Chief Joseph Hatchery Program

Monitoring and Evaluation Plan for

Summer/Fall Chinook Salmon

November 12, 2009

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1 INTRODUCTION

This monitoring and evaluation (M&E) plan is a critical component of the Chief Joseph Hatchery Program (CJHP). It is composed of several monitoring elements: hatchery production, harvest and spawning habitat, and progress toward conservation goals. M&E will ensure that hatchery operations produce high quality, disease-free fish that can survive in the receiving environment. The quality and quantity of basin habitat will continue to be monitored under the ongoing Okanogan Basin Monitoring and Evaluation Program (OBMEP) to track changes and confirm that habitat actions are effective.

Harvest (in terminal area fisheries and at the Okanogan River weir), adult escapement, weir operations and hatchery actions will be managed from data and information made available through M&E activities described in this plan. Harvest rates and hatchery program size have been defined to meet program objectives for abundance and composition of the natural spawning escapement. Implementation of the M&E plan will create a self-correcting in-season management process (ISMP) to ensure that harvest goals are compatible with conservation goals established for Chinook populations in the Okanogan River subbasin.

Additionally, M&E results will be used to document to the extent that CJHP conservation and harvest goals are being achieved over the anticipated time frames.

Section 2 of this plan summarizes the objectives of the Chief Joseph Hatchery program. Key monitoring assumptions that form the basis of this M&E plan are described in Section 3. Section 4 identifies the variables that will be monitored to estimate various attributes, and Section 5 addresses how these attributes will be used to make decisions about the hatchery and harvest operations.

2 OVERVIEW OF THE CJHP

Conservation is the primary long-term objective of this program. The Chief Joseph Hatchery will seek to achieve harvest goals that are consistent with conservation of Chinook salmon. To work toward this goal, the CJHP will be implemented in three phases; current, transition and long term. In the current phase, only the Similkameen portion of the program will be operated[1] and managed through the Rock Island and Rocky Reach Conservation Plans, with annual planning through the hatchery committee. During the transition phase, the segregated hatchery program at Chief Joseph Hatchery will be implemented and hatchery production increased in the Okanogan River to accelerate the re-colonization of Chinook. During this phase, some hatchery fish are intentionally allowed to spawn naturally. For the long term, the program is sized in a manner that protects the natural summer/fall Chinook population by promoting local adaptation, while providing harvest to the Colville Tribes and local

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[1] The existing summer/fall Chinook hatchery program releases fish in the Similkameen River and at Bonaparte Pond. Release sites will be expanded as the full CJHP comes on line.

communities. During this phase, hatchery fish are intended for harvest and not natural spawning.

The CJH program has an integrated and a segregated broodstock component (Table 1). The first component will release juvenile summer/fall Chinook into the Okanogan River and will be operated over the long term as an integrated type program. The second component will release juvenile summer/fall Chinook at the Chief Joseph Hatchery on the Columbia River and will be operated as a segregated type program. Broodstock for the segregated program will come from hatchery-origin fish released from the integrated program. This approach is designed to reduce genetic impacts to wild fish from CJHP strays that may spawn in the Okanogan. Total hatchery production for the program will vary by phase and will depend on the ability of managers to achieve key performance criteria referred to as the "Decision Rule Set" (see Section 3.3).

A hatchery program is an integrated type if the intent is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild. In an integrated type program, the proportion of natural-origin broodstock in the hatchery and the proportion of hatchery-origin fish in the natural spawning escapement determine the influence of the hatchery and natural environments on the adaptation of the composite population. The larger the ratio of natural/wild fish to hatchery fish in either environment, the greater the influence wild fish genetics and adaptation will have on population fitness and survival (HSRG 2004; HSRG et al. 2004a). For an integrated program, the proportion of hatchery fish on the spawning grounds should never exceed 30%.

A hatchery program is a segregated type if the intent is for the hatchery population to represent a distinct population that is reproductively isolated from naturally spawning populations (HSRG et al. 2004b). The principal intent of a segregated program is to create a hatchery adapted population to meet goals such as harvest. Hatchery broodstock (and programs) are considered genetically segregated if the broodstock is maintained only with hatchery-origin fish. As a consequence, gene flow from the natural population to the hatchery (broodstock) is prevented in a segregated program. Also, hatchery-origin adults are prevented from spawning in the wild to prevent gene flow from the less well-adapted hatchery population to the naturally spawning population.

A segregated hatchery program that draws its broodstock from an integrated program is sometimes referred to as a stepping stone program. The progeny from a stepping stone program are thus genetically linked to an integrated population. The purpose of the stepping stone approach is to reduce the adverse effects of any straying that might occur into the natural population associated with the integrated program.

The three hatchery phases and the expected time frame for the implementation of each are shown in Table 1.

Table 1. **Program purpose and type for the Current, Transition, and Long-term phases of the CJHP.**

	Current	Transition		Long Term
		Period 1	Period 2	
	2009-2011	2012-2016	2017-2024	2025
Okanogan River Component	Integrated Conservation	Integrated Conservation	Integrated Conservation and Harvest	Integrated Harvest
Chief Joseph Hatchery Component	Not Applicable	Segregated Harvest	Segregated Harvest	Segregated Harvest

The maximum number of fish to be released by year, life stage and hatchery phase is shown in Table 2. The maximum release number will be achieved only if the hatchery program can be managed consistent with the Decision Rule Set (Section 3.3).

Table 2. **Maximum number of juvenile summer/fall Chinook released by year, life stage and hatchery phase from the Okanogan River and Chief Joseph release sites.**

Phase	Current	Transition		Long Term
Time Frame	2009-2011	Period 1 2012-2016	Period 2 2017-2024	2025
Okanogan River	576,000 yearlings	1,376,000 yearlings 300,000 sub-yearlings	1,450,000 yearlings	1,450,000 yearlings
Chief Joseph Hatchery		500,000 yearlings 400,000 yearlings	600,000 yearlings	600,000 yearlings

The expected outcomes for the CJHP based on modeling are shown in Table 3. The program will increase natural origin (NOR) adult escapement and harvest levels, while at the same time it will reduce the proportion of hatchery fish on the spawning grounds (pHOS). The end result will be improved population fitness as indicated by the increasing values for proportionate natural influence (PNI).

Table 3.   Expected outcomes for each phase of the CJHP.

	Outcomes	Current	Transition 1	Transition 2	Long Term
Natural Production	Average NOR escapement	800	833	1,276	4,052
	pHOS average	62%	36%	23%	5%
	PNI	0.0*	0.73	0.77	0.85
Harvest	Terminal harvest	1,510	7,819	6,439	6,992
	Total harvest	4,826	14,198	16,430	19,279
Hatchery	Return of integrated HORs to Wells Dam	3,214	6,796	5,566	5,566
	Return of segregated HORs to Wells Dam	0	2,840	2,303	2,303

* PNI is not applicable as it has not been possible to distinguish Okanogan River origin HOR from NOR adults because broodstock for the program has been collected at Wells Dam.

3   IN-SEASON MANAGEMENT AND ANNUAL REVIEW

3.1   ANNUAL PROJECT REVIEW

Each year before decisions about harvest and broodstock management for the coming season have to be made, an Annual Project Review (APR) will be conducted through a workshop. The purpose of the APR is to implement the four-step In-Season Management Procedure (ISMP) described in Section 3.4.

The APR workshop for the summer/fall Chinook program will occur in mid-March of each year. The agenda for the workshop will follow the steps in the ISMP. The APR is a science-driven process that informs the workshop participants and will result in an action plan for the coming season. This action plan will be completed in the workshop and then presented as a recommendation to decision makers. The APR participants will include habitat, harvest, and hatchery biologists. The workshop and subsequently adopted action plan constitute the all-H coordinated implementation component of the CJHP.

The APR workshop will be conducted over a four day period in early spring of each year. The first day of the workshop will be devoted to presentations of results of monitoring and research activities related to the key assumptions for the CJH hatchery program (see Step 1 of the ISMP). This first day of the workshop will be facilitated by the Colville Tribal M&E lead scientist. There will be three sessions covering the following topics: (1) habitat and natural production, (2) pre-terminal harvest and out-of-subbasin survival, (3) hatchery operations. Prior to the workshop, the M&E leader will make sure that draft annual reports on each of these subjects are completed and available at the workshop. The ISMP tool will also be populated with the most recent data and analytical results. The facilitator will invite a panel of reviewers for each of the three topics to address two questions: a) Given the information provided, what are the best estimates for the key assumptions (see Step 1 of the ISMP)?, and b) How could the M&E

program be improved in the coming year? The facilitator will summarize the conclusions at the end of the first day.

The remaining three days of the workshop will attended by project staff and their policy and science supervisors.

On the second day of the workshop, results from last year's operations will be presented and reviewed. Sessions will cover terminal fisheries, operation of weirs and other capture activities, and hatchery operations. A special session will be devoted to run-reconstruction results and status and trend analysis. These sessions will be facilitated by the M&E leader. The objective for the second day is to address two questions: a) How can operations be improved in terms of effectiveness and efficiency in the coming year[2], and b) were biological targets met last year (and if not, why not?).

On the third day of the workshop, the CJH program management team will meet to review the implications of conclusions from day one on application of the Decision Rules (see Step 2 of the ISMP). The CJH management team will consist of policy and technical personnel. The M&E lead scientist will present his conclusions from days one and two, and will present options for implementing the Decision Rules. Note that the purpose of the Decision Rules is to assure that the long-term goals for conservation and harvest established in the hatchery Master Plan are met over time. The product of the third day will be an updated plan for operating fisheries, weirs and hatchery activities in the coming year. These activities will be triggered by the NOR run size prediction for the coming season.

On the fourth day, the M&E operational plan will be reviewed and updated. Staff assignments will be made regarding year end activities (i.e., finalizing annual reports) and for implementing harvest, hatchery and M&E plans for the coming year.

3.2 BASIS OF THE PLAN

Resource management goals directly affected by and relevant to the CJHP are to rebuild and maintain sustainable naturally spawning summer/fall Chinook populations in the Okanogan subbasin, and to provide harvest for tribal and non-tribal fishers.

The long-term purpose of the CJHP is to contribute to harvest goals in a manner that is compatible with sustainable natural production (i.e., conservation). During the transition phase(s), the CJHP will be operated in a manner that may accelerate the re-population of Chinook throughout the Okanogan subbasin.

The Okanogan summer/fall Chinook population has been designated as a primary population by the co-managers. This population has two components, 1) those fish that spawn in the Okanogan River basin, and 2) fish that spawn in the mainstem Columbia River between Chief Joseph Dam and Wells Dam.

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[2] The operating standards proposed by the HSRG and contained in the HPV tool (www.hatcheryreform.us) will be used as the initial standards for in-hatchery operations.

For the first component, management of hatchery production and natural escapement will adhere to guidelines that minimize the genetic and ecological influence of hatchery fish on the naturally spawning population. These guidelines stipulate that the proportion of the natural spawning escapement composed of hatchery-origin fish must be less than 5%, unless the hatchery program is genetically integrated with the naturally spawning population. In such a case, this proportion must be less than half of the proportion of natural-origin fish in the hatchery broodstock (HSRG et al. 2004a).

Hatchery fish management for the second component (fish spawning in the mainstem Columbia) will be less restrictive. Initially, no limitations will be placed on the proportion of hatchery fish spawning in this area. This is necessitated by the fact that water depth and clarity make it difficult to determine spawning numbers or composition (HOR or NOR). Studies will be undertaken to better estimate the proportion of NOR fish passing Wells Dam that spawn in this section of the river.

There is uncertainty about the future natural production potential for Okanogan River summer/fall Chinook salmon. While the expectation is that investments in habitat improvements in the Okanogan will improve Chinook productivity and abundance, it is unknown when and to what extent those investments will be effective. Future survival conditions in the mainstem Columbia, the estuary and the ocean also remain uncertain. Additionally, harvest management policies beyond the control of the Colville Tribes influence the viability of the Okanogan natural Chinook populations. Thus, M&E is needed to track the key attributes that may affect program outcomes.

3.3   CJHP DECISION RULES

Because of the uncertainty identified above and also the annual variability in abundance of natural-origin adult returns, the hatchery program has been designed for flexible production and operations. This flexibility is reflected in the design and operation of the hatchery facilities and weirs and in a set of Decision Rules that determine the size of the hatchery program and the management of natural escapement abundance and composition (Table 4).

Table 4.   CJHP Decision Rule set for Current, Transition and Long-term phases of the program.

Natural Escapement	Current	Transition		Long Term
		Period 1	Period 2	
Minimum natural-origin (NOR) escapement	800	800	1,200	1,600
Proportion hatchery-origin spawners (pHOS)-maximum target for integrated program[3]	30%	40%	30%	30%
NOR escapement at which pHOS must be achieved	800	800	1,200	1,600
Maximum pHOS for segregated program	5%	5%	5%	5%
Minimum hatchery-origin spawners (HOS) + natural-origin spawners (NOS)	500	500	500	500

[3] Actual pHOS will vary depending on HOR and NOR run size. The values in this row are the upper limit of pHOS based on HSRG guidelines.

Natural Escapement	Current	Transition		Long Term
		Period 1	Period 2	
Hatchery Program				
Proportion natural-origin brood (pNOB) target	100%	100%	75%	30%
Run size at which pNOB will be reached	800	800	1,200	1,600
NOR broodstock allocation	75%	75%	75%	30%
Adjust segregated program to reduce strays?	Yes	Yes	Yes	Yes
Harvest				
% of NOR in excess of NOS and NOB taken as harvest[4]	10%	10%	10%	10%

The purpose of the Decision Rules is to assure that hatchery programs, terminal fisheries and weirs are managed to meet the guidelines for abundance, composition, and distribution of the natural spawning escapement. The ultimate goal of the Decision Rules is to increase fitness of the natural population by maintaining a PNI > 0.67[5]. The Decision Rules are based on a set of key assumptions about our capability to accurately detect and respond to the annual abundance of natural-origin returns of Okanogan summer/fall Chinook to Wells Dam. This M&E plan identifies the information needed to update and apply the Decision Rules and describes how data will be collected to derive this information. Resource goals are expected to be met as a result of appropriate in-season management actions taken over time.

It is important to note that this represents a new approach to managing and evaluating hatchery programs. Success of the program will not be based on the ability to meet the same fixed smolt output or the same escapement goal each year. Instead the program will be managed for variable smolt production and natural escapement. Success will be based on meeting and exceeding targets for abundance and composition of natural escapement and hatchery broodstock as established in the Decision Rules (Table 4). This requires flexibility in terms of the operation of hatchery and harvest programs, but firm adherence to the Decision Rules, which will remain largely unchanged over time.

3.4 IN-SEASON MANAGEMENT PLAN AND GOALS

The keys to achieving resource goals over time are a) to assemble the most recent and relevant information and b) to use this information to operate fisheries, weirs and hatcheries consistent with the established guidelines each year. To this end, the Colville Tribe intends to implement a four-step, In-Season Management Procedure (ISMP) (Figure 1). This procedure is formalized in

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[4] This percentage indicates how NORs will be allocated between natural escapement and harvest, after the minimum escapement and broodstock needs are met. For example, if 10% is taken as harvest, 90% of the remainder goes to natural escapement.

[5] For a natural/hatchery composite population at equilibrium, the influence of the hatchery and natural environments on the adaptation of the composite population is determined by the proportion of natural-origin broodstock in the hatchery (pNOB) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). The larger the ratio pNOB/(pHOS+pNOB), the greater the strength of selection in the natural environment relative to that of the hatchery environment. This ratio is referred to as the proportionate natural influence (PNI).

a database and a set of management tools that assure consistency and accountability. As shown in Figure 1, the boxes in the dashed frame represent the tools to be used to carry out the ISMP. These tools are linked Excel spreadsheets that store and document data and assumptions and derive biological targets for the operation of terminal fisheries, weir and hatchery programs. The tools document the basis for these targets and establish expectations for all performance indicators. They also will help simplify the implementation process and document the rationale for the management actions taken each year. The tribal management biologist responsible for implementation of in-season management will use these tools in preparation for the APR workshop, where analytical results will be presented and shared with all interested parties. The tools are the instruments for implementing this M&E plan—they make sure it is more than just another document for the shelf.
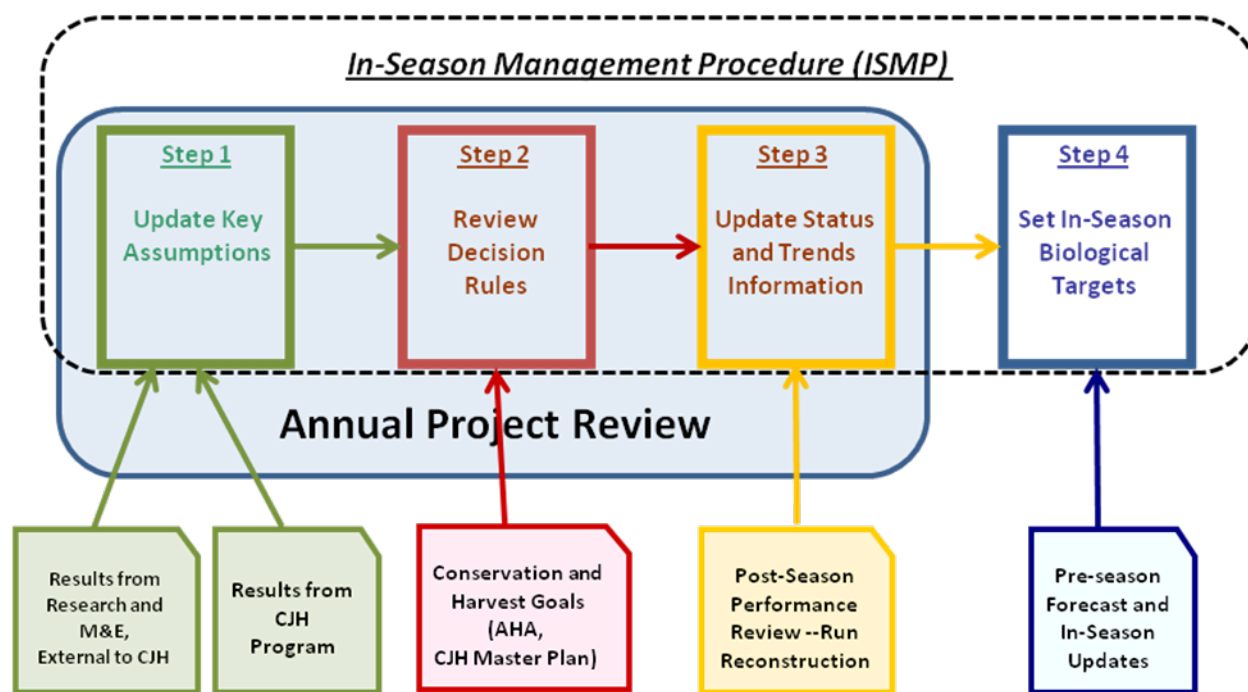
Figure 1.   In-Season Management Procedure Framework.

The shaded box at the top represents the ISMP. The boxes below indicate management tools and reports used to support the procedure. For example, there is a long term plan supported in part by the AHA tool, which in turn informs Step 1 of the ISMP.

3.4.1   Step 1 - Update Key Assumptions

The CJHP was developed from a set of key assumptions:

- The quality and quantity of Okanogan subbasin habitat

- Survival rates of fish migrating to and from the ocean

- Ocean survival

- Harvest rates in freshwater and ocean fisheries

- Effectiveness of weirs and live-capture techniques to remove hatchery fish from the spawning environment without killing substantial numbers of wild summer/fall Chinook

- Productivity of both NOR and HOR adults spawning naturally

Table 5 identifies the current and estimated future values for each of these parameters. Table 6 lists key assumptions about the expected performance of CJHP fish in each operational phase. The highlighted column indicates the phase that starts with implementation of the CJHP.

The first step in the ISMP is to update these assumptions each year based on data collected from monitoring and evaluation activities. This step ensures that the best available information and knowledge is applied to the in-season management process. The key assumptions driving the program will be reviewed each year at the Annual Program Review workshop. Conclusions from the workshop review will be captured, documented in the database and the results brought forward to Step 2 in the process.

Table 5. **Key assumptions for natural production and harvest affecting the return of Okanogan natural-origin adults (NORs) to Wells Dam.**

	Parameter Name	Current	Transition 1	Transition 2	Long Term
Natural Production (Spawner and Smolts)	Smolt Productivity-Habitat Potential	712	712	712	712
	Smolt Capacity-Habitat Potential	1,186,780	1,186,780	1,186,780	1,186,780
	Fitness factor from (AHA)	50%	50%	50%	90%
	Fitness Floor	0.50	0.50	0.50	0.50
	Adjusted Smolt Productivity	356	356	356	641
	Adjusted Smolt Capacity	593,390	593,390	593,390	593,390
Smolt to Adult Survival	Juvenile Migration Survival	0.270	0.270	0.270	0.270
	Ocean Survival	0.047	0.047	0.047	0.047
	Adult Migration Survival	0.830	0.830	0.830	0.830
	Total SAR	0.0105053	0.0105053	0.0105053	0.0105053
Pre-terminal Harvest on Unmarked Fish	Marine	0.430	0.430	0.200	0.200
	Lower Mainstem	0.050	0.050	0.017	0.017
	Upper Mainstem	0.100	0.100	0.230	0.230
Pre-terminal Harvest on Marked Fish	Marine	0.430	0.430	0.400	0.400
	Lower Mainstem	0.050	0.050	0.086	0.086
	Upper Mainstem	0.100	0.100	0.230	0.230
Terminal Harvest and Weir	Max Rate on Integrated HORs	0.500	0.500	0.500	0.500
	Max Rate on Segregated HORs	0.150	0.500	0.500	0.500
	Induced NOR Loss as % of Segregated HOR rate	100%	6%	6%	6%
	Weir Factor (Efficiency)	0.50	0.95	0.95	0.95
	Mark Rate - Integrated HORs	0.95	0.95	0.95	0.95
	Mark Rate - Segregated HORs	0.95	0.95	0.95	0.95
	Weir Mort. (NORs) as % of Weir Factor	0.02	0.02	0.02	0.02
	Terminal NOR rate	0.167	0.049	0.049	0.049
	Total NOR Exploitation Rate	0.594	0.537	0.424	0.424

Table 6.   Key assumptions about hatchery programs and the performance of hatchery fish.

	Parameter Name	Current	Transition Period 1	Transition 2	Long Term
HORs Spawning in Nature	Relative Reproductive Success of HORs	0.80	0.80	0.80	0.80
	Stray Rate of Integrated HORs to Segregated Hatchery	2%	2%	2%	2%
	Stray Rate of Segregated HORs to Natural Spawning[1]	20%	20%	20%	20%
Okanogan Hatchery Release	Program 1 Purpose	Conservation	Conservation	Both	Harvest
	Program 1 Type	Integrated	Integrated	Integrated	Integrated
	Maximum Local Broodstock	248	1,107	976	976
	Maximum Imported Broodstock	140			
	Pre-spawning Mortality	0.10	0.10	0.10	0.10
	Eggs per Female	5,000	5,000	5,000	5,000
	% Females	50%	50%	50%	50%
	Egg to Smolt-subyearlings	0.74	0.74	0.74	0.74
	Egg to Smolt-yearlings	0.66	0.66	0.66	0.66
	Maximum Smolt Release (Yearling)	576,000	1,376,000	1,450,000	1,450,000
	Maximum Smolt Release (Sub-yearling)	0	300,000		
	Recruits/Spawner	17.0	12.6	13.5	13.5
	% Hatchery Program 1 Spawning below Weir	2%	2%	2%	2%
Chief Joseph Hatchery On-Station Release	Program 2 Purpose		Harvest	Harvest	Harvest
	Program Type		Segregated	Segregated	Segregated
	Stepping Stone?	No	Yes	Yes	Yes
	Maximum Local Broodstock	0	577	404	404
	Pre-spawning Mortality	0.00	0.10	0.104	0.10
	Eggs per Female	5,000	5,000	5,000	5,000
	% Females	50%	50%	50%	50%
	Egg to Smolt-subyearlings	0.74	0.74	0.74	0.74
	Egg to Smolt-yearlings	0.66	0.66	0.66	0.66
	Maximum Smolt Release (Yearling)	0	500,000	600,000	600,000
	Maximum Smolt Release (Sub-yearling)	0	400,000	0	0
	Recruits/Spawner	10.1	10.1	13.5	13.5

1- The value represents the percentage of HORs not captured in fisheries that end up in the Okanogan River

3.4.2 Step 2 -Review Decision Rules

Once the key assumptions have been updated, a review of the Decision Rules (see Table 4 and Figure 2) will be conducted to determine if they need alteration. This step will occur at the Annual Program Review workshop. As noted above, Decision Rules are not expected to change frequently, although they may need to be altered to account for change in population policy status (e.g., ESA listing), collapse of the run, new science discoveries or other dramatic changes in salmonid management in the basin or the region. The main purpose of Step 2 is to reaffirm the existing Decision Rules and to assure that all involved with the management and operation of the programs are aware of these rules and understand their importance.

