile hatchery survival, rearing density index, incidence of disease
D	Post-release survival and harvest	HHR Exploitation rate	SAR, harvest rates
E	Smolt trapping	Smolts per redd	Smolt production, egg-to-smolt survival, overwinter survival, size at emigration
F	Spawning ground surveys	NRR Spawn timing Redd Distribution	Spawning escapement, redd count, spawning composition, age structure, size at maturity, stray rates,
G	Relative abundance	NRR	Recruits
H	Genetics	Genetic variation Stock structure Effective pop. size	Broodstock composition, spawning composition, stray rates
I	NTTOC	NTTOC	Size, abundance, and distribution
J	Disease sampling	Naturally produced fish incidence of disease Hatchery fish incidence of disease	Flow index, hatchery effluent

Implementation

A statement of work based on this document will be developed annually that outlines and prioritizes proposed M&E activities for the upcoming field season. This document will be reviewed by the HCP HC for approval before being finalized prior to the field season. The draft statement of work should be completed no later than July 1 and approved by the HCP HC no latter than September 1, unless otherwise agreed to by the HCP HC.

The annual plan will serve two purposes; allow the HCP HC to determine whether the monitoring efforts are prioritized correctly and to determine costs of the program for budgeting.

Reporting

A yearly comprehensive report, in the form of a technical memorandum, will be completed for HC review. A draft of the report will be ready for distribution by March 1 of the year following the monitoring efforts. A final report will be completed by the middle of May of the same year.

Within the annual report, all indicators that were measured for that particular year will be displayed. This will include topics such as smolt trapping information, run timing, spawn timing, redd distribution, stray rates, and all other information that is generated by additional analyses, like smolt-to-adult survival, NRR, HRR, etc. Tables 3 and 4 should be used as guidance on what indicators are reported, as well as the yearly statement of work that is agreed upon by the HC.

It will also be important to maintain cumulative information that is updated yearly as appendices to the technical memorandum.

Glossary

The following is a definition of terms used throughout the M&E Plan:

<u>Age at maturity</u>: the age of fish at the time of spawning (hatchery or naturally)

<u>Augmentation</u>: a hatchery strategy where fish are released for the sole purpose of providing harvest opportunities.

<u>Adult-to-Adult survival (Ratio)</u>: the number of parent broodstock relative to the number of returning adults.

<u>Broodstock</u>: adult salmon and steelhead collected for hatchery fish egg harvest and fertilization.

<u>Donor population</u>: the source population for supplementation programs before hatchery fish spawned naturally.

Effective population size (N*e*): the number of reproducing individuals in an ideal population (i.e., N*e* = N) that would lose genetic variation due to genetic drift or inbreeding at the same rate as the number of reproducing adults in the real population under consideration (Hallerman 2003).

ESA: Endangered Species Act passed in 1973. The ESA-listed species refers to fish species added to the ESA list of endangered or threatened species and are covered by the ESA.

Expected value: a number of smolts or adults derived from survival rates agreed to in the Biological Assessment and Management Plan (BAMP 1998).

Extraction rate: the proportion of the spawning population collected for broodstock.

Genetic Diversity: all the genetic variation within a species of interest, including both within and between population components (Hallerman 2003).

Genetic variation: all the variation due to different alleles and genes in an individual, population, or species (Hallerman 2003).

Genetic stock structure: a type of assortative mating, in which the gene pool of a species is composed of a group of subpopulations, or stocks, that mate panmictically within themselves (Hallerman 2003).

HCP: Habitat Conservation Plan is a plan that enables an individual or organization to obtain a Section 10 Permit which outlines what will be done to “minimize and mitigate” the impact of the permitted take on a listed species.

HCP-HC Habitat Conservation Plan Hatchery Committee is the committee that directs actions under the hatchery program section of the HCP’s for Chelan and Douglas PUDs.

HRR: Hatchery Replacement Rate is the ratio of the number of returning hatchery adults relative to the number of adults taken as broodstock, both hatchery and naturally produced fish (i.e., adult-to-adult replacement rate).

Long-term fitness: Long-term fitness is the ability of a population to self-perpetuate over successive generation.

Naturally produced: progeny of fish that spawned in the natural environment, regardless of the origin of the parents.

NRR: Natural replacement rate is the ratio of the number of returning naturally produced adults relative to the number of adults that naturally spawned, both hatchery and naturally produced.

(NTTOC) Non-target taxa of concern: species, stocks, or components of a stock with high value (e.g., stewardship or utilization) that may suffer negative impacts as a result of a hatchery program.

Productivity: the capacity in which juvenile fish or adults can be produced.

Reference population: a population in which no directed artificial propagation is currently directed, although may have occurred in the past. Reference populations are used to monitor the natural variability in survival rates and out of basin impacts on survival.

Segregated: a type of hatchery program in which returning adults are spatially or temporally isolated from other populations.

(SAR) Smolt-to-adult survival rate: smolt-to-adult survival rate is a measure of the number of adults that return from a given smolt population.

Size-at-maturity: the length or weight of a fish at a point in time during the year in which spawning will occur.

Smolts per redd: the total number of smolts produced from a stream divided by the total number of redds from which they were produced.

Spawning Escapement: the number of adult fish that survive to spawn.

Stray rate: the rate at which fish spawn outside of natal rivers or the stream in which they were released.

Supplementation: a hatchery strategy where the main purpose is to increase the relative abundance of natural spawning fish without reducing the long-term fitness of the population.

Target population: a specific population in which management actions are directed (e.g., artificial propagation, harvest, or conservation).

Literature

Busack, C., Watson, B., Pearsons, T., Knudsen, C., Phelps, S., and Johnston, M. 1997. Yakima fisheries project spring Chinook supplementation monitoring plan. Bonneville Power Administration, Portland, Oregon DOE/BP-64878-1.

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Appendices

APPENDIX A

Broodstock Collection Protocols

The Broodstock Collection Protocol is intended to be implemented over a five-year period, consistent with the M & E plan. This protocol will be updated annually base don the yearly run size estimates by the HCP-HC. This appendix provides the methodology to determine where and when the actual broodstock would be collected and allows for in-season escapement estimates. Appendix B (broodstock collection) provides the broodstock composition and numbers and will be used annually to adjust the broodstock collection composition.

This protocol was developed for hatchery programs associated with the Wells Habitat Conservation Plan. Hatchery programs or facilities operated by other agencies or tribes are not addressed in the document. Trapping facilities associated with these programs have been operated in a similar manner without modifications for an adequate period of time to allow baseline data collection. Using the actual trap extraction efficiencies broodstock collection protocols could be developed under a large range of run escapement scenarios. This adult broodstock collection protocol is intended for implementation over a five-year period, consistent with the M & E plan. After which, the Hatchery Committee could modify the protocol where appropriate to ensure collection goals are met while maintaining consistency with the overall program goals. As trap modifications are completed in the Methow Basin (Twisp trap in 2005, Chewuch trap in 2006), trap efficiencies and extraction rates for the new facilities would be calculated.

The general approach in developing this protocol involved analyzing the last five years of run timing and trapping data. Using the trapping period outlined in the 2004 protocol, stock specific daily and cumulative passage dates (i.e. 25%, 50%, 75%) were calculated (Table 1). Weekly collection goals were calculated based on the proportion of the broodstock goal expected to migrate upstream of the collection location (Table 2). Weekly collection values would differ if the broodstock goal was not expected to be obtained for a given stock. Using pre-season escapement estimates and the five-year trap extraction efficiencies (Table 3), the probability of achieving the broodstock collection goal can be estimated assuming the following general guidelines:

- **Very high probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year minimum trap extraction efficiency.

- **High probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year average trap extraction efficiency.

- **Moderate probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year maximum trap extraction efficiency.

- **Low probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is above the observed five-year maximum trap extraction efficiency.

As previously mentioned, in-season escapement estimates will also be used to estimate the probability of achieving broodstock collection goals. When the probability of achieving the broodstock goal is estimated to be moderate or low, modifications to the collection protocol, broodstock composition, or production level would occur on a stock specific basis (See flow charts).

Table 1. Cumulative passage dates of salmon and steelhead stocks based on the trapping period.

Stock	Cumulative passage dates during trapping period[1]			
	25%	50%	75%	100%
MEOK summer	12 Jul	22 Jul	08 Aug	14 Sept
MEOK steelhead	29 Aug	15 Sep	28 Sep	31 Oct
Met comp. spring	10 May	21 May	2 Jun	28 Jun
Twisp spring[1]	10 May	21 May	2 Jun	28 Jun

[1] To be determined at Twisp Weir following operation of new weir.

Table 2. Weekly collection quotas for spring Chinook, summer Chinook and steelhead.

Week	MetComp[1]	Twisp spring		Wells Summer		MEOK Steelhead	
		H	NP	H	NP	H	NP
07 May	24		12				
14 May	32		16				
21 May	42		21				
28 May	44		22				
04 Jun	24		12				
11 Jun	20		10				
18 Jun	16		8				
25 Jun	14		7				
02 Jul	10		5				
09 Jul	8		4				
16 Jul	4		2	232	26		
23 Jul	2		1	195	22		
30 Jul	1		1	195	22		
06 Aug				195	22	15	6
13 Aug				154	17	20	8
20 Aug				69	8	32	11
27 Aug				37	4	32	11
03 Sep						32	11
10 Sep						32	11
17 Sep						51	21
24 Sep						36	12
01 Oct						28	11
08 Oct						25	10
15 Oct						15	6
22 Oct						5	4
29 Oct						3	1
31 Oct							
07 Nov							
Total	242	0	121	1077	121	326	123

[1] A combination of hatchery and wild fish collected at Methow FH, Foghorn and Chewuch weir.

Table 3. Historical trap extraction rates and required escapement levels to achieve broodstock goal under average extraction rates.

Stock	Broodstock goal		Required escapement		Observed extraction rate[1]		
	W	H	W	H	Mean	Min	Max
Wells summer	121	1077					
MEOK steelhead	123	326					
Twisp spring	121	0					
Met comp	121	121					

Methow River Basin Spring Chinook

The spring Chinook collection protocols will target specific populations of fish in the Methow Basin through broodstock collections in tributary locations and the remainder collected at Methow Hatchery. Fish will be collected from tributaries in an attempt to increase the number of natural origin fish incorporated into the broodstock and to improve local tributary survival attributes.

Consistent with the BAMP (1998), Biological Opinion for ESA Section 10 Permit 1196; Permit 1196; and the Biological Opinion for Section 7 Consultation on the Interim Operations for the Priest Rapids Hydroelectric Project (FERC N0. 2114), WDFW proposes to collect broodstock consistent with the production level of 550,000 smolts, development of local tributary attributes and in a manner that reduces the Carson lineage within the supplementation production.

The collection protocol outlines trapping at the Methow FH outfall and tributary trapping on the Methow, Chewuch, and Twisp rivers. Site specific broodstock collection numbers and origin may vary due to unknown tributary trap efficiency, origin composition and extent of the return; however, the maximum number of broodstock spawned will not exceed 363 fish (assuming a 50:50 sex ratio). If sex ratios are skewed toward the male component, additional females may be targeted for broodstock collection. Accurate sex determination is difficult early in the collection period; therefore, any shortfall in the number of females required for full production will likely be known toward the latter stages of broodstock collection. Additional collection at this time will require release of excess males in an effort to maintain a total spawning population no greater than 363 fish. All fish released will be retuned to the tributary of collection. Three hundred and sixty-three fish (182 females) accounts for a 15% reduction expected due to ELISA culling, 5% pre-spawn mortality and maximum facility production of 550,000 smolts. The number of natural origin fish available for broodstocking purposes will be revised “in-season” and will be proportional, based on the initial forecast provided in Table 2 of the 2005 upper Columbia River Salmon and Steelhead Escapement and Broodstock Forecast.

Current estimates have 4,573 Chinook destine above Wells Dam, 33% or 1,528 are expected to be natural origin (TAC forecast have no effect on this estimate, since the estimate was derived from hatchery releases, hatchery SARs, and natural production (R/S estimates) and not based on the TAC estimate). "In-season" estimates of natural origin Chinook to individual tributaries will be estimated based on proportion natural origin returns to Twisp, Chewuch and upper Methow (Table 2 of the 2004 upper Columbia River Salmon and Steelhead Escapement and Broodstock Forecast) and 33% proportion of natural origin fish in the total return past Wells Dam. Natural origin fish inclusion into the broodstock will be a priority, with natural origin fish specifically being targeted; however, natural origin fish collections will not exceed 33% of the projected or in-season estimated return to any tributary spawning population.

Methow FH Spring Chinook

Biological Assumptions

Production level	550,000 yearling smolts
Propagation survival	90% fertilization to release
Maximum broodstock require	363
Natural origin/hatchery broodstock composition	90% / 10%
Pre-spawn survival	95%
Female to male ratio	1 to 1
Fecundity	4,200 eggs/female
ELISA cull rate	15%

Winthrop NFH spring Chinook program (BAMP):

Production Objective	600,000 yearling smolts
Broodstock required	352 (BAMP)

Trapping Locations

<u>Methow River</u>

Foghorn Dam 1 May – 30 July

Trap 7-days/week- Operated by WDFW personnel. Adipose present Chinook will be retained at this site. All fish collected at this site will be held at the Methow FH. Up to 121 fish (9.9% of the 1,228 fish projected to return to the mainstem Methow River) may be retained for broodstock purposes. One hundred percent (121 fish) may be natural origin (29.5% of the 410 natural origin fish projected to return to the mainstem Methow River). If other trap locations at the Methow FH, and Fulton Dam experience collection shortfalls, additional fish may be collected over and above the 121 fish to effectively minimize the shortfall.

In-season estimates of natural origin fish returning to the upper Methow River will be provided through initial estimates provided in Table 2 of the 2005 escapement and broodstock forecast and observed passage at Wells Dam. Overall broodstock collection and number of natural origin fish retained will be modified, in-season, as necessary to maintain a collection protocol that removes no more than 33% of the return. Fish collected at from the Methow River will be held at the Methow FH.

Chewuch River

Fulton Dam Trap 1 May – 30 July

Trap 7-days/week- Operated by WDFW personnel. The WDFW will also attempt to seine broodstock once a week at locations determined to be effective and where fish can be safely transported to Methow Hatchery. Angling will be used as a last resort if all other methods do not provide adequate broodstock.

Adipose present spring Chinook will be retained from the Chewuch River. Up to 121 fish (7.9% of the 1,524 fish projected to return to the Chewuch River) may be retained for broodstock purposes, of which, up to 121 natural origin fish (17% of the 680 natural origin fish projected to return to the Chewuch River) may be retained for broodstock purposes. If other trap locations at the Methow FH and Foghorn Dam experience collection shortfalls, additional fish may be collected over and above the 121 fish to effectively minimize the shortfall.

In-season estimates of run size and origin of spring Chinook to the Chewuch River will be made, similar to that described for the Methow River. The collection protocols will be modified as necessary to maintain an extraction of no more than 33% of the projected return. Fish collected at the Chewuch trap will be held at the Methow FH.

The trapping efficiency of the Fulton facility averaged 30% between 1992 and 1994, ranging from a low of 9.2 in 1992 to a high of 58.2% in 1993. Significant river flows in 1996 and 1997 disrupted the configuration of the dam, likely reducing the potential trapping efficiencies from those observed between 1992 and 1994. Maintenance work completed in the spring of 2001 was expected to return trapping efficiencies to approximately 60%. Unfortunately, the 2001 trapping efficiencies were approximately 3.5%, significantly less than anticipated. During the late winter/early spring of 2002, minor construction was again performed at the Fulton Dam site, seeking improvements to trapping efficiencies. Trapping efficiencies during the 2002 broodstock collection fell to just 0.3%, a clear indication that the modifications completed in 2001 and 2002 failed to return the trap to pre-1994 trapping efficiencies.

Current snow-pack in the Methow River Basin is low and reminiscent of conditions in 2001. Based on current snow-pack conditions, WDFW expects flow in the Chewuch basin to be similar to 2001 and therefore, expects trap extraction rates to be similar to 2001 (approximately 3.5%). WDFW anticipates the Fulton Dam trap to provide approximately 24 natural origin and 29 hatchery origin fish. Based on the anticipated collection at Fulton Dam, collections at the Methow FH will be required to address the shortfall in adult collections at Fulton Dam.

Twisp River

Twisp Weir 1 May – 30 July

Trap 7-days/week- Operated by WDFW personnel. A floating weir on the Twisp River provides for collection of Twisp stock spring Chinook. Historically, trap efficiency at this facility has been low, averaging 16% (range 10.4% – 23.7%) between 1992 and 1994. During the 2001 trapping season, the trap efficiency was just 6% and fell to just 0.2% in 2002. A modified V-trap installed along the weir sill, adjacent to the trap entrance, increased the trap efficiency in 2003 to 42%; however the 2004 trap efficiency was estimated at 19.2%. The installation of the permanent V-trap will allow trapping over a greater range of stream flows and should provide greater extraction potential than observed in 2004. To guard against extracting more than 33% of the natural origin return, WDFW assumes the weir to have 100% extraction potential. Based on an assumed 100% extraction potential, one of three natural origin fish captured will be retained for broodstock, effectively limiting the extraction to 33%.

Based on an escapement estimate of 1,167 fish, including 445 natural origin and 722 hatchery origin fish (2005 escapement and broodstock forecast), up to 121 fish (10.4% of the projected return to the Twisp River.) may be retained for broodstock purposes, of which a collection goal of 121 fish (27% of the projected natural origin return to the Twisp River) may be natural origin. In-season estimates of run size and origin of spring Chinook to the Twisp River will be made, similar to that described for the Methow River. The collection protocols will be modified as necessary to maintain an extraction of no more than 33% of the projected return. Twisp origin spring Chinook trapped at this site will be held at the Methow FH.

The Twisp weir poses several operating constraints, including stranding of steelhead and spring Chinook on the weir pickets during upstream and downstream movement. The new weir design is capable of submerging the pickets to allow stranded fish to swim off the pickets. The weir will be manned 24-hours/day to facilitate operation to minimize impact to steelhead kelts and spring Chinook fallback. If the new weir design and operation cannot adequately address kelt migration or spring Chinook fallback, trapping will cease and the weir removed (pending appropriate flow conditions).

Methow FH

Methow FH Outfall Trap 01 May – 30 July

Collection at the Methow Fish Hatchery outfall will be variable and dependent upon success of tributary collections. Outfall trapping will be used in conjunction with tributary traps, seining and angling to achieve a production level of 550,000 ESA-listed upper Columbia River spring Chinook smolts.

<u>Winthrop NFH</u>

Trapping is expected to occur at the Winthrop NFH and will be consistent with collection protocols provided by the USFWS. Additional adult collection at Winthrop NHF may occur, if required to meet broodstock collection shortfalls at the Methow FH, Foghorn Dam and Fulton Dam.

<u>Wells Dam</u>

No spring Chinook trapping at Wells Dam will occur unless the total annual adult return to Wells Dam is predicted to be 668 or less as identified in Section 10 Permit 1196.

Columbia River Mainstem below Wells Dam

Wells Hatchery Summer Chinook

Biological Assumptions

Wells program	320,000 yearling smolts (182 adults)
	484,000 subyearlings (266 adults)
Lake Chelan program	100,000 green eggs (44 adults)
Rocky Reach program	200,000 yearling smolts (114 adults)
	628,000 subyearlings (345 adults)
	450,000 accel. subyearling (247 adults)
Broodstock required	1,198
Broodstock composition	10% natural origin from west ladder
Pre-spawn survival	90%
Female to male ratio	1 to 1
Fecundity	5,000 eggs per female
Propagation survival	81% unfertilized egg to 0+ release
	78% unfertilized egg to 1+ release

Trapping Assumptions

Trapping period	14 July – 28 August (hatchery origin)
	01 July – 14 September (natural origin)
# Days/week	3
# Hours/day	16 (Monday-Wednesday)
Broodstock composition	10% natural origin from west ladder
Broodstock number	Not to exceed 33% of the population

The goal of the Wells/Turtle Rock summer Chinook program is to provide harvest augmentation. Those fish that are not harvested have the potential and have been documented to spawn in tributaries where supplementation is currently ongoing. Until a terminal fishery is developed or methods to reduce the number of Wells/Turtle Rock fish that spawn in tributaries are found, infusing natural origin genes into the broodstock will minimize the risk of inbreeding depression, genetic drift, and domestication selection. This is consistent with the objectives of the Harvest and Genetic Reserve program as outlined by NOAA Fisheries (Rob Jones, NOAA Fisheries, personal communication).

Collect 1,198 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall (1,077 hatchery fish) and west ladder (121 natural origin fish). The 3-year old component will be limited to 10% of the broodstock collection to minimize the potential of reduced production as a result of a strong 3-year-old age class, as was the case in 2001. In the event excess fish are collected, they will be returned to the Columbia River below Wells Dam.

<u>**Methow / Okanogan River Basins**</u>

Wells Hatchery Steelhead

Biological Assumptions

Wells HCP (Methow/Okanogan)	349,000 yearling smolts (178 adults)
Grant PUD BiOp (Methow/Okanogan)	100,000 yearling smolts (52 adults)
WNFH transfer (Methow River)	100,000 smolts (55 adults)
Ringold transfer (Columbia River)	180,000 smolts (88 adults)
Grant PUD Survival Studies	150,000 yearling smolts (76 adults)
Broodstock required	449 Adults
Natural origin/hatchery broodstock composition	
Wells Production [1/]	33% / 67%
Survival Studies	0% / 100%
Pre-spawn survival	97%
Female to male ratio	1 to 1
Fecundity	5,400 eggs per female
Propagation survival	87% fertilization to eyed egg
	86% eyed egg to yearling release
	75% fertilization to yearling release

[1/]- Includes Wells HCP, Grant PUD BiOp, Winthrop NFH and Ringold production.

Trapping Assumptions

Trapping period	01 July – 29 October
# Days/week	3
# Hours/day	16

Broodstock number/composition	
Wells Production	373 - (33% natural / 67% hatchery)
Survival Studies	76 - (0% natural / 100% hatchery)
Total Broodstock	449 – (27% natural / 735 hatchery)

Trapping efforts will selectively retain 449- steelhead at Wells Dam (East and West ladder collection), to attain a 33% natural origin component within the “Wells production” broodstock (123 natural origin steelhead) and 100% hatchery origin within the survival study production components. Overall collection will not exceed 33% of the expected return (hatchery or natural origin). Increasing the natural origin component within the broodstock to near 33% will provide opportunities to increase the HxW and WxW parental cross proportion from what has occurred previously under random run-at-large collections. Increasing the number of HxW and WxW parental crosses within the Wells Program is consistent with management objectives described in WDFW’s ESA Section 10 Permit 1395 Application and consistent with other upper Columbia River summer steelhead supplementation efforts. Collection within the “Wells Production” component will also be selective for adipose present hatchery origin steelhead (HxW parental crosses), consistent with production objectives. The east and west ladder traps at Wells Dam will be operated concurrently, three days per week, up to 16 hours per day. Trapping on the east ladder will be commensurate with summer Chinook brood stocking efforts through 14 September and will continue through 29 October, concurrent with west ladder collections. All steelhead excluded from the broodstock will be directly passed upstream at the trapping site or captured, examined and released upstream from the trap site.

Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and Wells dams. Broodstock collection adjustments will be made consistent with the estimated return of natural origin steelhead to Wells Dam and production objectives

APPENDIX B

Broodstock Collection

Task 1: Collect the required number of broodstock that represent the demographics of the donor population with minimal injuries and stress to target and non-target fish. (*Broodstock number, male to female ratio, run composition, run timing, trap efficiency, extraction rate*)

Task 1-1. Develop broodstock trapping protocol based on program goal, estimated escapement, number and age classes of returning wild fish, minimum proportion of wild fish required in the broodstock, and demographics of the donor population to achieve production levels (Table 1).

a. Ensure broodstock collection protocols are consistent with Section 10 Permits.

b. Reexamine and modify assumptions of the broodstock protocol to reflect recent data (e.g., male to female ratio, fecundity, prespawn survival, egg to smolt survival).

Table 1. Annual broodstock collection worksheet for Wells Complex programs.

Stock	Estimated escapement		Broodstock goal		Required extraction rate		Observed extraction rate			Estimated broodstock	
	W	H	W	H	W	H	Avg	Min	Max	W	H
Wells summer			121	1,077							
Wells steelhead			76	153							
Met comp. spring			242	0							
Twisp spring			121	0							

Task 1-2. Monitor operation of adult traps in the Twisp River, Chewuch River, Fulton Dam, Methow Hatchery, Wells Hatchery and Wells Dam. Ensure compliance with established broodstock collection protocols and Section 10 permits for each station.

a. Record date, start time, and stop time of trapping operations.

Task 1-3. Conduct in-season run forecasts and modify broodstock protocols accordingly (Table 2).

a. Monitor run timing at Columbia River dams and make comparisons using previous years data.

b. Determine run timing and size using PIT tag detections at Columbia River Dams.

c. Make recommendations to broodstock collection protocols to increase probability of collecting broodstock goal.

Table 2. In-season Chinook and steelhead escapement worksheet.

Stock	Pre-season run estimate	Cumulative passage dates during trapping period[1]				In-season run estimate
		25%	50%	75%	100%	
MEOK summer		12 Jul	22 Jul	08 Aug	14 Sept	
MEOK steelhead		29 Aug	15 Sep	28 Sep	31 Oct	
Met comp. springer		10 May	21 May	2 Jun	28 Jun	
Twisp spring[1]		10 May	21 May	2 Jun	28 Jun	

[1] To be determined at Twisp Weir following operation of new weir.

Task 1-4. Monitor timing, duration, composition, and magnitude of the salmon and steelhead runs at adult collection sites.

a. Maintain daily records of trap operation and maintenance, number and condition of fish trapped, and river stage.

b. Record species, origin, and sex of all fish collected for broodstock.

c. Record species, origin, and sex of all fish not collected for broodstock (i.e., passed upstream).

d. Collect biological information on trap-related moralities. Determine the cause of mortality if possible.

Task 1-5. Evaluate the efficacy of the broodstock protocol in achieving collection goals.

a. Summarize results and review assumptions, escapement estimates, extraction rates, and broodstock goals.

b. Calculate trapping efficiency (TE).

TE = Number of fish trapped/Estimated spawning escapement

c. Calculate extraction rate (ER).

ER = Number of fish collected/Estimated spawning escapement

d. Ensure broodstock collections follow weekly collections quotas.

e. Calculate trap operation effectiveness (TOE).

$$TOE = \frac{\text{Number of hours trap operated}}{\text{Maximum number of hours trap could operate per protocol}}$$

f. Calculate estimated maximum trap efficiency (i.e., TOE = 1).

$$\text{Estimated Max. TE} = \frac{\text{Number of fish trapped/TOE}}{\text{Estimated spawning escapement}}$$

g. Provide recommendations on means to improve adult trapping and refinements to broodstock collection protocols for each stock.

APPENDIX C

Hatchery Evaluation

Task 2: Conduct spawning operations and collect biological data from broodstock (*Age at maturity, length at maturity, spawn timing, fecundity)*

Task 2-1. Collect biological data from all broodstock during spawning including mortality (i.e., date, origin, scales, fork length and POH, DNA, CWT, and PIT tags).

a. All females are sampled for disease (i.e., kidney, spleen, ovarian fluid).

Task 2-2. Ensure proper mating schemes are followed that is consistent with the program objectives and per broodstock protocol.

a. One female per incubation tray unless physically separated within tray.

b. All egg lots will be run through an egg counter to determine fecundity

Task 3: Monitor growth and health during rearing and determine life stage survival rates for each stock at each of the Wells Hatchery Complex facilities. (*Broodstock survival*, j*uvenile hatchery survival, rearing density index, size at release, incidence of disease*)

Task 3-1. Monitor growth of juvenile fish during rearing and prior to release.

a. Collect end of month length and weight data.

1. Whenever possible, crowd fish and dip net into 500-1000 fish into a net pen.
2. Measure and record fork length on 100 fish to the nearest millimeter.
3. Dip net approximately 200 fish into a bucket and record weight. Calculate grams/fish by dividing total weight by number.
4. Repeat weight sample three times and calculate average weight of fish.

b. Collect length and weight data prior to release.

1. Whenever possible, crowd fish and dip net into 500-1000 fish into a net pen.

2. Measure and record fork length (nearest millimeter) and weight (nearest 0.1 g) on 200 fish.

c. Analyze data to ensure fish were released at the proper fork length, condition factor, and size distribution (i.e., CV of fork length).

Task 3-2. Calculate end of month density indices for juvenile fish.

a. Use end of month length and weight data and the total rearing volume to calculate rearing density index (DI).

$$DI = \frac{(\text{Population size* mean weight (lbs)})/\text{total rearing volume } (ft^3)}{\text{Mean fork length (inches)}}$$

Task 3-3. Monitor fish health, specifically as related to cultural practices that can be adapted to prevent fish health problems.

a. Standard hatchery fish health monitoring will be conducted monthly by fish health specialist, with intensified efforts to monitor presence of specific pathogens that are known to occur in the donor populations. Significant fish mortality of unknown cause(s) will be sampled for histopathological study.

b. Collect biological information on all adult broodstock moralities. Determine the cause of mortality whenever possible.

c. The incidence of viral pathogens in salmon and steelhead broodstock will be determined by sampling fish at spawning in accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Stocks of particular concern may be sampled at the 100% level and may require segregation of eggs/progeny in early incubation or rearing.

d. Determine antigen levels of *Renibacterium salmoninarum* (Rs, causative agent of bacterial kidney disease) in Chinook salmon broodstock by sampling fish at spawning using the enzyme-linked immunosorbent assay (ELISA).

e. If required, provide recommendations to hatchery staff on means to segregate eggs/progeny based on levels of Rs antigen, protecting “low/negative” progeny from the potential horizontal transmission of Rs bacteria from “high” progeny.

f. Autopsy-based condition assessments (OSI) or other physiological assessments deemed valuable would be used to assess hatchery-reared salmon smolts at release. If needed, perform assessments at other key times during hatchery rearing.

g. Provide recommendations on fish cultural practices at Wells Complex hatcheries and satellite stations on monthly basis. Summarize results for presentation in annual report or technical memorandum if applicable.

Task 3-4. Calculate various life stage survival rates for broodstock and juvenile fish (Table 3).

a. Use the stock inventory at time of tagging to recalculate population sizes and life stage survival rates.

Task 3-5. Summarize broodstock collection, spawning, rearing survival, and release information in an annual technical memorandum.

a. Where applicable, provide recommendations to increase survival rates of life stages that were lower than the survival standard or recommend studies to investigate causes of poor survival.

Task 4: Determine if broodstock collections and hatchery survival was adequate to achieve smolts releases at the programmed production levels (*Number of fish released, size at release*).

Task 4-1. Calculate the number of fish released from Wells FH Complex facilities.

a. If release numbers are within ± 10% of the production levels no further action required (Table 4).

b. If release numbers are not within ± 10% of the production levels determine what factors contributed to the shortage/overage.

Task 4-2. Calculate the size of fish released from Wells FH Complex facilities.

a. If size at release numbers is within ± 10% of the target no further action required (Table 5).

b. If size at release is not within ± 10% of the target determine what factors contributed to the shortage/overage.

Table 3. Hatchery life stage survival rate standards, 5 year mean (SD), and survival achieved for current brood year.

Life stage	Survival standard	Wells steelhead		Wells summer Chinook		Methow spring Chinook		Chewuch spring Chinook		Twisp spring Chinook	
		Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved
Collection-to-spawning	*90.0 Female*										
Collection-to-spawning	*85.0 Male*										
Unfertilized egg-to-eyed	92.0										
Eyed egg-to-ponding	98.0										
30 d after ponding	97.0										
100 d after ponding	93.0										
Ponding-to-release	*90.0*										
Transport-to-release	95.0										
Unfertilized egg-to-release	*81.0*										

Italics are revised survival standards

Table 4. Summary of the number of fish released from Wells FH Complex.

Stock	Target	5-year min.	5-year max.	5-year mean	Number released
Wells yearling summer Chinook	320,000	185,200	45,770	321,060	
Wells subyearling summer Chinook	484,000	370,617	498,500	416,369	
Methow spring Chinook	183,024	66,454	218,499	155,570	
Chewuch spring Chinook	183,023	0	261,284	143,092	
Twisp spring Chinook	183,024	15,470	75,704	53,668	
Wells steelhead	348,858	390,965	694,765	539,768	

Table 5. Size at release targets for fish released from Wells FH Complex.

Stock	Target		Actual	
	Fork length (CV)	Weight	Fork length (CV)	Weight
Wells yearling summer	176 (9.0)	45.4		
Wells subyearling summer	140 (9.0)	22.7		
Methow spring Chinook	154 (9.0)	30.2		
Chewuch spring Chinook	154 (9.0)	30.2		
Twisp spring Chinook	154 (9.0)	30.2		
Wells steelhead	198 (9.0)	75.6		

APPENDIX D

Post-release Survival and Harvest

Task 5: Determine whether the survival from release-to-adult of fish from the Wells Hatchery Complex is sufficient to achieve the program goal. (*Smolt to adult survival, hatchery replacement rate, exploitation rate, harvest rate*)

Task 5-1. Mark (i.e., adipose fin clip) and tag (i.e., coded-wire tag or elastomer) each stock subjected to ocean fisheries or mainstem Columbia River commercial, sport, or tribal fisheries with sufficient coded-wire tags (CWT) to estimate harvest contribution.

a. Provide summary of marked and unmarked smolt releases from the Wells Hatchery Complex.

b. Determine the statistical requirements to provide reliable estimates of escapement and harvest contribution. Determine the number of coded-wire tags and other marks needed in relation to the number of recoveries expected.

Task 5-2. Summarize information at time of release that may influence post-release survival and performance.

a. Calculate mean fork length (FL) at release, FL coefficient of variation (CV), and condition factor (K) for all stocks released from Wells Complex.

b. Summarize fish health information (e.g., reports, OSI, precocity rates).

c. Calculate the number of days rearing on well and river water. Calculate the number of days reared at acclimation sites.

Task 5-3. When applicable, estimate travel time and smolt-to-smolt survival rates of hatchery and wild fish using PIT tag recaptures.

a. Compare smolt-to-smolt survival, emigration rate, and duration with rearing water source, duration of acclimation, and size at emigration.

Task 5-4. Estimate the harvest contribution for each stock released from the Wells Hatchery Complex.

a. Compile CWT recovery data from Wells Hatchery releases for inclusion in reports.

b. Recover heads from marked (adipose fin clipped) returns to Wells Fish Hatchery Facilities during routine spawning operations. Transfer heads to WDFW tag recovery lab in Olympia, Washington.

c. Conduct statistically valid creel surveys during sport fisheries in the mid-Columbia River to estimate harvest and adult returns of hatchery stocks from Wells Complex releases.

d. For each brood year and run year, calculate exploitation rate and harvest rates in commercial, tribal, and sport fisheries.

Task 5-5. Estimate the contribution to spawning escapement for each stock released from the Wells Hatchery Complex.

a. Provide a summary of the number of fish contributing to spawning escapement, broodstock, commercial, sport, and tribal fisheries.

b. Calculate stray rates for all stocks released form Wells FH Complex facilities and compare with rearing water source and duration.

Task 5-6. Determine the smolt to adult survival rates (SAR) for each stock.

a. Determine the total estimated the number of hatchery adults recovered in all fisheries, hatcheries, and spawning ground surveys using CWT data.

b. To calculate SAR for salmon, use the estimated number of smolts released divided by the estimated number of hatchery adults.

c. To calculate SAR for steelhead, use the estimated number of smolts released divided by the estimated number of adults migrating pass Priest Rapids Dam

d. Examine the influence of size, fish health, rearing location, and acclimation on survival and straying.

e. Compare SARs using CWT recoveries and PIT tag recaptures of adults, when applicable.

Task 5-7. Determine the expected and actual hatchery replacement rate for each brood year (Table 6).

a. Calculate HRR by dividing the number of broodstock collected by the estimated number of returning adults.

b. For stocks that fail to meet or exceed the expected hatchery replacement rate determine the life history stage that limited survival.

Table 6. The expected and actual smolt to adult (SAR) and hatchery replacement rates (HRR) or adult to adult survival rates for Wells FH Complex programs.

Program	Number of broodstock	Smolts released	SAR	Adult equivalents	# smolts/ adult	HRR
Wells yearling summer Chinook						
Expected	182	320,000	0.003	960	333	5.3
Actual						
Wells subyearling summer Chinook						
Expected	266	484,000	0.0012	581	833	2.2
Actual						
Twisp spring Chinook						
Expected	121	183,024	0.003	549	333	4.5
Actual						
Methow spring Chinook						
Expected	121	183,024	0.003	549	333	4.5
Actual						
Chewuch spring Chinook						
Expected	121	183,023	0.003	549	333	4.5
Actual						
Wells steelhead						
Expected	229	348,858	0.010	3,489	100	15.2
Actual						

Appendix E

Smolt Production

Task 6: Calculate freshwater production estimates of anadromous salmonids from selected river systems (*Egg-to-smolt survival, smolts per redd, emigration timing, size at emigration*)

Task 6-1. Install and operate a rotary smolt trap(s) in a location downstream from the majority of the spawning areas and that allows operation throughout the emigration period.

Task 6-1-1. Identify potential trap positions based on variation in flows. Large variations in discharge may require alternate trap locations.

Task 6-1-2. Operate trap continuously throughout the emigration period.

a. During the first year of operation at a new location determine the extent of emigration during daylight hours. Significant emigration during the daylight hours will require trap efficiency trails to be conducted during both the day and night.

b. Trap should be checked at a minimum every morning of operation. Remove fish from the live box and place in an anesthetic solution of MS-222. Identify fish to species and enumerate.

c. Determine sample size requirements of target and nontarget species for biological sampling.

d. All fish should be allowed to fully recover in fresh water prior to being released in an area of calm water downstream from the smolt trap.

e. Pressure wash trap and clean debris from cone and live box prior to leaving.

Task 6-2. Collect daily environmental and biological data.

a. Record the time the trap was checked, water temperature, river discharge, and trap position, if applicable.

b. Identify species and enumerate all fish captured to include life stage for non-anadromous species (e.g., fry, juvenile, and adult) or degree of smoltification for anadromous species (i.e., parr, transitional, or smolt). Parr have distinct parr marks, transitional fish have parr marks that are fading and not distinct, and smolts do not have parr marks and exhibit a silvery appearance, often with a black band on the posterior edge of the caudal fin.

c. Examine all fish for external marks as a result of trap efficiency trails and record them as recaptures.

d. Record fork length and weight measurements for all fish, or per designated sample size. All fish to be used in mark/recapture efficiency trials will be measured and weighed, and again as subsequent recaptures. Fork length is measured to the nearest millimeter and weight to the nearest 0.1 g.

e. Scales samples should be randomly collected throughout the emigration period from species with multiple year class smolts (i.e., steelhead and sockeye).

Task 6-3. Conduct mark-recapture trials for target species to develop a discharge-trap efficiency linear regression model to estimate daily trap efficiency.

Task 6-3-1. Conduct mark/recapture efficiency trials throughout the trapping season at the largest range of discharge possible.

a. No less than 100 fish should be used for each trial.

b. Parr and smolts can be marked by clipping the tip of either the upper or lower lobe of the caudal fin. Alternate fin clip location for each trial. Fry should be marked with dye.

c. All marked fish should be allowed to recover in a live pen for at least 8 h before being transported to a release site at least 1 km upstream of the trap. Release marked fish across the width of the river, when possible, or equally along each bank in pools or calm pockets of water.

d. Nighttime efficiency trials should be conducted after sunset. Daytime efficiency trials should be conducted after sunrise.

e. The following assumptions should be valid for all mark-recapture trials:

   1. All marked fish passed the trap or were recaptured during time period *i*.

   2. The probability of capturing a marked or unmarked fish is equal.

   3. All marked fish recaptured were identified.

   4. Marks were not lost between the time of release and recapture.

f. Calculate trap efficiency using the following formula.

   Trap efficiency = $E_i = R_i / M_i$

Where E_i is the trap efficiency during time period *i*; M_i is the number of marked fish released during time period *i*; and R_i is the number of marked fish recaptured during time period *i*.

Task 6-3-2. Perform linear regression analysis using discharge (independent variable) and trap efficiency (dependent variable) data from the mark-recapture trails to develop a model to estimate trap efficiency on days when no mark-recapture trials were conducted. Separate models should be developed for each trap position and target species.

Task 6-4. Estimate daily migration population by dividing the number of fish captured by the estimated daily trap efficiency using the following formula:

Estimated daily migration = $\hat{N}_i = C_i / \hat{e}_i$

where N_i is the estimated number of fish passing the trap during time period *i*; C_i is the number of unmarked fish captured during time period *i;* and e_i is the estimated trap efficiency for time period *i* based on the regression equation.

Task 6-5. Calculate the variance for the total daily number of fish migrating past the trap using the following formulas:

Variance of daily migration estimate = $$\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{\mathrm{MSE}\left(1 + \frac{1}{n} + \frac{\ldots}{(n-1)s_X^2}\right)}{\hat{e}_i^2}$$

where X_i is the discharge for time period *i*, and *n* is the sample size. If a relationship between discharge and trap efficiency was not present (i.e., $P < 0.05$; $r^2 \lesssim 0.5$), a pooled trap efficiency was used to estimate daily emigration:

Pooled trap efficiency = $E_p = \sum R / \sum M$

The daily emigration estimate was calculated using the formula:

Daily emigration estimate = $\hat{N}_i = C_i / E_p$

The variance for daily emigration estimates using the pooled trap efficiency was calculated using the formula:

Variance for daily emigration estimate = $\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{E_p(1 - E_p) / \sum M}{E_p^2}$

Task 6-6. Estimate the total emigration population and confidence interval using the following formulas:

Total emigration estimate = $\sum N_i$

95% confidence interval = $1.96 \times \sqrt{\sum \mathrm{var}\lfloor N_i \rfloor}$

Task 7: Calculate survival rates at various life stage for target species.

Task 7-1. Calculate the total estimated egg deposition for the selected river.

a. When possible, estimated egg deposition should be based on the average fecundity of the spawning population. Hatchery broodstock randomly collected from the run should provide a representative sample of the spawning population.

b. Multiply the average fecundity by the total number of redds upstream of the trap location to estimate the total egg deposition.

Task 7-2. Calculate the egg-to-emigrant or egg-to-smolt survival of the target species, dependent on the trap location in the watershed and life history of the target species.

a. Egg-to-emigrant survival rates are calculated by dividing the total estimated number of subyearling and yearling fish of the same brood year by the total estimated number of eggs deposited.

b. Egg-to-smolt survival rates are calculated by dividing the total estimated number of smolts of the same brood year by the total estimated number of eggs deposited. For species with multiple year class smolts, the egg-to-smolt survival may require several years of trapping data.

Task 7-3. Calculate egg-to-parr and parr-to-smolt (i.e., overwinter) survival for target species.

a. Egg-to-parr survival rates are calculated by dividing the total estimated number of parr the total estimated number of eggs deposited. Parr estimated are derived independently using snorkel methodologies described in Hillman and Miller (2002).

b. Parr-to-smolt survival rates are calculated by dividing the overwinter population by the total estimated number of smolts that emigrated that following spring. The overwinter population is calculated by subtracting the estimated number of parr that emigrated following the completion of the summer parr estimate.

c. To estimate the parr-to-smolt survival rate of those parr that emigrated, representative samples of subyearling and yearling emigrants should be PIT tagged (*N* = 5,000/group). Subsequent PIT tag survival analysis would provide the relative survival of the two groups. The estimated number of parr could be converted to smolts based on the reduced survival. Subsequently, an egg-to-smolt survival estimate (versus and egg-to-emigrant) could be calculated.

Appendix F

Spawner Escapement and Distribution

Task 7: Determine the stock demographics, spawn timing, redd distribution, redd abundance, and estimate the spawning escapement of selected streams (*spawner escapement, proportion of hatchery fish, fish per redd, number of precocial fish, sex ratio, redd distribution, spawn timing, stray rate*).

Task 7-1. Delineate survey reaches of all available spawning habitat. Whenever possible, use historical reaches for comparisons across years.

a. Reaches should not take longer than one day to survey.

b. Historical reaches can be subdivided if required.

c. Beginning and end points of reaches should be fixed locations (e.g., confluence with a stream or bridge).

Task 7-2: Conduct comprehensive spawning ground surveys of all available spawning habitat and count all redds within a selected stream (i.e., total redd count).

a. Conduct weekly surveys of all reaches by foot or raft. The survey period should begin at the earliest known date of spawning and continue until no new redds have been observed within a reach.

   1. One person can conduct surveys on small stream were both stream margins are easily observed. Two people should conduct surveys whenever both stream margins cannot be easily observed from a location.

   2. When a raft is used to conduct surveys, two observers should be in a elevated position at the front of the raft while one person navigates the raft.

b. Individually number all completed redds.

   1. In areas with low spawner density, flagging can be placed on the nearest vegetation. Data on flag should include unique redd number, distance from flag to redd, and date. Data recorded in field notes should include date, water temperature, reach, and redd number. If applicable, the number and origin of the fish on the redd should be recorded.

   2. In areas with medium and high spawner density, mapping of redds is required. Site specific (e.g., a single riffle), area specific (e.g., section of stream between two power lines), or aerial photographs can be used to

annotate redds. Redds should be uniquely number on the map(s). Different symbols should be used complete, incomplete, and test redds.

3. All completed redds should have the correct redd morphology (i.e., well developed tailspill and pit or the appropriate size for the target species). Incomplete redds have fish actively constructing a redd, but no completed. Test digs are disturbed areas of substrate that do not have the correct morphological characteristics for the target species.

Task 7-3: Conduct index spawning ground counts and estimate the total number of redds in a selected stream.