Once the key assumptions and Decision Rules have been confirmed, Step 3 of the ISMP will be implemented. This will ensure that standards for the Okanogan subbasin primary population are met and progress toward conservation and harvest goals is maintained.

Figure 2.   Control panel for Step 2 of the In-Season Management Tool.

3.4.3 Step 3- Update Stock Status Information.

In this step, the most recent stock status information will be entered into the database for both the hatchery and natural components of the run (Figure 3). Recent natural and hatchery escapement is entered by origin (hatchery vs. natural). The number of hatchery-origin spawners (HOR) from hatchery programs other than the Okanogan integrated program is entered separately as HOS (segregated). This information is used to determine pHOS for the

integrated and segregated programs, as well as pNOS and pNOB. A PNI value is calculated from this data each year and a cumulative value tracked over a five-year period.

Step 3: In the yellow cells below, enter most recent historical escapement data. Make sure the bottom row shows data for last year (do not add rows).

	Hatchery									Natural Production						
	Seg. (CJH)			(Okanogan)						Spawners			pHOS (total) (<030%?)	pHOS (Seg) (<5%?)	Total Recuitment (Run Recon.)	Smolts
Year	Hatchery Orogin Brood	Smolt Release	Total Return	Natural Orogin Brood	Hatchery Orogin Brood	pNOB	PNI (>0.67?)	Smolt Release	Total Return	NOS	HOS(total)	HOS(Seg)				
5-year ave					374					4,049	1,689	1,689				
4-year ave					337					3,746	1,731	1,731				
3-year ave					316					2,840	1,500	1,500				
2-year ave					316					1,158	1,051	1,051				
Last year					316					1	1	1				
					243											
					362											
1993					1,069	-	-	360,380		731	754	754	45%	45%	1,044	
1994					585	-	-	537,190		1,409	2,623	2,623	60%	60%	2,013	
1995					413	-	-	379,139		889	2,113	2,113	66%	66%	1,270	
1996					513	-	-	217,818		579	1,240	1,240	63%	63%	827	
1997					462	-	-	574,197		760	1,429	1,429	60%	60%	1,086	
1998					364	-	-	487,776		576	516	516	42%	42%	823	
1999					513	-	-	572,531		1,426	2,190	2,190	55%	55%	2,037	
2000					503	-	-	287,948		1,273	2,428	2,428	60%	60%	1,819	
2001					357	-	-	610,868		4,614	6,242	6,242	52%	52%	6,262	
2002					488	-	-	528,639		4,149	9,709	9,709	65%	65%	5,927	
2003					482	-	-	26,315		1,971	1,449	1,449	37%	37%	2,816	
2004					522	-	-			5,262	1,518	1,518	19%	19%	7,367	
2005					400	-	-			6,464	2,426	2,426	23%	23%	9,234	
2006					316	-	-			6,204	2,397	2,397	24%	24%	8,952	
2007					316	-	-			2,315	2,102	2,102	42%	42%	3,274	
Last Year 2008					316					1	1	1				

11/13/2009

Figure 3.   Control Panel for ISMP Step 3.

3.4.4   Step 4- Set Biological Target for the Coming Season

With updated stock status, the data can now be used to set biological targets (broodstock needs, harvest levels, weir catch and escapement) for the migration year based on run-size predictions (see Section 5). The run size prediction will be updated each week and entered into the analysis tool shown in Figure 4. The tool then outputs biological targets for the program, expected outcomes, and progress being made towards achieving pHOS, PNI and pNOB objectives over a five-year period.

Step 4: Enter runsize updates (YELLOW CELLS) as they become available and adopt harvest and hatchery targets as shown under "Biological Targets".

Biological Targets for Transition 1 Phase

Projected Returns to Wells Dam (most recent update):

NOR Return	2500	
Return from Integrated Program	2500	
Return from Segregated Program	2500	

128	=5.6% of Catch in Fishery	
1,130	=40.7% of Weir Catch	1,107 Broodstock
1,192	=87% of Escapement	

924	=40.1% of Catch in Fishery	
1,422	=51.2% of Weir Catch	- Broodstock
154	=11.2% of Escapement	

1,250	=54.3% of Catch in Fishery	
226	=8.1% of Weir Catch	577 Broodstock
24	=1.8% of Escapement	
1,000	to CJH hatchery rack	

Expected Outcome

Harvest	Terminal Catch	2,302
	Harvest Rate on HORs	43.5%
	Harvest Rate on NORs (Incidental)	2.2%
	Weir Catch (including mortality)	2,778
Integrated Hatchery Program	Natural Origin Brood (NOB)	1,107
	Hatch. Origin Brood (HOB) -Int.	-
	Projected Annual pNOB-Int.	100%
	Smolt Release from Int Program	1,349,373
Segregated Program	Hatch. Origin Brood (HOB) -CJH	577
	Smolt Release-CJH	902,912
Natural Spawning Escapement	Nat. Origin Spawners (NOS)	1,192
	Hat. Origin Spawners (HOS-tot.)	178
	HOS (from Seg hatch)	24
	Total Number of Spawners	1,370
	Expected Natural Smolt Production	263,870
	pHOS	11%
	PNI	0.90

Progress toward goals for PNI (>0.67) and pHOS (<30%)

	5-Years	4-Years	3-Years	2-Years	This Year
Cum pNOB	45%	54%	64%	78%	100%
Cum pHOS	31%	33%	39%	13%	11%
Cum PNI	0.60	0.62	0.62	0.86	0.90
pHOS (Seg)	30%	31%	37%	2%	2%

10/6/2009

Figure 4.　　Example control panel for ISMP Step 4.

To better refine in-season run size estimates at Wells Dam, a portion of each year's juvenile outmigration will be PIT-tagged so that upon their return as adults, their migration timing and progress through the Columbia River mainstem dams can be calculated (see Section 4.1.1).

4　DATA COLLECTION

This monitoring and evaluation program is designed to collect data that:

- Is needed to implement the four-step ISMP

- Is likely to vary from year to year, and

- Can be monitored precisely enough to ensure performance parameters are being achieved.

The CJHP data collection program is presented under the following headings:

- Variables Monitored at Wells Dam
- Variables Monitored in Fisheries and at the Okanogan Weir
- Variables Monitored on Spawning Grounds

- Variables Monitored at Hatchery Facilities
- Variables Monitored During Juvenile Out-migration
- Existing Okanogan River Monitoring Activities

The data will be used to estimate a set of performance parameters for the program. Methods used for calculating each parameter are presented in Section 5 of this plan. Data collection efforts will be summarized each year in an annual report that will be available prior to the APR.

4.1   VARIABLES MONITORED AT WELLS DAM

NOR and HOR Counts

The number and timing of natural- and hatchery-origin summer/fall Chinook at Wells Dam is used for in-season management decisions (Step 3 and Step 4). These variables are used to determine summer/fall Chinook run size, stock composition (HOR and NOR) and run-timing.

NOR and HOR Counts at Wells Dam: The number and timing of NOR and HOR adult summer/fall Chinook of Okanogan and Chief Joseph Hatchery-origin arriving at Wells Dam will be reported.

- **Attributes/Parameters Estimated**: Run size abundance, composition, and timing

- **ISMP Purpose**: Will be used to update Step 3 stock status and trends (Section 3.4.3) and in-season biological targets (Step 4, Section 3.4.4)

4.1.1   Methods

Both direct enumeration of adults at Wells Dam and PIT-tag detections will be used to develop NOR and HOR counts at this facility.

4.1.1.1   Direct Enumeration

Summer/Fall Chinook

Summer/fall Chinook arriving at Wells Dam will be enumerated daily by fish counters stationed at the upstream passage facilities. This run consists of both HOR and NOR adults originating from the Methow and Okanogan rivers as well as those adults that may spawn in the upper Columbia below Chief Joseph Dam. For the Chief Joseph ISMP, the number of NORs destined for the Okanogan River is a critical value as it determines escapement levels, hatchery production levels and harvest rates.

To estimate Okanogan River NOR returns, the adult counts at Wells Dam will be adjusted for:

- Mark rate for HOR adults. Initially this is assumed to be 95% (accounts for mismarked fish).

- The proportion of total NOR and HOR count at Wells Dam destined for the Okanogan River.

Historically, redd and carcass counts in the Methow and Okanogan rivers indicate that 70% of the NOR population passing Wells Dam is destined for the Okanogan River.

In-season estimates of the summer/fall Chinook run-size at Wells Dam will be based on historical counts collected at Bonneville Dam, Priest Rapids Dam and Wells Dam (see Section 5 for details). Additional monitoring at hatchery facilities, weirs and spawning grounds will be used to better refine the mark rate on hatchery fish and the proportion of the NOR run at Wells Dam that are of Okanogan River origin.

The number of HOR adults from the CJHP program counted at Wells Dam each year will be based on the proportion of the total number of hatchery juveniles released upstream of Wells Dam from the CJHP and the assumed survival rates for each release group. Hatchery releases will occur in the Okanogan and Methow rivers, as well as from the new Chief Joseph Hatchery. Initially, historical survival rate values for the Okanogan and Methow programs will be used to estimate release group survival. Survival rates will be updated yearly as new data become available for all release groups.

Spring Chinook and Steelhead

Spring Chinook and summer steelhead arriving at Wells Dam will be enumerated daily by fish counters stationed at the upstream passage facilities. This run consists of both HOR and NOR adults originating from the Methow and Okanogan rivers. NOR and HOR abundance of summer steelhead and spring Chinook at Wells Dam is important for ensuring that ESA take levels are not violated

Chinook adults arriving at Wells Dam from May 1 through June 28 are classified as spring Chinook. Summer steelhead begin arriving at Wells Dam about the same time but their migration continues into the fall. Fish counters will develop daily estimates of the number of HOR and NOR adults (and jacks) passing this facility for each species.

Harvest take levels of ESA listed steelhead and spring Chinook that are permitted by NMFS are shown in Table 7 and 8.

Table 7.   Tribal Incidental Take Thresholds for Unmarked Spring Chinook

Wells Dam Count Unmarked Spring Chinook	Maximum CCT
April 1 – June 30	Take
< 1,000	1%
1,000 – 2,000	3%
2,001 – 3,000	5%
3,001 – 8,000	7%
8,001 – 10,000	10%
>10,000	15%

Table 8.   Tribal Incidental Take Thresholds for ESA-Listed Upper Columbia River Steelhead

Steelhead Count Wells Dam	Maximum CCT Take *Hatchery-origin*	Maximum CCT Take *Natural-origin*
< 1,000	3%	1%
1,000 – 2,000	5%	1%
2,001 – 3,000	7%	2%
3,001 – 5,000	15%	3%
5,001 – 10,000	30%	5%
>10,000	50%	10%

4.1.1.2   PIT-Tags

Because the number of hatchery fish released each year from the program will vary depending on the ISMP, the percentage of future Okanogan River-origin adult returns will also vary over time. Therefore, to better estimate the number of Chief Joseph HORs and Okanogan River NORs arriving at Wells Dam each year, a subset of the total NOR and HOR juvenile production will be PIT-tagged.

Both hatchery- and natural-origin summer/fall Chinook will be PIT-tagged and released in the river. Hatchery-origin juvenile fish will be tagged at hatchery facilities prior to their release from hatchery facilities and acclimation ponds. Natural-origin juveniles will be collected at screw traps currently used to monitor the outmigration from the Okanogan River.

Up to 25,000 hatchery and 25,000 naturally produced juveniles (when available) will be tagged each year in a manner representative of the release[6]. Based on an assumed average smolt-to-adult survival value of 0.5%, approximately 250 PIT-tagged adults will return to the Columbia

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[6] Because high flow conditions present in the spring and early summer reduce trap capture efficiency, the 25,000 natural fish target may not be achieved in some years.

River each year[7]. PIT-tagging activities and the number of fish tagged will be coordinated with regional M&E activities.

Returning PIT-tagged adults will be tracked daily as they pass mainstem Columbia River dams equipped with adult PIT-tag detection facilities. Detections at Bonneville Dam will provide an early indicator of Okanogan River run-size about four weeks prior to the first adults arriving at Wells Dam[8]. Over time, these data will help managers develop better estimates of Okanogan River run size, migration timing, adult losses between dams and the likely proportion of HOR to NOR returns each year.

In addition, PIT-tag detections at Wells Dam and at the Okanogan weir will allow managers to develop estimates of NOR adult survival between the two points. This data, along with that being collected for fishing gear effectiveness studies, will be used to guide actions to ensure that NOR mortality is less than the 6% target assumed in the ISMP.

4.2 VARIABLES MONITORED IN FISHERIES AND AT THE OKANOGAN WEIR

4.2.1   Variables to be Monitored

Variables that will be monitored in fisheries and at the Okanogan weir are presented below:

- Fishing gear effectiveness
- Acoustic-tag fish recoveries
- Count of dead fish handled/harvested and live fish released at the weir
- Counts of NOR and HOR fish at the Okanogan weir
- Catch sampling
- Coded wire-tag recoveries

The ISMP purpose and the attributes/parameters estimated from each of these variables include the following:

Radio-Tag Fish Recoveries[9]: The number of acoustic-tags detected below the weir and detected at the weir over time

- **Attributes/Parameters Estimated**: Weir efficiency (WeirEff), weir delay (Wd) and Okanogan HOR spawning below the weir (OkBW)

- **ISMP Purpose**: Will be used in ISMP Step 1 to update key assumptions (see Section 3.4.1)

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[7] RMIS data indicate that total survival on average for Similkameen River summer/fall Chinook hatchery releases has been approximately 0.9%. It is assumed that 50% of the PIT-tagged fish will be captured and removed during ocean and lower Columbia River fisheries.
[8] Information from Zone 6 fisheries will also provide information on NOR and HOR run composition and size.
[9] Acoustic tags may also be used in this study

Count of Dead Fish Handled/Harvested and Live Fish Released at the Weir:

- **Attributes/Parameters Estimated**: Weir mortality (WeirMort)

- **ISMP Purpose**: Will be used in ISMP Step 1 to update key assumptions (see Section 3.4.1)

Fishing Gear Effectiveness:

- **Attributes/Parameters Estimated**: Terminal harvest rate on NOR (TermHRN) and HOR (TermHRH)

- **ISMP Purpose**: Will be used in ISMP Step 1 to update key assumptions (see Section 3.4.1)

Counts of NORs and HORs at Weir: Number and timing of adult summer/fall Chinook

- **Attributes/Parameters Estimated**: pHOS, PNI, mark rate (MarkR) and total census escapement

- **ISMP Purpose**: Will be used to update ISMP Step 3 stock status and trends (Section 3.4.3) and in-season biological targets (Step 4, Section 3.4.4)

Terminal Catch: Number and composition of fish caught in terminal fisheries

- **Attributes/Parameters Estimated**: Total NOR (NRec) and HOR (HRec) recruitment, total catch (NOR and HOR), and terminal harvest rate on HOR (TermHOR)

- **ISMP Purpose**: Will be used to update ISMP Step 3 stock status and trends (Section 3.4.3) and in-season biological targets (Step 4, Section 3.4.4)

Coded Wire-Tag Recoveries: Number of Okanogan River and CJH-origin HORs recovered everywhere

- **Attributes/Parameters Estimated**: Pre-terminal exploitation rate (PreERM, for marked fish and preERU for unmarked); total catch of NOR and HOR (NORCatch and HORCatch); total HOR and NOR recruitment (HRec and NRec); total exploitation rate of NOR and HOR (NORExpl and HORExpl); rate of return to point of release (homing); contribution to fisheries and escapement of other populations; CJH stray rate to Okanogan River (StCJ); rate of return of Okanogan River HOR to Okanogan River (RetOk); hatchery productivity (HatPr); and mark rate (MarkR)

- **ISMP Purpose**: Will be used in ISMP Step 1 to update key assumption (Section 3.4.1) and stock status and trends (Step 3, Section 3.4.3)

4.2.2   Methods

4.2.2.1   Fishing Gear Effectiveness

The Colville Tribes are currently evaluating the efficacy of live capture techniques and gear to harvest hatchery-origin fish between Wells Dam and the Okanogan weir, while at the same time minimizing impacts to natural-origin fish (Kutchins et al. 2008). The results of the fishing effectiveness study are used to estimate the terminal harvest rate on NOR (TermHRN) and HOR (TermHRH)[10]. The parameter TermHRN is estimated by counting the number of NOR fish released alive from the fishing operations and the number dead, injured or lethargic when released. The parameter TermHRH is estimated from harvest sampling. Mortality rates on by-catch species such as steelhead and sockeye will also be documented as part of this evaluation.

As currently measured, TermHRN is an estimate of acute mortality due to fishing operations (Kutchins et al. 2008). In the ISMP, the parameter will include both acute and any delayed mortality that occurs from fisheries[11].

Data needed for calculating TermHRN will be developed as follows:

- All NOR fish captured in live-capture fisheries will be enumerated and classified as either alive or dead, injured or lethargic. Live NOR fish will be classified on a scale of 1-5 as outlined in Kutchins et al. (2008).

- A subsample of live NOR fish (summer/fall Chinook, sockeye and steelhead) will be tagged with a unique external tag and released back to the river[12].

- Sampling for tagged fish will occur in all fisheries, at the weir and at hatchery facilities[13].

- Tag number, time and date of recovery as well as location will be recorded.

The study will be undertaken for three years. The need for additional work will be based on study results.

4.2.2.2   Radio-tag Fish Recoveries

Radio-tagged[14] adults and jacks will be used to develop estimates of weir efficiency (WeirEff), weir delay (Wd) and the number of Okanogan-origin fish that spawn or die between Wells Dam and the weir (OkBW). Methods are presented below and parameter definitions and calculations are presented in Section 5.

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[10] Based on two years of data, fish collected using purse and beach seines have survival rates of 99%. This value is greater than the minimum adult survival rate used for program planning (94%).

[11] Delayed mortality consists of the period from time of release to recapture/detection at the weir.

[12] Kutchins et al. (2008) noted that the additional stress of marking these fish may upwardly bias estimates of mortality. This is recognized and accepted, as higher mortality estimates result in more conservative management actions that result in increased protection for natural-origin spawners.

[13] Sampling for tags will occur on the spawning grounds if weir efficiency is found to be less than 100%.

[14] Acoustic tags may also be used for this study. Tag selection will depend on the results of a sockeye acoustic-tag study being conducted in the Okanogan River in 2010.

Radio-tags

Approximately 100 radio-tagged adults of each species (summer/fall Chinook, sockeye and steelhead) will be captured at Wells Dam, radio-tagged and released back to the river. These tagged fish will be tracked using mobile surveys and with antenna arrays at six locations:

- Site 1   100-150 feet downstream of the Okanogan weir
- Site 2   at the Okanogan weir
- Site 3   100-150 upstream of the weir
- Site 4   mouth of the Methow River
- Site 5   mainstem Okanogan River (boat surveys)
- Site 6   Chief Joseph Dam

Radio-tagged fish first detected at Site 1 and then next at Site 2 will be considered to have been successfully diverted by the weir. Radio-tagged fish first detected at Site 1 and then next at Site 3 will be considered to have slipped past the weir structure. Weir delay will be based on the difference in detection times between Site 1 and Site 2, and Site 1 and Site 3. Fish that are not detected at Site 1 through 3 will make-up the group used in estimating OkBW. These are fish that were detected at the Methow River, Chief Joseph Dam and/or the mainstem Columbia River.

All radio-tagged fish collected (physically handled) at the weir will be enumerated and released upstream of the weir unless they are needed for hatchery broodstock. The fish will be tracked after their release to determine behavior, survival and ultimate spawning location in The Okanogan River.

Mobile surveys will be used to determine the behavior of fish tracked in the mainstem Columbia River between Wells Dam and Chief Joseph Dam. Areas where tagged fish appear to hold for long periods will be examined for spawning activity using underwater cameras.

The radio-tag study will be conducted for the first two years of Okanogan weir operations. It will be repeated in additional years if average weir efficiency was determined to be less than 95%, or if more than 2% of the total NOR run failed to pass the weir (based on radio-tag results and carcass surveys conducted below the weir). Summary statistics of the data will be provided in report format.

4.2.2.3   Count of Dead Fish Handled and Live Fish Released at the Weir

HOR and NOR fish (all species) arriving at the weir will be enumerated on a daily basis from July through mid-November. Biologists will count the number and species of fish killed during weir operations as well as the number released alive back to the river each day. These data are needed to calculate the weir mortality (WeirMort) parameter. This parameter is an estimate of the proportion of the natural population killed by weir operations.

Estimates of weir mortality will be developed daily and summarized by week, month and for the season by species.

4.2.2.4   Counts of NORs and HORs at the Weir

The number of HOR and NOR summer/fall Chinook, sockeye, steelhead (and other species such as bull trout) arriving at the weir will be enumerated on a daily basis from July through mid-November. For summer/fall Chinook, this information will be used to calculate the following parameters:

- pHOS: Proportion of the total natural spawning population of hatchery origin

- PNI: Proportionate natural influence

- TCE: Total census escapement

Hatchery-origin adults will be distinguished by the absence of an adipose fin or the presence of an adipose fin and coded wire-tag (CWT)[15]. This latter group occurs when the adipose fin grows back due to clipping error associated with the tagging process.

HOR and NOR counts at the weir will be summarized by day, week, month and for the season for each species captured.

Any bull trout collected at the weir will be radio-tagged and released above the weir. These fish will be tracked using aerial and mobile surveys to determine if spawning occurs in the Okanogan River basin.

4.2.2.5   Terminal Catch

The number of HOR and NOR summer/fall Chinook caught in river reaches upstream of Wells Dam is referred to as terminal catch. Terminal catch is used to estimate parameters dealing with total catch by fishery, run-size and recruitment for both HOR and NOR fish.

Terminal harvest consists of:

- HOR and NOR fish harvested in live-capture fisheries

- HOR and NOR fish harvested in sport fisheries

- HOR and NOR fish harvested in other tribal fisheries (snag fishery, etc.)

- HOR and NOR fish harvested at the weir

HOR and NOR fish harvested at the weir consist of:

- HOR summer/fall Chinook caught at the weir that are surplus to broodstock needs and not released to spawn naturally, and

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[15] It is possible for an HOR to not have an adipose fin or CWT due to complete failure of the tagging technique used. However, because these fish cannot be distinguished from NOR, the probability of a double error is deemed low.

- NOR fish killed or significantly injured during weir operations

Biologists and fishers engaged in live-capture fisheries and weir operations will record and report the number of HOR and NOR summer/fall Chinook harvested on a daily basis; they will also document the number of non-target species (sockeye, steelhead, and bull trout) captured.