Task 7-3-1: Identify index reaches in selected tributaries.

a. Index reaches should overlap historical reaches whenever possible.

b. Index reaches should be identified in streams with known or suspected spawning populations.

c. Index reaches should be located in the core spawning locations of the stream.

d. Multiple index areas should be identified for streams when any of the following apply:

   1. Potential spawning habitat of target species cannot be surveyed in one day for any reason.

   2. Large tributaries enter the stream that may affect visibility.

   3. Significant gradient changes that may affect visibility.

Task 7-3-2: Conduct comprehensive spawning ground surveys and count all redds within an index area (See Task 5-2).

Task 7-3-3: Conduct a final survey of the entire reach(s) at the end of spawning or after peak spawning if poor water conditions are expected (n_{total}).

a. Count all redds in each reach. Marking redds is not required.

b. A different surveyor should survey within the index area. Count only redds that are visible.

c. Calculate an index expansion factor (*IF*) by dividing the number of visible redds in the index by the total number of redds in the index area.

$$IF = n_{visible} / n_{total}$$

d. Expand the non-index area redd counts by the proportion of visible redds in the index to estimate the total number of redds in the entire reach (*RT*).

$$RT = n_{non-index} / IF$$

e. Estimate the total number of redds (*TR*) by summing the reach totals.

$$TR = \sum RT$$

Task 7-4: Conduct comprehensive modified-peak spawning ground surveys and estimate the total number of redds in a selected stream.

Task 7-4-1: Establish index areas per Task 5-3-1.

Task 7-4-2: Conduct comprehensive spawning ground surveys and count all redds within an index area (See Task 5-2).

Task 7-4-3: Conduct comprehensive peak spawning ground surveys within non-index and index areas.

a. Different survey crew must perform the index area total counts and the index area peak counts.

b. Count all visible redds within the non-index area, but do not individually mark the redds.

Task 7-4-4: Calculate an index peak expansion factor (*IP*) by dividing the peak number of redds in the index by the total number of redds in the index area.

$$IP = n_{peak} / n_{total}$$

Task 7-4-5: Expand the non-index area peak redd counts by the *IP* to estimate the total number of redds in the entire reach (*RT*).

$$RT = n_{peak} / IP$$

Task 7-4-6: Estimate the total number of redds (*TR*) by summing the reach totals.

$$TR = \sum RT$$

Task 7-5: Conduct carcass surveys on selected streams and collect biological data from a representative sample (i.e., 20%) of the spawners.

a. Determine the sampling protocol based on escapement and effort. A sampling rate of 100% of all carcasses encountered is normally required, the exception is for sockeye.

b. Collect biological data from all carcasses sampled, including:

1. Sex.
2. Fork and post orbital-to-hypural length (cm).
3. Scales.
4. Remove snout including the eyes for CWT analysis is adipose fin-clipped or if origin is undetermined.
5. Number of eggs in body cavity, if body cavity is intact.
6. DNA tissue (5 hole punches from opercle) if applicable.

c. All biological information should be recorded on the scale card to include:

1. Date.
2. Stream.
3. Reach.
4. Stream survey tag number if snout was collected.
5. DNA sample number if tissue was collected.

d. All sampled carcasses must have the tail removed (posterior of the adipose fin) and placed back into the stream after data have been recorded.

Task 7-6: Conduct snorkel surveys on redd to determine the incidence of precocial fish spawning in the wild.

a. Determine sampling protocol based on escapement and personnel.

b. Survey crews should consist of two snorkelers.

c. Snorkel surveys should be conducted only on active redds (i.e., presence of spawning female).

d. Snorkel surveys should be conducted in an upstream direction.

e. Record the number of males by size (e.g., adult, jack, or precocial) and origin (e.g., wild or hatchery).

Task 7-7: Determine the spawning distribution of wild and hatchery fish in a selected stream.

a. Assume the carcass recovery location (i.e., reach) is also the spawning location.

b. Calculated the proportion of the spawning population that spawned in each reach and compare with historical values (i.e., before supplementation).

c. Compare the proportion of each component (i.e., wild and hatchery) that spawned in each reach.

Task 7-8: Calculate a sex ratio and fish per redd ratio (i.e., redd expansion factor) for a selected stream.

a. Sex ratios for spawning populations should be calculated for the hatchery broodstock if the broodstock was randomly collected from the run-at-large.

b. If broodstock stock was not collected randomly from the run-at-large, trapping records can be used in conjunction with the broodstock to develop a random sample provided sex was recorded for those fish trapped and released.

c. Once a sex ratio has been determined for a stock (e.g., 1 female: 1.5 males) a redd expansion factor can be calculated by summing the ratio (e.g., 1 female: 1.5 males = 2.5 fish per redd).

    1. Assumptions associated with this methodology include: a female constructs only one redd and male fish only spawn with one female.

d. This redd expansion factor can be applied to stocks without a hatchery broodstock, but have similar age compositions.

e. An alternative method (Meekin 1967) involves using previously calculated adults per redd values (i.e., 2.2 adults/redd for spring Chinook and 3.1 adults/redd for summer Chinook) and adjusting for the proportion of jacks in the run (e.g., jack spring Chinook comprise 10% of the run. The redd expansion factor = 2.2 x 1.1 = 2.4 fish/redd).

Task 7-9: Calculate the proportion of hatchery fish (target and non-target or strays) on the spawning grounds.

a. The proportion of hatchery on the spawning grounds is determined via scale analysis from carcasses randomly collected over the spawning period and all available habitat.

b. Stray rates are calculated from CWT recoveries divided by tag rate and sample rate.

Task 7-10: Summarize length-at-age and age-at-maturity data for the spawning population.

Appendix G

Relative Spawner Abundance Monitoring

Task 8: Determine if the relative abundance of supplemented populations is greater than non-supplemented populations and the influence the relative proportion of hatchery origin spawners may have on the abundance (*NRR, recruits*).

Task 8-1. Calculate the adult-to-adult survival rates or natural replacement rate (NRR) for selected stocks using the formula

$$NRR = r_{i+1} + r_{i+2} + r_{i+3} + \cdots / S_i$$

a. Estimate the number of spawners (*S*) from redd counts during year *i* by expanding the total redd count by a redd expansion value. When comparing across years, the number of spawners should be calculated using the same methodologies.

1. When available, use the sex ratio of broodstock randomly collected from the run as the redd expansion factor.

2. The alternate method would be the modified Meekin method that is calculated using a 2.2 adults/redd values expanded for the proportion of jacks within the run.

b. Estimate the number of recruits (*r*). When applicable, use the age composition derived from broodstock randomly collected from the run in stock reconstruction. Age composition data derived from spawning round surveys may bias towards larger and older fish.

1. Exploitation rate of hatchery fish (indicator stock) may be used for naturally produced fish provided the stock was not subjected to selected fisheries. In which case, a hooking mortality should be applied and recruits adjusted accordingly.

2. Stocks without a hatchery component (i.e., reference streams) may use exploitation rate of supplemented stock provide there is no difference in run timing or probability of harvest.

c. Conduct spawner-recruit analysis to explain density dependent effects within each of the supplemented and reference stream and correlate with the proportion of hatchery spawners for each brood year.

Task 8-2. Compare NNR of supplemented stream and reference stream to detect differences due to supplementation program.

a. When possible, establish baseline conditions (i.e., before supplementation) for supplemented and reference streams. Ensure spawning data is comparable across years and calculated using similar methodologies for each stream, preferably both streams.

b. High variability in SAR may preclude use of NRR.

Task 8-3. Compare the relationships of the number of smolts per redd (independent variable) and NRR (dependent variable) of the supplemented and reference streams.

a. Conduct regression analysis using number of smolts per redd and NRR of both the supplemented stream and reference stream. Adjust the number of smolts per redd variable for differences in the number of Columbia River hydro projects between the supplemented and reference streams.

b. Perform statistical analysis to determine if the slope of the two regression equations is similar.

Task 8-4. Conduct statistical analysis to determine what influence hatchery fish may have on relative abundance.

a. Examine the relationship between the proportion of hatchery fish on the spawning grounds and NRR.

b. Examine the relationship between the proportion of hatchery fish on the spawning grounds and egg-to-emigrant survival.

c. Examine the relationship between the proportion of hatchery fish on the spawning grounds and the number of smolts per redd.

d. Examine the relationship between the proportion of hatchery fish on the spawning grounds and smolt-to-adult survival.

Appendix H

Genetics

Task 9: Determine if genetic variation of hatchery-origin fish is similar to that of donor population and naturally produced fish in supplemented populations (*Genetic variation, proportionate natural influence*).

Task 9-1. Establish a genetic sampling and analysis schedule for programs in the Wells FH Complex.

a. Prioritize programs for evaluation relative to recovery monitoring needs. An example scheme is shown in Table 7.

b. Determine if adequate genetic samples (N= 50 to 100 per year for at least 2 years) of donor population per program have been collected.

c. If necessary, design a sampling plan to collect additional donor population samples.

d. Determine whether suitable DNA markers are available or need to be developed for target species.

e. Determine the number of genetic samples from current wild population(s) and hatchery-origin adults that need to be collected each year of an evaluation period (period length depends on species).

f. Develop annual schedule of laboratory analysis and reporting with agency genetics staff.

g. Conduct analyses and evaluate results.

h. Determine the frequency of analysis necessary for long-term monitoring of genetic variation in naturally produced and hatchery-origin populations.

Table 7. Example of prioritized genetic sampling and analysis scheme for evaluation of Wells FH programs (D=Donor population pre-hatchery program, H=hatchery, NP=naturally produced).

Stock	Origin	Last samples collected			Priority	Start year
		Year(s)	*N*	Stage		
Twisp spring Chinook	D				1	2006
	H				1	2006
	NP				1	2006
MetComp spring Chinook	D				2	2007
	H				2	2007
	NP				2	2007
Wells Steelhead	D				3	2008
	H				3	2008
	NP				3	2008
Wells summer Chinook	D				4	2009
	H				4	2009
	NP				4	2009

Task 9-2. In conjunction with genetic sampling schedule, conduct evaluation of phenotypic traits that serve as indicators of potential domestication impacts of hatchery programs

a. Determine availability and applicability of historical phenotypic data from donor populations. If data are not adequate, develop plan to acquire appropriate contemporary data.

b. Determine availability and extent of phenotypic data from current hatchery and natural populations and whether sample sizes from annual samples are adequate. Phenotypic data sets should extend over a series of years to account for effects of environmental variability. Plan data collection schedule if necessary for current populations.

c. Conduct data analysis using appropriate statistical methods.

d. Where available spawning ground survey data are suitable, calculate recent and historical proportionate natural influence (PNI; formula shown below) for target stocks. Develop survey protocol where data are unavailable, and collect spawning ground data for target stocks throughout evaluation period in order to calculate PNI.

$$PNI = \frac{\text{proportion of natural produced fish in the broodstock (pNOB)}}{\text{pNOB + proportion of hatchery fish on the spawning grounds (pHOS)}}$$

Task 10: Determine if genetic stock structure of within-basin natural populations has changed due to effects of hatchery programs.

Task 10-1. Establish a sampling and analysis schedule for potentially affected populations in the Upper Columbia Basin.

a. Based on program prioritization established in Task 9-1, determine if adequate historical genetic samples (N= 50 to 100 per year for at least 2 years) of potentially affected populations are available.

b. If necessary, design and conduct a sampling plan to collect appropriate within-basin population samples. An example scheme is shown in Table 8 relative to the Chiwawa spring Chinook program.

c. Depending on baseline data available (historical and/or recent), develop data analysis plan to assess temporal variability of with-in basin genetic population structure over meaningful time frames.

d. Develop schedule of laboratory analysis and reporting with agency genetics staff.

e. Conduct analyses and use results to determine subsequent evaluation needs.

Task 10-2. Establish a field sampling and data analysis program to verify and monitor impacts from hatchery programs on affected within-basin populations.

a. Based on genetic results from Task 10-1, design a sampling plan to enumerate hatchery-origin strays within non-target, affected populations and to collect genetic samples of naturally produced fish of pertinent brood years from these populations.

b. Conduct genetic laboratory and statistical analyses and evaluate results.

c. Determine the frequency of analysis necessary for long-term monitoring of genetic effects of hatchery supplementation fish on non-target natural populations.

Table 8. Example of genetic sampling and analysis scheme for evaluation of effect of Methow spring Chinook supplementation program on within-basin population structure (NP=naturally produced).

Stock	Origin	Last samples collected			Priority	Year
		Year	*N*	Stage		
Twisp spring Chinook	NP				1	2006
Methow spring Chinook	NP				1	2006
Chewuch spring Chinook	NP				1	2006
Entiat R. spring Chinook	NP				1	2006

Task 11: Determine if effective population size (N_e) of target natural spawning populations increases at rate expected given an increase in hatchery-origin fish on the spawning grounds.

a. In order to estimate current or baseline N_e, assess whether temporal samples of naturally spawning populations planned in Task 9-1(e) provided the necessary genetic data from natural-origin adults of same brood year from at least three brood years. (Indirect estimates of N_e are made from temporal variation of gene frequencies or genetic linkage disequilibrium in cohorts).

b. If adult (by brood year) sample sizes are adequate, estimate N_e for the base period using genetic methods.

c. If adult (by brood year) sample sizes are not adequate, design and conduct genetic sampling of same brood year naturally produced juveniles for at least a three year period.

d. Conduct laboratory analyses to collect genetic data from juvenile samples and estimate N_e.

e. Compare N_e results to spawning ground survey estimates of annual spawner population census sizes, and proportions of naturally spawning hatchery- and wild-origin fish.

f. At least one generation later, assuming supplementation program is providing large proportions of hatchery-origin fish and their natural adult progeny on spawning grounds, ensure that sampling for other evaluation and monitoring purposes includes adequate temporal genetic samples of same-brood year natural adults.

g. Conduct laboratory analyses to collect genetic data from adult samples *if* these data are not being collected to accomplish another evaluation task.

h. Estimate N_e for the later period using genetic methods and compare results to survey data on census size and hatchery/wild proportions.

Appendix I

Monitoring non-target taxa of concern

Task 12: Monitor non-target taxa of concern (NTTOC) to determine if impacts are within acceptable levels.

Task 12-1. Identify NTTOC for each target stock and define acceptable level of impact associated with hatchery program (Table 9).

Task 12-2. Identified the most probable interactions (Table 10) that would impact NTTOC as described by Pearsons et al. (19XX).

Task 12-3. Conduct risk assessment to prioritize monitoring effort (Table 11).

Task 12-4. Monitor size, distribution, and abundance of NTTOC as it relates to target stock and determine impact levels.

a. Monitor size and abundance of NTTOC using smolt traps.

b. Monitor distribution of NTTOC using snorkel surveys.

c. If impact levels exceed acceptable levels determine if changes in NTTOC are correlated to changes in production levels, size of fish released from hatchery, or location hatchery fish are released.

   1. Determine if changes in abundance are a result from predation, disease, or competition.

   2. Determine if changes in size are a result of competition.

   3. Determine if changes in distribution are a result of predation, disease, or competition.

Task 12-5. Develop and implement specific research studies to determine causation of impacts to NTTOC.

Table 9. NTTOC containment objectives for hatchery programs in the Upper Columbia River ESU. Impacts are defined as the decline in one or more variables (size, abundance, and distribution) that can be attributed to hatchery fish.

Target Species/Stock	NTTOC	Containment Objective
Common to all programs	Bull trout	No impact (0%)
	Pacific lamprey	No impact (0%)
	Mountain sucker	Very low impact (≤ 5%)
	Leopard dace	Very low impact (≤ 5%)
	Westslope cutthroat	Low impact (≤ 10%)
	Resident *O. mykiss*	Low impact (≤ 10%)
	Mountain whitefish	Moderate impact (≤ 40%)
	Other native species[1]	High impact (≤ Maximum)
Twisp spring Chinook	Methow steelhead	No impact (0%)
	Twisp spring Chinook	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Metcomp spring Chinook	Methow spring Chinook	No impact (0%)
	Chewuch spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Methow steelhead	Methow spring Chinook	No impact (0%)
	Chewuch spring Chinook	No impact (0%)
	Twisp spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Methow summer Chinook	Methow spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Okanogan summer Chinook	Okanogan steelhead	No impact (0%)
	Okanogan summer Chinook	Low impact (≤ 10%)
Wells summer Chinook	Methow spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Okanogan steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
	Okanogan summer Chinook	Low impact (≤ 10%)

1/ Native species refers to all other species endemic to the subbasin. Impacts to should not exceed a level required to maintain a sustainable population.

Table 10. Species interactions between hatchery programs and NTTOC (C=competition, F=Prey for predators, P=Predation, D=disease).

Hatchery program	NTTOC	Interaction			
		Type	Risk	Potential	Uncertainty
Methow/Twisp spring Chinook	Steelhead	C, F, D	Low	Low	Mod.
	Spring Chinook	C, F, D	High	Mod	High
	Bull trout	C, F, D	Low	Low	Low
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Mod	Mod	Mod
	Mountain sucker	C, F, D	Low	Low	Low
Wells steelhead	Spring Chinook	C, P, D	Mod	Mod	Low
	Summer Chinook	C, P, D	Mod	Mod	Low
	Sockeye	C, P, D	Low	Low	Low
	Bull trout	C, P, D	Low	Low	Low
	WCT	C, P, D	Mod	Mod	Low
	Resident *O. mykiss*	C, P, D	Mod	High	Mod
	Mountain sucker	C, P, D	Low	Low	Low
	Pacific lamprey	C, P, D	Low	Low	Low
	Leopard dace	C, P, D	Low	Low	Low
Wells summer Chinook	Spring Chinook	C, F, D	High	Mod	Mod
	Steelhead	C, F, D	Low	Low	Low
	Bull trout	C, F, D	Low	Low	Low
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Low	Low	Low
	Mountain sucker	C, F, D	Low	Low	Low
	Pacific lamprey	C, F, D	Low	Low	Low
	Leopard dace	C, F, D	Low	Low	Low

Table 11. Risk assessment of target and nontarget taxa for hatchery programs.

Target species	Interactors	Life stage	Interaction	Risk Assessment
Spring Chinook	Steelhead	Fry, parr	F, C	Low
	Spring Chinook	Fry, parr, smolt	C, D	Low
	Bull trout	Fry, parr	F, C	Low
Steelhead	Spring Chinook	Fry, parr, smolt	P, C, D	High
	Summer Chinook	Fry, parr, smolt	P, C, D	High
	Steelhead	Fry, parr, smolt	P, C, D	Mod
Summer Chinook	Spring Chinook	Smolt	C, D	Low
	Steelhead	Fry, parr, smolt	P, C, D	Mod

Appendix J

Disease monitoring of hatchery programs

Task 13: Determine if hatchery programs have influenced incidence or magnitude of disease in hatchery and naturally produced fish.

Task 13-1. Monitor disease in broodstock and juvenile fish.

a. Sample all female broodstock for disease per WDFW Fish Health protocols.

   1. Monitor density and flow index in adult holding pond.

   2. Examine relationship between holding conditions and disease.

b. Sample juvenile fish monthly and prior to release to develop disease profile (*N*=30).

   1. Monitor density and flow index during rearing.

   2. Examine relationship between holding conditions and disease.

c. Sample naturally produced fish monthly, both upstream and downstream of acclimation ponds or release sites (*N*=30).

d. Sample naturally produced fish monthly from a population without hatchery program (*N*=30).

Task 13-2. Examine the influence between the incidence of disease in the broodstock and progeny.

Task 13-3. Monitor incidence of disease in hatchery effluent and natural environment.

a. Collect monthly water samples from hatchery effluent and upstream and downstream of acclimation ponds.

b. Determine if acclimation ponds increase disease load in river.

Appendix B

Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs

ANALYTICAL FRAMEWORK FOR MONITORING AND EVALUATING PUD HATCHERY PROGRAMS

Final

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Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs

This document is a supplement to the Monitoring and Evaluation Programs for the Mid-Columbia PUDs Hatchery Programs (e.g., Murdoch and Peven 2005; Cates et al. 2005). The analyses and data used to support the information contained in this document are subject to change as new information becomes available. Any changes to these programs are subject to the approval of the HCP Hatchery Committees or PRCC Hatchery Subcommittee as appropriate.

There are currently 10 objectives associated with monitoring the effectiveness of hatchery programs funded by the mid-Columbia PUDs (Murdoch and Peven 2005; Cates et al. 2005). For each objective specific data are needed to assess the risks to the resource and to determine if the hatchery programs are meeting their goals. Effectiveness monitoring requires analytical rules that guide statistical analyses and management decisions. In many cases these rules come directly from agreements between the agencies and the PUDs. Other rules are made outside the directives of the agreements, but nonetheless are necessary in managing hatchery programs and guiding effectiveness monitoring. Identified below are descriptions of analytical rules that need to be made in developing a hatchery monitoring program.

Effect Size—Effect size refers to the size of change in a variable that constitutes the level of acceptable change. More formally, it is the amount of departure of the data from the null hypothesis (i.e., that the treatment or management action has resulted in no important change in the variable) that is needed before accepting the alternative hypothesis (i.e., that the treatment or management action has resulted in an important or unacceptable change in the variable). Effect size should be identified before conducting effectiveness monitoring and is usually identified in binding agreements (e.g., number and size of hatchery smolts produced) or is a policy decision associated with the risk or scientific uncertainty in the parameter of interest.

Minimum Detectable Difference (a.k.a. Minimum Detectable Effect Size)—The size of change in the variable of interest (e.g., the difference between the treatment and reference condition) that can be detected statistically at the specified significance level, power, and sample size. The minimum detectable difference could be greater than the effect size identified by management.

Type I Error—A Type I Error occurs when one concludes that there is a difference between treatment and reference condition when in fact there is no difference. This error may be costly to funding entities, because one may conclude that the hatchery program is not successful when in fact it is. Committing a Type I Error may result in additional studies or management actions that are not necessary. This error is under the control of the investigator and is set before conducting effectiveness monitoring. In this plan, we follow the generally accepted standard of $P < 0.05$ (i.e., a 5% chance of committing a Type I error).[22]

Type II Error—A Type II Error occurs when one concludes that there is no difference when in fact there is a real difference. This error may be harmful to the resource, because one may conclude that the hatchery program is successful when in fact it is not. This error can be reduced by selecting the appropriate sample size needed to detect a biological or practical effect size (see below).

Power—Power is the probability that a statistical test will result in a significant difference (reject the hypothesis of no difference when there is truly a difference—a correct decision). More technically, it is the probability of detecting a specified treatment effect when it is present. This is the intent of all monitoring programs. Power is calculated as 1 – Type II Error.

Sample Size—Sample size indicates the number of replicates (in space or time) that is needed to avoid making a Type II error (failing to reject the hypothesis of no difference). Typically, a larger sample size is needed to increase power (or reduce the probability of a Type II error).