The co-managers will conduct intensive creel surveys of sport and tribal fisheries throughout the season. Protocols call for randomly sampling 25% of the fishing effort in mainstem Columbia, Okanogan and below Chief Joseph Dam fishing areas. Samplers will collect data on fish species, size, sex, presence of marks, and check for the presence of a CWT in the snout or cheek using a hand wand. CWT will be taken from each fish (where applicable), sent to a lab for reading and the results entered into the regional CWT database. (http://www.psmfc.org/Regional_Mark_Processing_Center_RMPC)

4.2.2.6   Coded Wire-Tag Recoveries

All hatchery-origin fish released from the program will be coded wire-tagged (CWT) and adipose fin-clipped so they may be identified upon capture in fisheries, collection facilities, hatcheries and on the spawning grounds (Table 9). CWT recoveries are used to develop estimates of total recruitment, rate of return to point of release (homing), contribution to fisheries, survival rates, mark rate and other parameters (see Section 4.2.1).

Program HOR fish will be tagged as shown in Table 9 during the transition period.

Table 9.   Marking protocols for program HOR summer/fall Chinook (Transition Period 1).

Stock	% CWT and Tagging Location	Adipose Fin-Clip
Okanogan Integrated		
Similkameen	100% -Snout	100%
Bonaparte Pond	100%-Snout	100%
Riverside Pond	100%- Snout	100%
Omak Pond	100%- Snout	100%
Chief Joseph Segregated	100% -Right Cheek	100%

Fish from the Okanogan integrated program will be differentially tagged depending on their release location. Fish released from the Chief Joseph segregated program will be 100% adipose fin-clipped and a CWT placed in the right cheek. The tagging protocol will allow managers to identify (and remove) strays from the segregated program arriving at the Okanogan weir.

A subsample of all NOR and HOR fish captured at the weir will be checked for marking error. A marking error is a fish that exhibits the following characteristics:

- Adipose fin-clip, no CWT[16]

- CWT without an adipose fin-clip

- No adipose fin-clip and no CWT, but scale analysis indicates hatchery rearing

The final spawning location for all HOR fish released upstream of the weir will be confirmed by marking 10% of the returning run at the weir with a unique external mark and collecting these tags on the spawning grounds as part of ongoing survey work.

All recovered CWTs will be reported to the Regional Mark Processing Center operated by the Pacific States Marine Fisheries Commission. Their web site can be found at: (http://www.psmfc.org/Regional_Mark_Processing_Center_RMPC)

4.3   VARIABLES MONITORED ON SPAWNING GROUNDS

Three variables will be monitored on the spawning grounds for summer/fall Chinook:

- NOR and HOR Spawning Success: Number of NOR and HOR that spawned successfully

- NOR and HOR Spawning Location: In basin

- NOR and HOR Demographics: Age, size and sex-ratio of spawning NOR and HOR fish

Data collected on these variables will be used to estimate the parameters of:

- Pre-spawn Survival: Percentage of the total spawning population that successfully spawned

- Relative Reproductive Success of HORs: The probability that an HOR spawning naturally will produce adult offspring expressed as a fraction of the same probability for a NOR

- Spawning Timing and Spatial Distribution: Geographic distribution of spawners and timing in the basin

- Composition: Percentage of HOR and NOR spawners in the spawning population

The ISMP purpose and the attributes/parameters estimated from each of these variables monitored on the spawning grounds include the following:

NOR and HOR Spawning Success: Number of NOR and HOR that spawned successfully

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[16] Management calls for placing wire in all hatchery summer/fall Chinook released in the Upper Columbia River Basin.

- **Attributes/Parameters Estimated**: Pre-spawn survival, relative productivity, spawning spatial distribution (SD) and composition, relative reproductive success of HOR (RRS)

- **ISMP Purpose**: Will be used in Step 1 to update key assumptions (Section 3.4.1) and Step 3 stock status and trends (Section 3.4.3)

NOR and HOR Demographics: Age, size and sex-ratio of spawning NOR and HOR natural spawners, diversity (Div)

- **Attributes/Parameters Estimated**: Pre-spawn survival, spawning distribution and composition

- **ISMP Purpose**: Will be used in Step 1 to update key assumptions (Section 3.4.1), Step 3 stock status and trends (Section 3.4.3), and the in-season biological targets (Step 4, Section 3.4.4)

4.3.1   Methods

4.3.1.1   NOR and HOR Spawning Success

Spawning Ground and Redd Surveys

Summer/fall Chinook spawning ground and redd surveys will be conducted weekly from late September through mid-November. Surveys will be conducted by foot, raft and aircraft (BioAnalysts 2007). During the foot and raft surveys, biologists will sample 25% of recovered female summer/fall Chinook to determine if they spawned successfully. Females will be cut open to determine the presence/absence of eggs. The number of eggs present will be enumerated and recorded for both NOR and HOR fish.

All female fish possessing an external mark from weir operations will be sampled to determine spawning success. The tag number and number of eggs present will be recorded.

Pedigree Analysis

A pedigree analysis will be used to determine the reproductive success of both the natural and hatchery components of the run. The DNA needed for the study will be obtained from the operculum of fish randomly sampled on the spawning grounds. Microsatellite genotyping of each sample will be performed as described in Narum et al. (2006). The number of microsatellite loci needed to distinguish hatchery and naturally produced summer/fall Chinook will be adjusted over time as indicated by study results. The study will be used to:

- Monitor trends in the genetic composition (e.g., gene frequency) and diversity of the population

- Determine reproductive success of HOR and NOR fish

- Determine hatchery contribution to natural production

- Determine effective population size

Because of the large costs associated with this study, it will not be implemented until such time as long-term funding is assured. The Colville Tribes will work with other entities engaged in regional M&E efforts to identify funding sources and coordinate efforts in determining hatchery impacts to natural populations.

4.3.1.2 NOR and HOR Demographics and Spawning Habitat Location and Quality

During spawning surveys, 25% of recovered carcasses will be sampled for species, size, sex, location and date of recovery. Scale samples will be taken from all NOR fish and CWTs collected from all HOR fish to determine age. A subsample of the coded wire-tag HOR fish will be collected to estimate the accuracy of scale readers to properly age sample scales.

Redds will be enumerated weekly and their location recorded on a map (BioAnalysts 2007). Redd surveys will be conducted from RM 0 to RM 129.6 of the Okanogan River, RM 0 to 9.1 of the Similkameen River, and in the lower reaches of all tributaries to detect any change in habitat utilization over time. The number of redds and spawners will also be calculated for the following spawning aggregations:

- Site 1   Okanogan River mouth to weir (RM 0 to 17)

- Site 2   Weir to Omak Pond (RM 17 to 32)

- Site 3   Omak Pond (RM 32 to 41)

- Site 4   Riverside Pond (RM 41 to 56)

- Site 5   Bonaparte Pond (RM 56 to 62)

- Site 6   Similkameen Pond (RM 62 to 65.4 and Similkameen River RM 0 to 9.1)

- Site 7   Okanogan River Reach 5 (RM 65.4 to 91.4)

- Site 8   Mouths of all tributaries

- Site 9   Okanogan River Reach 6 (RM 91.4 to 129.6)

Escapement estimates developed at the weir will be compared to the results of the redd and carcass surveys to determine the percent of the population observed during the surveys.

Additionally, the percent fines present in spawning gravels at each site (32 samples per site) will be monitored yearly and tracked over time by site. This information will be used to determine if increased salmon spawning results in a decrease in fine sediment levels in the lower Okanogan River.

Inter-gravel dissolved oxygen readings will be collected from three redds at each site after spawning and also at emergence (determined based on temperature units). This information will be used to determine if oxygen levels exceeded those needed to ensure high survival.

4.4   VARIABLES MONITORED AT HATCHERY FACILITIES

The quality of the fish produced at hatchery facilities depends on the fish husbandry protocols used in hatchery operations. Thus, all rearing phases of the hatchery program will be monitored based on the best management practices outlined in the hatchery operations manual which is being developed. The hatchery will be operated to maximize survival at all life stages by implementing the disease control and disease prevention techniques outlined in the Co-managers Fish Health Disease Policy and the Tribal Health Manual available from: http://access.nwifc.org/enhance/fh_downloads.asp. Hatchery operations will be monitored to ensure fish releases meet size targets and are in good health, therefore posing little disease risk to native fish populations.

Seven variables are important to the ISMP and will be monitored at the hatchery each year. These data are needed to calculate parameters of:

- Hatchery pre-spawn mortality: Number of HOR and NOR fish that die prior to spawning in the hatchery

- Age, sex, spawn timing and composition (HOR or NOR) of broodstock

- Fecundity: Average number of eggs per female

- Egg-to release survival rate for yearlings and sub-yearlings: Number of eggs that survive to the identified life stage measured at the point of release. Will include all life stages until release.

- Total release number by age: Total number of juvenile fish released at either the yearling or sub-yearling life stage for the entire program and release site

- Marking efficiency: Proportion of the fish released that were successfully marked (calculated for each release component)

- Juvenile survival rate: Overall survival rate from release site to McNary and Bonneville dams

The ISMP purpose and the attributes/parameters estimated from each of these variables monitored at hatchery facilities include the following:

Number of NORs and HORs used for Broodstock:

- **Attributes/Parameters Estimated**: pNOB, PNI, percent females (%Fem), total broodstock (HatSp)

- **ISMP Purpose**: Will be used to monitor Step 3 stock status and trends (Section 3.4.3) and in-season biological targets (Step 4, Section 3.4.4)

Composition of Broodstock Spawned:

- **Attributes/Parameters Estimated**: Age, sex, timing, composition of hatchery brood

- **ISMP Purpose**: Will be used to monitor Step 1 key assumption (Section 3.4.1) and in-season biological targets (Step 4, Section 3.4.4)

Holding Mortality: Number of fish that die from time of broodstock collection until spawning

- **Attributes/Parameters Estimated**: Pre-spawning mortality

- **ISMP Purpose**: Will be used to monitor Step 1 key assumption (Section 3.4.1)

Eggs per Female Spawned:

- **Attributes/Parameters Estimated**: Fecundity (Fec)

- **ISMP Purpose**: Will be used to monitor Step 1 key assumption (Section 3.4.1)

Juvenile Census Information: Counts of live and dead eggs/fish from incubation to release

- **Attributes/Parameters Estimated**: Egg to release survival for yearlings (EtoS1) and sub-yearlings (EtoS0), and total release number by age

- **ISMP Purpose**: Will be used to monitor Step 1 key assumption (Section 3.4.1)

Fish Marking Efficiency: Sampling of juveniles for marks (CWT and/or adipose fin clips) prior to release

- **Attributes/Parameters Estimated**: Mark rate for each of the release components

- **ISMP Purpose**: Will be used to monitor Step 1 key assumption (Section 3.4.1)

4.4.1   Methods

All of the variables are measured through direct enumeration or classification by hand or by machine as part of hatchery operations. They will be reported by hatchery staff in the annual hatchery report. A summary of all hatchery operations and data collection conducted as part of hatchery operations are presented in the CJHP Operations and Maintenance Manual (currently being developed).

All juveniles released from the hatchery will be adipose fin-clipped and CWT. Up to 25,000 of the juveniles released each year will be PIT-tagged in a manner representative of the release. PIT-tagged fish will be tracked at mainstem Columbia River dams via detection systems already in place.

4.5 VARIABLES MONITORED DURING JUVENILE OUTMIGRATION

Hatchery fish released into basin waters have the potential to compete for food and space with naturally produced summer/fall Chinook. In addition, the large number of hatchery yearlings released each year may prey on wild juvenile summer/fall Chinook (and other species). These impacts to naturally produced fish have the potential to reduce NOR population abundance and productivity.

Two variables will be monitored during the juvenile outmigration:

- Juvenile Trap Counts in the Lower Okanogan River: Number of juvenile HOR and NOR collected at traps

- Juvenile HOR Predation on NOR Juveniles: Number of NOR juveniles consumed by HOR juveniles released from facilities

These two variables will be used to develop estimates for four parameters:

- Smolt Abundance: Annual abundance of out-migrant smolts as measured at mouth of Okanogan River

- Smolt Productivity: Productivity parameter in the Beverton-Holt survival function

- Smolt Capacity: Capacity parameter in the Beverton-Holt survival function

- Total SAR: Survival rate from subbasin to subbasin in the absence of harvest

The ISMP purpose and the attributes/parameters estimated from each of these variables monitored during juvenile migration include the following:

Juvenile Trap Counts at Mouth of Okanogan River:

- **Attributes/Parameters Estimated**: Smolt abundance (Smolt), natural smolt productivity (Prod), smolt capacity (Cap) and Fitness (Fit), smolt-to-adult survival (TotSAR)

- **ISMP Purpose**: Will be used to monitor Step 1 key assumptions (Section 3.4.1) and stock status and trends (Step 3, Section 3.4.3)

Juvenile HOR Predation on NOR Juveniles: Number of NOR juveniles consumed by HOR juveniles released from facilities

- **Attributes/Parameters Estimated**: Outmigrant abundance, natural smolt productivity and capacity

- **ISMP Purpose**: Will be used to monitor Step 1 key assumptions (Section 3.4.1) and stock status and trends (Step 3, Section 3.4.3)

Juvenile Monitoring at Dams: Detections of PIT-tagged fish at mainstem Columbia River dams

- **Attributes/Parameters Estimated**: Juvenile passage survival (JuvPass)

- **ISMP Purpose**: Will be used to monitor Step 1 key assumptions (Section 3.4.1) and stock status and trends (Step 3, Section 3.4.3)

4.5.1   Methods

4.5.1.1   Annual Summer/Fall Juvenile Chinook Production

An index of juvenile summer/fall Chinook NOR production will be developed each year based on the results of rotary screw trap operations in the lower Okanogan River. Screw trap operations have been on-going since 2006 using methods described in Rayton and Wagner (2006). Trapping operations provide estimates of yearly abundance and run-timing for Chinook, steelhead and sockeye juvenile migrants. Data will also be collected on fish size and condition factor for each species.

A pooled Peterson estimator with a Chapman modification will be used to produce population estimates of Chinook fry and smolts (both NOR and HOR). Because of high and variable flows that affect trapping efficiency, resulting estimates of production have had a relatively wide confidence interval (Table 10). The Colville Tribe will continue to improve capture techniques to increase the precision of juvenile production estimates. The goal of the juvenile monitoring is to achieve juvenile abundance estimates that have a coefficient of variation (CV) of 15% or less (Crawford and Rumsey 2009). Additionally, a power analysis of juvenile production will be conducted over time to determine the power of the data to detect a significant change in juvenile abundance.

Table 10.   Estimated Okanogan River wild Chinook production for migration years 2006-2008.

Year	Species	Origin	Population Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval
2006	Chinook	NOR	381,554	175,731	587,377
2007	Chinook	NOR	1,126,545	394,671	1,858,419
2008	Chinook	NOR	1,513,508	999,943	2,027,073

Additionally, up to 25,000 NOR juvenile Chinook captured in the traps will be marked with a PIT-tag. The tag will allow managers to estimate juvenile and adult survival rates through the mainstem Columbia River. Tagging fish in this manner will provide better estimates of the proportion of the run each year that may rear in the mainstem Columbia River upstream of Wells Dam. Upon their return as adults, the PIT-tagged fish will enable managers to estimate adult (NOR) survival and timing through the Columbia River and at the Okanogan River weir. Over time, this data will be used to improve in-season management of the program.

4.5.1.2 Predation

Because of their release size, yearling HOR juvenile Chinook have the potential to prey on the smaller wild component of the run. To address this concern, a predation index study with the following components will be implemented:

- PIT-tags will be used to determine the amount of time hatchery fish spend in the Okanogan River after release from facilities based on recaptures.

- Stomach analysis will be used to estimate the number, size and species of juvenile fish consumed by the hatchery juveniles.

PIT-Tags

For this portion of the study, PIT-tagged HOR yearling Chinook will be released from each juvenile release location in the basin. PIT-tag arrays located on the outlet structure of each release site will be used to determine the data and time when each PIT-tagged fish began its migration. Screw traps located near the mouth of the Okanogan River will be used to collect a subsample of the Pit-tagged fish. Differences in detection timing between the release and recapture sites will be used to estimate the amount of time hatchery fish are co-mingled with native fish in the river by release site. The more time spent in the river by these HOR yearlings, the greater the opportunity for predation to occur.

Stomach Sampling

A subsample (10 fish per day) of migrating yearling HOR Chinook captured during screw trap operations will be collected and their stomach contents removed for analysis. Stomachs will be sent to a lab for examination and enumeration of the number, size and species of salmonids present. This data will be combined with the radio-tag results to produce a predation index (PI).

PI will be calculated as:

$$PI = TT * F_{CON} * H_{REL}$$

Where

TT = Median travel-time (in days) for PIT-tagged hatchery fish from point of release to mouth of Okanogan River

FCON = Number of fish consumed per stomach sampled

HREL = Number of hatchery fish released at each site

Data will be summarized by release site and for the program as a whole.

If the PI index exceeds 10% of estimated total wild juvenile fish production for that year (based on rotary screw trap mean abundance estimate), two actions may be undertaken:

1. Implement a more rigorous predation study to develop more quantitative estimates of predation.

2. Alter hatchery release locations, size at release, or numbers released to reduce predation impacts to wild fish.

If the second action is selected, the predation index study would be repeated to confirm action effectiveness.

4.6 EXISTING MONITORING IN THE OKANOGAN RIVER

The ongoing Okanogan Basin Monitoring and Evaluation Program (OBMEP) is based on the structure and methods employed by the Monitoring Strategy for the Upper Columbia Basin (Hillman 2006). Colville tribal biologists have implemented the Environmental Protection Agency's Environmental Monitoring & Assessment Program (EMAP) sampling framework (EPA 1997), a statistically based and spatially explicit sampling design, to quantify trends in physical habitat, water quality, and biological parameters. Standardized protocols were developed to be consistent with other programs throughout the Upper Columbia and Pacific Northwest regions while remaining specifically applicable to the needs of the Colville Tribes and the Okanogan River.

The EMAP sampling design is represented in Table 11. Each year, OBMEP personnel perform habitat and snorkel surveys on the annual panel (panel 1) and on one of the five rotating panels (panels 2 through 6). The shaded areas of the table indicate the years in which sites within each panel are sampled. For example, sites in the annual panel (panel 1) will be visited every year, while sites in panel 2 will be visited in 2010, 2015, and 2020, assuming a 20-year sampling frame.

Table 11.   Rotating panel design for status/trend monitoring within a given status/trend monitoring zone, e.g., Okanogan subbasin.

Panel	Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
2	█					█					█					█				
3		█					█					█					█			
4			█					█					█					█		
5				█					█					█					█	
6					█					█					█					█

Current monitoring within the Okanogan River and Okanogan subbasin focuses on 38 habitat indicators and 21 biological indicators as outlined in the Upper Columbia Strategy (Hillman 2006) and other selected references and regional guidance documents. Discharge,

temperature and water quality data are collected primarily through cooperative agreements with the United States Geological Survey (USGS), Environment Canada, and the Washington Department of Ecology. The OBMEP also collects temperature data at tributary EMAP sites throughout the Okanogan subbasin. Habitat data are collected annually at 25 sites throughout the Okanogan subbasin and once every five years at 125 additional rotating panel sites (25/year) selected randomly using the EMAP protocols. Figure 5 illustrates a typical sampling layout.

Biological data are collected using a variety of experimental design approaches depending upon the data being collected. Sampling designs include monitoring at specific sites, census monitoring, and probabilistic sampling. Biological indicators include redd abundance and distribution, parr abundance and distribution, smolt and adult enumeration, as well as others. The protocols used for each biological parameter can be found at: http://nrd.colvilletribes.com/obmep/Reports.htm.
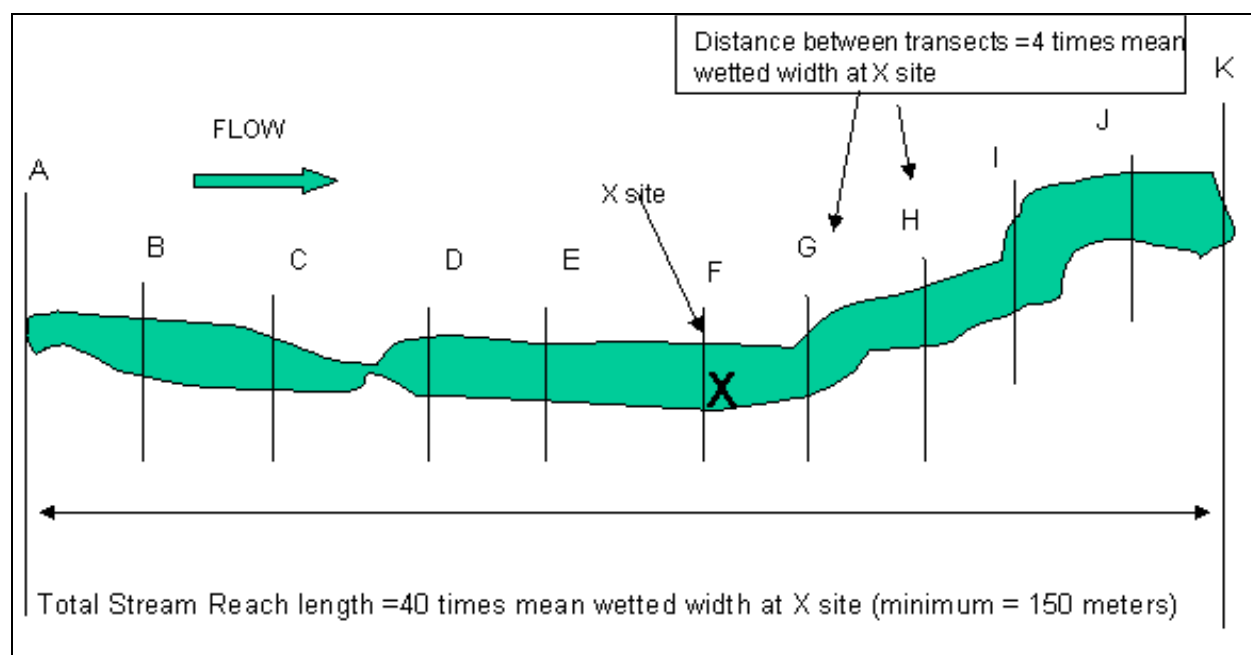

Figure 5.   Typical EMAP habitat sampling site layout.

A partial list of biological and physical parameters monitored by OBMEP includes:

Turbidity

Temperature

Conductivity

pH

Dissolved oxygen

Width to depth ratios

Wetted width

Bank-full width

Riparian structure

Riparian disturbance

Canopy cover

Diversions, crossings, and fishways

Land use

Land ownership

Dominate substrate

Embeddedness

LWD frequency

Habitat classification

Disturbance

Road densities

Discharge (continuous)

Smolt monitoring at the City of Okanogan

Redd counts

Carcass counts

Benthic macro-invertebrates

Adult fish passage at Zosel Dam

5   ATTRIBUTE/PARAMETER ESTIMATION AND HYPOTHESIS TESTING

The purpose of the In-Season Management Plan is to guide management of the summer/fall Chinook population in the Okanogan towards a state where a locally adapted naturally spawning population will be sustained in the long term. This will require that all Viable Salmonid Population (VSP) parameters be addressed: productivity will increase by reducing the influence of hatchery fish, abundance will be maintained by assuring high natural escapements, spatial structure will increase spawning distribution in space in the Okanogan, and diversity will be addressed by managing escapement to assure that all temporal segments of the population are represented. Overarching management objectives to this end are to maintain natural escapements as high as possible (no fishing or broodstock collection when runs are less than 800 adults) and hatchery influence as low as possible (PNI must be above 0.67 over time and pHOS must be less than 30%).

This section identifies and defines the parameters used in the four-step ISMP and how they will be used. Different kinds of information are needed for each step. In Step 1, the key assumption parameters are used to predict how the system will respond to future management actions. These parameters will be reviewed annually (Step 2), although they may not change every year. The Decision Rules (Table 4) set the management controls so that if the key assumptions are true, the biological targets for the populations will be met. No monitoring is needed in Step 1 as it is a decision step.

In Step 3, the status and trend analysis, outcomes based on empirical data are assembled, the current status of the population is established and progress toward population goals is analyzed (Section 5.2).

In Step 4, inputs to the Decision Rules are obtained, most importantly run size updates for the NOR run as well as hatchery run sizes at Wells Dam (Section 5.3). In this step, progress towards the biological targets is also tracked and at the end of the season this information is used to assess the management performance in terms of achievement of biological targets. Note that Step 4 continues throughout the season following the APR workshop. Only the pre-season forecast for the expected NOR run size will be available at the workshop. This prediction will be updated as the season progresses and more precise and accurate estimates become available.

At each step in this process the managers will describe any and all analytical results and changes to parameter values and record them in the ISMP data base. At the end of the season, this information will be compiled in an annual report developed prior to the Annual Project Review in March.

A key element of this plan is that <u>all</u> assumptions will be reviewed and challenged each year to assure the most current and reliable information is used in the decision-making process.

5.1 KEY ASSUMPTIONS (ISMP STEP 1)

The key assumptions are a set of parameters that relate to future expectations (i.e., what is the basis for predictions about what will happen). Generally these assumptions are based on data and information collected over time. They represent our understanding of how the system works, creating a working hypothesis that forms the basis for management decisions in-season and long term. The parameters are grouped into five categories: 1) habitat and natural production, 2) smolt to adult survival, 3) harvest in fisheries and at the weir, 4) hatchery fish spawning in nature, and 5) in-hatchery parameters. Each is described below.

5.1.1 Habitat and Natural Production Parameters

Annual estimates of natural spawning escapement and juvenile outmigration abundance will be fitted to the Beverton-Holt survival function, yielding estimates of the productivity and capacity parameters. The current estimates of productivity and capacity are habitat based (EDT) and incorporate a fitness correction due to substantial hatchery influence. An initial relative fitness of 0.5 is assumed for the population.

Increasing fitness is a major objective of this program. The influence of hatchery fish on the natural population will be reduced in two ways. First, the proportion of hatchery fish on the spawning ground will be minimized through selective harvest and the operation of a weir. Second, the hatchery population will be genetically integrated with the natural population so that any straying that occurs will be less detrimental. The expectation is that the naturally spawning population will achieve a fitness greater than 0.9, i.e., natural population productivity will increase by 80%. It will take the population several generations to achieve this level of local adaptation.

Due to measurement imprecision (especially of juvenile abundance) and high variability in survival, the variance of estimates for smolt productivity and smolt capacity will be high. Managers will review trends in natural production annually and determine whether these

parameter values should be revised. Additionally, research elsewhere in the region may shed light on the fitness assumptions and thus the guidelines for escapement management.

Habitat and natural production variables to be monitored are:

Smolt Productivity (Prod)

- **Definition**: Productivity parameter in the Beverton-Holt survival function

- **Assumed Value**: Prod=356 smolts per spawner

Smolt Capacity (Cap)

- **Definition**: Capacity parameter in the Beverton-Holt survival function

- **Assumed Value**: Cap=590,000 smolts

Fitness Factor (Fit)

- **Definition**: The probability that a fish from the existing population will survive and produce adult offspring expressed as a fraction of the same probability for a fish from a locally adapted population

- **Assumed Value**: Fit=0.5

Fitness Floor (FF)

- **Definition**: The lowest value assumed for the fitness factor

- **Assumed Value**: FFloor=0.5

5.1.2　Smolt to Adult Survival

Survival is highly variable from year to year. The survival rate of natural-origin juveniles passing the weir near the mouth of the Okanogan and returning to the weir as adults will be estimated from PIT-tag recoveries. Up to 25, 000 juveniles will be PIT-tagged at the screw traps (see Section 4.1.1.2)[17].

TotSAR

- **Definition:** Survival from subbasin to subbasin in the absence of harvest under average conditions
- **Assumed Value**: SARave=1.053%

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[17] Beach seining may be used if insufficient NOR juveniles are captured at screw traps

A method of moments estimate of the annual TotSAR can be obtained from:

$$\text{TotSAR} = \frac{R}{P \times (1-f) \times (1-t) \times (1-w)} \, ,$$

where R is the total adult recovery (all ages) of CWT tags from a release of CWT smolts (P), f = exploitation rate, t= tagging mortality, and w = weir efficiency. Estimates of f, t and w will be obtained independently.

SAR will be estimated each year for all NOR and HOR groups and the average value used for future predictions will be adjusted based on this evolving time series.

PIT-tags will also be used system-wide to estimate survival through the hydropower system (NMFS 2008).

5.1.3   Harvest (in Fisheries and Weir)

All hatchery fish will be marked with an adipose fin-clip and 100% coded wire-tagged (see Section 4.2.1.6). This will allow the annual exploitation rates in all fisheries for hatchery-origin fish to be estimated by program component. The exploitation rate on natural-origin fish in pre-terminal fisheries is assumed to be the same as for hatchery-origin fish, except in the case of mark selective fisheries. Data for estimating these rates will be obtained from the coast-wide data system (http://www.rmpc.org/). Unless there is a significant change in the pre-terminal management policy, the recent historical estimates of exploitation rates will be assumed for the coming year.

Terminal harvest rates will be based on post-season run size estimates (at Wells Dam), and annual tribal and recreational catch reports. A key assumption is that the terminal fisheries is capable of harvesting up to 50% of the HOR terminal run without exceeding an incidental mortality for NOR of 3% (6% of 50%). Post-season run-reconstruction analysis will provide annual estimates of fishing mortality for both HORs and NORs. Maximum annual rates as well as in-season estimates of daily harvest rates will be used to adjust the assumed values for the TermHRM and TermHRU parameters (see below).

Weir efficiency (WeirEff) and weir mortality will be estimated from radio tagging studies conducted in each of the first three years and periodically thereafter.

The number of unmarked HORs that pass the weir will be estimated from the mark rate of HOR adults returning to the Chief Joseph Hatchery rack. While the goal is to mark all hatchery fish, some failure rate must be anticipated. Since the marking methods will be similar for all mark groups, it is reasonable to assume that the proportion of unmarked fish at the Chief Joseph Hatchery rack is good estimate of the overall mark rate for hatchery fish. Carcass surveys conducted in the Okanogan River will provide an additional estimate of unmarked HORs.

Harvest variables to be monitored are:

Pre-terminal Exploitation Rate on Marked Fish (PreERM)

- **Definition:** Total exploitation rate on adipose fin-clipped fish in all fisheries downstream of Wells Dam

- **Assumed Value**: PreERM=52% for Okanogan and Chief Joseph Hatchery fish

Pre-terminal Exploitation Rate on Unmarked Fish (PreERU)

- **Definition:** Total exploitation rate on unmarked fish in all fisheries downstream of Wells Dam

- **Assumed Value**: PreERU=52%

Terminal Harvest Rate on HORs (TermHRH)

- **Definition**: Maximum harvest rate achievable by the terminal selective fishery for adipose fin-clipped hatchery fish.

- **Assumed Value**: Maximum TermHRM=50%

Terminal Harvest Rate on NORs (TermHRN)

- **Definition:** Incidental mortality rate on NORs in the terminal selective fisheries expressed as a percent of the terminal harvest rate on HORs (TermHRN)

- **Assumed Value**: TermHRN=6% of TermHRH

Weir Factor (WeirEff)

- **Definition:** The probability that a Chinook salmon entering the Okanogan River will be caught in the weir

- **Assumed Value**: WeirEff=95%

Mark Rate (MarkR)

- **Definition:** The proportion of HORs having a detectable mark (adipose fin-clip and/or CWT)

- **Assumed Value**: MarkR=95%

NOR Weir Mortality (WeirMort)

- **Definition**: The probability that a NOR fish captured in the weir will die as a result of this experience

- **Assumed Value**: WeirMort=2%

5.1.4 HORs Spawning in Nature

A number of factors contribute to the effects of hatchery fish spawning in nature. The number and proportion of hatchery fish on the spawning grounds depend on stray rates from the each hatchery program, their genetic relationship to the naturally spawning population (and thereby their adaptation to the natural environment), the contribution rate of hatchery fish (pHOS), and their phenotypic ability to produce adult offspring. Selective harvest, weir operation, release numbers, and release locations are used to control the abundance, composition and distribution of hatchery fish on the spawning grounds. Census counts will be obtained from mark recovery analysis of weir and spawning survey data. The reproductive success of HORs will be evaluated from pedigree analysis (See Section 4.3.1.1). The important long-term fitness of the combined population spawning in the wild will be estimated over time. Standard methods, as described in recent literature (Crawford and Rumsey 2009) will be used to obtain estimates with minimal bias and sufficient precision (targets are: coefficient of variation less than 15% for juvenile abundance estimators and less than 5% for adults).

HOR spawning variables to be monitored are:

Relative Reproductive Success of HORs (RRS)

- **Definition**: The probability that an HOR will produce adult offspring expressed as a fraction of the same probability for a NOR

- **Assumed Value**: RRS=80%

Stray Rate of HORs from Segregated CJH Program into the Okanogan River (StCJ)

- **Definition**: The probability that an HOR released from CJH and escaping fisheries will survive and enter the Okanogan River to spawn

- **Assumed Value**: StCJ=20%

Rate of Return of Okanogan Integrated Program HORs to the Okanogan River (RetOk)

- **Definition**: The probability that an HOR released in the Okanogan River and escaping fisheries will survive and enter the Okanogan River to spawn

- **Assumed Value**: RetOk=98%

Okanogan HOR Spawning Below Weir (OkBW)

- **Definition**: The probability that an HOR from the Okanogan integrated program will spawn downstream of the weir

- **Assumed Value**: OkBW= negligible

5.1.5 In-Hatchery Assumptions

In-hatchery operations will incorporate detailed record keeping and tracking of mortality at stage from broodstock collection through release. Overall survival of hatchery fish will be measured in terms of recruits per spawner, which means the total number of adults produced at all ages per fish collected for broodstock (not just those actually spawned). For production planning purposes, in-hatchery survival from collection to release will be based on recent observed averages for the Similkameen program. It is important to note that the number of fish collected for broodstock will vary from year to year based on the annually determined biological targets.

The size of the program is measured in terms of broodstock (number and composition), not release numbers. This is a departure from the norm where a constant smolt release target has been the objective.

In-hatchery variables to be monitored are:

Pre-Spawning Mortality (PSMortH)

- **Definition**: The probability that a fish collected for broodstock will survive to spawning

- **Assumed Value**: PSMortH=10%

Eggs/Female (Fec)

- **Definition**: Average number of eggs per female spawned

- **Assumed Value**: Fec=5000

% Females (%Fem)

- **Definition:** Proportion of females collected in the broodstock

- **Assumed Value**: %Fem=50%

Egg to Smolt Survival - Sub-yearlings (EtoS0)

- **Definition**: In-hatchery survival from egg (at spawning) to release as sub-yearling

- **Assumed Value**: EtoS0=0.74

Egg to Smolt Survival—Yearlings (EtoS1)

- **Definition**: In-hatchery survival from egg (at spawning) to release as yearling

- **Assumed Value**: EtoS1=0.66

Recruits per Spawner (RS)

- **Definition**: Mean number of adult recruits produced per HOR collected for broodstock

- **Assumed Value**: RS=13.5

5.2 STATUS AND TRENDS (ISMP STEP 3)

Status and trends represent actual outcomes (i.e., looking back at what happened). This information will be collected and reported annually and incorporated into the historical record of outcomes. These outcomes will be re-analyzed each year as part of an annual review that will evaluate key assumptions and parameter estimates. It also will be used to evaluate performance of the ISMP (e.g., Did we meet the biological targets? Were these targets correct?). This information will also be shared with the public and other management entities as part of the accountability responsibility. The attributes involved in status and trend monitoring are arranged into five categories: 1) natural production, 2) hatchery production, 3) harvest, 4) migration, and 5) habitat. Each is addressed below.

5.2.1   Natural Production

Each year a full accounting of the natural run will be obtained through run reconstruction. Marked hatchery groups will serve as indicators of pre-terminal harvest contributions. The variables listed below will be estimated each year. Tracking performance of the natural population over time is a primary objective of this monitoring plan. The new weir and mark recapture studies will greatly improve the ability to estimate spawner abundance, distribution and composition. Juvenile abundance estimates will be obtained from mark recapture estimates using a screw trap near the mouth of the Okanogan River. Precision of adult abundance will be high (coefficient of variation of 5% is a goal). Juvenile abundance estimates will be less precise (coefficient of variation of 15% is the goal).

Natural production variables are:

Spawner Abundance (NatSp)

- **Definition**: Total number of adult spawners each year

- **Biological Target**: Specified in terms of NORs and pHOS, not total spawners.

Total NOR Recruitment (NRec)

- **Definition:** Annual number of adult recruits (catch plus escapement)

- **Biological Target**: 800 adults. This is the minimum value during the initial transition phase. This minimum target will increase in steps to 1,600 adults in the long term. Adult NORs in excess of this minimum will be split between broodstock, harvest and additional spawning escapement as prescribed by the Decision Rules (Table 4).

Smolt Abundance (Smolt)

- **Definition**: Annual abundance of out-migrant smolts as measured mouth of the Okanogan River

- **Biological Target**: No specific annual target, but the expectation is that smolt production will double in the long term (from approximately 1 to 2 million)

Recruits per Spawner (NatRS)

- **Definition:** The number of adult recruits produced per NOR spawner

- **Biological Target**: The expectation in the long term is that abundance in excess of 4,500 will be sustainable, i.e., NatRS should be greater than one for escapements smaller than 4,500 fish. The corresponding value in the near term is about 1,200 adults.

Spatial Distribution (SD)

- **Definition**: The fraction of NatSp that spawned in each of nine defined spawning areas

- **Biological Target**: Nine spawning aggregations

Diversity (Div)

- **Definition**: The composition of the spawning population in terms of sex, age, spawn-timing

- **Biological Target:** No quantitative targets are specified; however, it is the expectation that the natural environment will drive diversity, rather than fisheries and hatchery practices. During the transition phase, efforts will be made to extend run- and spawn-timing through an all-H effort to increase use of underutilized spawning habitat. The Okanogan Chinook population has been labeled a summer/fall run to emphasize the temporal diversity of the population.

PNI

- **Definition**: An indicator of the influence of natural and hatchery environments on population adaptation

- **Biological Target**: The minimum three year running average for PNI is 0.67; however, it is expected that PNI will be significantly larger in the long term.

5.2.2   pHOS

- **Definition**: The proportion of HORs in the natural spawning population

- **Biological Target:** The running three-year average percent of effective HOR spawners will not exceed 30%, and the proportion of effective spawners from hatchery programs other than the integrated Okanogan program will not exceed 5% of the total spawning escapement. The number of effective HOR spawners is the census number multiplied by the relative reproductive success factor (RRS). The expectation is that the two pHOS values will be significantly smaller in the long term (< 20% and <2%, respectively).

5.2.3   Hatchery Production

All hatchery fish will be marked with adipose fin-clips and CWTs to allow estimation of total recruitment for each program component (see Section 4.2). Run reconstruction will be performed each year to obtain estimates of recruitment. These estimates, along with broodstock information, will be used to estimate hatchery productivity for each program component.

Hatchery production variables are:

Broodstock (HatSp)

- **Definition**: The number of fish collected for hatchery broodstock for each hatchery program (integrated and segregated)

- **Biological Target**: For the Chief Joseph segregated on-station program, the annual target is 576 adults. For the integrated Okanogan program, the number will be determined annually as prescribed by the Decision Rules.

Total HOR Recruitment (HRec)

- **Definition:** Annual number of adult recruits (catch plus escapement) for each program

- **Biological Target**: The long-term average target for HRec is 13,000 recruits, including pre-terminal harvest for the integrated program and 5,500 for the CJH on-station program.

pNOB

- **Definition:** The proportion of NORs from the Okanogan population in the integrated hatchery broodstock

- **Biological Target**: pNOB is a management control variable that helps achieve the PNI target. pNOB will be 100% during the early transition and may be reduced if pHOS can effectively be maintained at low levels (<30%) in the future.

5.2.4   Harvest

All hatchery fish will be marked with adipose fin-clips and CWTs to allow estimation of fishery contribution rates for each program component and all major fisheries (see Section 4.2). Run reconstruction will be performed each year to obtain a full accounting for the destination of each run component. This information will be reported annually before the following season.

Harvest variables to be monitored are:

Total Catch of NORs (NORCatch)

- **Definition**: Annual catch of Okanogan NOR adults in all fisheries

- **Target:** No target specified. The primary goal for the natural population is conservation. The long-term expectation is that several thousand NORs will be available for harvest in the terminal areas.

Total Exploitation Rate of NORs (NORExpl)

- **Definition:** Proportion of total NOR recruits caught in fisheries

- **Biological Target**: Maximum NORExpl is 43% in the long term. The rate is expected to decrease from about 60% overall to 43% as a result of reduced impact on NORs in some pre-terminal fisheries and a maximum terminal incidental harvest mortality rate of less than 6% (including fisheries and weir).

Total Catch of HORs (HORCatch)

- **Definition**: Annual catch of Okanogan and Chief Joseph Hatchery HOR adults in all fisheries

- **Target:** Average harvest varies by year and phase. In the Transition phase (period 1), total harvest is expected to average ~14,000 in all fisheries combined; with ~8,000 harvested in terminal fisheries (upstream of Wells Dam).

Total Exploitation Rate of HORs (HORExpl)

- **Definition:** Proportion of HOR recruitment caught in fisheries for the integrated and segregated hatchery programs

- **Target**: 75% or greater. Overall exploitation is expected to increase significantly, largely due to higher selective rates in the terminal areas.

5.2.5   Migration

This program will be coordinated with system-wide efforts to monitor and evaluate out-of-subbasin survival. Subset of outmigrant HORs and NORs will be marked for this purpose.

Migration variables to be monitored are:

Juvenile Passage Survival (JuvPass)

- **Definition**: Annual survival from the mouth of the Okanogan to below Bonneville Dam

- **Biological Target**: Equal to or higher than current survival rate

Adult Passage Survival (AdPass)

- **Definition:** Annual survival from Bonneville Dam to Wells Dam

- **Biological Target**: Equal to or higher than current survival rate

SAR

- **Definition**: Annual survival from outmigrant smolts at the mouth of the Okanogan to adult returning to Wells Dam

- **Biological Target**: Equal to or higher than current survival rate

5.2.6   Habitat

Overall habitat conditions for Chinook salmon are expected to improve as a result of on-going restoration and protection activities. Section 4.6 identifies status and trend monitoring associated with habitat programs.

5.3   IN-SEASON MANAGEMENT TOWARD BIOLOGICAL TARGETS (ISMP STEP 4)

This information will be obtained during the season to implement the Decision Rules and achieve the biological targets identified by those rules, adjusted based on recent history (e.g., recent PNI, pHOS and spawner abundance). Two types of information will be described here: run size information that is used to determine biological targets through the Decision Rules and

those biological targets themselves (i.e., the inputs and outputs of the Decision Rules. The actual outcome of the ISMP is part of the status and trends evaluation (ISMP Step 3). The in-season parameters thus fall into two categories: 1) in-season run size updates and 2) biological targets.

5.3.1   In-Season Run Size Updates (Inputs to Decision Rules)

While there is a relatively strong correlation ($r^2 > 0.75$) between Bonneville and Priest Rapids dam counts in June and the observed natural escapement to the Okanogan River (Figures 6 and 7), the precision of predictions based on dam counts is low. This is due in large part to the imprecise measurement of the "observed" escapement through spawning ground surveys. During the initial transition phase of the hatchery program, until a fully operational weir is in place and adults from an integrated Okanogan program begin to return, the in-season management decisions will have to be based on fish passage counts at Bonneville, Priest Rapids and Wells dams (Figure 8).

During the early transition phase (period 1), the Priest Rapids prediction will be combined with the Bonneville counts to obtain an initial run size update in the first week of July[18]. The next update would occur when the counts at Wells Dam through July 10 become available. These predictive relationships must be revised once the new hatchery programs and the weir are in operation. At that time, a) the ability to estimate the Okanogan return will be more precise (using the weir); b) there will be a stronger separation between hatchery and natural run components; c) all hatchery groups will be marked; and d) subgroups of NORs and HORs will be PIT-tagged. Note also that during the early transition phase, there is intent to allow HORs to spawn naturally as part of the repopulation of previously vacant spawning habitat, thus the pHOS targets during this phase are higher.

An important purpose of the ISMP and APR process is to assure that methods for pre-and post-season estimation of run size are improved from year to year. Substantial improvements in precision and accuracy of these estimates are expected as data becomes available from the monitoring program described in Section 4 above. In fact, Section 4 of this report may be substantially re-written as sampling methods are refined during the three to five years following implementation of the plan.

Variables to input to the Decision Rules are:

NOR Terminal Run Size (TermNR)

- **Definition:** Number of Okanogan NORs returning to Wells Dam

- **Critical Value**: 1,100 adults. For NOR run sizes less than 1,000 fish, only the on-station release program will collect broodstock. The Okanogan integrated program will be suspended and fisheries will be limited to minimize NOR mortality. The estimate of NOR run size is the most critical information in the ISMP. Overestimates of NOR will result in

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[18] Information from the Zone 6 fishery will also be used to determine the ratio of NOR to HOR summer/fall Chinook.

failure to meet biological targets. In a sense, the "default value" for the NOR run size is less than 1,000. There should be a 90% certainty that the actual run size is no less than 90% of the estimated run size. Until better variance estimates are available, the critical values for the point estimates of NOR will be increased by 10%, (i.e., to 1,100 adults). Assuming no bias in the run size estimate, this implies a 50% certainty that the run is greater than 1,100.

Segregated HOR Terminal Run Size (TermSHR)

- **Definition**: Number of Chief Joseph Hatchery HORs returning to Wells Dam

- **Critical Value**: 10,000 adults. For CJH, HOR run sizes greater than 10,000 and NOR run sizes less than 1,000, there is a risk that the pHOS for segregated HORs will exceed 5% even with an effective weir and selective fishery.

Integrated HOR Terminal Run Size (TermIHR)

- **Definition**: Number of HORs from the Okanogan integrated program returning to Wells Dam.