The monitoring program is set up so that the null hypothesis is stated as “no difference.” Therefore, in some but not all cases, the null hypothesis will be stated such that the supplementation program has no harmful effect on the natural population (or that hatchery goals have been met). The alternative hypothesis is that supplementation has harmed the natural population. In this case, failure to reject the null hypothesis leads to the conclusion that there is no real evidence that supplementation has harmed the natural population. In other words, the data have to provide “evidence” that the supplementation program is harmful. The supplementation program is “innocent” until proven “guilty.”[23]

A primary goal of supplementation is to contribute to the rebuilding and recovery of naturally reproducing populations within their native habitat. In this plan, natural replacement rates (NRR), recruitment of naturally produced fish (NOR), and juvenile productivity (juveniles/redd) are important indicators for assessing the success of supplementation. However, these indicators are difficult to measure precisely and are

[22] In this plan we do not attempt to make an experiment-wide error-rate adjustment. Our analyses are predicated on the idea that all of the null hypotheses are true. Making an adjustment effectively penalizes us for conducting multiple tests, because the standard for rejection of the null hypothesis increases as more tests are conducted. Yet it is the pattern of which particular tests are rejected that is important in this program. Adjusting the error-rate may cause us to throw out this important information (see Gotelli and Ellison (2004) for a discussion on error-rate adjustments). We do, however, avoid excessive statistical tests that are not independent of one another.

[23] The alternative is to state the null hypothesis so that the supplemented population and reference population are not equivalent (the concept of bioequivalence). In this case the data have to provide evidence that the null hypothesis is not true before the populations are declared to be equivalent (i.e., supplementation has no harmful effects). Thus, an adverse effect is assumed unless the data suggest otherwise.

quite variable in space and time (i.e., these measures can carry high uncertainty).[24] Therefore, this plan identifies several other indicators that will be measured to help explain some of the uncertainty associated with productivity indicators. These monitoring indicators, which are either directly or indirectly affected by the hatchery programs, can be evaluated to determine if changes (or no changes) in productivity were related to the hatchery programs or other unexplained factors. These indicators include stray rates, hatchery replacement rates, genetics, run timing, spawn timing, spawning distribution, age-at-maturity, and size-at-maturity.

The relationship between supplementation hatchery programs and indicators can be viewed in a chain-of-causation (Figure 1). That is, management actions within hatchery programs affect the status of monitoring indicators, which influence productivity indicators. Non-supplementation programs, such as harvest-oriented programs, include many of the same factors.

Figure 1. The relationship of indicators to the assessment of supplementation programs viewed in a chain-of-causation. In the chain-of-causation, the hatchery program affects monitoring indicators, which influence productivity indicators. Data may be available in the future that identify monitoring indicators having greater influence on productivity.

Both monitoring and productivity indicators will be used to evaluate the success of hatchery programs. In the event that productivity indicators cannot be measured with enough precision (e.g., 95% certain that the point estimates fall within some specified range of the true value) to make sound decisions, some of the monitoring indicators may be used instead.

Identified below are the types of indicators (monitoring or productivity) associated with each objective described in Murdoch and Peven (2005). For each indicator we identified monitoring questions, specific populations and species associated with each indicator, hypotheses, measured variables, derived variables, spatial and temporal scales of

[24] Natural replacement rates are affected by many factors that are independent of the hatchery programs. For example, natural replacement rates are affected by climatic conditions; mainstem, estuary, and ocean conditions; predators and competitors; different fisheries; and habitat. These factors add variability (uncertainty) to estimates of productivity.

analysis, and statistical analyses. Lastly, we identified draft analytical rules for each indicator. We included effect sizes and statistical rules for each indicator.

<u>Objective 1</u>: Determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and if the change in the natural replacement rate (NRR) of the supplemented population is similar to that of the non-supplemented population.

At the core of a supplementation program is the objective of increasing the number of spawning adults (i.e., the combined number of naturally produced and hatchery fish) in order to affect a subsequent increase in the number of returning naturally produced fish or natural origin recruits (NOR). This is measured as the Natural Replacement Rate (NRR) or the ratio of NOR to the parent spawning population. The proportion of the hatchery origin spawners that will increase natural production without creating adverse effects to the genetic diversity or reproductive success rate of the natural population is not known. All other objectives of the M&E Plan either directly support this objective or seek to minimize impacts of the supplementation program to non-target stocks of concern.

Differences in carrying capacities of supplemented and non-supplemented streams can confound the effects of supplementation on total number of spawners returning to the streams. For example, if the supplemented population is at carrying capacity and the non-supplemented population is not, the total number of spawners returning to the non-supplemented population may show an increasing trend over time, while the supplemented population would show no increasing trend. To avoid concluding that the supplementation program has no effect or perhaps a negative effect on total spawners, the capacity of the habitats must be estimated and removed from the analyses. The Supplementary Hypotheses offered under each “regular” hypothesis are designed to remove the confounding effects of different carrying capacities from the analyses.

1.1 Adult Return Rates of Hatchery Fish (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the annual number of hatchery fish that spawn naturally greater than the number of naturally and hatchery produced fish taken for broodstock?

Target Species/Populations:

- Q1 applies to all supplemented species and populations.

Hypothesis:

- Ho_1: The annual number of hatchery produced fish that spawn naturally is less than or equal to the number of naturally and hatchery produced fish taken for broodstock.
- Ha_1: The annual number of hatchery produced fish that spawn naturally is greater than the number of naturally and hatchery produced fish taken for broodstock.

Measured Variables:

- Number of hatchery produced fish on spawning grounds annually
- Number of naturally and hatchery produced fish removed for broodstock annually

Derived Variables:

- No derived variables needed for the analysis

Spatial/Temporal Scale:

- Analyzed annually based on return year.
- On a five-year period analyze return years for patterns that correlate with extraneous factors such as ocean conditions.

Statistical Analysis:

- No statistical test is needed for hypothesis 1.
- Additional analysis over time may include correlating (regressions analysis) escapements with other extraneous variables (e.g., ocean conditions, climatic effects, etc.).
    - Analysis may include the use of reference areas.

Analytical Rules:

- This indicator is simply used to document whether or not the annual number of hatchery fish that return and spawn is greater than the number of naturally and hatchery produced fish taken for broodstock.
- No statistical analysis is needed.

1.2 Hatchery Contribution to Recruitment of Naturally Produced Fish (*Productivity Indicator*)

Monitoring Questions:
Q1: Is the annual change in the number of natural origin recruits (NORs) produced from the supplemented population greater than or equal to the annual change in NORs in a non-supplemented population?

Target Species/Populations:
- Q1 applies to all supplemented species and populations assuming reference populations are available.

Hypothesis:
- Ho_1: ∆NOR/Max Recruitment $_{\text{Supplemented population}}$ ≥ ∆NOR/Max Recruitment $_{\text{Non-supplemented population}}$
- Ha_1: ∆NOR/Max Recruitment $_{\text{Supplemented population}}$ < ∆NOR/Max Recruitment $_{\text{Non-supplemented population}}$
    - These hypotheses incorporate carrying capacity.[25]

Measured Variables:
- Number of hatchery and naturally produced fish on spawning grounds
- Number of naturally produced fish harvested

Derived Variables:
- Number of naturally produced recruits by brood year for both naturally produced parents and hatchery parents (≥age-3).
- May include ratio or difference scores of NORs (requires reference area).
- Spawner-recruit ratios (in part rely on data from Objective 7).

Spatial/Temporal Scale:
- Analyzed annually based on brood year.
- Analyze as a time series (initially as a 5-year period; i.e., 5-year mean of annual change).
- Ho_1 will be used for both temporal scales.

Statistical Analysis:
- Two-sample t-test (other tests may include RIA, ARIMA, or other tests) to evaluate difference scores or ratios over time (initial 5-year period).
- On a five-year period analyze brood years for patterns that correlate with extraneous factors such as ocean conditions.
    - Analysis may include the use of reference areas.

[25] At this time, estimates of carrying capacity (maximum recruits) is unknown at this time for all populations within the Upper Columbia.

Analytical Rules:

- This is a productivity indicator that will be used to assess the success of the supplementation program.
- Type I Error of 0.05.
- Interim analytical rules will be based on effect sizes reported in Table 1.

1.3 Natural Replacement Rates of Supplemented Populations (*Productivity Indicator*)

Monitoring Questions:

Q1: Is the change in natural replacement rates (NRRs) within the supplemented population greater than or equal to the change in natural replacement rates in a non-supplemented population?

Target Species/Populations:

- Q1 applies to all supplemented species and populations.

Hypothesis 1.3:

- Ho_1: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$
- Ha_1: Δ NRR $_{\text{Supplemented population}} < \Delta$ NRR $_{\text{Non-supplemented population}}$

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds.
- Number of hatchery and naturally produced fish taken for broodstock.
- Number of hatchery and naturally produced fish taken in harvest (if recruitment is to the Columbia).

Derived Variables:

- NORs (number of naturally produced recruits (total recruits) by brood year for both naturally produced parents and hatchery parents (≥age-3)).
- NRRs (calculated as NORs/spawner).
- May include ratio or difference scores of NRRs (requires reference area).

Spatial/Temporal Scale:

- Analyzed annually based on brood year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data; i.e., 5-year mean of annual change).
- Ho_1 will be used for both temporal scales.

Statistical Analysis:

- Two-sample t-test (other tests may include RIA, ARIMA, or other tests) to evaluate difference scores or ratios over time (initial 5-year period).
- On a five-year period analyze brood years for patterns that correlate with extraneous factors such as ocean conditions.

- The testing is appropriate if populations are below carrying capacity and density-dependent factors are not regulating the populations at high spawner abundances.

Analytical Rules:

- This is a productivity indicator that will be used to assess the success of the supplementation program.
- Type I Error of 0.05.
- Interim analytical rules will be based on effect sizes reported in Table 1.

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Inherent in the supplementation strategy is that hatchery and naturally produced fish are intended to spawn together and in similar locations. Run timing, spawn timing, and spawning distribution may be affected through the hatchery environment (i.e., domestication). If supplemented fish are not fully integrated into the naturally produced spawning population, the goals of supplementation may not be achieved. Hatchery adults that migrate at different times than naturally produced fish may be subject to differential survival. Hatchery adults that spawn at different times or locations than naturally produced fish would not be integrated into the naturally produced spawning population (i.e., segregated stock).

2.1 Migration Timing (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the migration timing of hatchery and naturally produced fish from the same age class similar?

Target Species/Populations:

- Q1 applies to all supplemented species and populations.

Hypothesis 2.1:

- Ho: Migration timing $_{\text{Hatchery Age X}}$ = Migration timing $_{\text{Naturally produced Age X}}$
- Ha: Migration timing $_{\text{Hatchery Age X}}$ ≠ Migration timing $_{\text{Naturally produced Age X}}$

Measured Variables:

- Ages of hatchery and naturally produced fish sampled via pit tags or stock assessment monitoring.
- Time (Julian date) of arrival at Bonneville, Priest Rapids, Wells, and within tributaries (e.g., Tumwater, Dryden, weirs).

Derived Variables:

- Mean Julian date for a given age class.

Spatial/Temporal Scale:

- Analyzed annually based on return year and age class.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:

- ANOVA by age and origin

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

2.2 Timing of Spawning (*Monitoring Indicator*)

Monitoring Questions:

Q1: Is the timing of spawning (measured as the time female salmon carcasses are observed) similar for hatchery and naturally produced fish? (Timing of spawning of hatchery and naturally produced steelhead may be evaluated if marking or tagging efforts provide reasonable results)

Target Species/Populations:

- Q1 applies to all supplemented species and populations.

Hypothesis 2.2:

- Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ha: Spawn timing $_{\text{Hatchery}} \neq$ Spawn timing $_{\text{Naturally produced}}$

Measured Variables:

- Time (Julian date) of hatchery and naturally produced salmon carcasses observed on spawning grounds within defined reaches.
- Time (Julian date) of ripeness of steelhead captured for broodstock.

Derived Variables:

- Mean Julian date.
- Elevations (covariate)

Spatial/Temporal Scale:

- Analyzed annually based on return year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:

- ANOVA by sex and location

Analytical Rules:
- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

2.3 Distribution of Redds (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the distribution of redds similar for hatchery and naturally produced fish?

Target Species/Populations:
- Q1 applies to all supplemented species and populations.

Hypothesis 2.3:
- Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$
- Ha: Redd distribution $_{\text{Hatchery}}$ ≠ Redd distribution $_{\text{Naturally produced}}$

Measured Variables:
- Location (GPS coordinate) of female salmon carcasses observed on spawning grounds. (The distribution of hatchery and naturally produced steelhead redds may be evaluated if marking or tagging efforts provide reasonable results)

Derived Variables:
- Location of female salmon carcass in RKm (0.01).
- Calculate percent overlap in distribution across available spawning habitat.

Spatial/Temporal Scale:
- Analyzed annually based on return year (ANOVA).
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:
- ANOVA by origin and sex

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

<u>Objective 3</u>: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

The genetic component of the M&E Plan specifically addresses the long-term fitness of supplemented populations. Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological, and behavioral components.[26] Maintaining the long-term fitness of supplemented populations requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location, and stray rates) is addressed under other objectives.

Assessing the genetic component of the hatchery program does not require annual sampling. Meeting stray-rate targets (hypotheses tested under Objective 5) should prevent significant changes in population genetics. Therefore, testing statistical hypotheses associated with genetic components (Hypotheses 3.1, 3.2, and 3.3) should be conducted every three to five years, depending on the type of hatchery program. More frequent genetic sampling may be necessary if actual stray rates exceed targets.

3.1 Allele Frequency (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the allele frequency of hatchery fish similar to the allele frequency of naturally produced and donor fish?

Target Species/Populations:

- Q1 applies to all supplemented species and populations.

Hypothesis 3.1:

- Ho: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop.}}$
- Ha: Allele frequency $_{\text{Hatchery}}$ ≠ Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop.}}$ or

[26] These metrics are difficult to measure, and phenotypic expression of these traits may be all we can measure and evaluate.

- Ha: Allele frequency $_{Hatchery}$ = Allele frequency $_{Naturally\ produced}$ ≠ Allele frequency $_{Donor\ pop.}$ or
- Ha: Allele frequency $_{Hatchery}$ ≠ Allele frequency $_{Naturally\ produced}$ ≠ Allele frequency $_{Donor\ pop.}$

Measured Variables:
- Microsatellite genotypes

Derived Variables:
- Allele frequency

Spatial/Temporal Scale:
- Analyze as a time series, initially comparing pre- and post-hatchery samples and thereafter every 3-5 years.
- Compare samples within drainages.

Statistical Analysis:
- Population differentiation tests, analysis of molecular variance (AMOVA), and relative genetic distances.

Analytical Rules:
- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

3.2 Genetic Distances Between Populations (*Monitoring Indicator*)

Monitoring Questions:
Q1: Does the genetic distance among subpopulations within a supplemented population remain the same over time?

Target Species/Populations:
- Q1 applies to all supplemented species and populations.

Hypothesis 3.2:
- Ho: Genetic distance between subpopulations $_{Year\ x}$ = Genetic distance between subpopulations $_{Year\ y}$
- Ha: Genetic distance between subpopulations $_{Year\ x}$ ≠ Genetic distance between subpopulations $_{Year\ y}$

Measured Variables:
- Microsatellite genotypes

Derived Variables:

- Allele frequencies

Spatial/Temporal Scale:

- Analyze as a time series, initially comparing pre- and post-hatchery samples and thereafter every 3-5 years.
- Compare samples among drainages.

Statistical Analysis:

- Population differentiation tests, AMOVA, and relative genetic distances.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

3.3 Effective Spawning Population (*Monitoring Indicator*)

Monitoring Questions:

Q1: Is the ratio of effective population size (N_e) to spawning population size (N) constant over time?

Target Species/Populations:

- Q1 applies to all supplemented species and populations.

Hypothesis 3.3:

- Ho: $(N_e/N)_{t0} = (N_e/N)_{t1}$ for each population
- Ha: $(N_e/N)_{t0} \neq (N_e/N)_{t1}$ for each population

Measured Variables:

- Microsatellite genotypes

Derived Variables:

- Allele frequencies

Spatial/Temporal Scale:

- Analyze as a time series, initially comparing pre- and post-hatchery samples and thereafter every 3-5 years.
- Compare samples among drainages.

Statistical Analysis:

- Population differentiation tests, relative genetic distances, statistics to calculate effective population size (e.g., harmonic means).

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

3.4 Age at Maturity (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the age at maturity of hatchery and naturally produced fish similar?

Target Species/Populations:
- Q1 applies to all supplemented species and populations.

Hypothesis 3.4:
- Ho: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$
- Ha: Age at Maturity $_{\text{Hatchery}}$ ≠ Age at Maturity $_{\text{Naturally produced}}$

Measured Variables:
- Age of hatchery and naturally produced salmon carcasses collected on spawning grounds.
- Age of broodstock.
- Age of fish at stock assessment locations (e.g., Dryden, Tumwater, Wells, Priest Rapids).

Derived Variables:
- Saltwater ages

Spatial/Temporal Scale:
- Analyzed annually based on brood year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:
- Chi-square or ANOVA by origin and gender.
  - o Whenever possible age at maturity will be measured at weirs or dams near the spawning stream to avoid the size-related carcass recovery bias on spawning grounds (carcass sampling).

Analytical Rules:
- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

3.5 Size at Maturity (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the size (length) at maturity of a given age and sex of hatchery fish similar to the size at maturity of a given age and sex of naturally produced fish?

Target Species/Populations:
- Q1 applies to all species and populations.

Hypothesis 3.5:
- Ho: Size (length) at Maturity $_{\text{Hatchery Age X and Gender Y}}$ = Size (length) at Maturity $_{\text{Naturally produced Age X and Gender Y}}$
- Ha: Size (length) at Maturity by age and gender $_{\text{Hatchery}}$ ≠ Size (length) at Maturity by age and gender $_{\text{Naturally produced}}$

Measured Variables:
- Size (length), age, and gender of hatchery and naturally produced salmon carcasses collected on spawning grounds.
- Size (length), age, and gender of broodstock.
- Size (length), age, and gender of fish at stock assessment locations (e.g., Dryden, Tumwater, Wells, Priest Rapids).

Derived Variables:
- Calculate total age and saltwater age

Spatial/Temporal Scale:
- Analyzed annually based on brood year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:
- ANOVA by origin, gender, and age

Analytical Rules:
- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

<u>Objective 4</u>: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific HRR expected value based on survival rates listed in the BAMP (1998).

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome the survival disadvantage after release (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish the program should be modified or discontinued. Production levels were initially developed using historical run sizes and smolt-to-adult survival rates (BAMP 1998). Using the stock specific NRR and the values listed in the BAMP, comparisons to actual survival rates will be made to ensure the expected level of survival has been achieved.

4.1 Hatchery Replacement Rates (HRRs) (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the adult-to-adult survival rate of hatchery fish (HRR) greater than or equal to the adult-to-adult survival rate (NRR) of naturally produced fish?
Q2: Is the adult-to-adult survival rate of hatchery fish (HRR) greater than or equal to the value in BAMP (Table 6 in Appendix D; includes sum of adults harvested, taken for broodstock, and adults on spawning grounds)?

Target Species/Populations:
- Q1 applies to all species and populations.
- Q2 applies to all species and populations.

Hypothesis 4.1:
- Ho_1: $HRR_{\text{Year x}} \geq NRR_{\text{Year x}}$
- Ha_1: $HRR_{\text{Year x}} < NRR_{\text{Year x}}$
- Ho_2: HRR ≥ BAMP value (preferred)
- Ha_2: HRR < BAMP value

Measured Variables:
- Number of hatchery and naturally produced fish on spawning grounds
- Number of hatchery and naturally produced fish harvested
- Number of hatchery and naturally produced fish collected for broodstock.
- Number of broodstock used by brood year (hatchery and naturally produced fish).

Derived Variables:
- Number of hatchery and naturally produced adults by brood year (≥age-3).
- HRR (number of returning adults per brood year/broodstock)
- NRR (from above)

Spatial/Temporal Scale:
- Analyzed annually based on brood year.
- Analyze as a time series (initially as a 5-year period but include pre-2006 data to the extent possible).

Statistical Analysis:

- For Q1 a two-sample t-test to compare HRR to NRR
- For Q2 a one-sample t-test to evaluate HRR.
- On a five-year period analyze brood years for patterns that correlate with extraneous factors such as ocean conditions.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

<u>Objective 5</u>: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

Maintaining locally adapted traits of fish populations requires that returning hatchery fish have a high rate of site fidelity to the target stream. Hatchery practices (e.g., rearing and acclimation water source, release methodology, and location) are the main variables thought to affect stray rates. Regardless of the adult returns, if adult hatchery fish do not contribute to the donor population the program will not meet the basic condition of a supplementation program. Fish that do stray to other independent populations should not comprise greater than 5% of the spawning population. Likewise, fish that stray within an independent population should not comprise greater than 10% of the spawning population.

5.1 Stray Rates among Populations for Brood Return (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the stray rate of hatchery fish less than 5% for the total brood return?

Target Species/Populations:

- Q1 applies to all species and populations.

Hypothesis 5.1:

- Ho: Stray rate $_{\text{Hatchery fish}}$ ≥ 5% of total brood return
- Ha: Stray rate $_{\text{Hatchery fish}}$ < 5% of total brood return

Measured Variables:

- Number of hatchery carcasses found in non-target and target spawning areas.
- Number of hatchery fish collected for broodstock.
- Number of hatchery fish taken in fishery.

Derived Variables:

- Hatchery carcasses and take in fishery estimated from expansion analysis.
- Locations of live and dead strays (used to tease out overshoot).

Spatial/Temporal Scale:

- Analyzed annually based on brood year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:

- A simple statistical approach is to use a one-sample t-test to compare the actual stray rate with the target (5%) stray rate.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

5.2 Stray Rates among Populations for Return Year (*Monitoring Indicator*)

Monitoring Questions:

Q1: Is the stray rate of hatchery fish less than 5% of the spawning escapement within other independent populations?

Target Species/Populations:

- Q1 applies to all species and populations.

Hypothesis 5.2:

- Ho: Stray hatchery fish ≥ 5% of spawning escapement (based on run year) within other independent populations
- Ha: Stray hatchery fish < 5% of spawning escapement (based on run year) within other independent populations [27]

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[27] This stray rate is suggested based on a literature review and recommendations by the ICTRT. It can be re-evaluated as more information on naturally-produced Upper Columbia salmonids becomes available. This will be evaluated on a species and program specific basis and decisions made by the HCP HC. It is important to understand the actual spawner composition of the population to determine the potential effect of straying.

Measured Variables:

- Number of hatchery carcasses (PIT tagged steelhead) found in non-target and target spawning areas.

Derived Variables:

- Hatchery salmon carcasses (PIT tagged steelhead) estimated from expansion analysis.

Spatial/Temporal Scale:

- Analyzed annually based on return year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:

- A simple statistical approach is to use a one-sample t-test to compare the actual proportion of strays with the target of 5% strays

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

5.3 Stray Rates within the Population (*Monitoring Indicator*)

Monitoring Questions:

Q1: Is the stray rate of hatchery fish less than 10%[28] of the spawning escapement within other spawning aggregations within the target independent population?

Target Species/Populations:

- Q1 applies to all species and populations.

Hypothesis 5.3:

- Ho: Stray hatchery fish ≥ 10% of spawning escapement (based on run year) of any non-target streams within independent population
- Ha: Stray hatchery fish < 10% of spawning escapement (based on run year) of any non-target streams within independent population

Measured Variables:

- Number of hatchery carcasses (possibly PIT tagged steelhead) found in non-target and target spawning aggregates.

[28] This value should be reviewed annually by the Hatchery Committee. See footnote 5 for additional information.

Derived Variables:

- Hatchery salmon carcasses (possibly PIT tagged steelhead) estimated from expansion analysis.

Spatial/Temporal Scale:

- Analyzed annually based on return year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:

- A simple statistical approach is to use a one-sample t-test to compare the actual proportion of strays with the target of 10% strays.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

<u>Objective 6</u>: Determine if hatchery fish were released at the programmed size and number.

The HCP outlines the number and size of fish that are to be released to meet NNI compensation levels. Although many factors can influence both the size and number of fish released, past hatchery cultural experience with these stocks should assist in meeting program production levels.

6.1 Size of Hatchery Fish (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the size of hatchery fish released equal to the program goal?

Target Species/Populations:

- Q1 applies to all species and populations.

Hypothesis 6.1:

- Ho: Hatchery fish $_{\text{Size at release}}$ = Programmed $_{\text{Size}}$
- Ha: Hatchery fish $_{\text{Size at release}}$ ≠ Programmed $_{\text{Size}}$

Measured Variables:

- Length and weights of random samples of hatchery smolts.

Derived Variables:

- CVs.

Spatial/Temporal Scale:

- Analyzed annually.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:

- A simple statistical approach is to use a one-sample t-test to compare the actual size of hatchery fish at time of release with the program goal.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

6.2 Number of Hatchery Fish (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the number of hatchery fish released equal to the program goal?

Target Species/Populations:

- Q1 applies to all species and populations.

Hypothesis 6.2:

- Ho: Hatchery fish $_{\text{Number}}$ = Programmed $_{\text{Number}}$
- Ha: Hatchery fish $_{\text{Number}}$ ≠ Programmed $_{\text{Number}}$

Measured Variables:

- Numbers of smolts released from the hatchery.

Derived Variables:

- NA

Spatial/Temporal Scale:

- Review annually.

Statistical Analysis:

- No statistical analysis needed.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- No statistical analysis is necessary.

<u>Objective 7</u>: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Out-of-basin effects (e.g., smolt passage through the hydro system and ocean productivity) have a strong influence on survival of smolts after they migrate from the tributaries. These effects introduce substantial variability into the adult-to-adult survival rates (NRR and HRR), which may mask in-basin effects (e.g., habitat quality, density related mortality, and differential reproductive success of hatchery and naturally produced fish). The objective of long-term smolt monitoring programs in the Upper Columbia ESU is to determine the egg-to-smolt or egg-to-juvenile survival of target stocks. Smolt production models generated from the information obtained through these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that take into account all effects.

Differences in carrying capacities of supplemented and non-supplemented streams can confound the effects of supplementation on numbers of juveniles per redd. For example, if the supplemented population is at or above carrying capacity and the non-supplemented population is not, numbers of juveniles per redd in the non-supplemented population may be significantly greater than the number of juveniles per redd in the supplemented population. To avoid concluding that the supplementation program has no effect or perhaps a negative effect on juveniles per redd, the capacity of the habitats must be included in the analyses. The Supplementary Hypotheses are designed to address the confounding effects of different densities on the analyses.

7.1 Juvenile Productivity (*Productivity Indicator*)

Monitoring Questions:

Q1: Is the change in numbers of juveniles (smolts, parr, or emigrants) per redd in the supplemented population greater than or equal to that in the non-supplemented population?

Q2: Does the number of juveniles per redd decrease as the proportion of hatchery spawners increases?[29]

Target Species/Populations:

- Q1 applies to all supplemented species and populations (depending on reference areas).
- Q2 applies to all supplemented species and populations.

[29] Information is needed to estimate the effects of density dependence on these questions.

Hypothesis 7.1:

- Ho_1: Slope of Ln(juveniles/redd) vs redds $_{\text{Supplemented population}}$ = Slope of Ln(juveniles/redd) vs redds $_{\text{Non-supplemented population}}$
- Ha_1: Slope of Ln(juveniles/redd) vs redds $_{\text{Supplemented population}}$ ≠ Slope of Ln(juveniles/redd) vs redds $_{\text{Non-supplemented population}}$
- Ho_2: The relationship between proportion of hatchery spawners and juveniles/redd is ≥ 1.
- Ha_2: The relationship between proportion of hatchery spawners and juveniles/redd is < 1.

Measured Variables:

- Number of hatchery and naturally produced fish on spawning grounds.
- Numbers of redds.
- Number of juveniles (smolts, parr [not appropriate for all populations], and emigrants).

Derived Variables:

- Number of juveniles per redd.

Spatial/Temporal Scale:

- Analyzed annually based on brood year.
- Analyze as a time series (initially as a 5-year period and to the extent possible use pre-2006 data).

Statistical Analysis:

- Two-sample t-test to evaluate differences between treatment and reference slopes (initial 5-year period).
- Regression analysis to examine relationships between hatchery adult composition and juveniles/redd.

Analytical Rules:

- This is a productivity indicator that will be used to assess the success of the supplementation program.
- Type I Error of 0.05.
- Interim decisions will be based on effect sizes reported in Table 1.

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate (e.g., Turtle Rock program).

In years when the expected returns of hatchery adults are above the level required to meet program goals (i.e., supplementation of spawning populations and/or brood stock requirements), surplus fish may be available for harvest (i.e., target population). The M&E Plan specifically addresses harvest and harvest opportunities upstream from Priest Rapids Dam. Harvest or removal of surplus hatchery fish from the spawning grounds would also assist in reducing potential adverse genetic impacts to naturally produced populations (loss of genetic variation within and between populations).

8.1 Harvest Rates (*Monitoring Indicator*)

Monitoring Questions:
Q1: Is the harvest on hatchery fish produced from harvest-augmentation programs high enough to manage natural spawning but low enough to sustain the hatchery program?
Q2: Is the escapement of fish from supplementation programs in excess of broodstock and natural production[30] needs to provide opportunities for terminal harvest?

Target Species/Populations:
- Q1 applies to summer Chinook reared at Turtle Rock.
- Q2 applies to all supplemented stocks.

Hypothesis 8.1:
- Ho_1: Harvest rate ≤ Maximum level to meet program goals
- Ha_1: Harvest rate > Maximum level to meet program goals
- Ho_2: Escapement ≤ Maximum level to meet supplementation goals
- Ha_2: Escapement > Maximum level to meet supplementation goals

Measured Variables:
- Numbers of hatchery fish taken in harvest.

Derived Variables:
- Total harvest by fishery estimated from expansion analysis.

Spatial/Temporal Scale:
- Reviewed annually.

Statistical Analysis:
- A one-sample t-test can be used to compare harvest rates with the level needed for program goals.

Analytical Rules:
- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

[30] At this time, the escapement of adults needed to fully seed habitat in the Upper Columbia is unknown.

Regional Objectives

Hatchery programs have the potential to increase diseases that typically occur at low levels in the natural environment (Objective 9). In addition, hatchery fish can reduce the abundance, size, or distribution of non-target taxa through ecological interactions (Objective 10). These are important objectives that will be monitored at a later time. Analytical rules will be established for these objectives before monitoring activities begin.

Objective 9: Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.

The hatchery environment has the potential to amplify diseases that are typically found at low levels in the natural environment. Amplification could occur within the hatchery population (i.e., vertical and horizontal transmission) or indirectly from the hatchery effluent or commingling between infected and non-infected fish (i.e., horizontal transmission). Potential impacts to natural populations have not been extensively studied, but should be considered for programs in which the hatchery fish are expected to commingle with natural fish. This is particularly important for supplementation type programs. Specifically, the causative agent of bacterial kidney disease (BKD), *Renibacterium salmoninarum* (Rs), could be monitored at selected acclimation ponds, both in the water and fish, in which the risk and potential for transmission from the hatchery is highest. Although it is technologically possible to measure the amount of Rs in water or Rs DNA in smolts and adults non-lethally sampled, the biological meaning of these data are uncertain. Currently, the only metric available for M & E purposes is measuring the antigen level from kidney/spleen samples (i.e., ELISA). When available, non-lethal sampling may replace or be used in concert with lethal sampling.

Implementation of this objective will be conducted in a coordinated approach within the hatchery and natural environment. BKD management within the hatchery population (e.g., broodstock or juveniles) has the potential to reduce the prevalence of disease through various actions (e.g., culling or reduced rearing densities). BKD management must also take into account and support other relevant objectives of the M & E program (e.g., Hatchery Return Rate [HRR], number of smolts released). Hence, the goal of BKD management is to decrease the prevalence of disease and maintain hatchery production objectives (i.e., number and HRR).

As previously discussed, disease transmission from hatchery to naturally produced fish may occur at various life stages and locations. Of these, horizontal transmission from hatchery effluent, vertical transmission on the spawning grounds, and horizontal transmission in the migration corridor have been identified as disease interactions that could be examined under this objective, although others may also be relevant. Experimental designs addressing this objective may require technology not yet available, although in some instances samples may be collected, but not analyzed until a link can be established between bacteria levels in samples and disease prevalence.

Developing a complete set of questions and hypotheses statements for this objective may not be practical at this time, because there is currently no BKD Management Plan. However, while developing experimental designs for this objective, it may be feasible to incorporate both hatchery and natural environment monitoring under a single study design. Integration of the different aspects of the objective would likely result in a more robust approach into understanding the effectiveness of disease management strategies.

Monitoring Questions:
Q1: What is the effect of BKD disease management on BKD disease prevalence?
Q2: Are study fish exposed to hatchery effluent infected to a greater extent than control fish?
Q3: *Is Rs infection transferred at various life stages from hatchery fish to naturally produced fish or appropriate surrogates?*[31]

Target Species/Populations:
- Q1 and Q2 both apply to spring Chinook (primary focus) and summer Chinook programs.

Hypotheses Q1:
- Ho_1: Rearing density has no effect on survival rates of hatchery fish.
- Ha_1: Rearing density has an effect on survival rates of hatchery fish.

- Ho_2: Antigen level has no effect on survival rates of hatchery fish.
- Ha_2: Antigen level has an effect on survival rates of hatchery fish.

- Ho_3: Interaction between antigen level and rearing density has no effect on survival rates of hatchery fish.
- $Ha_{3:}$ Interaction between antigen level and rearing density has an effect on survival rates of hatchery fish.

Hypothesis Q2:
- o Ho_1: Rs infection is not transferred from hatchery effluent to study fish.
- o Ha_1: Rs infection is transferred from hatchery effluent to study fish.

Measured Variables:
- Hypotheses Q1:
  - o Numbers of fish (at different life stages)

- Hypothesis Q2:
  - o Numbers of Rs+ fish

[31] Hypothesis statements for these monitoring questions will be developed.

Derived Variables:

- Survival rates
- SARs
- HRRs

Spatial/Temporal Scale:

- Hypotheses Q1:
  - Analyze annually based on brood year.
- Hypothesis Q2:
  - Analyze annually.

Statistical Analysis:

- Hypotheses Q1: either 2-way ANOVA or response-surface design.
- Hypothesis Q2: ANOVA.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

Adaptively Managing Monitoring Results

Because of naturally large variation in productivity indicators, several years of data may be required before statistical inferences can be made regarding the effects of hatchery fish on productivity of naturally produced fish. Furthermore, given the large natural variation of productivity indicators, productivity could decrease as a result of the hatchery programs before a difference is detected statistically. In the interim, risk associated with supplementation programs and the productivity of naturally produced fish can be quantified based on observed natural variation in the indicator of interest (Table 1). If large differences in rates of change between supplemented and reference populations are observed, management actions may be required earlier than anticipated (every five years).

Assuming hatchery programs do not negatively affect the productivity of naturally produced fish, the observed difference in rates of change between the supplemented and reference populations should decrease over time as more of the natural variation within and between populations is incorporated into these data. More simply, as the number of years increases, the acceptable observed difference in the indicator(s) decreases. The value of the difference at any point in time would determine if management actions are warranted.

Table 1. Average differences between supplemented and reference conditions that represent different levels of management concerns. Large differences (red) indicate the need for relatively quick management changes, moderate differences (yellow) indicate that indicators need to be reviewed carefully before making management changes, and small differences (green) indicate that management changes are not currently necessary. Average differences corresponding to each level of concern are scaled to reflect the increasing risk associated with multiple brood years that show differences between supplemented and reference conditions. These differences are currently based on the temporal variability associated with each productivity indicator and will change as more information becomes available (i.e., information on the variability in difference scores between treatment and reference conditions).

Indicator	Number of Brood Years	No Concern	Warning	Concern
NRR	1	0-50%	51-100%	>100%
	2	0-40%	41-80%	>80%
	3	0-30%	31-60%	>60%
	4	0-20%	21-40%	>40%
	5	0-10%	11-20%	>20%
NOR	1	0-50%	51-100%	>100%
	2	0-40%	41-80%	>80%
	3	0-30%	31-60%	>60%
	4	0-20%	21-40%	>40%
	5	0-10%	11-20%	>20%
Juv/Redd	1	0-100%	101-200%	>200%
	2	0-80%	81-160%	>160%
	3	0-70%	71-140%	>140%
	4	0-60%	61-120%	>120%
	5	0-50%	51-100%	>100%

Appendix C

Implementation of Comprehensive Monitoring and Evaluation of Hatchery Programs

IMPLEMENTATION OF COMPREHENSIVE MONITORING AND EVALUATION OF HATCHERY PROGRAMS FUNDED BY DOUGLAS COUNTY PUD

Submitted to

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Introduction

The Douglas County PUD Monitoring and Evaluation Plan (M&E Plan; Wells HCP Hatchery Committee 2007) describes eight objectives specific to the hatchery programs funded by Douglas County PUD and two regional objectives that are related to artificial propagation. These same objectives have been identified in the M&E Plan for Chelan County PUD (Murdoch and Peven 2005) and are designed to address key questions regarding the use of supplementation as mitigation for mortality associated with the operation of Wells Hydroelectric Project. All objectives have specified indicators (i.e., primary) that will be measured and compared against target values established in the M&E Plan. Specific tasks and methodologies to be used in accomplishing the objectives are provided in the M&E Plan.

The primary focus of this proposal is the first eight objectives outlined in the M&E Plan, but additional regional objectives are included where warranted. Both disease (Objective 9) and non-target taxa (Objective 10) monitoring have been identified as important components of the M&E Plan. These regional objectives will be implemented once experimental designs have been developed and approved by the Wells HCP Hatchery Committee.

Successful implementation of the M&E Plan requires a continuation and potential expansion of existing relationships between the WDFW and other entities conducting similar field work in the Upper Columbia River Basin. Certain objectives require data to be collected from both target and reference populations. Field activities (i.e., data collection) not conducted by the WDFW, that are also required to implement the M&E Plan (i.e., reference populations) are not included in this proposal.

Addressing all the objectives within the M&E Plan will require multiple years of data collection. Several objectives may be adequately addressed after one year or five years (Table 1), and may require only periodic monitoring (e.g., every five or ten years). This proposal and budget encompasses one year of work in which WDFW will furnish all supervision, labor, services, materials, tools, and equipment necessary to implement the Monitoring and Evaluation Plan of hatchery programs funded by Douglas County PUD. All statistical analyses will be conducted consistent with the Analytical Framework for Monitoring and Evaluating PUD Hatchery Programs (Hays et al. 2007).

Table 1. A potential long-term implementation schedule of objectives outlined in the Douglas County PUD M&E Plan.

Objective	Year of implementation									
	1-4	5	6-9	10	11-14	15	16-19	20	21-24	25
1	X	X	X	X	X	X	X	X	X	X
2	X	X		X		X		X		X
3	X				X				X	
4	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X
6	X	X	X	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X	X	X	X
8	X	X		X		X		X		X
9	Experimental design not complete									
10	Experimental design not complete									

Reference Streams

Reference streams or populations are a critical component of the M&E Plan (Goodman 2004; ISRP & ISAB 2005). Data collected from reference populations will be included in the analysis for objectives 1 and 7. Depending on the reference population, data collected may also be included in the analysis for objectives 3, 4, 5, and 8. Suitability of a population as a reference or control for target populations for ongoing hatchery programs funded by Douglas County Public Utility District (DCPUD) has not yet been determined. The Hatchery Evaluation Technical Team (HETT) is currently evaluating potential spatial reference streams for all supplemented populations in the Methow and Okanogan Rivers. The HETT will recommend to the Wells HCP HC, reference populations that should be incorporated into the M&E Plan. Historical data may or may not exist for some proposed reference populations. If data has been collected, an assessment of the methodology used must also be conducted to determine if the historical data is suitable for inclusion in the analysis. As part of the M&E Plan, future data collection activities in the reference populations should use similar methodologies and metrics as those used in treatment populations.

WORK PLAN BY OBJECTIVE

Objective 1: Determine if a) supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and b) the changes in the natural replacement rate (NRR) of the supplemented population are similar to that of the non-supplemented population.

Hypotheses:

- Ho_1: Number of hatchery fish that spawn naturally > number of naturally and hatchery produced fish taken for broodstock.
- Ha_1: Number of hatchery fish that spawn naturally ≤ number of naturally and hatchery produced fish taken for broodstock.
- Ho_2: ΔNOR/Max recruitment $_{\text{Supplemented population}}$ ≥ ΔNOR/Max recruitment $_{\text{Non-supplemented population}}$
- Ha_2: ΔNOR/Max recruitment $_{\text{Supplemented population}}$ < ΔNOR/Max recruitment $_{\text{Non-supplemented population}}$
- Ho_3: Δ NRR $_{\text{Supplemented population}}$ ≥ Δ NRR $_{\text{Non-supplemented population}}$
- Ha_3: Δ NRR $_{\text{Supplemented population}}$ < Δ NRR $_{\text{Non-supplemented population}}$

General Approach

Spawning ground, broodstock, and harvest data (e.g., selective fisheries) will be the source of all abundance, composition, and productivity information required for this objective. Identification of suitable non-supplemented populations will be problematic in the Upper Columbia Basin because some species/races do not have populations that have not been either supplemented or influenced by hatchery fish (e.g., summer Chinook). For those supplemented populations without a suitable spatial reference population, temporal references may be used (i.e., prior to hatchery intervention). Temporal reference populations may also be initiated if deemed necessary, by discontinuing hatchery releases in a target population for a predetermined period of time (i.e., at least one generation minimum).

Methodology

Standard spawning ground survey methodology outlined in Appendix F of the M&E Plan (Spawning ground surveys) and data analysis outlined Appendix G of the M&E Plan (Relative Abundance) will be used under this objective. WDFW will coordinate with other Agencies (i.e., USFWS, USFS, Tribes) that conduct spawning ground surveys to ensure methodologies and sample rates are consistent with methodologies used in this objective (Table 2). Spawning/carcass surveys will be conducted for Methow Basin spring Chinook (WDFW); Methow Basin steelhead (WDFW); and Okanogan steelhead (CCT). The use of a composite spring Chinook broodstock in the Methow and Chewuch Rivers suggests that the Methow and Chewuch spawning aggregates be treated as a single group. The combined group (i.e., MetChew) is supported by genetic data, which concluded that both spawning aggregates are very closely related (Snow et al. 2007). However, differences in spawner abundance and carrying capacity of the two subbasins may require that each subbasin be treated independently for data analysis purposes.

Table 2. Methodologies used to determine biological information used in Objective 1.

Population	Spawning ground methodology	Spawner composition	Age composition
Methow steelhead	Expanded index	Wells Dam	Wells Dam
Twisp steelhead	Expanded index/Total ground	Twisp weir	Twisp weir
Okanogan steelhead [a]	Total ground	Wells Dam	Wells Dam
Methow sp. Chinook	Total ground	Carcasses	Wells Dam
Chewuch sp. Chinook	Total ground	Carcasses	Wells Dam
Twisp sp. Chinook	Total ground	Carcasses	Wells Dam

[a] Conducted by CCT.

Schedule of Activities

Table 3. Schedule for conducting spawning ground surveys and data analysis (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow/Okanogan steelhead	A	A	D	D	D	D	A	A	A	A	A	A
Methow Basin spring Chinook	A	A	A	A	D	D	D	D	D	A	A	A

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Hypotheses:

- Ho_4: Migration timing $_{\text{Hatchery Age X}}$ = Migration timing $_{\text{Naturally produced Age X}}$
- Ha_4: Migration timing $_{\text{Hatchery Age X}}$ ≠ Migration timing $_{\text{Naturally produced Age X}}$
- Ho_5: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ha_5: Spawn timing $_{\text{Hatchery}}$ ≠ Spawn timing $_{\text{Naturally produced}}$
- Ho_6: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$
- Ha_6: Redd distribution $_{\text{Hatchery}}$ ≠ Redd distribution $_{\text{Naturally produced}}$

General Approach

A properly integrated hatchery program produces fish that have similar life history traits as naturally produced fish. Differences in any of these behavioral life history traits may affect progeny survival. Migration timing in the Columbia River of both juvenile and adult fish will be assessed using PIT tags when available. Migration timing into spawning tributaries will be assessed at broodstock collection locations, or using in-stream PIT antenna arrays. In 2009, in-stream antenna arrays were installed in the lower Methow and Twisp rivers to assess the distribution and migration timing of adult hatchery and wild steelhead. These antennas, in conjunction with arrays installed by other researchers (i.e., USGS) will be used to assess steelhead and spring Chinook run timing and distribution throughout the Methow Basin.

Spawn timing and redd distribution data for spring Chinook will be collected during spawning ground surveys. We propose selecting index reaches to evaluate spawn timing in reaches where similar proportions of hatchery and naturally produced fish are expected to spawn (based on carcass recovery data). The use of index reaches will eliminate any potential bias in spawn timing due to differences in spawning locations. For fish that are not adipose fin clipped, the female carcass recovery date will allow for a comparison of the relative spawn timing. Carcass recovery locations will be used as a surrogate for spawning location.

In 2010, WDFW will conduct an evaluation of steelhead spawn timing throughout the Methow Basin. Because visual observation of spawning fish will be required to evaluate spawn timing and location, adult female steelhead sampled in 2009 at Wells Dam, Priest Rapids Dam, and at the Twisp River weir in 2010 will be externally floy tagged based on stock and origin, and surveyors will conduct intensive surveys to quantify redd distribution and collect observational data from floy-tagged females.

Methodology

Migration Timing

As previously stated, when available, PIT tags will be used to evaluate differences in migration timing in the Columbia River. During broodstock collection activities at mainstem dams, tributary traps, and the Twisp River weir, PIT tags will be inserted in all fish captured and released in excess of broodstock requirements so that data on migration timing to spawning tributaries can be collected (Table 4). Migration timing into spawning tributaries will be assessed using PIT antenna arrays deployed in the lower Methow and Twisp rivers, and utilizing antennas installed by other researchers within the Methow and Okanogan Basins.

Table 4. Methods and locations used for evaluating differences in migration timing between hatchery and naturally produced salmon and steelhead.