- **Critical Value:** 10,000 adults. When the Okanogan integrated HOR return exceeds 10,000 and the NOR run is less than 1,000, there is a risk that pHOS for integrated HORs will exceed 30% even with an effective weir and selective fishery.
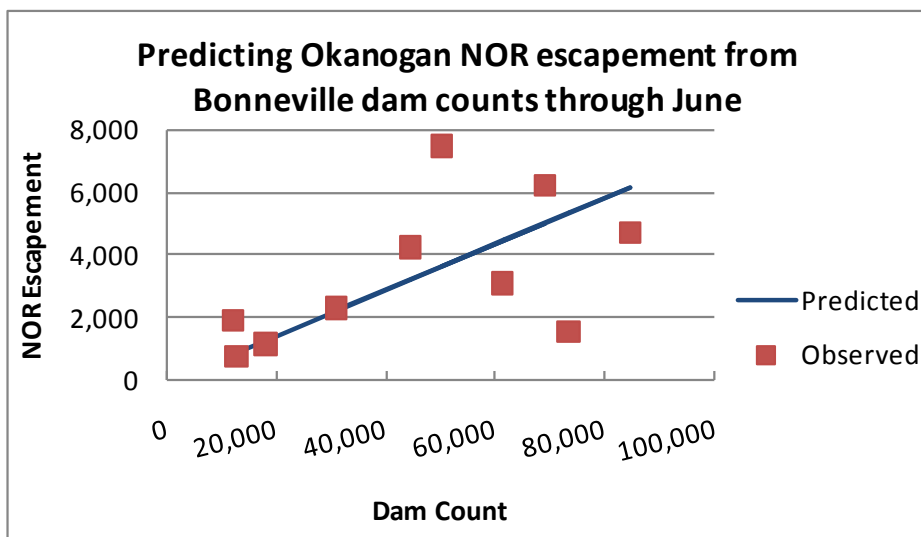
Figure 6.   Observed Okanogan NOR spawning escapement plotted against Chinook counts between June 1 and June 30 at Bonneville Dam for the 10-year period ending 2007. The predicted line is the regression through the origin.
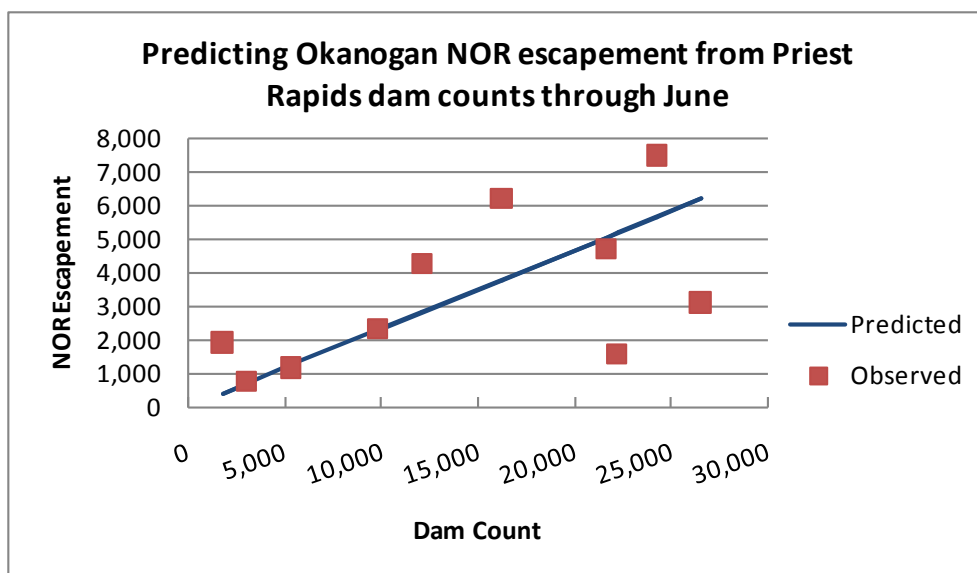
Figure 7.   Observed Okanogan NOR spawning escapement plotted against Chinook counts between June 14 and June 30 at Priest Rapids Dam for the 10-year period ending 2007. The predicted line is the regression through the origin.
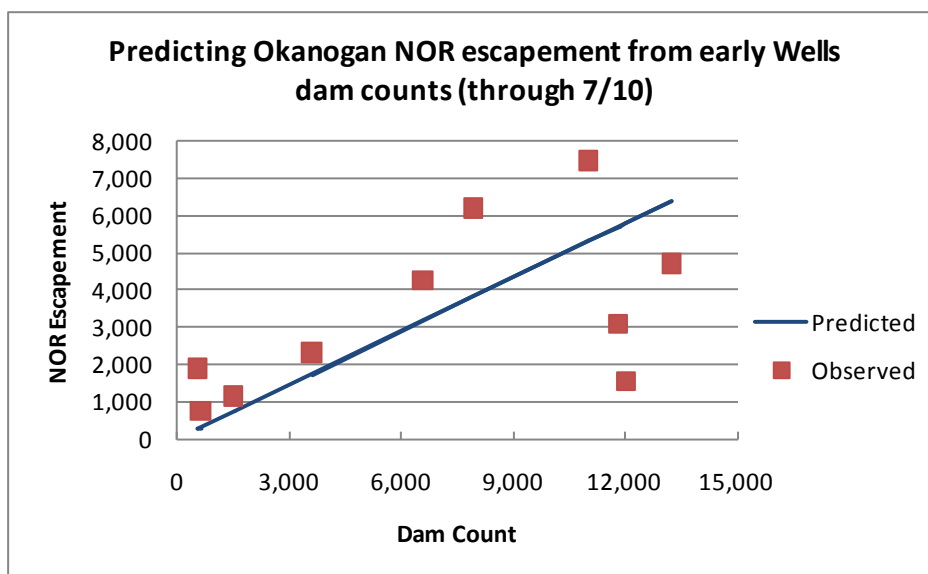
Figure 8.   Observed Okanogan NOR spawning escapement plotted against early (through July 10) Chinook counts at Wells Dam for the 10-year period ending 2007. The predicted line is the regression through the origin.

5.3.2   Biological Targets (Outputs from Decision Rules)

The biological targets are calculated each season from the key assumptions and the most recent run size updates. These calculations are intended to assure that hatchery programs, fisheries, and weirs are operated to meet the conservation goals of a sustainable, locally adapted natural population in the Okanogan River. The calculations are incorporated in the "electronic" decision tree, which is part of the ISMP spreadsheet application.

Variables derived from the Decision Rules include:

Escapement Target (EscTarg)

- **Definition**: Number of fish of all origins targeted to pass upstream of the Okanogan weir [this season]

pHOS Target

- **Definition:** Target proportion of HORs in escapement [this season]

Broodstock for Integrated Program

- **Definition**: Target number of spawners for the integrated (Okanogan) program [this season]

pNOB for Integrated Program

- **Definition**: Target proportion of NORs in Okanogan broodstock [this season]

Broodstock for Segregated Program

- **Definition:** Target number of spawners for the segregated (Chief Joseph on-station) program [this season]

Weir Mortality (WeirMort)

- **Definition:** Max NOR mortality due to weir

5.4   CRITICAL PARAMETER ESTIMATION AND HYPOTHESIS TESTING

The central, working hypothesis for the Okanogan summer/fall Chinook program can be captured in three fundamental assumptions:

A. Under prevailing habitat and out-of-subbasin survival conditions and current hatchery and pre-terminal harvest regimes, the Okanogan summer/fall Chinook population can sustain a natural spawning escapement greater than 800 adults.

B. The productivity of the natural population can be significantly increased (by as much as 80%) by reducing the influence of hatchery fish on the spawning grounds as prescribed by the HSRG guidelines for "primary" populations (HSRG 2004).

C. The abundance and composition of the natural spawning escapement and hatchery broodstock can be managed in the terminal areas to meet HSRG guidelines for hatchery influence on a "primary" population.

A primary purpose of the M&E plan described in the preceding sections is to test this central hypothesis. This purpose must remain in focus as this M&E plan is implemented. In this section we discuss the metrics that can help discriminate between this hypothesis and the alternative, which says that at least one of assumptions A, B, or C is false.

The VSP parameters are the metrics that most directly relate to assumptions A and B, in particular, the productivity and capacity parameters. Typically, these parameters are estimated by fitting recruit per spawner data to the Beverton-Holt survival function. Due to high survival variability and poor precision in the estimation of both recruitment and spawning escapement, it usually takes many years (decades) to detect significant changes in the B-H parameters. Because of more extensive marking and tagging programs and improved sampling, particularly at the new weir in the lower reach of the Okanogan, the precision and accuracy of spawner recruit information should be greatly improved in the future. More extensive marking may also make it possible to explain and correct for variation in annual survival.

The precision in the estimation of natural spawning escapement is most critical. The goal is to achieve a CV of 5% or better for the estimates of natural spawner abundance by age class. This can be achieved if the efficiency of the weir meets its target of 95%. Using standard run reconstruction methods (tools for these calculations will be prepared for the APR process) recruitment can then be estimated.

The rationale for assumption A is as follows: The habitat-based estimate of the Beverton-Holt parameters of productivity and capacity are 7.5 and 12,500 respectively (derived from the EDT analysis conducted for the Okanogan Subbasin Plan) before harvest. The total exploitation rate is currently about 60%. A 50% fitness loss due to hatchery influence is estimated from the AHA analysis. This results in adjusted productivity and capacity estimates of 1.5 and 2,500 respectively, which in turn implies that the Beverton-Holt survival (from escapement to escapement) is greater than 1 when escapement is less than 833. Observed spawner-recruit data, at least, do not contradict these assumptions (see Figure 9 and Appendix 1).

A metric that can help discriminate between the working hypothesis and its alternate is the recruit per spawner ratio (R/S) for escapement less than 800. First of all, escapements below 800 should be rare under the working hypothesis and secondly, when they occur, R/S should be greater than one. Consequently, the assumptions A and B will be challenged each year in the APR by updated R/S information and the relevant key assumptions adjusted accordingly.

It is worth noting also that in addition to estimating productivity and capacity from spawning to spawning, juvenile abundance estimates will be used to test the corresponding assumptions

about productivity and capacity from spawning to out migration. This has the advantage that it eliminates the variability in smolt-to-adult survival, but it is also not a complete measure of population productivity—fish that survive well to the smolt stage may not survive well from smolt to adult. Furthermore, the estimates of juvenile abundance will have a significantly higher CV (15% is an optimistic target). Nevertheless, juvenile production can be informative and will be incorporated in the APR.

Assumption C, management precision, depends upon the accuracy and precision of preseason forecasts and in-season updates of run size, and on the effectiveness of the weir.

Run-size forecasts and updates determine the biological targets for the coming season, through the Decision Rules, and specify how fisheries and weirs should be operated to meet these targets. The preseason forecast is based on brood year escapement and juvenile survival indicators. As the season nears, this information is supplemented with return data from downstream dam counts (see Figures 6 through 8). Adjustment based on these dam counts will become more informative in the future as close to 100% of hatchery fish will be marked and the relationship described in Figures 6 through 8 will be based on natural returns primarily, which should improve the precision of these projections considerably. These preseason forecasts will be further refined by mark ratios in Zone 6 fisheries early live capture sampling in the terminal area fisheries. The major concern is overestimation of the NOR component of the run; however, this risk is mitigated by the fact that all fisheries, during the transition period, will release all natural-origin fish encountered. The final adjustment in spawner abundance, composition and broodstock collection will occur at the weir. Consequently, in the end, the critical assumption is the efficiency of the weir, including the capture rate and the induced mortality. In the M&E plan described above, considerable effort will be devoted to testing the assumptions that 95% of all fish entering the Okanogan weir site will be captured and that the mortality on NORs will be less than 6%. The 6% induced mortality applies to the fisheries and weir combined.

In conclusion, when fully funded and implemented, this M&E plan will collect the data needed to effectively challenge the central hypothesis of the program.
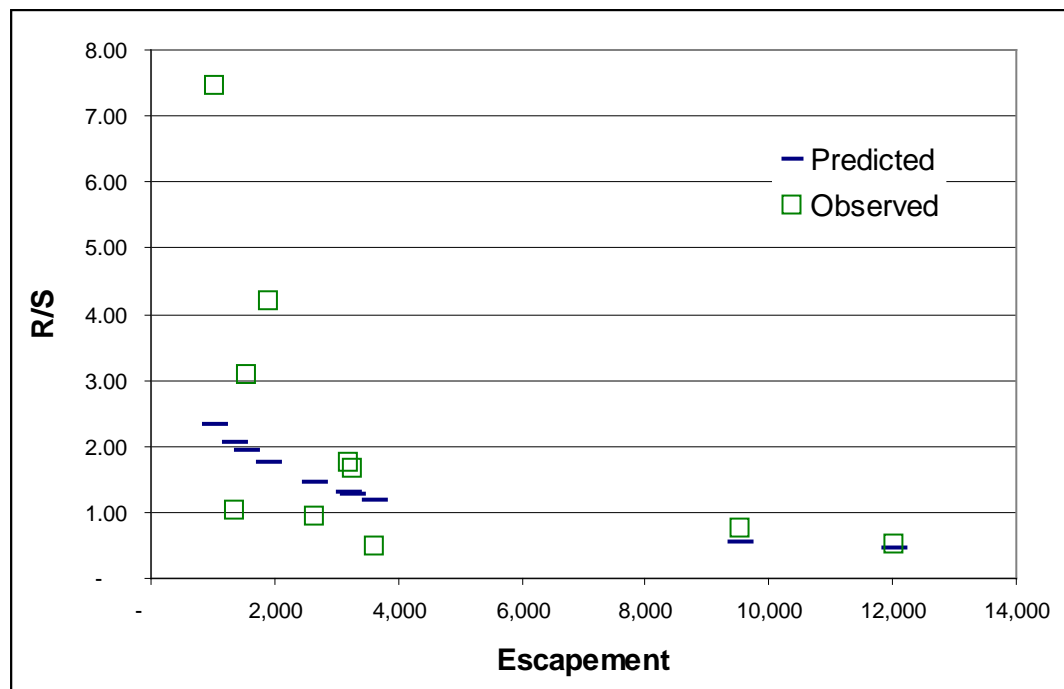
Figure 9.   **Comparison of observed recruits per spawner ratios with those predicted from a habitat based Beverton-Holt model**

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Appendix 1

ISRP Comments and Colville Tribes' Response

- 3/11/09 Response of Colville
  Tribes' to ISRP Comments

- 3/11/09 Decision Tree

- 4/17/09 ISRP Comments

RESPONSE OF COLVILLE TRIBES' TO ISRP COMMENTS

Colville Confederated Tribes
Fish and Wildlife Department
P.O. Box 150
Nespelem, WA 99155
Phone: 509-634-2110 / Fax: 509-634-2126

March 11 2009

Mr. Tony Grover, Director
Fish and Wildlife Division
Northwest Power and Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204

Dear Tony,

The Colville Tribes appreciated meeting with the Independent Scientific Review Panel (ISRP) and your staff on March 2, 2009, regarding the Chief Joseph Hatchery Program (Program) and management of Okanogan River summer/fall Chinook. I believe the meeting was successful in relating the latest refinements in the Program based on the ISRP's earlier comments and recommendations for hatchery reform recently arising from the Hatchery Scientific Review Group (HSRG). We appreciated the ISRP's additional comments and suggestions during the meeting. I trust the attached comments provide the ISRP and your staff with the information needed to conclude the project review.

The Colville Tribes realize the Step 2 review has been lengthy, but necessary. We believe the recommendations of the ISRP to create a Biological Rule Set to clarify and refine Program design and a Decision Tree to direct Program implementation and adaptation have been major advancements not only for our proposed Program, but more broadly for Columbia River fisheries management. These advancements coupled with the hatchery and harvest reform recommendations of the HSRG has required considerable work to fully integrate and reflect in the Program. I believe our development of an automated Decision Tree fully responds to the ISRP and HSRG recommendations. This management tool will provide transparent support and documentation for annual Program operational decisions integrating artificial propagation, natural production and harvest. Our Decision Tree will similarly support and document our longer-term Program adaptations to achieve the conservation rules and maximize harvest opportunity.

Our extensive analyses during Step 2 confirm that implementation of the revised Program will both improve the viability and sustainability of the Okanogan summer/fall Chinook while providing substantial ceremonial and subsistence harvest for the Colville Tribes. Harvest benefits for pre-terminal sport, tribal and commercial fisheries will also be substantial. Extensive sensitivity analysis and identification of contingency actions has demonstrated that the Chief Joseph Hatchery Program is very robust relative to significant annual variations in key life history and human parameters, and design assumptions. We will complete a final monitoring
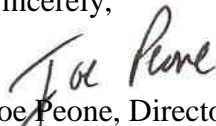
and evaluation plan and HGMPs during Step 3 that will ensure collection of the information needed to support and adapt the Program. Monitoring and evaluation funding is assured in our Columbia Basin Fish Accord.

We believe our Program is now based on the best available scientific information, applies state-of-the-art analytical tools and reflects the scientific principles and standards as articulated by the Council's Program and HSRG. While there will always be some level of uncertainty in the underlying Program assumptions, we have fully accounted for these uncertainties in a robust Program design and the Tribes' management commitment to sound principles of conservation science. That said, uncertainty alone should not hinder the construction of Chief Joseph Hatchery and the Colville Tribes from finally achieving the fishery resources and harvest that we were guaranteed over a century ago.

Based on productive interactions, I believe the attached information addresses the remaining four ISRP issues as identified in their January 21, 2009 memo to you. At this point, we look forward to the ISRP's Step 2 review and subsequent consideration of the Chief Joseph Hatchery Program before the Council.

In Step 3, the Colville Tribes intend to reflect our recent Program refinements and the ISRP review in a 'living' planning document, the content and format of which we will want to discuss with you and other regional entities (particularly NOAA Fisheries) to ensure it meets all ongoing planning, regulatory and review requirements. I look forward to completing the Step 2 review and discussing the Chief Joseph Hatchery Program before the Council.

Sincerely,

Joe Peone, Director
Fish and Wildlife Department
Colville Confederated Tribes

Attachment

Cc:
Mark Fritsch, Erik Merrill – NPCC
ISRP members

Bcc:
Jerry Marco, Keith Kutchins, John Arterburn – CCT
Lars Mobrand, Kevin Malone, Stephen Smith

Colville Tribes' Response
For the Independent Scientific Review Panel's Step 2 Review
of the Chief Joseph Hatchery Program

The information presented in this paper responds to the January 21, 2009 request of the Independent Scientific Review Panel (ISRP) for supplemental information on the Chief Joseph Hatchery Program (Program). This document also summarizes data and analysis presented to the ISRP by the Colville Tribes on March 2, 2009.

The paper begins with a brief summary of the key changes that have been made to the Program based on ISRP review and the recent recommendations of the Hatchery Scientific Review Group. The paper finishes by responding to the four outstanding issues identified by the ISRP in its latest request. These issues were as follows:

1. (ISRP Issue 1)- A specific time-frame process (i.e., decision tree) that outlines the expected range of the production scenarios.
2. (ISRP Issue 2)- Additional discussion of the proposal as it relates to alternative forms of mitigation.
3. (ISRP Issue 5)- Provision of basic information regarding the in-basin and out-of basin assumptions concerning survival.
4. (ISRP Issue 6)- Specifics on methods, designs (including controls), and hypothesis need to be incorporated in the monitoring plan.

Key Program Changes

The Colville Tribes would like to thank the ISRP for their detailed comments on the Master Plan and Hatchery and Genetic Management Plans. These comments have led us to revisit identified issues and highlight the changes we believe make the Program more scientifically justifiable. The key changes made to the program based on ISRP review are presented below.

Development of a Decision Tree
The ISRP requested that the Decision Tree for the hatchery and harvest Program be more clearly presented. At the March 2nd meeting the Colville Tribes presented an EXCEL-based program that demonstrates how the Program would be operated in-season based on Key Assumptions and a Biological Rule Set. The Decision Tree clearly shows that Program size (e.g. number of juvenile fish released) is dependent on achieving low proportion of hatchery-origin spawners (pHOS), high proportionate natural influence (PNI) parameters for a primary population, as well as minimum spawning ground escapement for natural-origin recruits (NOR) adults. If the parameter performance values cannot be achieved, Program size decreases. The size of the Program is therefore "self-correcting" to the status of the natural primary population based on estimates of PNI and pHOS.

The Program will be implemented in 3-Phases: Current Facilities, Transition, and Long-term Program. Initially, the Program will focus on actions that emphasize Conservation and as

objectives are achieved, transition to a program focused on harvest, but consistent with conservation rules.

The web link to HSRG papers concerning hatchery and harvest reform is: www.hatcheryreform.us

Reduction in Risk to the Natural Population
The ISRP is concerned about Program risks to natural population productivity and abundance. First, it must be emphasized that changing the current Similkameen program, which uses non-local broodstock, to an Integrated program using local broodstock is expected to increase Okanogan population fitness. Thus, benefits to natural fish will accrue relatively short-term. To further reduce risks to natural fish, the following clarifications or changes have been made to the Program:

1. PNI must exceed 0.67 on a 5-year rolling average.
2. For expected average run-size of hatchery-origin recruits (HOR) and NOR adults, resulting PNI values will be higher than 0.67 (generally > 0.80 for all Phases except the initial 2-year period).
3. The live-capture harvest efficiency value used for initial planning has been decreased from the target value of 95% to 50% in phase 1 and 90% during the transition period. Program size could therefore be smaller in the transition period until monitoring and evaluation confirms the efficacy of the live-capture gear and accuracy/precision of resulting estimates of PNI and pHOS.
4. Given that the obtainment of a 95% harvest rate is theoretical at this point in time, and may be difficult to obtain, the Colville Tribes are designing a weir to be located in the lower Okanogan River. The weir will be built for harvest, management of pHOS, broodstock collection and M&E. The weir would demark the boundary between the Okanogan River primary population and the mainstem stabilizing population[19].
5. The Conservation component of the program is eliminated when the 5-year rolling average of natural-origin spawners is 5,000 or greater; this represents a near doubling of current natural-origin escapement levels.
6. Program size decreases as NOR run size falls below 1,400 adults. Hatchery releases into the Okanogan are eliminated at NOR run-size of 800 or less.
7. The Chief Joseph Hatchery on-station release will use HORs from the Okanogan program as broodstock. Because they will be similar genetically to wild Okanogan Chinook, fish straying from this Columbia River program to the Okanogan will have less of an impact on fitness. The HSRG refers to this type of program as a stepping stone.
8. Running the Chief Joseph Hatchery on-station release as a segregated stepping stone program (with brood drawn from Okanogan hatchery-origin returns) will reduce the number of NOR adults needed for Program broodstock.

Elimination of the Okanogan River Component at small NOR Adult Run Size
The ISRP concluded that abandoning thresholds for PNI, pHOS, proportion of natural-origin fish in the hatchery broodstock (pNOB), and the proportion of natural fish collected for broodstock to maintain hatchery production from the Similkameen program at low run sizes was not consistent

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[19] The mainstem Columbia River from Wells Dam to Chief Joseph Dam will be considered a stabilizing population as it impossible to estimate pHOS because of river size (especially depth).

with best practices of the Council's Fish and Wildlife Program. We agree that maintaining the full Similkameen program at small natural-origin run sizes is inconsistent with conservation principles. Therefore, the Program now includes elimination of all hatchery releases to the Okanogan River when summer/fall Chinook adult NOR escapement over Wells Dam is 800 or less[20]. Additionally, the Program release number would be reduced as NOR run size at Wells Dam falls below 1,400 adults. Sub-yearling hatchery releases would be the first eliminated to reduce competition with natural-origin sub-yearling juveniles and to achieve the greatest benefit from available NOR broodstock. Hatchery-origin yearlings are released prior (early May) to the majority of natural sub-yearlings migrating from the system (mid-May to July) thereby reducing competition.

Response to Four Issues Identified by the ISRP

ISRP Step One Issue 1. A specific time-frame process (i.e. decision tree) that outlines the expected production scenarios.

Colville Tribes' Response
The Chief Joseph Hatchery Program will move in Phases from the current segregated hatchery program through a transition, where conservation is a major purpose, to a long-term program, where the purpose of the hatchery is to contribute to harvest goals, consistent with conservation rules. The components of the decision framework, for the initial phase of the project are illustrated in Table 1.

Table 1	**Key Assumptions**	
In-Hatchery Survival	Pre-spawning Mortality	10%
	Eggs per Female	5,000
	% Females	50%
	Egg to Smolt-subyearlings	74%
	Egg to Smolt-yearlings	66%
	Natural Productivity (Hi/Lo)	**Low**
	Rel. HOR Reprod. Success	0.80
Fate of Returning Adults	Max HOR Removal Rate	**50%**
	Induced Mort on NORs	6%
	% to Hatchery - Okan.	30%
	% to Hatchery - CJH	80%
	CJH Stray Rate into Okan.	20%

The key in-hatchery survival assumptions (Table 1) imply that 1,485 yearling smolts are produced per spawner. This estimate is updated annually by hatchery staff and used to determine the number of spawners needed to meet the yearling release target. The natural productivity assessment (Low = 3.75 recruits/spawner) is based on a habitat based estimate of 7.5 recruits/spawner (from EDT)[21] and a fitness loss due to hatchery influence of 50% (from All-H Analyzer fitness calculations).

Natural productivity estimates will be updated annually as new spawner-recruitment data becomes available. Current estimates of productivity are supported by spawner survey information from 1993-2007 (See issue 3 below). The "Max HOR Removal Rate" is another

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[20] The Similkameen program is mitigation for mainstem PUD dam losses. The Colville Tribes will work with the WDFW and the PUD's to alter the program to reflect these assumptions.
[21] EDT data does not account for fitness loss due to hatchery impacts. EDT provides a measure of habitat potential to support summer/fall production.

critical assumption. For the first phase of the project it is set at 50% assuming that terminal fisheries can harvest half of the returning hatchery-origin adults.

Key assumptions will be re-evaluated and updated during the transition period. These assumptions directly affect the "Rule Set" used to guide in-season management decisions (Table 2).