Target population	Migration timing	
	Columbia River*	Spawning tributary
Methow spring Chinook	Wells Dam, PIT tags, CWTs	Chewuch/Twisp weirs
Methow steelhead	Wells Dam, PIT tags, VIE	Twisp weir
Okanogan steelhead	Wells Dam, PIT tags, Ad clip	Omak Cr. Weir/Zosel Dam

* PIT tags will be used when available (i.e., in conjunction with other objectives).

Spawn Timing

All spawn timing information necessary for evaluating differences between hatchery and naturally produced salmon and steelhead will be collected during spawning ground surveys (M&E Plan Appendix F). Specific spawn timing information will only be collected within index spawning areas. Index areas identified are likely to have a similar proportion of hatchery and naturally produced fish spawning based on carcass recoveries between 2003 and 2006 (Table 5). Carcass recovery date of female spring Chinook salmon will be used to examine relative differences in spawn timing.

Determining the relative spawn timing of steelhead in the natural environment is problematic because not all hatchery fish are adipose fin clipped. In 2010, an evaluation of steelhead spawn timing in the Methow Basin will be conducted utilizing female steelhead floy-tagged in 2009 at mainstem Columbia River dams (i.e., Priest Rapids and Wells) or fish captured in 2010 at the Twisp River weir. Approximately 85% of the steelhead in the Twisp River spawn upstream of the Twisp River weir (mean 2003-2005). Steelhead will be captured and tagged at the Twisp River weir between 1 March and 1 June. All fish captured will be examined to determine origin (VIE, PIT, CWT, or eroded fins), age, and tagged with colored anchor tags depending on stock and origin. Because the number and spawning location of wild steelhead throughout the Methow Basin is unknown, surveys will target sections within each subbasin which have high spawning activity. Surveyors will record the tag color and date of all female steelhead observed during surveys and record GPS locations of all redds. Because of inherent differences in spawn timing due to changes in elevation, comparisons of spawn timing may be limited to those reaches within the Methow Basin with the highest number of wild steelhead.

Table 5. Potential tributary index areas identified for each respective target population used for evaluating differences in spawn timing between hatchery and naturally produced salmon and steelhead.

Target population	Historical reach(s)
Twisp spring Chinook	Twisp River (T5 - T6)
Chewuch spring Chinook	Chewuch River (C4 - C6)
Methow spring Chinook	Methow River (M9 - M11)
Twisp steelhead	Twisp River (T4 - T10)
Methow steelhead	Methow River (M10 – M11)
Chewuch steelhead	Chewuch River (C4)

Spawning Distribution

Redd distribution data will also be collected during spawning ground surveys (M&E Plan Appendix F). The origin of spawners will be identified from carcasses (i.e., scales or CWT), and carcass recovery location (i.e., rkm) of female spring Chinook will be used to determine redd distribution. Overall steelhead redd distribution will be determined from GPS location information for each redd observed. Distribution by origin of spawning adult steelhead cannot be determined without application of an additional mark (e.g., floy tag) because not all hatchery steelhead were adipose fin-clipped. Steelhead spawning distribution by origin of spawning adults will be assessed at the Twisp River weir in 2010. Surveys will be conducted weekly in all sections upstream of the weir to assess distribution of floy-tagged females as previously described. Additionally, all female steelhead without existing PIT tags will be PIT tagged in the body cavity to determine spawning distribution by scanning redds for expelled PIT tags. Resident rainbow, residual hatchery steelhead, and cutthroat trout females will also be PIT tagged in the body cavity to determine if these species or resident stages contribute to steelhead redd count estimates.

Schedule of Activities

Table 6. Schedule for conducting migration timing, spawn timing, and spawning distribution field activities and data analysis (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow steelhead	A	A	D	D	D	D	D	D	D	D	A	A
Methow spring Chinook	A	A	A	A	D	D	D	D	D			

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in the phenotypic characteristics of natural populations.

Hypotheses:

- Ho_7: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor}}$
- Ha_{7a}: Allele frequency $_{\text{Hatchery}}$ ≠ Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor}}$
- Ha_{7b}: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ ≠ Allele frequency $_{\text{Donor}}$
- Ha_{7c}: Allele frequency $_{\text{Hatchery}}$ ≠ Allele frequency $_{\text{Naturally produced}}$ ≠ Allele frequency $_{\text{Donor}}$
- Ho_8: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$
- Ha_8: Genetic distance between subpopulations $_{\text{Year x}}$ ≠ Genetic distance between subpopulations $_{\text{Year y}}$
- Ho_9: $(N_e/N)_{t0} = (N_e/N)_{t1}$ for each population
- Ha_9: $(N_e/N)_{t0} \neq (N_e/N)_{t1}$ for each population
- Ho_{10}: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$
- Ha_{10}: Age at Maturity $_{\text{Hatchery}}$ ≠ Age at Maturity $_{\text{Naturally produced}}$
- Ho_{11}: Size (length) at Maturity $_{\text{Hatchery Age X and Gender Y}}$ = Size (length) at Maturity $_{\text{Naturally produced Age X and Gender Y}}$
- Ha_{11}: Size (length) at Maturity by age and gender $_{\text{Hatchery}}$ ≠ Size (length) at Maturity by age and gender $_{\text{Naturally produced}}$

General Approach

Genotypes of hatchery and naturally produced populations will be sampled and monitored based upon the schedule outlined in Appendix H of the Douglas PUD M&E Plan. Priority of analysis was based upon recovery needs or relative risk a hatchery program may have on the naturally produced population. Differences in phenotypic characteristics that may arise as a result of hatchery programs (i.e., domestication) will be measured using historical (i.e., prior to current hatchery programs) and recent data collected from wild fish and broodstock or carcasses recovered on the spawning grounds. Data related to additional important phenotypic characteristics will be collected and analyzed as part of Objective 2 (e.g., run timing, spawn timing, and spawning location), Objective 4 (e.g., fecundity), and Objective 7 (e.g., size and age at smolt migration).

Methodology

Specific methodologies related to DNA extraction and genetic analysis are available from the WDFW Genetics Lab and were not included in the M&E Plan (Appendix H). Historical donor population samples (i.e., DNA collected from tissue or scale samples collected before hatchery programs) will be used to establish a genetic baseline for comparing against samples collected from current hatchery and naturally produced fish.

In 2010, summer Chinook DNA collected at Wells Hatchery will be incorporated into the analysis scheduled for summer Chinook stocks within the Chelan PUD M&E Plan.

Data for monitoring phenotypic characteristics (i.e., age at maturity and size at maturity) will be collected annually as part of the broodstock collection protocol (M&E Plan Appendix B). Broodstock for all programs are not collected randomly from the run at large with respect to sex, origin, or age. Trapping activities do provide an opportunity to collect data from a random sample from the run at large (i.e., those fish collected during broodstock trapping and released upstream). Historically, information related to the spawning population was derived from broodstock, carcasses, or a combination of both. Recent data suggests that these methods are biased and additional sampling at broodstock collection sites is required (Zhou 2002; Murdoch et al. 2005). Broodstock collection sites are located near or below a majority of the spawning locations (Table 7). All fish trapped, or a random sample depending on the stock, will be sampled to determine origin, age, and size. Additionally, PIT tags may be inserted into adult fish released upstream of Wells Dam to address other M&E Plan objectives (i.e., migration timing, Objective 2; stray rates, Objective 5).

Table 7. Broodstock collection locations for stock assessment and phenotypic characterization of hatchery and naturally produced fish.

Stock	Primary location	Secondary location
Methow Basin spring Chinook	Wells Dam	Twisp weir
Methow/Okanogan steelhead	Wells Dam	Twisp weir / Priest Rapids Dam

Schedule of Activities

Table 8. Schedule for conducting genetic analysis and size and age at maturity comparisons (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow/Okanogan steelhead	D	D	D	D	A	A	D	D	D	D	D	D
Methow spring Chinook	A	A	A	A	D	D	D	D	D			

Objective 4: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific expected value (BAMP 1998).

Hypotheses:

- Ho_{12}: $HRR_{Year\ x} \geq NRR_{Year\ x}$
- Ha_{12}: $HRR_{Year\ x} < NRR_{Year\ x}$
- Ho_{13}: HRR ≥ BAMP value (preferred)
- Ha_{13}: HRR < BAMP value

General Approach

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome lower post-release survival (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a biologically significant greater number of adults than naturally spawning fish, the program should be modified or discontinued. More simply, the hatchery replacement rate should always be greater than the natural replacement rate.

Hatchery programs in the Upper Columbia River were initially designed based on observed mean survival rates for each stock (BAMP 1998). Performance of the hatchery programs will be assessed using those expected survival rates and the number of broodstock collected on a brood year basis. Harvest augmentation hatchery programs will only be compared to the expected HRR value because a corresponding NRR is not available or applicable (e.g., Wells summer Chinook).

Methodology

Smolt to adult (SAR) and HRR values will be calculated for each stock. SAR values are currently calculated using CWT recoveries from all locations (harvest, hatcheries, and spawning grounds), except for steelhead, which is calculated based on sampling that occurs at Priest Rapids Dam or Wells Dam. HRR values that fall below the expected values or NRR (M&E Plan Appendix G) will be evaluated to determine whether in-hatchery (M&E Plan Appendix C) or out of hatchery (M&E Plan Appendix D) factors contributed to the reduced survival.

An unknown number of Wells summer Chinook spawn immediately downstream of Wells Dam, and possibly in areas on Bridgeport Bar (G. Wiest, WDFW, personal communication). Surveys will be conducted by boat or helicopter to determine redd abundance and to recover carcasses in these areas per protocols outlined in the M&E Plan.

Schedule of Activities

Table 9. Schedule of activities for hatchery evaluation activities (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow/Okanogan steelhead	A/D	A/D	D	D	D	D	D	D	D	D	D	D
Wells summer Chinook	A/D	A/D	D	D	D	D	D	D	D	D	D	D
Methow Basin spring Chinook	A/D	A/D	D	D	D	D	D	D	D	D	D	D

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation.

Hypotheses:

- Ho_{14}: Stray rate $_{\text{Hatchery fish}}$ < 5% of total brood return
- Ha_{14}: Stray rate $_{\text{Hatchery fish}}$ ≥ 5% of total brood return
- Ho_{15}: Stray hatchery fish < 5% of spawning escapement (based on run year) within other independent populations
- Ha_{15}: Stray hatchery fish ≥ 5% of spawning escapement (based on run year) within other independent populations
- Ho_{16}: Stray hatchery fish < 10% of spawning escapement (based on run year) of any non-target streams within independent populations
- Ha_{16}: Stray hatchery fish ≥ 10% of spawning escapement (based on run year) of any non-target streams within independent populations

General Approach

Excessive strays from hatchery programs pose significant genetic risk (loss of genetic variation between populations) and must be monitored in order to determine the magnitude of the problem and develop reasonable and appropriate recommendations. Stray rates will be monitored using CWT recoveries from Chinook spawning ground surveys. The Regional Mark Information System (RMIS) database will provide all necessary CWT information needed when calculating stray rates for each brood year or within and outside basin stray rates based on spawning escapement estimates.

Brood year stray rates will require multiple year CWT recoveries (i.e., all age classes) from broodstock and carcass recoveries on the spawning grounds. The estimated number of strays for the entire brood year will be calculated by dividing the number of strays by the total number of hatchery fish that returned. Stray rates within, and between independent populations will be calculated in a similar manner as brood year stray rates, except on an annual basis and based on the estimated spawning escapement.

Collecting stray rate information for steelhead poses the greatest challenge because carcasses are not available for examination. When available, radio tag information and/or adult PIT tag monitoring may provide adequate information for evaluating stray rates. Some data needed for evaluating stray rates for the Methow/Okanogan steelhead will be collected during broodstock trapping activities at Wells Dam (M&E Plan Appendix B), and through operation of the Twisp River weir when assessing spawn timing (see Objective 2). Stray rates in other tributaries may need to be calculated by other types of sampling (i.e., PIT tags, radiotags, hook and line) if warranted. Antenna arrays installed by WDFW and other researchers should provide tributary stray rate information, provided that adequate numbers of juvenile fish are PIT tagged prior to release (hatchery fish) or within natal streams (wild fish).

Methodology

Stray rates will be calculated using procedures outlined in the spawning ground survey methodology (M&E Plan Appendix F). As stated previously, information needed to evaluate steelhead stray rates will occur during broodstock collection activities at Wells Dam, operation of the Twisp weir and antenna array, and through other proposals. However, direct observations on the spawning grounds by other Agencies (e.g., USFWS, CCT, or USGS) or via PIT tags may be required in non-target streams (Table 10).

Table 10. Proposed methodologies used to evaluate stray rates for target and non-target streams.

Hatchery program	Target stream	Method
Methow steelhead	Methow, Twisp, Chewuch	PIT/Observation/creel*
Okanogan steelhead	Okanogan, Similkameen	PIT/Observation/creel*
Methow Basin spring Chinook	Methow, Twisp, Chewuch	CWT
Wells summer Chinook	Wells Hatchery	CWT

***** The number of strays will also be estimated during broodstock collection activities or PIT tag detections at Columbia River or tributary dams/detectors where applicable.

Schedule of Activities

Table 11. Schedule for data analysis to determine stray rates of hatchery fish (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow steelhead	A	A	D	D	D	D						
Okanogan steelhead	A	A	D	D	D	D						
Methow Basin spring Chinook	A	A						D	D			
Wells summer Chinook	A	A								D	D	

Objective 6. Determine if hatchery fish were released at the programmed size and number.

Hypotheses:

- Ho_{17}: Hatchery fish $_{\text{Size at release}}$ = Programmed $_{\text{Size at release}}$
- Ha_{17}: Hatchery fish $_{\text{Size at release}}$ ≠ Programmed $_{\text{Size at release}}$
- Ho_{18}: Hatchery fish $_{\text{Number released}}$ = Programmed $_{\text{Number released}}$
- Ha_{18}: Hatchery fish $_{\text{Number released}}$ ≠ Programmed $_{\text{Number released}}$

General Approach

The HCP outlines the number and size at which fish of each program are to be released. The programmed size and number of fish for each program will be compared to actual values at release each year. The number of broodstock collected and the assumptions (i.e., sex ratio, fecundity, and survival) in the broodstock collection protocol are important components that need to be considered. A program's failure to meet the HCP standards (e.g., over or under program goals) will be evaluated taking into account the number of broodstock and assumptions. The size of fish will be compared using a representative sample collected immediately prior to release.

Methodology

The number and size of fish released will be calculated according to methodologies outlined in the M&E Plan (Appendix C). An annual review of size and number of fish from each program will be compared to those values defined in the HCP. If release targets were achieved within acceptable levels (i.e., 10% +/- of HCP defined values) then no change would be recommended. If release targets are not achieved then causation will be determined and recommendations will be made based upon the results of the evaluation. A review of the broodstock protocols will occur every five years (or more frequently if necessary) concurrently with an evaluation of the number of fish released from each program.

Schedule of Activities

Table 12. Schedule of activities to determine the number and size of fish released (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Wells steelhead	D	D	D	D	D	A	D	D	D	D	D	D
Wells summer Chinook	D	D	D	D	D	D	D	A	D	D	D	D
Methow spring Chinook	D	D	D	D	D	A	D	D	D	D	D	D

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Hypotheses:

- Ho_{19}: Slope of Ln(juveniles/redd) vs redds $_{\text{Supplemented population}}$ = Slope of Ln(juveniles/redd) vs redds $_{\text{Non-supplemented population}}$
- Ha_{19}: Slope of Ln(juveniles/redd) vs redds $_{\text{Supplemented population}}$ ≠ Slope of Ln(juveniles/redd) vs redds $_{\text{Non-supplemented population}}$
- Ho_{20}: The relationship between proportion of hatchery spawners and juveniles/redd is ≥ 1.
- Ha_{20}: The relationship between proportion of hatchery spawners and juveniles/redd is < 1.

General Approach

Supplementation should result in an increase in the natural production of the target stock. Given variability in abundance of adult salmonid populations in the Upper Columbia River Basin, monitoring juvenile production (e.g., smolts/redd) should provide a direct assessment of the efficacy of hatchery fish in rebuilding natural populations. Monitoring the freshwater production of both supplemented and non-supplemented populations may provide an early indication of the reproductive success of hatchery fish on the spawning grounds (i.e., no out of basin effects on survival). Conversely, without a smolt monitoring program, changes in smolt production may be masked by out of basin effects. Thus, subsequent recommendations concerning hatchery program modifications may be misdirected.

Smolt monitoring programs are currently ongoing for most treatment streams (Table 13). Coordination with the Agencies operating the various traps is ongoing to ensure similar levels of effort and methodologies are used.

Table 13. Population and location of smolt traps that may be used in examining the influence of hatchery fish on freshwater productivity.

Population	Smolt trap	Size	Agency
Methow Basin spring Chinook	Methow	1 - 8 ft trap; 1 - 5 ft trap	WDFW
Twisp spring Chinook	Twisp	1 - 5 ft trap	WDFW
Methow Basin steelhead	Methow	1 - 8 ft trap; 1 - 5 ft trap	WDFW
Twisp steelhead	Twisp	1 - 5 ft trap	WDFW
Okanogan steelhead	Okanogan	1 - 8 ft trap; 1 – 5 ft trap	CCT

Comparisons between supplemented and unsupplemented populations require extensive data sets, with potentially high annual variability that may require years before the efficacy of the program can be determined. Furthermore, the Wells steelhead program began decades before the HCP was signed and pretreatment data may not be available.

Methodology

Procedures for this objective are outlined in Appendix E of the M&E Plan. Juvenile monitoring requires an extensive trapping period (Table 15) over many successive generations due to the diverse life history of spring Chinook (subyearling and yearling emigrants) and summer steelhead (multiple age class smolts). Random scale samples must be collected for all stocks with multiple age class smolts in order to calculate the number of smolts produced from each brood year. Additionally, whenever possible direct measurements of the proportion of hatchery fish on the spawning grounds should be conducted (i.e., Twisp weir).

Current estimates of egg to smolt survival for Methow spring Chinook are much lower than expected. Based on scale analysis of returning Chinook adults, we assumed that at the Methow smolt trap all yearling emigrants were spring Chinook and subyearling emigrants were summer Chinook. Results of DNA sampling at the Methow River trap during the fall of 2006 and 2007 indicated that the majority of subyearling Chinook captured were spring Chinook. Because of this, fall trapping and DNA sampling will be conducted at the Methow smolt trap. Provided no unmarked subyearling hatchery fish are released prior to trapping, we propose to conduct DNA sampling during the spring period to determine the extent of subyearling spring Chinook spring emigration at the Methow smolt trap.

The low abundance of steelhead and yearling Chinook captured at smolt traps in the Methow Basin limits the sample size to conduct migration timing comparisons and life stage survival estimates (e.g., PIT tag recaptures). The installation of PIT tag antenna arrays in the lower Twisp and Methow rivers will provide additional opportunities to assess migration behavior and survival, provided an adequate number of fish are PIT tagged. We propose to conduct additional PIT tagging of juvenile steelhead and Chinook that are encountered during ongoing sampling activities. These fish would be captured via hook-and-line angling, seine netting, or rescued from de-watering areas via traps or nets. Tagging methodology would be consistent with ongoing activities in the Wenatchee and Entiat basins following protocols developed under the ISEMP (Table 14).

For life-stage survival comparisons and to monitor stray rates, migration patterns, rate, and speed within the basin, we propose that comparison groups of hatchery steelhead be tagged at Wells Hatchery prior to release (Table 14). Comparison groups of hatchery spring Chinook and steelhead were historically tagged at each smolt trap, but tag rates were likely too low to provide meaningful comparisons. Further, PIT tagging at the Methow trap likely incorporated fish from hatchery programs not covered under the M&E Plan (i.e., WNFH) because release time and hatchery mark are often the same for steelhead and spring Chinook released from WDFW and USFWS hatcheries in the Methow Basin. Since releases of similar fish from these hatcheries have exhibited different survival rates (Townsend and Skalski 2004), tagging should occur at the hatchery of origin to ensure that evaluations are conducted with target stocks.

Table 14. PIT tagging goals for remote sampling (wild fish) and in-hatchery tagging (hatchery fish) in the Methow Basin.

Target population	Wild fish		Hatchery fish	
	Steelhead	Subyearling Chinook	Target population	Steelhead
Methow	500	500	Methow (ad-clipped)	10,000
Twisp	500	500	Methow (non-clipped)	10,000
Chewuch	500	500	Okanogan (ad-clipped)	10,000
Misc. tribs	500			
Total	2,000	1,500		30,000

Schedule of Activities

Table 15. Schedule of activities for smolt monitoring programs in the Methow Basin (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D
Methow Basin steelhead	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Twisp steelhead	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Methow Basin spring Chinook	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Twisp spring Chinook	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A
Methow summer Chinook	A	D/A	D/A	D	D	D	D	D	D	D	D	D/A

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate (e.g., Wells Chinook salmon).

Hypotheses:

- Ho_{21}: Harvest rate ≤ Maximum level to meet program goals
- Ha_{21}: Harvest rate > Maximum level to meet program goals
- Ho_{22}: Escapement ≥ Maximum level to meet supplementation goals
- Ha_{22}: Escapement < Maximum level to meet supplementation goals

General Approach

In years when the expected returns of hatchery adults are above the levels required to meet program goals (i.e., broodstock, natural escapement), surplus fish may be available for harvest. Harvest of returning adults is the goal of some programs (e.g., Wells summer Chinook) and an ancillary benefit of other programs (e.g., Methow/Okanogan steelhead). Contribution to fisheries, whether incidental or directed, will be monitored using CWT recoveries on a brood year basis. Target harvest rates have not been outlined in the M&E Plan. Hence, a qualitative assessment of the contribution rates of hatchery fish to fisheries versus broodstock or spawning grounds is required to determine if the objective has been met.

One approach, based on the goal of the hatchery program, is to compare CWT recoveries by recovery location (i.e., broodstock, fisheries, or spawning grounds). For example, a majority of the CWT recoveries for harvest augmentation programs should occur in fisheries. Conversely, supplementation programs should have a majority of the CWT recoveries occur on the spawning grounds.

Methodology

Robust statistically valid creel programs will be conducted for all sport fisheries in the Upper Columbia River to estimate harvest of hatchery fish from Douglas County PUD funded hatchery programs (M&E Plan Appendix D). Creel survey programs will be designed and implemented by WDFW Fish Management staff. Creel surveys in the Upper Columbia River are also an important component in calculating the HRR (Objective 4) because most CWT recoveries occur within the Upper Columbia River, the exception being summer Chinook. Significant time lags in reporting CWT recovery data to the Regional Mark Information System (RMIS) database requires a continual requerying of recovery data until the number of estimated fish does not change. The number of fish and proportion by brood year for CWT recoveries will be summarized in several categories (Table 16).

Table 16. Categories for CWT recoveries of hatchery fish released from Douglas County PUD funded programs.

Category	Estimated number of fish (%)		
Broodstock	Total	Target stream	Nontarget streams
Spawning ground	Total	Target stream	Nontarget streams
Fisheries	Total	Commercial	Sport
Commercial	Ocean	Columbia River Treaty	Columbia River non-Treaty
Sport	Ocean	Columbia River	Terminal

Schedule of Activities

Table 17. Schedule of activities to determine harvest rates of hatchery fish (D = data collection; A = data analysis).

Target population	J	F	M	A	M	J	J	A	S	O	N	D

Methow/Okanogan steelhead	D	D	D	A	A	A		D	D	D	D	D
Wells summer Chinook	A	A					D	D	D	D		
Methow basin spring Chinook	A	A										

DELIVERABLES

Annual Reports: A draft annual report will be provided to the District by 1 April. A final report will be provided to the HCP HC within 30 days of receiving comments on the draft report. The annual report will summarize all field activities conducted during the contract period. The format of the report will be similar to the 2007 and 2008 annual reports that have been provided to the District, with each task reported in a separate chapter. Primary indicators and the data used in calculations during each task will also be presented in each chapter. Secondary and tertiary indicators will be reported if needed to calculate the primary indicator.

Chapter 1. Hatchery Brood Report

a. Broodstock
   - Number collected
   - Age composition
   - Size at maturity

b. Juvenile
   - Number released
   - Size at release

c. Hatchery replacement rates

Chapter 2. Harvest

a. Hatchery fish
   - Number
   - Location
   - Stray rates

b. Wild fish
   - Number
   - Location

Chapter 3. Smolt Monitoring

a. Smolt production
   - Number of smolts (captured and total estimate)
   - Smolts/redd
   - Size at emigration
   - Age at emigration

b. Survival
   - Egg to emigrant survival
   - Number of fish PIT tagged
   - Smolt to smolt survival

c. Remote PIT tagging
   Number tagged

Chapter 4. Steelhead Spawning Ground Surveys

a. Migration timing
b. Spawn timing
c. Redd distribution
   Number of redds
   Spawning escapement
   Spawner composition
   Number of NOR
   NRR
   Stray rates

Chapter 5. Chinook Spawning Ground Surveys

a. Migration timing
b. Spawn timing
c. Redd distribution
   Number of redds
   Spawning escapement
   Spawner composition
   Number of NOR
   NRR
   Stray rates

Chapter 6. Genetic Analysis

a. Genetic distances
b. Allele frequencies
c. Effective population sizes

Five-Year Summary Report: In addition to the annual report, a draft five-year summary report will be developed and provided to the District no later than 1 April 2011. A final report will be provided to the HCP HC within 30 days of receiving comments on the draft report. The format of the five-year summary report will be similar to the M&E Plan and results will be presented by objective, not by task as in the annual reports. Statistical analysis of data will be based on the statistical design that is currently under development. All raw data used in the statistical analysis will also be presented in the report.

Recommendations: Recommendations to modify the M&E Plan or reporting will occur on an annual basis and again at the five-year summary. Initially, changes to protocols or methodologies may be necessary to ensure the data required in the M&E Plan is collected. Changes to the M&E Plans' implementation or hypotheses will be included in the five-year summary report. Recommendations will be consistent with the hatchery program goals and will be included in a separate section of the summary report.

Presentations: A formal presentation (i.e., power point format) of the M&E Plan results will be provided to Douglas PUD or the HCP HC at their convenience. Presentations will include the status of all hatchery programs in meeting their objectives, potential problems and recommendations. Similar presentations of annual results from field activities can be requested and provided if warranted.

COORDINATION BETWEEN DOUGLAS PUD AND HATCHERY STAFF

The WDFW Supplementation Research Team (a.k.a. Methow Field Office) has been directly involved in the evaluation, development, and implementation of the hatchery programs since 1992. Currently, the WDFW is contracted by Douglas PUD not only to operate its hatcheries, but also to implement the Evaluation Plan developed when the Methow Hatchery program came online.

Coordination with hatchery staff has been a continual process. Hatchery staff conducts routine sampling at the hatcheries and data is provided to us for inclusion in monthly reports. However, special meetings with the hatchery staff are typically conducted prior to significant events (i.e., broodstock collection, spawning, release of juveniles) to ensure proper methodologies are used and critical data is collected. Evaluation staff is present at all significant events and collect data needed for evaluation purposes.

Additional coordination between evaluation staff, hatchery staff, and the WDFW ESA Permitting biologist is often required to ensure that conditions of ESA Section 10 permits are not violated. The ESA permitting biologist is co-located with evaluation staff, which allows for efficient and effective communication on a daily basis in order to ensure compliance with existing permits. Currently, all ESA reporting related to the hatchery programs is the responsibility of the WDFW Permitting Biologist (0.5 FTE). Given the limited resources dedicated to ESA Permit reporting and the extensive workload required to meet reporting requirements, this relationship is critical to ensuring hatchery programs operate within the conditions of the permit.

Monthly reports have served as a primary mode of coordination and are used to keep Douglas PUD as well as HCP Committee members and co-managers informed on all hatchery and evaluation related activities. Unless otherwise requested by Douglas PUD, the role of monthly reports will remain the same. Upon request, additional information can be included in the monthly reports.

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Appendix D

2009 UCR Salmon and Steelhead Broodstock Objectives and Site-Based Broodstock Collection Protocols

Appendix D

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
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April 15, 2009

To: Kristine Petersen, Salmon Recovery Division, NMFS

From: Kirk Truscott, WDFW

Subject: **Final DRAFT 2009 UPPER COLUMBIA RIVER SALMON AND STEELHEAD BROODSTOCK OBJECTIVES AND SITE-BASED BROODSTOCK COLLECTION PROTOCOLS**

The attached protocol was developed in coordination with the mid-Columbia Habitat Conservation Plans (HCPs) for hatchery programs rearing spring Chinook salmon, sockeye salmon, summer Chinook salmon and summer steelhead associated with the mid-Columbia HCPs, spring Chinook salmon and steelhead programs associated with the 2008 Biological Opinion for the Priest Rapids Hydroelectric Project (FERC No. 2114) and fall Chinook consistent with Grant County Public Utility District and Federal mitigation obligations associated with Priest Rapids and John Day dams, respectively. These programs are funded by Chelan, Douglas, and Grant County Public Utility Districts (PUDs) and are operated by the Washington Department of Fish and Wildlife (WDFW). Additionally, the Yakama Nation's (YN) Coho Reintroduction Program broodstock collection protocol, when provided by the YN, will be included in this protocol because of the overlap in trapping dates and locations.

This protocol is intended to be a guide for 2009 collection of salmon and steelhead broodstocks in the Methow, Wenatchee, and Columbia River basins. It is consistent with previously defined program objectives such as program operational intent (i.e., conservation and/or harvest augmentation), mitigation production levels (HCPs, Priest Rapids Dam 2008 Biological Opinion and to comply with ESA permit provisions.

Notable in this year's protocols are: (1) Wenatchee spring Chinook broodstock collection strategies targeting Chiwawa hatchery origin Chinook at Tumwater Dam, intended to provide improved hatchery origin broodstock collection and to reduce the number of Leavenworth NFH strays into other Wenatchee basin UCR spring Chinook spawning aggregates; (2) Natural origin Chiwawa spring Chinook collection at the Chiwawa Weir, consistent with ESA Section 10 Permit 1196; (3) Methow spring Chinook broodstock protocol targeting natural origin spring Chinook at Wells Dam and at the Twisp River weir; (4) utilization of genetic sampling/assessment to differentiate Twisp River and non Twisp River natural origin adults collected at Wells Dam and CWT interrogation during spawning of hatchery spring Chinook collected at the Twisp Weir, Methow FH and Winthrop NFH to differentiate Twisp and Methow Composite hatchery fish for discrete management of Twisp and Methow Composite production components; (5) the collection of hatchery origin spring Chinook for the Methow River Basin program in excess of production requirements for BKD management, (6) the use of ultra-sound technology to determine sex of Wenatchee summer Chinook during collection to aid in achieving the appropriate female equivalents for programmed production, and (7) the potential collection of Wells summer Chinook to support the Yakama Nation (YN) summer Chinook re-introduction program in the Yakima River Basin (requires agreement of the HCP Hatchery Committee). These protocols may be adjusted in-season, based on actual run monitoring at mainstem dams and other sampling locations.

Above Wells Dam

Spring Chinook
Natural origin fish inclusion into the broodstock will be a priority, with natural origin fish specifically being targeted. Natural origin fish collections will not exceed 33 percent of the MetComp and Twisp natural origin run escapement at Wells Dam.

To facilitate BKD management, to comply with ESA Section 10 permit take provisions and to meet programmed production, hatchery origin spring Chinook will be collected in numbers excess to program production requirements. Based on historical Methow FH spring Chinook ELISA levels above 0.12, the hatchery origin spring Chinook broodstock collection will include hatchery origin spring Chinook in excess to broodstock requirements by approximately 18 percent. The parties to the HCP have acknowledged that targeting broodstock collection objectives at levels that provide for culling of eggs from higher ELISA level hatchery origin females and prioritizing natural origin fish for rearing to yearling smolt stage is a viable approach to balance the promotion of fish health while limiting indirect reductions in genetic diversity and reduced program production, particularly for ESA listed supplementation programs. For purposes of BKD management and to comply with maximum production levels and other take provisions specified in ESA Section 10 permit 1196, culling will include the destruction of eggs from hatchery origin females with ELISA levels greater than 0.12 and or that number of hatchery origin eggs required to maintain production at 550,000 yearling smolts. Culling of eggs from natural origin females will not occur, unless their ELISA levels are determined by WDFW Fish Health to be a substantial risk to the program. Juveniles from natural origin females with ELISA levels greater than 0.12 will be differentially tagged for evaluation purposes. To monitor the efficacy of culling in reducing the prevalence of BKD in Methow Basin spring Chinook, annual monitoring and evaluation of the prevalence and level of BKD in returning hatchery and natural origin spring Chinook will continue and will be reported in the annual monitoring and evaluation report for this program.

The 2009 Methow spring Chinook broodstock collection will occur at Wells Dam, Twisp River Weir, Methow FH and Winthrop NFH. Limited on-station release of smolts from the Methow FH, absence of a trapping facility on the Chewuch River and poor trapping success at Foghorn Dam on the mainstem Methow River preclude reasonable certainty of meeting adult collection requirements via tributary and Methow FH outfall collections. The aforementioned limitations are the principle reasons for the inclusion of broodstock collection at Wells Dam and Winthrop NFH during 2009.

Recent WDFW genetic assessment of natural origin Methow spring Chinook (Small et al. 2007) suggest that Twisp natural-origin spring Chinook can be identified with sufficient confidence that natural origin collections can occur at Wells Dam, thereby facilitating natural origin inclusion in the broodstock, while maintaining the ability to manage separately the Twisp origin spring Chinook spawning aggregate. Although Twisp natural origin fish can be assigned to the Twisp population with confidence, some gene flow between the Twisp and Methow Composite spawning aggregates are anticipated as a result of collecting natural origin broodstock at Wells Dam. Based on projected Proportion Natural Origin (pNOB) broodstock composition for Twisp and Methow Composite programs (31% and 30%, respectively) and composite brood year assignment errors for wild Twisp and MetComp spring Chinook provided in Snow et al. (2007), the projected non-source fish contributions to the Twisp and MetComp hatchery programs for 2009 are 1.6% and 1.5%, respectively. In this instance, percent non-source fish contribution may be considered a gene flow estimate between the two program production elements (Twisp and Methow Composite) and is an unavoidable consequence associated with natural origin broodstock collection at Wells Dam during 2009. Although gene flow between the two hatchery production components is likely, it is expected to be relatively low in 2009 and supports a hatchery broodstock collection program objective to infuse natural origin fish into the hatchery program to maintain/improve genetic diversity and reduced domestication. For complete discussion regarding Methow Spring Chinook genetic monitoring and evaluation see Snow et al. (2007).

Non-lethal tissue samples (fin clips) for genetic analysis and scale samples will be obtained from adipose present, non-CWT, non-ventral clipped spring Chinook (suspected natural origin spring Chinook) collected at Wells Dam for origin analysis. Natural origin fish retained for broodstock will be tagged with a PIT tag (dorsal sinus) for tissue sample/genetic analysis cross-reference. Tissue samples will be preserved and sent to WDFW genetics lab in Olympia Washington for genetic/stock analysis. The spring Chinook sampled will be retained at Methow FH and will be sorted as Twisp or non-Twisp natural origin fish prior to spawning. The number of natural origin Twisp and Methow Composite (non-Twisp) spring Chinook retained will be dependent upon the number of natural origin adults returning and the collection objective limiting extraction to no greater than 33% of the natural origin spring Chinook return past Wells Dam. Based on the broodstock collection schedule (3-day/week, 16 hours/day), natural origin spring Chinook extraction is expected to be approximately 33% or less.

Weekly estimates of natural-origin spring Chinook passage past Wells Dam will be provided through stock assessment and broodstock collection activities and will provide the opportunity to adjust, in-season, the extraction of natural origin spring Chinook to maintain no greater that 33% extraction of Twisp and Methow Composite natural origin components while maximizing the opportunity for the inclusion of natural origin spring Chinook in the broodstock. Additionally, in-season estimates of Twisp and Methow Composite natural origin escapement past Wells Dam provides the opportunity to utilize both Wells Dam and the Twisp Weir as natural origin collection sites for the Twisp production component, thereby providing additional flexibility to account for differences between projected and actual returns of Twisp and Methow Composite natural origin fish. Twisp and Methow Composite hatchery origin spring Chinook will be captured at the Twisp Weir, Methow FH outfall. Trapping at the Winthrop NFH will be included if needed to address broodstock shortfalls.

The Methow FH rears spring Chinook salmon for three acclimation/release sites in the Methow River Basin, including: (1) Methow River (Methow FH); (2) Twisp River (Twisp Acclimation Pond) and (3) Chewuch River (Chewuch Acclimation Pond). The total production level target is 550,000 smolts divided equally among the three release sites (approximately 183,000 smolts per site).

Pre-season run-escapement of Methow origin spring Chinook past Wells Dam during 2009 are estimated at 2,237 spring Chinook, including 1,943 hatchery and 294 natural origin Chinook (Table 1 and Table 2). In-season estimates of natural origin spring Chinook will be adjusted proportional to the estimated returns to Wells Dam at weekly intervals and may result in adjustments to the broodstock collection targets presented in this document.

Based on current juvenile rearing capacity at Methow FH, programmed production levels (550,000 smolts), BKD management strategies, projected return for BY 2009 Methow Basin spring Chinook at Wells Dam (Table 1 and Table 2), and assumptions listed in Table 3, the following broodstock collection protocol was developed.

The 2009 Methow spring Chinook broodstock collection will target 359 adult spring Chinook. Based on the pre-season run forecast, Twisp fish are expected to represent 3% of the adipose present, CWT tagged hatchery adults and 12% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution, and a collection objective to limit extraction to no greater than 33%, the 2009 Twisp origin broodstock collection will be predominantly hatchery origin and total 33 fish (11 wild and 22 Hatchery), representing 30% of the broodstock necessary to meet Twisp program production of 183,000 smolts. Methow Composite fish are expected to represent 97% of the adipose present CWT tagged hatchery adults and 88% of the natural origin spring Chinook passing above Wells Dam (Tables 1 and 2). Based on this proportional contribution and a collection objective to limit extraction to no greater than 33%, the 2009 Methow Composite (combined Methow and Chewuch river spawning aggregates) broodstock collection will be predominantly hatchery origin and total 326 spring

Chinook (86 wild and 240 Hatchery). The broodstock collected for the Methow Composite production represents 100% of the broodstock necessary to meet Methow Composite program production of 367,000 smolts (combined Methow and Chewuch production), and sufficient to backfill the expected shortfall of 129,000 Twisp River spring Chinook. The Twisp River releases will be limited to releasing progeny of broodstock identified as wild Twisp and or known Twisp hatchery origin fish, per ESA Permit 1196. The Chewuch Pond and Methow FH releases will include progeny of broodstock identified as wild non-Twisp origin and known Methow Composite hatchery origin fish.

Table 1. Brood Year 2004-2006 age-class return projection for wild spring Chinook Dam above Wells during 2009.

	Smolt Estimate		Age-at-Return								
	Twisp [1/]	Methow Basin [2/]	Twisp				Methow Basin				
BY			**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**SAR** [3/]
2004	5,873	22,941	2	21	**10**	33	6	83	**38**	128	0.005581
2005	5,372	55,381	1	**19**	9	30	15	**201**	93	309	0.005581
2006	18,580	198,400	**5**	67	31	104	**55**	720	332	1107	0.005581
2009 Return Year			**5**	**19**	**10**	**34**	**55**	**201**	**38**	**294**	

[1/]- Smolt estimate based on sub-yearling and yearling emigration (Snow et al. 2008)

[2/]- Estimated Methow Basin smolt emigration, based on Twisp Basin smolt emigration, proportional redd deposition in the Twisp River and Twisp Basin smolt production estimate.

[3/]- Mean 1998-2003 Chiwawa River wild SAR as a surrogate wild SAR for Methow spring Chinook

BY 2004-2006 age-class and origin run-escapement projection for UCR spring Chinook at Wells Dam, 2009

	Projected Escapement											
	Origin								Total			
	Hatchery				Wild				Methow Basin			
Stock	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**	**Age-3**	**Age-4**	**Age-5**	**Total**
MetComp	164	947	42	1,153	50	182	28	260	214	1,129	70	1,413
% Total				59%				88%				63%
Twisp	14	47	6	67	5	19	10	34	19	66	16	101
% Total				3%				12%				5%

Winthrop (MetComp)	723					723
	37%					
Total	1,943	55	201	38	294	2,237
	87%				13%	100%

Table 3. Assumptions and calculations to determine number of broodstock needed for BY 2009 production of 550,00 smolts

Smolt release		**550,000**	**Smolts**
Fertilization-to-release survival	90%		
Egg-take (Production)		611,000	Eggs
18% cull allowance [2/]		73,000	
Total Egg Take		**684,000**	**Eggs**
Fecundity	4,000 [1/]	171	Females spawned
Female to male ratio	1 to 1	341	Total spawned
Pre-spawn survival	**95%**	**359**	**Broodstock collection target**

1/- Based on historical program age-4 fecundities and expected 2009 return age structure (Table 1).

2/- Hatchery origin MetComp. component only, and is based on projected natural origin collection and assumption that all Twisp (hatchery and wild) and wild MetComp. will be retained for production.

Trapping at Wells Dam will occur at the East and West ladder traps beginning on 04 May, or at such time as the first spring Chinook are observed passing Wells Dam and continue through 24 June 2009. Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Trapping schedule will consists of 3-day/week (Monday-Wednesday), up to 16-hours/day. Two of the three trapping days will be concurrent with the stock assessment sampling activities authorized through the 2009 Douglas PUD Hatchery M&E Implementation Plan. Natural origin spring Chinook will be retained from the run, consistent with spring Chinook run timing at Wells Dam (weekly collection quotas). Once the weekly quota target is reached, broodstock collection will cease until the beginning of the next week. If a shortfall occurs in the weekly trapping quota, the shortfall will carry forward to the following weeks collection quota. All natural origin spring Chinook collected at Wells Dam for broodstock will be held at the Methow FH.

To meet Methow FH broodstock collection for hatchery origin Methow Composite and Twisp River stocks, adipose-present coded-wire tagged hatchery fish will be collected at Methow FH, Winthrop NFH and the Twisp Weir beginning 01May or at such time as spring Chinook are observed passing Wells Dam and continuing through 21 August 2009. Natural origin spring Chinook will be retained at the Twisp weir as necessary to bolster the Twisp program production so long as the aggregate collection at Wells Dam and Twisp River weir does not exceed 33% of the estimated Twisp River natural origin return past Wells Dam. All hatchery and natural origin fish collected at Methow FH, Twisp Weir and Winthrop NFH for broodstock will be held at the Methow FH.

Steelhead

Steelhead mitigation programs above Wells Dam (including the USFWS steelhead program at Winthrop NFH) utilize adult broodstock collections at Wells Dam and incubation/rearing at Wells Fish Hatchery (FH). The Wells

Steelhead Program also provides eggs for UCR steelhead reared at Ringold FH, not as a mitigation requirement, but rather an opportunity to reduce the prevalence of early spawn hatchery steelhead in the mitigation component above Wells Dam. Typically, Wells hatchery origin steelhead held at Wells FH spawn earlier than natural origin steelhead. Early maturation of hatchery fish in the hatchery may indicate a propensity for these fish to spawn early in the natural environment as well and may have a negative effect on hatchery spawner success. In efforts to minimize impacts from early maturation, the Wells Hatchery program has transferred eggs from the earliest spawn hatchery steelhead to Ringold FH. Preliminary evaluations indicate that the mean spawn timing of HxH steelhead at Wells FH has been delayed and may be a function of these actions (Figure 1). Based on these preliminary evaluations, WDFW proposes to continue the transfer eggs from early spawn hatchery origin steelhead to Ringold FH.

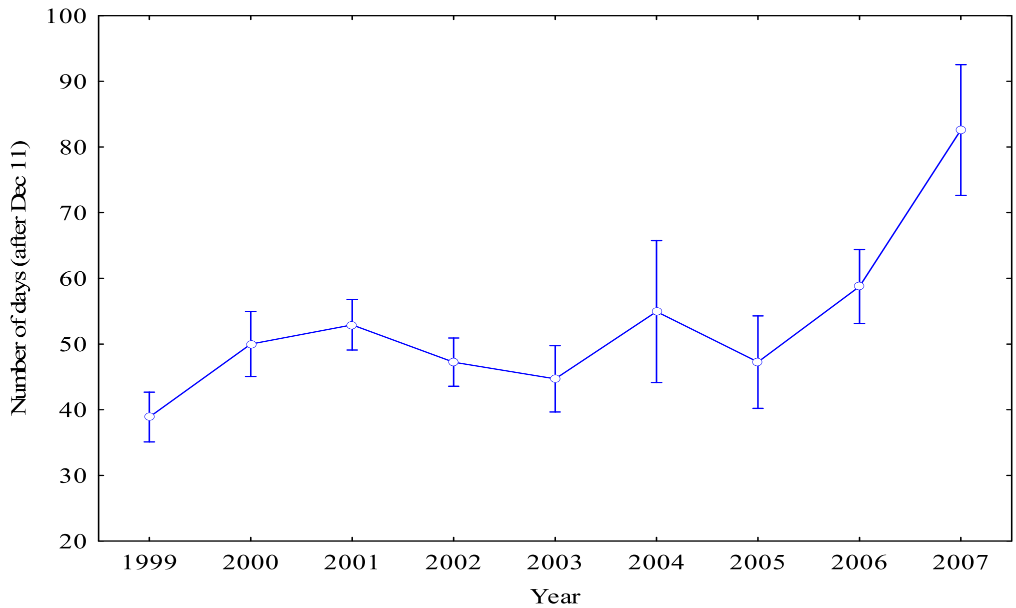

Figure 1. Mean spawn timing of HxH steelhead at Wells FH, BY 1999-2007 (WDFW unpublished Data).

Based on mitigation program production objectives (Table 4) and program assumptions (Table 5), the following broodstock collection protocol was developed.