Table 2	Decision/Control Parameters ("Rule Set")	
	Threshold NOR Escapement	800
	Max % of NOR used for Broodstock	30%
Okan. Release	Max Number Yearlings	576,000
	Max Number Sub-yearlings	-
	pNOB when NOR is small	**100%**
	pNOB Trigger (NOR run)	**2,500**
	pNOB when NOR is large	**100%**
CJH On-Station	Max Number Yearlings	-
	Max Number Sub-yearlings	-
	Backfill w/ HORs (y,n)	n
	Harvest Rate on CJH HORs	0.50

Based on the key assumptions and the requirement to achieve a PNI > 0.67 during the initial phase of the project, the Rule Set for the initial phase requires that a minimum of 800 NORs must be assured for natural spawning in the Okanogan before hatchery broodstock can be collected. Also no more than 30% of the NORs returning to Wells may be used for hatchery brood. During this preconstruction phase, the maximum hatchery release will be 576,000 yearling smolts. Because of the low natural productivity and low removal rate of HORs, the percent natural origin fish in the hatchery brood (pNOB) must be set at 100% to achieve a PNI > 0.67 even in years with relatively low NOR abundance.

Table 3	In-Season Update (Triggers)
NOR Return to Wells	2,500
Okan. HOR Return to Wells	2,500
CJH HOR Return to Wells	-
Management Response	
Harvest Rate on Okan HORs	0.50
Natural Origin Brood (NOB)	388
Realized pNOB-Okan	100%
Hatch. Origin Brood (HOB) -Okan	0
Hatch. Origin Brood (HOB) -CJH	-
Smolt Release-Okanogan	576,000
Smolt Release-CJH	-
Expected Outcome	
Terminal Catch of HORs	1,250

Est. Natural Smolts	713,530
%Natural Smolts	55%
Nat. Origin Spawners (NOS)	1,962
Hat. Origin Spawners	1,250
Total Number of Spawners	3,212
pHOS	**34%**
PNI	**0.75**

Table 3 illustrates how the Rule Set in Table 2 applies, when the observed run sizes returning to Wells Dam are 2,500 NORs and 2,500 HORs. The rules, combined with this run size, elicit the management responses indicated in the table. For example, 388 NORs would be collected for broodstock and 576,000 yearlings would be released. The target harvest of HORs would be 50% of 2,500 or 1,250 hatchery adults.

The calculated expected outcome from this management scenario would be as shown at the bottom of Table 3.

Table 4 (Phase 1) illustrates management results for a range of different run sizes. The white cells in Table 4 near the center represent average conditions as presented in Table 3.

Table 4. Current facilities (Similkameen) (Phase 1).

Table 4	PNI					
	Return of Okanogan HORs					
	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800		-	-	-		
1,000	75%	64%	58%	57%	56%	56%
1,100	75%	64%	58%	57%	56%	56%
1,400	77%	66%	59%	58%	57%	56%
1,600	79%	68%	61%	59%	58%	57%
1,800	81%	70%	62%	61%	59%	58%
2,500	86%	75%	66%	65%	63%	62%
3,500	89%	80%	71%	69%	67%	66%
5,000	92%	84%	76%	74%	72%	70%
6,000	93%	86%	78%	76%	74%	73%
8,000	95%	89%	82%	80%	78%	76%
10,000	96%	91%	85%	83%	81%	79%

(Okanogan NOR Return — row labels)

	Smolt Release					
	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800	-	-	-	-	-	-
1,000	207,921	207,921	207,921	207,921	207,921	207,921
1,100	347,525	347,525	347,525	347,525	347,525	347,525
1,400	576,000	576,000	576,000	576,000	576,000	576,000
1,600	576,000	576,000	576,000	576,000	576,000	576,000

(Okanogan NOR Return — row labels)

1,800	576,000	576,000	576,000	576,000	576,000	576,000
2,500	576,000	576,000	576,000	576,000	576,000	576,000
3,500	576,000	576,000	576,000	576,000	576,000	576,000
5,000	576,000	576,000	576,000	576,000	576,000	576,000
6,000	576,000	576,000	576,000	576,000	576,000	576,000
8,000	576,000	576,000	576,000	576,000	576,000	576,000
10,000	576,000	576,000	576,000	576,000	576,000	576,000

Tables 1-4 are taken from a spreadsheet (provided via March 11th e-mail) that captures all assumptions, the Rule Set, and calculates management responses and expected outcomes for any combination of NOR and HOR run size at Wells Dam. Separate spreadsheets are used for each phase (two for the transition phase) of the Program (see Appendices A-D). The key assumptions and decision/control variables for each phase is shown in Table 5. A main difference among the phases is the assumed ability to effectively harvest HOR adults; we assume this will increase over time (with the planned weir, this assumption becomes more certain). Additionally, the proportion of NOR used as broodstock (pNOB) decreases over time to reduce impacts to the natural population; yet, the PNI rule of >0.67 is maintained.

Table 5. Key Okanogan Program Assumptions and Decision/Control Variables by Phase

		2009-2011	Transition		Long-term
			2012-2016	2017-2024	

Key Assumptions

			Conservation	Conservation Harvest	Conservation Harvest	Harvest Consistent With Conservation
	Hatchery Program Purpose		Conservation	Conservation Harvest	Conservation Harvest	Harvest Consistent With Conservation
In-Hatchery Survival	Pre-spawning Mortality		10%	10%	10%	10%
	Eggs per Female		5,000	5,000	5,000	5,000
	% Females		50%	50%	50%	50%
	Egg to Smolt-sub-yearlings		74%	74%	74%	74%
	Egg to Smolt-yearlings		66%	66%	66%	66%
	Natural Productivity (R/S) (Hi/Lo)		**Lo**	**Lo**	**Lo**	**Hi**
	Rel. HOR Reprod. Success		0.80	0.80	0.80	0.80
Fate of Returning Adults	Max HOR Removal Rate		**50%**	**90%**	**90%**	**95%**
	Induced Mort on NORs		6%	6%	6%	6%
	% to Hatchery - Okan.		30%	30%	30%	30%
	% to Hatchery - CJH		80%	80%	80%	80%
	CJH Stray Rate into Okan.		20%	20%	20%	20%

Decision/Control Parameters ("Rule Set")

	Min NOR Escapement	800	800	800	800
	Max % of NOR used for Broodstock	30%	30%	30%	30%
Okan. Release	Max Number Yearlings	576,000	1,376,000	1,450,000*	1,450,000*
	Max Number Sub-yearlings		300,000		
	pNOB when NOR is small	**100%**	**75%**	**50%**	**50%**
	pNOB Trigger (NOR run)	**2,500**	**2,500**	**5,000**	**2,500**
	pNOB when NOR is large	**100%**	**50%**	**30%**	**30%**
CJH On-Station	Max Number Yearlings	-	500,000	600,000	600,000
	Max Number Sub-yearlings	-	400,000		
	Backfill w/ HORs (y,n)	**n**	**n**	**n**	**n**
	Harvest Rate on CJH HORs	**0.50**	**0.80**	**0.80**	**0.90**

*- During these phases it is assumed that sub-yearling releases have been terminated and production shifted to yearlings.

Of interest to the ISRP is that hatchery production decreases as NOR run size over Wells Dam decreases and is totally eliminated at NOR runs of 800 adults or less (Figure 1). This same approach is used for all phases of the Program.
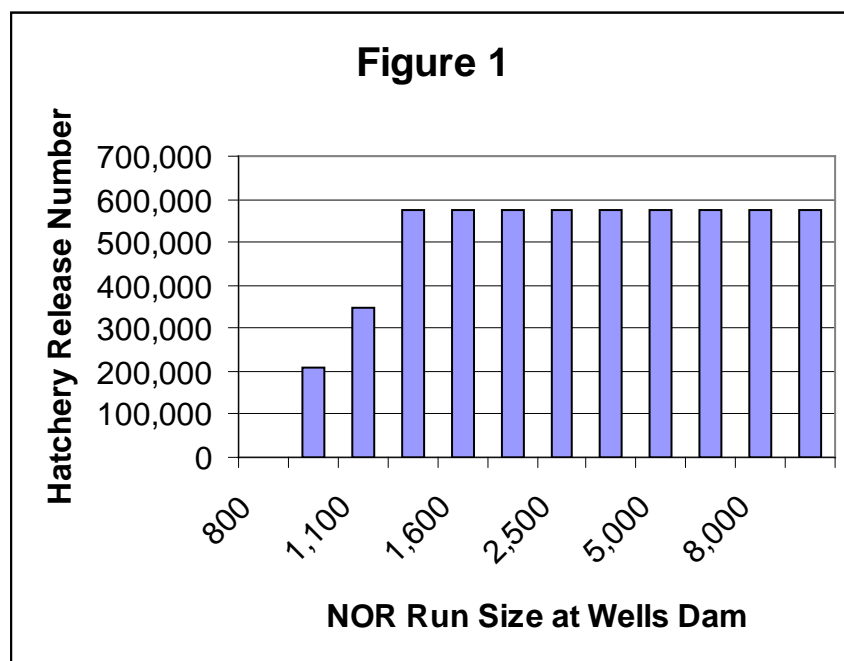
Figure-1. Total hatchery production versus NOR run size at Wells Dam (Current Facilities)

In-season indicators, management responses and expected outcomes by phase are shown in Table 6. Over time, the program:
1. Increases natural-origin adults as measured at Wells Dam from 2,900 to 6,200.
2. Increases terminal harvest from 1,600 to ~7,600.
3. Reduces the proportion of hatchery fish on the spawning grounds (pHOS) from 35% to 5%.
4. Increases population fitness (long-tem) by maintaining a high PNI of about 0.86.

The key assumptions for each phase of the program are presented by phase below.

Table 6. Average In-Season Indicators, Management Responses, and Expected Outcomes. (See Appendix A-D for management responses and expected outcomes at different run sizes.)

	2009-2011	Transition		Long-term
		2012-2016	2017-2024	
In-Season Indicators				
NOR Return to Wells	2,900	2,900	3,500	6,200
Okan. HOR Return to Wells	3,200	3,500	5,000	6,800
CJH HOR Return to Wells		2,500	2,500	2,500
Management Response				
Terminal Harvest Rate on Okan HORs	0.50	0.58	0.72	0.79
Natural Origin Brood (NOB)	388	552	488	293
Realized pNOB-Okan	100%	50%	50%	30%
Hatch. Origin Brood (HOB) -Okan	0	552	488	684
Hatch. Origin Brood (HOB) -CJH	-	575	404	404
Smolt Release-Okanogan	576,000	1,676,000	1,450,000	1,450,000
Smolt Release-CJH	-	900,000	600,000	600,000
Expected Outcome				
Terminal Catch of HORs	1,600	4,023	5,608	7,622
Est. Natural Smolts	763,364	665,730	734,541	1,559,911
%Natural Smolts	57%	28%	34%	52%
Nat. Origin Spawners (NOS)	2,338	2,174	2,802	5,335
Hat. Origin Spawners	1,600	370	520	350
Total Number of Spawners	3,938	2,544	3,322	5,885
pHOS	**35%**	**12%**	**13%**	**5%**
PNI	**0.74**	**0.81**	**0.79**	**0.86**

Current Hatchery Facilities
From 2009 to 2011 – Phase 1 (Appendix A)

1. Emphasis on Conservation
2. Transition current segregated Similkameen program into integrated program with maximum release of 576,000 yearlings.
3. The PNI and pHOS objectives are 0.67 and 35% respectively. (Note that currently PNI = 0 and pHOS is 47%)
4. Program cannot use more than 30% of NOR returns to Wells Dam for broodstock.
5. Okanogan releases are suspended for NOR run sizes of 800 or less.
6. Hatchery releases are reduced when NOR run size at Wells Dam falls below 1,400
7. Hatchery brood consists of 100% NORs (pNOB = 100%)
8. Assumptions:
   a. Population productivity is Low (i.e. current NOR average abundance potential 2,500)
   b. Minor change in HOR or NOR harvest rates. No selective fisheries.

Transition
From 2012 to 2016 – Phase 2 (Appendix B)

1. Hatchery purpose is Conservation and secondarily Harvest.
2. PNI must exceed 0.67 for the Okanogan component, calculated as a 5-year running average. Failure to achieve the PNI criterion results in a decrease in program size.
3. pHOS for the Okanogan component must be less than 15% calculated as a 5-year running average. Failure to achieve the PNI criterion results in a decrease in program size.
4. Maximum Okanogan River program component release is 1,376,000 yearlings and 300,000 sub-yearlings.
5. Chief Joseph Hatchery program component releases 500,000 yearling and 400,000 sub-yearlings. Conversion to segregated stepping stone program using HOR adults from Okanogan.
6. Beginning in year five of the program, the sub-yearling release will be re-evaluated annually and terminated unless advantages to either fishery contributions or reproductive success is demonstrated that compensates for the expected lower post-release survival relative to yearlings.
7. Program must use less than 30% of NOR returns to Wells Dam for broodstock.
8. Okanogan component releases are suspended for NOR run sizes of 800 or less.
9. Hatchery releases in the Okanogan are reduced when NOR run size past Wells Dam falls below below1,400 (sub-yearling releases are reduced first).
10. Okanogan program component hatchery brood will consist of 75% NORs when NOR run is less than 2,500, otherwise 50% (i.e. pNOB is either 50% or 75%).
11. Assumptions
    a. Population productivity is Low (R/S of 3.75)
    b. Selective harvest in terminal areas can remove 90% of HORs with minimal impact (6%) on NORs.

Transition continued
From 2017 to 2024 or when NOR run size exceeds 5,000 calculated as 5-year rolling average-Phase 2 (Appendix C)

1. Hatchery purpose is Conservation and Harvest.
2. PNI must exceed 0.67 for the Okanogan component, calculated as a 5-year running average. Failure to achieve the criterion results in a decrease in program size.
3. pHOS for the Okanogan component must be less than 15% calculated as a 5-year running average. Failure to achieve the criterion results in a decrease in program size.
4. The Okanogan program component, including the existing Similkameen program will release a maximum of 1.45 million yearlings (300,000 sub-yearlings converted to 75,000 yearlings).
5. The Chief Joseph Hatchery program component will release a maximum of 600,000 yearlings (400,000 sub-yearlings converted to 100,000 yearlings). Continued conversion to segregated stepping stone program.
6. Sub-yearling release will be re-evaluated annually and converted to yearlings unless significant advantages to either fishery contributions or reproductive success is

demonstrated that compensates for the expected lower post-release survival relative to yearlings.

7. Program uses less than 30% of NOR returns to Wells Dam for broodstock.
8. Hatchery brood will consist of 50% NORs when NOR run is less than 5,000, otherwise 30% (i.e. pNOB is either 30% or 50%)
9. Hatchery releases in the Okanogan are reduced when NOR run size past Wells Dam falls below 1,400.
10. Okanogan component releases are suspended for NOR run sizes of 800 or less
11. Assumptions
    a. Population productivity is Low, but improving due to fitness increase.
    b. Selective harvest in terminal areas can remove 90% of HORs with minimal impact (6%) on NORs.

Long-term Hatchery Program
This program begins in 2025 or earlier if average NOR runs greater than 5,000 occur – Phase 3 (Appendix D)

1. The Okanogan program component is now an Integrated Harvest program that is operated consistent with HSRG guidelines for a Primary population to assure compatibility with conservation goals.
2. PNI must exceed 0.67 for the Okanogan component, calculated as a 5-year running average. Failure to achieve the PNI criterion results in a decrease in program size.
3. pHOS for the Okanogan component must be less than 15% calculated as a 5-year running average. Failure to achieve the PNI criterion results in a decrease in program size.
4. The Okanogan program, including existing Similkameen program, will release a maximum of 1.45 million yearlings.
5. The Chief Joseph Hatchery program component will release a maximum of 600,000 yearlings. This program becomes a stepping stone program using only HOR adults from the Okanogan program component as brood stock.
6. Sub-yearling releases terminated as the Conservation program has been eliminated. This action substantially reduces the concern about competition with natural smolts, since (unlike sub-yearlings) yearling smolts are released earlier in the spring and migrate from the subbasin very quickly.
7. For the Okanogan component, hatchery brood will consist of 50% NORs when NOR run is less than 2,500, otherwise 30% (i.e. pNOB is either 30% or 50%).
8. Program can use no more than 30% of NOR returns to Wells Dam for broodstock.
9. Okanogan releases are suspended for NOR run sizes of 800 or less.
10. Hatchery releases in the Okanogan are reduced when NOR run size past Wells Dam falls below 1,400.
11. Assumptions
    a. Population productivity is High (6.9 R/S) (i.e. NOR average abundance potential of 6,200)
    b. HOR harvest rate assumed at 95%; with selective fisheries in terminal area and some pre-terminal fisheries.

ISRP Step One Issue 2. additional discussion of the proposal as it relates to alternative forms of mitigation.

Colville Tribes' Response
Three alternatives to meeting the same or similar conservation and harvest goals were examined. Two involved no hatchery programs and one would convert the proposed integrated program to a single segregated program.

Alternative 1 involves habitat improvements only. Our analysis concluded, that in order to achieve natural abundance and harvest levels similar to those expected from the proposed hatchery program, both population productivity and capacity would have to double. The projected natural spawning escapement for this alternative was 4,900 adults after a terminal harvest of 4,900 fish (i.e. assuming a 50% terminal harvest rate). Although we did not analyze the feasibility of accomplishing this in detail, we conclude that it is most likely not possible within reasonable time and cost, and so this alternative was therefore rejected. This does not mean, however, that habitat improvement actions will not be implemented in the basin. The Colville Tribes are working with local, state and federal agencies to improve habitat conditions in the U.S. portion of the basin, and with Canadian entities to improve habitat in that country.

Alternative 2 attempted to meet the goals by altering harvest management. The only way to return sufficient numbers of fish to meet natural escapement and terminal harvest goals would be to completely eliminate all pre-terminal harvest. This alternative would produce a return of about 10,000 adults, which would split evenly between spawning escapement and harvest. This alternative was also rejected as unrealistic.

Alternative 3 is a hatchery option. A segregated hatchery program releasing about 1.5 million yearling smolts from the Chief Joseph Hatchery would produce harvest levels of 5,000 or more at terminal harvest rates in the mainstem Columbia of 90% or more. Natural escapement of 5,000 spawners might be achieved over time, if hatchery strays could be controlled to maintain pHOS levels below 5%. This alternative might be an option if the integrated program fails. However, this alternative would not allow the Colville Tribes to pursue their C&S harvest in the Okanogan River as reserved by legal right. This would be an unacceptable outcome to the Colville Tribes.

Other alternatives exist that are combinations of habitat, harvest and hatchery measure, however, they tend to involve both greater cost and uncertainty than the proposed plan.

ISRP Step One Issue 5. provision of the basic information regarding the in-basin and out-of-basin assumptions concerning survival.

Colville Tribes' Response
In-basin and out-of-basin survival data are presented in Table 7 below. Productivity and capacity data were developed through EDT modeling of basin habitat. Current conditions productivity and capacity values have been adjusted to account for fitness loss due to the large proportion of hatchery fish spawning with the natural population. The long-term condition represents higher population productivity and capacity as population fitness is improved over time.

Table 7. Comparison of Assumptions and Average Expected Outcomes Between Current and Long-Term Conditions.

		Current Conditions	Long-term Conditions
Assumptions			
Habitat	**Productivity ***	3.75	6.9
	Capacity	9,400	12,000
Out-of-subbasin Survival	**Juv. Passage**	27%	27%
	Marine	2.5%	2.5%
	Adult. Passage	83%	83%
Harvest	**NOR Rate**	58.6%	39.6%
	HOR Rate	58.6%	95.8%
Hatchery	**Release #**	576,000	2,050,000
	pNOB	0%	>30%
	Purpose	Cons. & Harvest	Harvest
Expected Outcomes			
NOR Run past Wells		2,900	6,200
Harvest above Wells		900	8,000
Total Harvest		7,000	27,000
Total Spawning Escapement		4,300	5,885
Fitness Factor		50%	92%
Natural Origin Spawners (NOS)		2,500	5,535
% of Hatchery Origin (pHOS)		47%	5%
PNI		0	0.86

* Productivity (recruits per spawner at low density) corrected for fitness loss

To confirm that model estimates of population performance were reasonable, they were compared to observed data. Spawning escapement data collected in the Okanogan since 1993 are presented in Table 8 below. The data show that natural spawner abundance has averaged approximately 2,600 adults.

Table 8. Okanogan Summer/Fall Chinook spawning escapement 1993-2006.

Okanogan Summer/Fall Chinook Spawning Escapement			
Return Year	Total Spawners	% NORs	Natural Origin Spawners
1993	1,485	60%	891
1994	4,033	47%	1,910
1995	3,002	41%	1,237
1996	1,819	28%	510
1997	2,189	38%	841
1998	1,092	68%	743
1999	3,617	52%	1,896
2000	3,701	31%	1,152
2001	10,857	39%	4,241
2002	13,857	34%	4,700
2003	3,420	46%	1,558
2004	6,780	100%	6,780
2005	8,889	84%	7,476
2006	8,601	72%	6,204
Average	*5,239*		*2,593*

AHA estimates an average annual NOR spawner abundance of 2,535 based on current habitat, harvest and hydro conditions and a 50% fitness loss due to hatchery influence. Based on these data, it is apparent that model estimates of abundance are consistent with data collected in the basin since 1993.

At the March 2nd meeting, there was some discussion as to whether the runs were sustainable. To address this issue, the Beverton-Holt function produced for two different conditions was developed and plotted (Figure 2). The two conditions are as follows:

1. Current population accounting for assumed fitness loss and current harvest levels.
2. Expected future natural production with reduced fitness loss and selective fisheries.

The observed data seemed to indicate that on average 5,200 spawners (of natural and hatchery origin) produced only 2,600 natural returns (Table 8). What this suggests is that the population cannot sustain a run of 5,200 adults, but under the "Colville working hypothesis" the population can sustain a run of about 1,400 adults based on current harvest levels (see Figure 2, arrow #1). Additionally, under current conditions our hypothesis shows that we would expect a return of between 2,000 and 3,000 from an escapement between 5,000 and 6,000 (see Figure 2, arrow #2), which is consistent with the observed data (Table 8).