Trapping at Wells Dam will selectively retain 366 steelhead (east and west ladder collection). Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Hatchery and natural origin collections will be consistent with run-timing of hatchery and natural origin steelhead at Wells Dam. The collection will retain no greater than 33% natural origin broodstock for the mitigation programs and 100% hatchery origin within the Ringold FH production component. Overall collection will be limited to no more than 33% of the entire run or 33% of the natural origin return. The east and west ladder trapping at Wells Dam will begin on 01 August and terminate by 31 October and will be operated concurrently, three days per week, up to 16 hours per day, if required to meet broodstock objectives. Trapping on the east ladder will be concurrent with summer Chinook broodstocking efforts through 14 September and will continue through 31 October, concurrent with west ladder steelhead collections. Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and Wells dams. Broodstock collection adjustments may be made based on in-season monitoring and evaluation.

Table 4. Adult steelhead collection objectives for programs supported through adult steelhead broodstock collection at Wells Dam.

Program	# Smolts	# eyed eggs	% Wild	# Wild	# Hatchery	Total Adults	
DCPUD [1/]	349,000	401,149	33%	59	119	178	
GCPUD [1/]	80,000	91,954	33%	14	27	41	
USFWS [1/]	80,000	91,954	33%	14	27	41	3/
Sub-Total	**509,000**	**585,057**	**33%**	**87**	**174**	**260**	
Ringold	180,000	240,000	0%	0	106	106	3/
Sub-Total	**180,000**	**240,000**	**0%**	**0**	**106**	**106**	
Grand Total [2/]	**689,000**	**825,057**	**24%**	**87**	**289**	**366**	

1/- Above Wells Dam releases. Target HxW parental adults as the hatchery component

2/- Based on steelhead production consistent with Mid Columbia HCP's, GCPUD BiOp and Section 10 Permit 1395.

3/- Based on adults required for eyed egg allotment

Table 5. Program assumptions used to determine adult collection required to meet steelhead production objectives for programs above Wells Dam and at Ringold Springs Fish Hatchery.

Program assumption	Standard
Pre-spawn survival	97%
Female to male ratio	1.0 : 1.0
Fecundity	5,400
Propagation survival	
87% fertilization to eyed egg	87%
86% eyed egg to yearling release	86% [1/]
75% fertilization to yearling release	75% [1/]

1/- Not applicable to Ringold Springs Fish Hatchery

Summer/fall Chinook

Summer/fall Chinook mitigation programs above Wells Dam utilize adult broodstock collections at Wells Dam and incubation/rearing at Eastbank Fish Hatchery. The total production level target is 976,000 summer/fall Chinook smolts for two acclimation/release sites on the Methow and Similkameen rivers (Carlton Pond and Similkameen Pond, respectively).

The TAC 2009 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix A) and BY 2005, 2006 and 2007 spawn escapement to tributaries above Wells Dam indicate sufficient summer Chinook will return past Wells Dam to achieve full broodstock collection for supplementation programs above Wells Dam. Based on initial run expectations of summer Chinook to the Columbia River, program objectives and program assumptions (Table 6); the following broodstock collection protocol was developed.

WDFW will retain 556 natural-origin summer/fall Chinook at Wells Dam east and west ladder, including 278 females. Collection will be proportional to return timing between 01 July and 13 September. Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Trapping will occur 3-days/week, 16 hours/day. The 3-year old component will be limited to 10 percent of the broodstock collection. If the probability of achieving the broodstock goal is reduced based on actual natural-origin escapement levels, broodstock origin composition will be adjusted to meet the broodstock collection objective.

Table 6. Assumptions and calculations to determine number of broodstock needed for summer/fall Chinook production at Carlton and Similkameen ponds.

Program Assumption		Carlton Pond	Similkameen Pond	Total
Smolt release		**400,000**	**576,000**	**976,000**
Fertilization-to-release survival	90%			
Eggtake Target		**512,821**	**738,462**	**1,251,282**
Fecundity	5,000			
Female target		**103**	**148**	**250**
Female to male ratio	1 to 1			
Broodstock target		**205**	**295**	**501**
Pre-spawn survival	95%			
Total collection target		**228**	**328**	**556**

Columbia River Mainstem below Wells Dam

Summer/fall Chinook

Summer/fall Chinook mitigation programs that release juveniles directly into the Columbia River between Wells and Rocky Reach dams are supported through adult broodstock collections at Wells Dam. The total production level supported by this collection is 520,000 yearling and 1,562,000 sub-yearling Chinook. Upon agreement in the HCP, the 2009, summer Chinook broodstock collections at Wells FH may also include 250,000 green eggs to support the Yakama Nation (YN) reintroduction of summer Chinook to the Yakima River Basin. If approved by the HCP Hatchery Committee, the YN eggs will be the last eggs taken and will be the responsibility of staff associated with the YN program.

Adults returning from this program are to support harvest opportunities and are not intended to increase natural production and have been termed segregated harvest programs. These programs have contributed to harvest opportunities; however, adults

from these programs have been documented contributing to the adult spawning escapement in tributaries upstream and downstream from their release locations. Because adults from these programs contribute to the natural spawn escapement, the broodstock collection will incorporate 10 percent natural-origin fish into the broodstock to reduce the potential genetic risk to the naturalized summer/fall Chinook stocks in the upper Columbia River region. Based on mitigation objectives and program assumptions (Table 7), the following broodstock collection protocol was developed.

WDFW will collect 1,476 run-at-large summer Chinook including 1,339 hatchery fish from the volunteer ladder trap at Wells Fish Hatchery outfall and 137 natural-origin fish from the Wells Hatchery outfall, and/or Wells Dam east and west ladders. Access to the east ladder trap will be coordinated with staff at Wells Dam due to rotor rewind project. Overall extraction of natural-origin fish passing Wells Dam (Wells program and above Wells Dam summer/fall Chinook programs) will not exceed 33 percent. West ladder collections will begin 01 July and completed by 14 September and will be consistent with run timing past Wells Dam. Due to fish health concerns associated with the volunteer collection site (warming Columbia River water during late August), the volunteer collection will begin 10 July and terminate by 31 August. The 3-year old component will be limited to 10 percent of the broodstock collection.

Table 7. Assumptions and calculations to determine number of broodstock needed for summer/fall Chinook production at Wells and Turtle Rock Island hatcheries.

	Standard		Wells FH		Turtle Rock FH		YN [1/]	
Program Assumption	**Sub-yearling**	**Yearling**	**Sub-yearling**	**Yearling**	**Sub-yearling**	**Yearling**	**green-egg**	**Total**
Smolt release			484,000	320,000	1,078,000	200,000	250,000	NA
Fertilization-to-release survival	73% [2/]	78%					NA	NA
Eggtake Target			663,014	410,256	1,476,712	256,410	250,000	3,056,392
Fecundity	4,600	4,600						
Female target			144	89	321	56	54	664
Female to male ratio	1 to 1	1 to 1						
Broodstock target			288	178	642	111	109	1,328
Pre-spawn survival	90%	90%						
Total collection target			**320**	**198**	**713**	**124**	**121**	**1,476**

[1/]- Green eggs for YN reintroduction program in the Yakima River Basin.

[2/]- Based on increased monitoring of the green egg-to-marking loss for BY 07 and 08 that indicates a un-fertilized- to- marking loss of 27%.

Coho
Yakama Nation will provide broodstock collection objectives for the coho reintroduction program in the Methow River basin. WDFW will work collaboratively with the Yakama Nation to facilitate coho collections at Wells Dam. Access to the east ladder trap will be coordinating with staff at Wells Dam due to the rotor rewind project.

Wenatchee River Basin

Spring Chinook

The Eastbank Fish Hatchery (FH) rears spring Chinook salmon for the Chiwawa River acclimation pond located on the Chiwawa River. The program production level target is 672,000 smolts, requiring a total broodstock collection of 379 spring Chinook (Table 8).

Table 8. Assumptions and calculations to determine number of broodstock needed for Chiwawa program release of 672,000 smolts.

Program Assumption	Standard	Chiwawa program
Smolt release		**672,000**
Fertilization-to-release survival	83%	
Eggtake Target		**809,639**
Fecundity	4,400	
Female target		**184**
Female to male ratio	1 to 1	
broodstock target		**368**
Pre-spawn survival	97%	
Total broodstock collection		**379**

Natural origin fish inclusion into the broodstock will continue to be a priority, with natural origin fish specifically being targeted. Consistent with ESA Section 10 Permit 1196, natural origin fish collections will not exceed 33 percent of the return to the Chiwawa River and will provide, at a minimum, 33 percent of the total broodstock retained.

In addition to production levels and ESA permit provisions, the 2009 broodstock collection, will again, as in 2008, target hatchery origin Chiwawa spring Chinook at Tumwater Dam. Also in 2009, an interim measure will include extraction of adipose clipped non-coded wire tag adult spring Chinook, as a strategy to reduce straying of Leavenworth NFH spring Chinook to the upper Basin habitat.

Pre-season estimates project 5,114 spring Chinook destine for the Chiwawa River, of which 703 (13.7%) and 4,411 fish (86.3%) are expected to be natural and hatchery origin spring Chinook, respectively (Table 9 and 10). Based on the projected 2009 Chiwawa River run-size and origin composition, and provisions in ESA Section 10 Permit 1196, WDFW will retain 379 spring Chinook for broodstock purposes, representing 100% of the program broodstock objective. Two hundred and thirty-two (232) natural origin spring Chinook will be retained at the Chiwawa Weir and 147 adipose-clipped, CWT hatchery origin spring Chinook will be collected at Tumwater Dam. In-season assessment of the magnitude and origin composition of the spring Chinook return above Tumwater Dam will be used to provide in-season adjustments to broodstock collection, consistent ESA Section 10 Permit 1196.

Table 9. BY 2004-2006 age-class return projection for wild spring Chinook above Tumwater Dam during 2009

	Smolt Estimate		Chiwawa				Wen. Basin above Tumwater Dam				
Brood Year	**Chiwawa** [1/]	**Wen. Basin** [2/]	**Age-3** [3/]	**Age-4** [3/]	**Age-5** [3/]	**Total**	**Age-3** [3/]	**Age-4** [3/]	**Age-5** [3/]	**Total**	**SAR** [4/]
2004	101,172	197,944	28	367	**169**	565	55	718	**331**	1,105	0.005581
2005	140,737	338,079	39	**510**	236	785	94	**1,226**	566	1,887	0.005581
2006	86,579	153,918	**24**	314	145	483	**43**	558	258	859	0.005581
Total 2008 Return			**24**	**510**	**169**	**703**	**43**	**1,226**	**331**	**1,600**	

1/- Smolt production estimate.

2/- smolt production estimate based on proportional redd disposition in the Wenatchee Basin above Tumwater Dam and Chiwawa smolt production estimate.

3/- Based on average age-at-return for natural-origin spring Chinook above Tumwater Dam (WDFW unpublished data).

4/- Mean Chiwawa spring Chinook SAR to the Wenatchee Basin (BY 1998-2003)(WDFW unpublished data).

Table 10. BY 2004-2006 age-class return projection for Chiwawa Hatchery spring Chinook above Tumwater Dam during 2009

	Smolt Estimate	Adult Return				
Brood Year	**Chiwawa** [1/]	**Age-3** [2/]	**Age-4** [2/]	**Age-5** [2/]	**Total**	**SAR** [3/]
2004	494,517	883	2,564	**757**	4,203	0.0085
2005	494,012	882	**2,561**	756	4,199	0.0085
2006	612,482	**1,093**	3,176	937	5,206	0.0085
Total 2008 Return		**1,093**	**2,561**	**757**	**4,411**	

1/- Chiwawa smolt release (Hillman et al. 2007)

2/- Based on average age-at-return for natural-origin spring Chinook above Tumwater Dam (Hilllman et al. 2007) . and total estimated BY return.

3/- Mean Chiwawa hatchery spring Chinook SAR to the Wenatchee Basin (BY 1996-2001)

Trapping at Tumwater Dam will begin 01 May and will be concurrent with trapping for the Spring Chinook Reproductive Success Study. Collection at both Tumwater Dam and Chiwawa Weir will be based on weekly quotas, consistent with average run timing at Tumwater Dam. If the weekly quota is attained prior to the end of the week, retention of spring Chinook for broodstock will cease. If the weekly quota is not attained, the shortfall will carry forward to the next week. The number of hatchery origin fish retained at Tumwater Dam will be adjusted in-season, based on estimated Chiwawa River natural-origin returns provided through extrapolation of returns past Tumwater Dam. If hatchery origin Chinook are retained in excess to that required to maintain a minimum 33 percent natural origin composition in the broodstock, excess fish will be returned to the Chiwawa River beginning the third week of July.

Throughout broodstock collection at Tumwater Dam, adipose absent, non-CWT spring Chinook will be extracted and provided to USFWS as a measure to reduce the prevalence of non-endemic spring Chinook above Tumwater Dam. All adults that are found at Tumwater Dam with a missing adipose fin and lacking a coded wire tag will be putatively classified as LNFH strays. However, it is likely that some proportion of the adipose clipped non-CWT fish are ESA-listed hatchery adults that have shed their tags. Based on the BY 2004, 2005, and 2006 tag rate for Chiwawa spring Chinook and the projected 2009 Chiwawa hatchery return to Tumwater Dam, the extraction of adipose clipped non-CWT spring Chinook may include 61 Chiwawa spring Chinook, representing just 1.4% of the projected 4,411 returning Chiwawa hatchery origin spring Chinook. Based on the USFWS estimates of projected LNFH strays arriving at Tumwater Dam in 2009 (USFWS 2009), the extraction action is expected to remove an estimated 89 LNFH stays, representing 54% of the total stray estimate. With reduced rates of CWT marking at LNFH (in upcoming return years) the USFWS forecasts that the rate of extraction of LNFH strays at Tumwater will increase to 68% in 2010, 75% in 2011, and 80% in 2011. As long as CWT marking rates remain at the current USFWS goal of 17%, the extraction rate of LNFH strays at Tumwater Dam will remain greater than 80% for 2012 and beyond. Logistics for 2009 extraction activities will be coordinated between USFWS, WDFW and CPUD.

Broodstock collection at the Chiwawa Weir will begin 01 June and terminate no later than 10 September. Spring Chinook trapping at the Chiwawa Weir will follow a 4-days up and 3-days down schedule, consistent with weekly broodstock collection quotas that approximate the historical run timing and a maximum 33 percent retention of the projected natural-origin escapement to the Chiwawa River. If the weekly quota is attained prior to the end of the 4-day trapping period, trapping will cease. If the weekly quota is not attained within the 4- day trapping period, the shortfall will carry forward to the next week.

All bull trout and spring Chinook in excess of broodstock needs trapped at the Chiwawa weir will be transported by tank truck and released into a resting/recovery pool at least 1.0 km upstream from the Chiwawa River Weir.

Steelhead

The steelhead mitigation program in the Wenatchee Basin use broodstock collections at Dryden and Tumwater dams located on the Wenatchee River. Per ESA section 10 Permit 1395 provisions, broodstock collection will target 50% natural origin fish and 50% hatchery origin fish, not to exceed 33% of the natural origin steelhead return to the Wenatchee Basin. Based on these limitations and the assumptions listed below (Table 11), the following broodstock collection protocol was developed.

WDFW will retain 208 mixed origin steelhead at Dryden and Tumwater dams, including 104 natural origin and 104 hatchery origin steelhead. Collection will be proportional to return timing between 01 July and 12 November. Collection may also occur between 13 November and 3 December at both traps, concurrent with the Yakama Nation coho broodstock collection activities. Hatchery x hatchery parental cross and unknown hatchery parental cross adults will be excluded from the broodstock collection. Hatchery steelhead parental origins will be determined through evaluation of VIE tags and PIT tag interrogation during collection. Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and at Dryden Dam. Broodstock collection adjustments may be made based on these in-season monitoring and evaluation.

In the event that steelhead collections fall substantially behind schedule, WDFW may initiate/coordinated adult steelhead collection in the mainstem Wenatchee River by hook and line. In addition to trapping and hook and line collection efforts, Tumwater and Dryden dams may be operated between February and early April to supplement broodstock numbers if the fall trapping effort provides fewer than 208 adults.

Table 11. Assumptions and calculations to determine number and origin of adult steelhead needed for Wenatchee Basin Steelhead program release of 400,000 smolts.

Program Assumption	Standard	Wenatchee program
Smolt release		**400,000**
Fertilization-to-release survival	75%	
Eggtake Target		**533,333**
Fecundity	5,400	
Female target		**99**
Female to male ratio	1 to 1	
broodstock target		**198**
Pre-spawn survival	95%	
Total broodstock collection		**208**
Natural : hatchery ratio	1 to 1	
Natural origin collection total		**104**
Hatchery origin collection total		**104**

Summer/fall Chinook

Summer/fall Chinook mitigation programs in the Wenatchee River Basin utilize adult broodstock collections at Dryden and Tumwater dams, incubation/rearing at Eastbank Fish Hatchery (FH) and acclimation/release from the Dryden Acclimation Pond. The total production level target is 864,000 smolts.

The TAC 2009 Columbia River UCR summer Chinook return projection to the Columbia River (Appendix A) and BY 2005, 2006 and 2007 spawn escapement to the Wenatchee River indicate sufficient summer Chinook will return to the Wenatchee River to achieve full broodstock collection for the Wenatchee River summer Chinook supplementation program. Review of recent summer/fall Chinook run-timing past Dryden and Tumwater dam indicates that previous broodstock collection activities have omitted the early returning summer/fall Chinook, primarily due to limitations imposed by ESA Section 10 Permit 1347 to minimize impacts to listed spring Chinook. In an effort to incorporate broodstock that better represent the summer/fall Chinook run timing in the Wenatchee Basin, the broodstock collection will front-load the collection to account for the disproportionate collection timing. Approximately 43 percent of the summer/fall Chinook passage to the upper Basin occurs prior to the end of the first week of July; therefore, the collection will provide 43 percent of the objective by the end of the first week of July. Weekly collection after the first week of July will be consistent with run timing of summer/fall Chinook during the remainder of the trapping period. Collections will be limited to a 33 percent extraction of the estimated natural-origin escapement to the Wenatchee Basin. Based on these limitations and the assumptions listed below (Table 12), the following broodstock collection protocol was developed.

WDFW will retain 492 natural-origin, summer Chinook at Dryden and Tumwater dams, including 246 females. To better assure achieving the appropriate females equivalents for programmed production, the collection will utilize ultra-sound equipment to determine the sex of each fish retained for broodstock. Trapping at Dryden Dam will begin 01 July and terminate no later than 14 September and operate up to 7-days/week, 24-hours/day. Trapping at Tumwater Dam may begin 15 July and terminate no later than 14 September and operate 3-days/week, 8-hours/day.

If the probability of achieving the broodstock goal is reduced, based on the estimated escapement levels, broodstock composition will be adjusted to meet the broodstock collection objective of 492 summer Chinook.

Table 9. Assumptions and calculations to determine number of summer Chinook broodstock needed for Wenatchee Basin program release of 864,000 smolts.

Program Assumption	Standard	Wenatchee program
Smolt release		**864,000**
Fertilization-to-release survival	78%	
Eggtake Target		**1,107,692**
Fecundity	5,000	
Female target		**222**
Female to male ratio	1 to 1	
broodstock target		**443**
Pre-spawn survival	90%	
Total broodstock collection		**492**

Sockeye

Sockeye Salmon mitigation in the Wenatchee River Basin utilizes adult broodstock collections at Tumwater Dam, incubation/rearing at Eastbank Fish Hatchery (FH) and rearing/pre-smolt releases from the net pens in Lake Wenatchee. The total production level for the 2009 BY is 200,000 pre-smolts. 1/

The TAC 2009 UCR sockeye return projection to Columbia River (Appendix A) indicates sufficient Lake Wenatchee sockeye will be available to meet broodstock collection objectives. Based on TAC projected return, 100% natural-origin broodstock composition and assumptions listed below (Table 13), the following broodstock collection protocol was developed.

WDFW will retain 260 natural origin sockeye, proportional to run timing at Tumwater Dam. Due to the unequal sex ratio in previous years, attempts will be made to collect an equal number of males and females. Trapping may begin on 15 July and terminate by 15 August. Trapping will occur no more than 3-days/week, 8- hours/day.

1/- Chelan HCP Hatchery Committee has agreed to future production level of 280,000 fish, pending appropriate infrastructure improvements.

Table 13. Assumptions and calculations to determine number of sockeye salmon broodstock needed for Wenatchee Basin program release of 200,000 pre-smolts.		
Program Assumption	**Standard**	**Wenatchee program**
Smolt release		**200,000**
Fertilization-to-release survival	78%	
Eggtake Target		**256,410**
Fecundity	2,615	
Female target		**99**
Female to male ratio	1 to 1	
broodstock target		**198**
Pre-spawn survival	76%	
Total broodstock collection		**260**

Coho
Yakama Nation will provide broodstock collection objectives and program assumptions for the coho reintroduction program in the Wenatchee River basin. WDFW will work collaboratively with the Yakama Nation to facilitate coho broodstock collections at Dryden and Tumwater Dam.

White River Spring Chinook Captive Brood

Smolt production associated with the White River Captive Broodstock Program (150,000 smolts) will be separate from the smolt production objective associated with the Chiwawa River adult supplementation program. Spawning, incubation, rearing acclimation and release will be consistent with provisions of ESA Permit 1592.

Broodstock collection efforts for brood year 2009 will be addressed in a document separate from this 2009 broodstock collection/protocol document and developed through the Priest Rapids Coordinating Committee Hatchery Committee (PRCC HC).

Priest Rapids Fall Chinook
Collection of fall Chinook broodstock at Priest Rapids Hatchery will generally begin in early September and continue through mid November. Smolt release objectives specific to Grant PUD (5,000,000 sub-yearlings) and Federal (1,700,000 sub-yearlings) mitigation commitments and biological assumptions are detailed in Table 14.

Agreements are in place and/or being negotiated that would allow Priest Rapids to take up to 3.7M eyed eggs for the Ringold Springs Rearing Facility. Us V Oregon parties recently agreed that the brood stock used for the program at Ringold should be Priest Rapids stock. This was also a key recommendation by HSRG. This program is partial mitigation for the John Day Dam and will be funded by the ACOE if implemented. Upon negotiated agreement among the effected parties for the additional egg collection for Ringold Springs Rearing Facility, the broodstock collection total will be adjusted accordingly.

Table 14. Assumptions and calculations to determine the number of fall Chinook broodstock needed for the Priest Rapids program release of 6,700,000 sub-yearling fall Chinook		
Biological Assumptions	**Standard**	**Program Objective**
Smolt Production level:		
Grant PUD Mitigation-PUD Funded		**5,000,000**
John Day Mitigation- Federally Funded		**1,700,000**
Fert.-to-release survival	87%	
Eggtake Target		**7,700,000**
Fecundity	*4,500*	
Female requirement		**1,711**
Sex ratio	*1:1*	
Pre-Spawn Survival	*88%*	
Broodstock Required		**3,888**

Reference

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