Natural Production Potential (Beverton-Holt)

Figures and labels in chart:
- Y-axis: Returns (8,000; 7,000; 6,000; 5,000; 4,000; 3,000; 2,000; 1,000; -)
- X-axis: Spawners (0; 1000; 2000; 3000; 4000; 5000; 6000; 7000; 8000)
- Replacement
- Expected Future Natural Production with Reduced Fitness Loss and Selective Harvest
- Current Population with Fitness Loss and Current Harvest
- ① ②
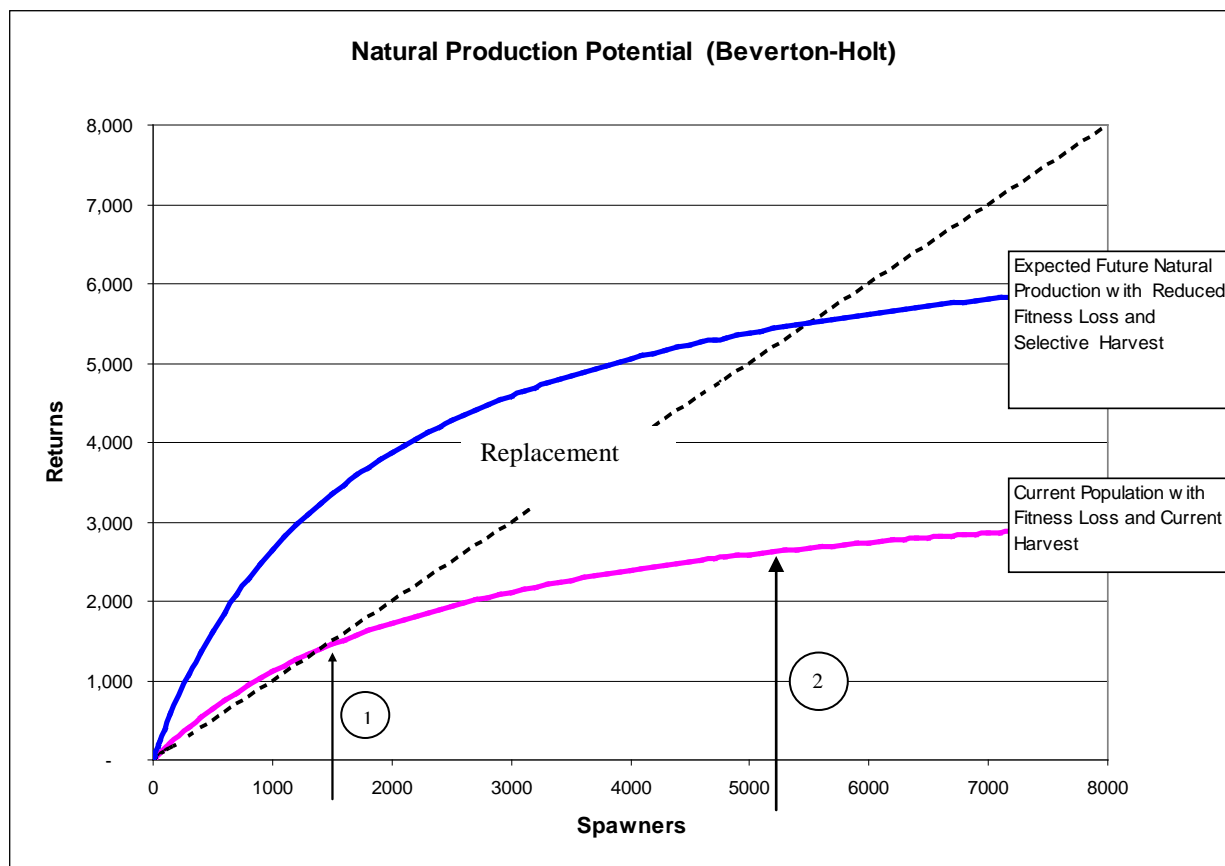
Figure-2. Natural Okanogan Summer/Fall Chinook production potential for the Current population and expected Future population.

The Beverton-Holt for the future condition indicates that substantial population benefits are possible by increasing fitness and reducing NOR harvest through the implementation of selective fisheries, which is the focus of the Program.

In regards to juvenile production estimates, the AHA sub-yearling smolt estimate is 700,000 annually from natural spawning (HOR and NOR) adults. The Peterson population estimate developed for summer/fall Chinook trapping in 2007 (2006 adult return year) was 1.126 million, with a 95% confidence interval range of 0.394 million to 1.858 million[22]. Therefore, it is evident that the AHA model, populated with EDT population productivity and capacity estimates, provides a reasonable estimate of natural summer/fall Chinook adult and juvenile abundance.

ISRP Step One Issue 6. Specifics on the methods, designs (including controls), and hypotheses need to be incorporated in the monitoring and evaluation plan.

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[22] Colville Tribes 2008. 2007 Okanogan Basin Monitoring & Evaluation Program Rotary Screw Trap Report.

Colville Tribes' Response
Monitoring and Evaluation
The monitoring and evaluation (M&E) plan will be updated in Step 3 as agreed to by the Northwest Power and Conservation Council, Bonneville Power Administration and Colville Tribes.

M&E will be used to:

- Determine the effectiveness of in-season broodstock collection and escapement management strategy.
- Monitor NOR and HOR run-size at Wells Dam (as well as other lower Columbia River hydroelectric projects).
- Develop in-season run-size estimates for NORs and HORs.
- Determine the abundance and composition (NOR and HOR) of natural spawning escapement (used to estimate PNI and pHOS)
- Determine spawner distribution and run timing (HOR vs NOR, yearling vs sub-yearling)
- Migration timing, speed and survival of yearling smolts vs sub-yearlings from the basin to Bonneville Dam.
- Develop yearly index estimates of natural juvenile production.
- Estimate fishery contributions of yearling and sub-yearling releases.
- Estimate efficiency of live-capture techniques to remove HOR adults from the spawning grounds.
- Develop estimates of live-capture mortality rates on NOR adults.

Detailed information on M&E methods currently in place in the basin can be found on the web at http://nrd.colvilletribes.com/obmep/Reports.htm.

Hypotheses

The key hypotheses to be tested as part of the Chief Joseph Hatchery Program include:

1. The likelihood that natural population productivity (R/S) is less than 3.5 is less than 5%.
2. Can in-season NOR run size at Wells Dam be determined within 15%?
3. Can live-capture techniques achieve an HOR capture rate of 95% and NOR mortality rate of less than 6%; with 90% certainty?
4. Can sufficient numbers of NOR adults be collected for broodstock to achieve the PNI goal?
5. Can the pHOS and PNI criteria be met with 90% certainty?
6. Will increased spawner abundance in the lower Okanogan River mainstem result in a 30% or greater reduction in fine sediment concentrations in spawning gravel?
7. Will the acclimation and release of hatchery juvenile summer/fall Chinook in the lower Okanogan River increase spawner spatial distribution and/or timing?
8. Will the release of hatchery sub-yearling summer/fall Chinook result in:

  a. Better survival than yearling releases?
  b. Higher contribution to ocean, pre-terminal or terminal fisheries than yearling releases?
  c. Older age at return to the subbasin than yearlings?

Control

 The ISRP commented:

  "absence of an appropriate reference population to serve as a control against which the treatment (i.e., supplementation) could be adequately compared"

There is no adequate control stream present in the Okanogan River. The environmental conditions present in possible candidate streams such as the Methow and Wenatchee are substantially different than those present in the Okanogan River and would therefore be inappropriate. Secondly, such an analysis would require both replicate controls and treatment streams which are not practicable. Third, the use of a control stream outside of the Okanogan is outside of the control of the Colville Tribes. The identification of control or reference streams should be treated as a regional/global issue.

Adult Capture Efficiencies and Program Effectiveness

The Colville Tribes have begun initial testing of the efficiency of live-capture techniques to remove HOR adult while minimizing impacts to wild fish. Initial 2008 data show that the use of beach seines results in a 99% direct survival rate of captured and released wild fish; similarly, use of a purse seine results in 100% direct survival rate of released wild Chinook. Starting in 2009, the study will focus on estimating the percentage of hatchery fish returning to the basin that can be effectively removed using live-capture techniques. In case the proportion of HOR removed is less than that needed to achieve program goals, the Colville Tribes will test other gears, including pound nets (passive traps). The Colville Tribes are also designing a weir to be located in the lower Okanogan River to increase the number of HOR collected and removed. Through its Columbia Basin Fish Accord with BPA, the Colville Tribes are assured $3.85 million in funding over 10 years to develop, test and deploy live-capture fishing gears to achieve the high selective harvest rates required of the Program.

The ISRP also noted:
"The submitted documents do not yet demonstrate that program effectiveness can actually be measured."

The Program is designed to provide adult summer/fall Chinook to satisfy the Colville Tribes fishing rights. The number of Program adults caught in all fisheries will be readily collected on an annual basis from coded-wire tag data and enumeration of adults caught in tribal and sport fisheries. Impacts to wild populations will be determined by annual estimates of PNI and pHOS. The efficiency of live-capture techniques to remove hatchery fish from the spawning grounds, survival rates of wild fish caught by the gear, and proportion of natural-origin fish used as broodstock will also be measured each year. Our ability to accurately measure these parameters is being explored through the live capture study currently in progress.

Because the program must achieve PNI and pHOS objectives, it is self correcting. Failure to achieve either parameter results in a decrease in hatchery production. The two parameters will be estimated by conducting intensive spawning ground surveys in the Okanogan River and, if possible, mainstem Columbia River from Wells Dam to Chief Joseph Dam, as well as enumerating the number of NOR used as broodstock.

Appendix A

Current Facilities: present to 2011

Transition to Integrated Conservation Program
Transition to HSRG standards for Primary population

Table 1.	Key Assumptions	
In-Hatchery Survival	Pre-spawning Mortality	10%
	Eggs per Female	5,000
	% Females	50%
	Egg to Smolt-subyearlings	74%
	Egg to Smolt-yearlings	66%
	Natural Productivity (Hi/Lo)	Lo
	Rel. HOR Reprod. Success	0.80
	Max HOR Terminal Removal Rate	50%
Fate of Returning Adults	Induced Mort on NORs	6%
	% to Hatchery - Okan.	30%
	% to Hatchery - CJH	80%
	CJH Stray Rate into Okan.	20%

Table 2.	Decision/Control Parameters ("Rule Set")	
	Min NOR Escapement	800
	Max % of NOR used for Broodstock	30%
Okan. Release	Max Nmbr Yearlings	576,000
	Max Nmbr Sub-yearlings	
	pNOB when NOR is small	100%
	pNOB Trigger (NOR run)	2,500
	pNOB when NOR is large	100%
CJH On-Station	Max Nmbr Yearlings	-
	Max Nmbr Sub-yearlings	-
	Backfill w/ HORs (y,n)	n
	Harvest Rate on CJH HORs	0.50

INPUT
OUTPUT

Table 4. **PNI**

			Return of Okanogan HORs				
		1,000	3,200	5,000	6,000	7,000	8,000
N O R R e t u r n	600	-	-	-	-	-	-
	800	-	-	-	-	-	-
	1,000	75%	62%	58%	57%	56%	56%
	1,100	75%	62%	58%	57%	56%	56%
	1,400	77%	63%	59%	58%	57%	56%
	1,600	79%	65%	61%	59%	58%	57%
	1,800	81%	67%	62%	61%	59%	58%
	2,900	87%	74%	68%	66%	65%	63%
	3,500	89%	77%	71%	69%	67%	66%
	5,000	92%	81%	76%	74%	72%	70%
	6,000	93%	84%	78%	76%	74%	73%
	8,000	95%	87%	82%	80%	78%	76%
	10,000	96%	89%	85%	83%	81%	79%

Smolt Release-Okanogan

		1,000	3,200	5,000	6,000	7,000	8,000
N O R R e t u r n	600	-	-	-	-	-	-
	800	-	-	-	-	-	-
	1,000	207,921	207,921	207,921	207,921	207,921	207,921
	1,100	347,525	347,525	347,525	347,525	347,525	347,525
	1,400	576,000	576,000	576,000	576,000	576,000	576,000
	1,600	576,000	576,000	576,000	576,000	576,000	576,000
	1,800	576,000	576,000	576,000	576,000	576,000	576,000
	2,900	576,000	576,000	576,000	576,000	576,000	576,000
	3,500	576,000	576,000	576,000	576,000	576,000	576,000
	5,000	576,000	576,000	576,000	576,000	576,000	576,000
	6,000	576,000	576,000	576,000	576,000	576,000	576,000
	8,000	576,000	576,000	576,000	576,000	576,000	576,000
	10,000	576,000	576,000	576,000	576,000	576,000	576,000

Appendix B

Transition: 2012-->2016

Integrated Conservation program
Meets HSRG standards for Primary population

Table 1.	Key Assumptions	
In-Hatchery Survival	Pre-spawning Mortality	10%
	Eggs per Female	5,000
	% Females	50%
	Egg to Smolt-subyearlings	74%
	Egg to Smolt-yearlings	66%
	Natural Productivity (Hi/Lo)	Lo
	Rel. HOR Reprod. Success	0.80
Fate of Returning Adults	Max HOR Removal Rate	90%
	Induced Mort on NORs	6%
	% to Hatchery - Okan.	30%
	% to Hatchery - CJH	80%
	CJH Stray Rate into Okan.	20%

Table 2. Decision/Control Parameters ("Rule Set")		
	Min NOR Escapement	800
	Max % of NOR used for Broodstock	30%
Okan. Release	Max Nmbr Yearlings	1,376,000
	Max Nmbr Sub-yearlings	300,000
	pNOB when NOR is small	75%
	pNOB Trigger (NOR run)	2,500
	pNOB when NOR is large	50%
CJH On-Station	Max Nmbr Yearlings	500,000
	Max Nmbr Sub-yearlings	400,000
	Backfill w/ HORs (y,n)	n
	Harvest Rate on CJH HORs	0.80

INPUT
OUTPUT

Table 4.

PNI

NOR Return	Return of Okanogan HORs					
	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800	-	-	-	-	-	-
1,000	-	-	-	-	-	-
1,100	88%	78%	69%	66%	64%	62%
1,400	89%	79%	70%	68%	66%	64%
1,600	90%	81%	72%	70%	68%	66%
1,800	91%	83%	74%	71%	69%	67%
2,500	91%	82%	73%	70%	67%	65%
3,500	94%	87%	79%	77%	74%	72%
5,000	96%	91%	85%	82%	80%	79%
6,000	96%	92%	87%	85%	83%	81%
8,000	97%	94%	90%	88%	87%	85%
10,000	98%	95%	92%	90%	89%	88%

Smolt Release-Okanogan

NOR Return	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800	-	-	-	-	-	-
1,000	-	-	-	-	-	-
1,100	473,373	473,373	473,373	473,373	473,373	473,373
1,400	849,643	849,643	849,643	849,643	849,643	849,643
1,600	971,021	971,021	971,021	971,021	971,021	971,021
1,800	1,092,398	1,092,398	1,092,398	1,092,398	1,092,398	1,092,398
2,500	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000
3,500	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000
5,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000
6,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000
8,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000
10,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000	1,676,000

Appendix C

Transition-cont'd: 2017--> 2024

Transition from an Integrated Conservation and Harvest program into an Integrated Harvest program

Meets HSRG standards for a Primary Population

Table 1. Key Assumptions

In-Hatchery Survival	Pre-spawning Mortality	10%
	Eggs per Female	5,000
	% Females	50%
	Egg to Smolt-subyearlings	74%
	Egg to Smolt-yearlings	66%
	Natural Productivity (Hi/Lo)	Lo
	Rel. HOR Reprod. Success	0.80
Fate of Returning Adults	Max HOR Removal Rate	90%
	Induced Mort on NORs	6%
	% to Hatchery - Okan.	30%
	% to Hatchery - CJH	80%
	CJH Stray Rate into Okan.	20%

Table 2. Decision/Control Parameters ("Rule Set")

	Min NOR Escapement	800
	Max % of NOR used for Broodstock	30%
Okan. Release	Max Nmbr Yearlings	1,450,000
	Max Nmbr Sub-yearlings	
	pNOB when NOR is small	50%
	pNOB Trigger (NOR run)	5,000
	pNOB when NOR is large	30%
CJH On-Station	Max Nmbr Yearlings	600,000
	Max Nmbr Sub-yearlings	
	Backfill w/ HORs (y,n)	n
	Harvest Rate on CJH HORs	0.80

INPUT
OUTPUT

Table 4.

PNI

	Return of Okanogan HORs					
NOR Return	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800	-	-	-	-	-	-
1,000	82%	70%	59%	57%	54%	53%
1,100	82%	70%	59%	57%	54%	53%
1,400	84%	72%	61%	58%	56%	54%
1,600	85%	74%	63%	61%	58%	56%
1,800	87%	77%	66%	63%	61%	59%
2,500	91%	83%	73%	70%	68%	66%
3,500	94%	87%	79%	77%	75%	72%
5,000	93%	87%	80%	80%	78%	76%
6,000	94%	89%	83%	83%	81%	79%
8,000	96%	91%	86%	86%	85%	83%
10,000	97%	93%	89%	89%	87%	86%

Smolt Release-Okanogan

NOR Return	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800	-	-	-	-	-	-
1,000	415,800	415,800	415,800	415,800	415,800	415,800
1,100	694,980	694,980	694,980	694,980	694,980	694,980
1,400	1,247,400	1,247,400	1,247,400	1,247,400	1,247,400	1,247,400
1,600	1,425,600	1,425,600	1,425,600	1,425,600	1,425,600	1,425,600
1,800	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
2,500	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
3,500	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
5,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
6,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
8,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
10,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000

Appendix D

Long-term harvest program 2025-->

Integrated Harvest program
Meets HSRG standards for a Primary Population

Table 1.	Key Assumptions	
In-Hatchery Survival	Pre-spawning Mortality	10%
	Eggs per Female	5,000
	% Females	50%
	Egg to Smolt-subyearlings	74%
	Egg to Smolt-yearlings	66%
	Natural Productivity (Hi/Lo)	Hi
	Rel. HOR Reprod. Success	0.80
Fate of Returning Adults	Max HOR Removal Rate	95%
	Induced Mort on NORs	6%
	% to Hatchery - Okan.	30%
	% to Hatchery - CJH	80%
	CJH Stray Rate into Okan.	20%

Table 2. Decision/Control Parameters ("Rule Set")		
Min NOR Escapement		800
Max % of NOR used for Broodstock		30%
Okan. Release	Max Nmbr Yearlings	1,450,000
	Max Nmbr Sub-yearlings	
	pNOB when NOR is small	50%
	pNOB Trigger (NOR run)	2,500
	pNOB when NOR is large	30%
CJH On-Station	Max Nmbr Yearlings	600,000
	Max Nmbr Sub-yearlings	
	Backfill w/ HORs (y,n)	n
Harvest Rate on CJH HORs		0.80

INPUT
OUTPUT

Table 4.

PNI

	Return of Okanogan HORs					
NOR Return	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800	-	-	-	-	-	-
1,000	88%	80%	70%	67%	65%	63%
1,100	88%	80%	70%	67%	65%	63%
1,400	89%	81%	72%	69%	67%	65%
1,600	91%	83%	74%	71%	69%	67%
1,800	92%	85%	77%	74%	72%	70%
2,500	92%	85%	76%	73%	70%	68%
3,500	94%	89%	82%	79%	77%	75%
5,000	96%	92%	87%	85%	83%	81%
6,000	97%	93%	89%	87%	85%	84%
8,000	98%	95%	91%	90%	88%	87%
10,000	98%	96%	93%	92%	91%	89%

Smolt Release-Okanogan

NOR Return	1,000	2,500	5,000	6,000	7,000	8,000
600	-	-	-	-	-	-
800	-	-	-	-	-	-
1,000	415,800	415,800	415,800	415,800	415,800	415,800
1,100	694,980	694,980	694,980	694,980	694,980	694,980
1,400	1,247,400	1,247,400	1,247,400	1,247,400	1,247,400	1,247,400
1,600	1,425,600	1,425,600	1,425,600	1,425,600	1,425,600	1,425,600
1,800	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
2,500	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
3,500	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
5,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
6,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
8,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000
10,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000	1,450,000

DECISION TREE

Yellow cells are input parameters, green ones are outputs. The blue cells show the values used in each phase of the hatcheyr program. Key assumptions may change as a result of new information (e.g. from M&E program). Rules sets may need to be adjusted when key assumptions change.
To view outcomes for the different phases, copy the values in the blue cells (columns A-D) into the corresponding yellow cells (columns X).
Select output variables to display from the dropdown menues above the green cells.

	Key Assumptions	X	A	B	C	D
In-Hatchery Survival	Pre-spawning Mortality	10%	10%	10%	10%	10%
	Eggs per Female	5,000	5,000	5,000	5,000	5,000
	% Females	50%	50%	50%	50%	50%
	Egg to Smolt-subyearlings	74%	74%	74%	74%	74%
	Egg to Smolt-yearlings	66%	66%	66%	66%	66%
	Natural Productivity (Hi/Lo)*	Lo	Lo	Lo	Lo	hi
	Rel. HOR Reprod. Success	0.80	0.80	0.80	0.80	0.80
Fate of Returning Adults	Max HOR Removal Rate	50%	50%	90%	90%	95%
	Induced Mort on NORs	6%	6%	6%	6%	6%
	% to Hatchery - Okan.	30%	30%	30%	30%	30%
	% to Hatchery - CJH	80%	80%	80%	80%	80%
	CJH Stray Rate into Okan.	20%	20%	20%	20%	20%

	Decision/Control Parameters ("Rule Set")	X	A	B	C	D
	Min NOR Escapement	800	800	800	800	800
	Max % of NOR used for Broodstock	30%	30%	30%	30%	30%
Okan. Release	Max Nmbr Yearlings	576,000	576,000	1,376,000	1,450,000	1,450,000
	Max Nmbr Sub-yearlings			300,000		
	pNOB when NOR is small	100%	100%	75%	50%	50%
	pNOB Trigger (NOR run)	2,500	2,500	2,500	5,000	2,500
	pNOB when NOR is large	100%	100%	50%	30%	30%
CJH On-Station	Max Nmbr Yearlings	-	-	500,000	600,000	600,000
	Max Nmbr Sub-yearlings	-	-	400,000		
	Backfill w/ HORs (y,n)	n	n	n	n	n
	Harvest Rate on CJH HORs	0.50	0.50	0.80	0.80	0.90
		INPUT	Current -->2011	Transition 2012-1016	Transition 2017-2024	Long-term 2025-->

* Hi = 1,200 smolts/spawner
  Lo = 670 smolts/spawner

PNI
#N/A

		Return of CJH HORs to Wells				2,500
		Return of Okanogan HORs					
		1,000	2,500	5,000	6,000	7,000	8,000
	600	-	-	-	-	-	-
N	800	-	-	-	-	-	-
O	1,000	74%	64%	58%	57%	56%	55%
R	1,100	74%	64%	58%	57%	56%	55%
	1,400	76%	65%	59%	58%	57%	56%
R	1,600	78%	67%	61%	59%	58%	57%
e	1,800	80%	69%	62%	61%	59%	58%
t	2,500	85%	74%	66%	64%	63%	62%
u	3,500	88%	79%	71%	69%	67%	65%
r	5,000	92%	84%	76%	73%	72%	70%
n	6,000	93%	86%	78%	76%	74%	72%
	8,000	95%	89%	82%	80%	78%	76%
	10,000	96%	91%	84%	82%	81%	79%

Smolt Release-Okanogan

		1,000	2,500	5,000	6,000	7,000	8,000
	600	-	-	-	-	-	-
N	800	-	-	-	-	-	-
O	1,000	207,921	207,921	207,921	207,921	207,921	207,921
R	1,100	347,525	347,525	347,525	347,525	347,525	347,525
	1,400	576,000	576,000	576,000	576,000	576,000	576,000
R	1,600	576,000	576,000	576,000	576,000	576,000	576,000
e	1,800	576,000	576,000	576,000	576,000	576,000	576,000
t	2,500	576,000	576,000	576,000	576,000	576,000	576,000
u	3,500	576,000	576,000	576,000	576,000	576,000	576,000
r	5,000	576,000	576,000	576,000	576,000	576,000	576,000
n	6,000	576,000	576,000	576,000	576,000	576,000	576,000
	8,000	576,000	576,000	576,000	576,000	576,000	576,000
	10,000	576,000	576,000	576,000	576,000	576,000	576,000

ISRP COMMENTS

Independent Scientific Review Panel

for the Northwest Power & Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204
www.nwcouncil.org/fw/isrp

Memorandum (ISRP 2009-12)   **April 17, 2009**

To: Tony Gover, Fish and Wildlife Division Director, Northwest Power and Conservation
            Council
From: Eric Loudenslager, ISRP Chair
Subject: Step-Two Review of the Chief Joseph Dam Hatchery Program, Project #2003-023-00

Background

On January 21, 2009, the ISRP requested[23] that the Colville Confederated Tribes provide
additional information and analysis regarding four of six conditions required by the Council
before completing Step Two of the Three-Step Review of the Chief Joseph Dam Hatchery
Master Plan. These were technical issues raised by the ISRP in the 2005 Step-One review that
remained unresolved after initial reviews of Step-Two submissions in March and November of
2008.

The Colville Tribes and consultants met with the ISRP on March 2, 2009 and presented their
response to the comments made by the ISRP on the four unresolved conditions. The Colville
Tribes provided a written explanation March 11, 2009. This memo serves as the ISRP's analysis
of the Colville Tribe's response and our recommendation for project 2003-023-00.

The four unresolved issues were:
1. *A specific time-frame process (decision tree) that outlines the expected range of
   production scenarios;*
2. *Additional discussion of the master plan as it relates to alternative forms of mitigation;*
3. *Providing basic information regarding the in-basin and out-of-basin assumptions
   concerning (salmon) survival; and*
4. *Specifics on methods, designs (including controls), and hypotheses need to be
   incorporated in the monitoring plan.*

The issues raised by the ISRP in the Step-One review were intended to provide a sufficient
understanding of the subbasin and program to evaluate its potential for success and consistency
with the Council's program and best management practices. There were at least three specific
themes. The first was whether the quantity and quality of the current environment in the
Okanogan River (and Columbia River between Chief Joseph and Wells Dam) were sufficient to
support increasing hatchery production beyond the Public Utility District supported releases
from the Similkameen Ponds. Second, given the state of mainstem Columbia River, estuary, and

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[23] ISRP 2009-2 Response Requested — Step Two Review of the Chief Joseph Dam Hatchery Program, Project #
2003-023-00 (www.nwcouncil.org/library/isrp/isrp2009-2.htm)

ocean salmon survival and harvest, would the yield from the hatchery production provide a reasonable terminal fishery benefit for the Colville Tribes? Third, how would the additional hatchery production be managed to be consistent with conservation principles for maintaining the viability the natural population of summer Chinook salmon in the Okanogan River?

ISRP Recommendation
Meets Scientific Review Criteria

Review Summary
The Chief Joseph Dam Hatchery Master Plan has progressed significantly from the document originally submitted in 2005 and additional materials provided in Step Two in 2007. The Colville Tribes have made serious efforts to address the issues raised by the ISRP. More empirical data on the abundance and productivity of the existing natural salmon population and hatchery program have been provided. A decision framework was developed with the assistance of the All-H Hatchery Analyzer (AHA) model. Some consideration of alternative mitigation options was provided. And the outline for a monitoring plan continues to be refined. Simulation modeling via AHA has allowed examination of options and uncertainties resulting in significant positive adjustments to the plan while maintaining best practices of the Fish and Wildlife Program and the Hatchery Scientific Review Group (HSRG).

The ISRP emphasizes that while the master plan has incorporated best management practices into the decision framework, performed simulation modeling, and developed operating rules, there remains much uncertainty as to whether the salmon harvest and conservation goals can be reached. Careful implementation of the program, with adequate monitoring and evaluation, should provide the answer to that uncertainty. The March meeting and written response received by ISRP demonstrated that the Colville Tribes have the capability to address this monitoring and uncertainty. The model results indicate that there is a probability of achieving the fishery resources and harvest that were guaranteed over a century ago, if the assumptions are correct.

To the extent possible, the expansion of artificial production should follow demonstration of achieving the selective harvest objectives and conversion of the Similkameen Ponds production from its current state to a functioning integrated harvest program.

Brief comments from the ISRP on the Colville Tribe's response to the four unresolved issues are as follows:

1. *A specific time-frame process (decision tree) that outlines the expected range of production scenarios* **-** Joe Peone, Director of the Fish and Wildlife Department, Colville Confederated Tribes, provided a summary of the latest successful refinements in the Chief Joseph Dam Hatchery Master Plan relative to the ISRP's earlier comments and recommendations for hatchery reform, recently arising from the HSRG. As he stated, the recommendations to create a Biological Rule Set to clarify and refine hatchery-harvest program design and a Decision Tree to direct program implementation and adaptation have been major advancements not only for the proposed master plan but more broadly for Columbia River fishery management. We agree and appreciate the seriousness and thoroughness with which they addressed our comments and suggestions.

The decision framework establishes the numbers of adults collected and juveniles released as functions of the size of the natural population at Wells Dam and the ability to harvest adult hatchery. If the natural population falls below a threshold of 800 fish, there will be no artificial production. If required proportions of adult hatchery fish are not captured in the selective fisheries to achieve pre-set pHOS targets, hatchery production will be reduced. These are important criteria because standard monitoring for effects likely will not be adequate or sufficiently expedient to measure deleterious impacts on abundance and fitness of the natural population. This provides a risk-management approach to limiting unintended detrimental effects from the artificial production program. The function of this decision framework and a successful outcome is contingent upon selective harvest of >90% of the hatchery returns. An in-river weir is proposed, among other possible solutions, to address this need, and the ISRP strongly encourages that approach as the best solution. The ISRP also applauds as essential the Colville Tribes' recognition of the need to eliminate hatchery releases when natural origin returns are small, a decision consistent with sound principles of conservation science. On page 9 of the March 11, 2009 response, the Colville Tribes provide a series of phases beginning in 2009 and continuing through 2024, during which artificial production increases as goals of the program are reached. Central to this decision process is the selective harvest; the ISRP advises that an effective selective fishery should be demonstrated prior to hatchery construction.

2. Additional discussion of the CJHMP as it relates to alternative forms of mitigation –
Three alternatives were briefly considered by the Colville Tribes: (1) habitat improvements only, (2) altered harvest management, and (3) a segregated hatchery program. The Tribes concluded that both habitat capacity and productivity would need to double to meet mitigation obligations by natural salmon production alone. They asserted that it is unlikely to achieve that by habitat improvement in a reasonable time period. Altered harvest management would require that all pre-terminal fisheries be eliminated, also an unlikely scenario. The ISRP accepts these as reasonable conclusions.

An open question is how the program might be reduced in size if substantial improvements in natural production are realized from habitat and hydrosystem improvements. A portion of this consideration is captured in sizing the program using the decision framework. Future reviews of the program should revisit this question.

3. Providing basic information regarding the in-basin and out-of-basin assumptions concerning (salmon) survival – On pages 15 through 19 of the March 11, 2009 response to the ISRP the Colville Tribes provide adequate detail on the in-basin and out-of-basin survival assumptions. Ecosystem Diagnosis and Treatment (EDT) modeling provided much of the summary of productivity and capacity for summer Chinook. This needs to be confirmed as part of the monitoring of the project. Stock/recruit analysis of the existing population and juvenile population estimates suggest that the goals of the project are possible.

Regardless, the key assumptions related to survival are sufficiently important to identify, measure rigorously, and report annually.

4. Specifics on methods, designs (including controls), and hypotheses need to be incorporated in the monitoring plan – The general data and derived metrics to be gathered for monitoring and evaluation appear sufficient for this program. The Colville Tribes identify 10 items that monitoring and evaluation will be conducted for (page 19), and 8 hypothesis (page 20) that will be tested as part of the Chief Joseph Hatchery Program. These elements cover the data the ISRP identified as needed for "primary management decisions" and the "primary and secondary biological attributes" (page 4 and 5 of our January 2009 review). The ISRP anticipates reviewing an explicitly detailed monitoring and evaluation plan in Step Three. In particular, we will be looking for a robust design, based on the selective harvest pilot studies now underway to address key programmatic assumptions on issues such as the efficiency of selective fishing, survival of retained broodstock and released adult fish, and related information needed to support and adaptively manage the project, as well as the critical inputs to simulation studies central to the decision framework and analytical tools. Developing the field protocols to estimate important salmon abundance and survival rates with sufficient precision is necessary to the use of the decision framework to adaptively manage the program. The ISRP recommends that the initiation of proposed hatchery production must be conditional not only on explicit refinement of the monitoring and evaluation plan but also on its rigorous implementation.

Columbia River basin scientists, organized as the Ad Hoc Supplementation Workgroup (AHSWG), produced recommendations for monitoring supplementation projects, including analysis models using reference locations. The ISRP encourages the Colville Tribes to become involved in the evaluation of hatchery programs at the basin level. Programs from regions such as the Okanogan can make important contributions to our understanding of the potential benefits and limits of using artificial production to mitigate for various anthropogenic alterations of the aquatic ecosystem. Indeed, with the addition of the in-river weir, the Okanogan project may become critical to the monitoring of supplementation effectiveness overall.

One of the points raised by the ISRP in this and other reviews is the need for reference locations for monitoring and evaluation. The Colville Tribes state that there is no adequate reference stream in the Okanogan River, concluding that candidate streams in the Wenatchee and Methow are substantially different and would be inappropriate. They further argue that identification of reference streams should be treated as a regional issue. The ISRP concur with the latter view and believe the former (inappropriateness of streams in the Wenatchee and Methow) may be an overly restrictive interpretation of the requirements of a reference location. The AHSWG report developed a range of strategies to provide reference sources to evaluate artificial production efforts. Consequently, the Colville Tribes should revisit the topic of evaluation using reference designs and consider the ongoing regional efforts (e.g., AHSWG) in Step Three.

Finally, in the Step One master plan and Step-Two materials, the Tribes identified that the independent population status of the Okanogan River and Columbia River (between Wells and Chief Joseph dams) summer Chinook was in question and under investigation. The monitoring and evaluation plan, and other Step-Three materials should clarify the status of these inquires and identify any monitoring and evaluation needed to assess the effects of the Okanogan and Chief Joseph artificial production on local genetic diversity as this program unfolds.

Appendix 2
In-Season Management Plan User Guide

1. Description/Background

The In-Season Management Plan (ISMP) is a component of a larger management framework for the Chief Joseph Hatchery Program that is designed to achieve fisheries resource goals over time (Figure 1). The ISMP is designed to be used in conjunction with the CJH monitoring and evaluation plan (M&E Plan), the Hatchery Scientific Review Group (HSRG) All H Analyzer tool (AHA), and the Hatchery Genetic Management Plan (HGMP).

The ISMP allows for a sliding scale management strategy to set harvest goals and biological targets such as composition of broodstock and natural spawning escapement. The program is easily updated with in-season status and trends. With this tool, users may track current and future management phases, defined for the Chief Joseph program as Current, Transition 1, Transition 2, and Long Term.

Four steps are involved in Tte ISMP: (1) key assumptions, (2) decision rules, (3) status and trends, and (4) biological targets (Figure 1). These steps are all Excel spreadsheets that store and document data and assumptions and that can be manipulated to derive biological targets for the in-season management of fisheries and hatchery programs. The steps and tools allow managers to document the basis for these targets and establish expectations for all performance indicators. They also help simplify the implementation process and document the rationale for the management actions taken each year.
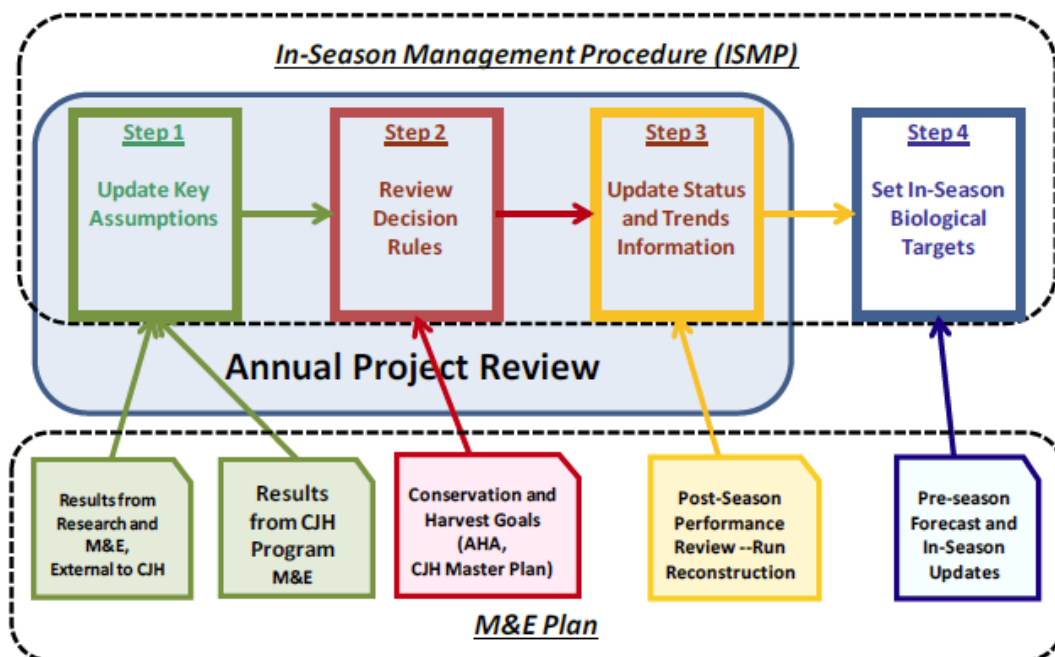

Figure 1.   In-Season Management Procedure framework

2.   Usage/Permission

3.   Getting Started

Population assumptions from AHA in conjunction M&E Plans results should be incorporated into your key assumptions (Step 1), followed by reevaluating the Decision Rules (Step 2), and then updating population status and trends (Step 3). Documentation for each step should be completed in the appropriate spreadsheet as status and patterns are updated.

3.1   Step 1: Key Assumptions

The first step in the ISMP is to update assumptions each year based on data collected from monitoring and evaluation activities and AHA population parameters. This step ensures that the best available information and knowledge is applied to the in-season management process.

First incorporate AHA population and M&E parameters into the ISMP key assumptions spreadsheet. To do this, download AHA for your population (available at http://www.hatcheryreform.us/hrp/tools/welcome_show.action) and follow the instructions found in the user guide (available at http://www.hatcheryreform.us/hrp_downloads/reports/columbia_river/system-wide/ 4_appendix_d_user_guide.pdf). Document these parameters as you go.

The key assumptions are a set of parameters that relate to future expectations. Generally these assumptions are based on data and information collected over time. They represent our understanding of how the system works, creating a working hypothesis that forms the basis for management decisions in-season and long term. The parameters are grouped into five categories: 1) habitat and natural production (Figure 2), 2) smolt to adult survival, 3) fisheries and weir, 4) hatchery fish spawning in nature, and 5) in-hatchery parameters. Conclusions from the Annual Project Workshop review will be captured, documented in the database and the results brought forward to Step 2 in the process.

Key Assumptions	Parameter Name *(Code)*	Select Phase	Transition 1 ▼		
		Current	Transition 1	Transition 2	Long Term
Natural Production (Spawner to Smolt)	Smolt Productivity-Habitat Potential	712	712	712	712
	Smolt Capacity-Habitat Potential	1,186,780	1,186,780	1,186,780	1,186,780
	Fitness factor from (AHA) *(Fit)*	50%	50%	50%	90%
	Fitness Floor *(FF)*	0.50	0.50	0.50	0.50

Figure 2.   Example of input for one category of key assumptions

3.2   Step 2: Decision Rules

In this spreadsheet, Decision Rules are established that include natural escapement controls, hatchery program controls and harvest controls. Natural escapement controls typically include targets for minimum NOR escapement and pHOS. Hatchery production controls typically include pNOB targets and broodstock allocation. Harvest controls typically include NOR and HOR harvest levels. Program managers will review the Decision Rules to determine if they are still appropriate. Although not expected to change frequently, the Decision Rules may need to be altered to account for changes in population policy status (e.g., ESA listing), collapse of the run, new science discoveries or other changes in salmonid management in the basin or the region.
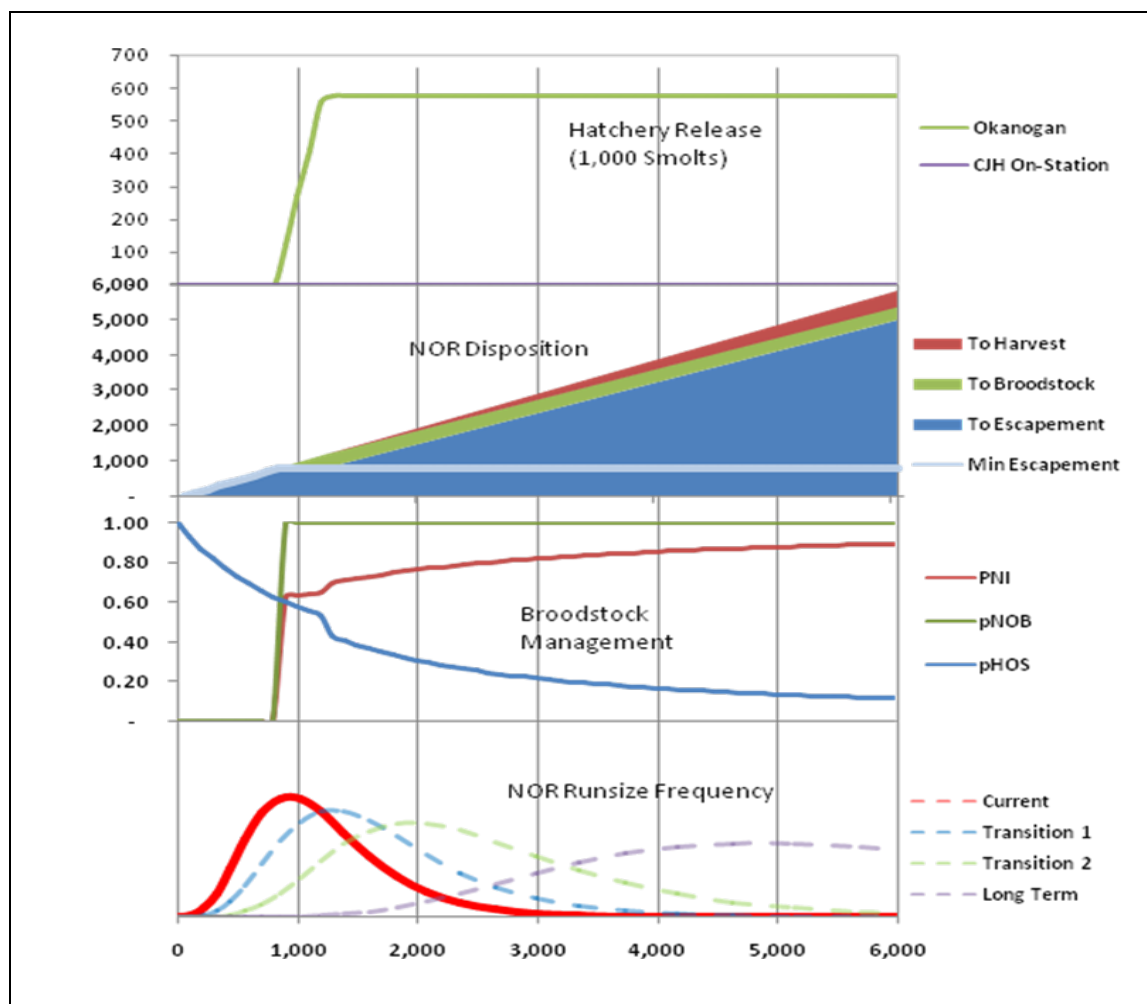
Figure 3. **Example of decision rules for hatchery releases, NOR disposition, and broodstock management. The NOR run size frequency is also displayed for all phases of management.**

3.3   Step 3: Status and Trends

This step is used to update historical data such as escapement for hatchery- and natural-origin fish. The attributes involved in status and trend monitoring can be arranged into five categories: 1) natural production, 2) hatchery productions, 3) harvest, 4) migration, and 5) habitat.

3.4   Step 4: Biological Targets

This spreadsheet has two components: 1) in-season run size updates, and 2) biological targets. These are based on key assumptions, Decision Rules, and population status and trends. This worksheet calculates both natural and hatchery returns and broodstock composition based on those returns. This step also calculates expected outcomes for harvest, hatchery programs, and

natural spawning escapement (Figure 4). Outcomes are based on key assumptions, decision rules, and population status and trends.

Expected Outcome			
Harvest	Terminal Catch	**1,250**	
	Harvest Rate on HORs	**50.0%**	
	Harvest Rate on NORs (Incidental)	**0.0%**	
	Weir Catch (including mortality)	**782**	
Integrated Hatchery Program	Natural Origin Brood (NOB)	**180**	
	Hatch. Origin Brood (HOB) -Int.	**-**	
	Projected Annual pNOB-Int.	**100%**	
	Smolt Release from Int Program	**267,209**	
Segregated Program	Hatch. Origin Brood (HOB) -CJH	**0**	
	Smolt Release-CJH	**0**	
Natural Spawning Escapement	Nat. Origin Spawners (NOS)	**792**	
	Hat. Origin Spawners (HOS-tot.)	**656**	
	HOS (from Seg hatch)	**0**	
	Total Number of Spawners	**1,448**	
	Expected Natural Smolt Production	**261,916**	
	pHOS	**40%**	
	PNI	**0.71**	

Figure 4.   **Example of expected outcomes for harvest, hatchery programs, and natural spawning escapement.**

4. Documentation

Documentation is critical for easy updating and data validation. Documentation spreadsheets are provided for key assumptions, decision rules, and run-reconstruction. Documentation fields include: Date, Name, Phase (current, transition 1, transition 2, or long term), New Value, Source, and Comment. A separate entry should be done for each phase.

4.1 Calculations

A calculation spreadsheet is included that uses the key assumptions, decision rules, and status and trends information to determine biological targets. These calculations should be adjusted with caution.

5.   Parameters and Analytical Methods

The typical parameters (inputs for key assumptions) and biological targets used in the ISMP are defined in the subsections below. The parameters and biological targets used in the ISMP will depend on the management plan. More information on parameters and biological targets can be found in the HSRG 2009 final report and technical papers (available:http://www.hatcheryreform.us/hrp/reports/system/welcome_show.action).

5.1   Habitat and Natural Production Parameters

The following parameters and definitions are used in calculating habitat and natural production.

Parameter	Definition
Smolt Productivity (Prod)	Productivity parameter in the Beverton-Holt survival function
Smolt Capacity (Cap)	Capacity parameter in the Beverton-Holt survival function
Fitness Factor (Fit)	The probability that a fish from the existing population will survive and produce adult offspring expressed as a fraction of the same probability for a fish from a locally adapted population
Fitness Floor (FF)	The lowest value assumed for the fitness factor
SAR	Survival from subbasin to subbasin in the absence of harvest under average conditions

5.2   Harvest Variables

The following parameters and definitions are used in calculating harvest variables.

Parameter	Definition
Pre-terminal Exploitation Rate on Marked Fish (PreERM)	Total exploitation rate on adipose fin-clipped fish in all fisheries downstream of terminal reaches.
Pre-terminal Exploitation Rate on Unmarked Fish (PreERU)	Total exploitation rate on unmarked fish in all fisheries downstream of terminal reaches.
Terminal Harvest Rate on HORs (TermHRH)	Maximum harvest rate achievable by the terminal selective fishery for adipose fin-clipped hatchery fish.
Terminal Harvest Rate on NORs (TermHRN)	Incidental mortality rate on NORs in the terminal selective fisheries expressed as % of HRN.
Total Catch of NORs (NORCatch)	Annual catch of NOR adults in all fisheries.
Total Exploitation Rate of NORs (NORExpl)	Proportion of total NOR recruits caught in fisheries
Total Exploitation Rate of HORs (HORExpl)	Proportion of HOR recruitment caught in fisheries
Weir Factor (WeirEff)	The probability that a fish entering the River will be caught in the weir.

Parameter	Definition
Mark Rate (MarkR)	The proportion of HORs having a detectable mark (adipose fin-clip and/or CWT)
NOR Weir Mortality (WeirMort)	The probability that a NOR fish captured in the weir will die as a result of this experience

5.3   HORs Spawning in Nature

The following parameters and definitions are used in calculating the rate of HORs that spawn naturally.

Parameter	Definition
Relative Reproductive Success of HORs (RRS)	The probability that an HOR will produce adult offspring expressed as a fraction of the same probability for a NOR
Stray Rate of HORs	The probability that an HOR that escaped fisheries will survive and enter the river of release.
Rate of Return of HORs	The probability that an HOR released in the river and escaping fisheries will survive and enter the river to spawn

5.4   In-Hatchery Assumptions

The following parameters and definitions are used in calculating in-hatchery assumptions.

Parameter	Definition
Pre-Spawning Mortality (PSMortH)	The probability that a fish collected for broodstock will survive to spawning
Eggs/Female (Fec)	Average number of eggs per female spawned
% Females (%Fem)	Proportion of females in the broodstock collected
Egg to Smolt Survival - Sub-yearlings (EtoS0)	In-hatchery survival from egg (at spawning) to release as sub-yearling
Egg to Smolt Survival—Yearlings (EtoS1)	In-hatchery survival from egg (at spawning) to release as yearling
Recruits per Spawner (RS)	Mean number of adult recruits produced per HOR collected for broodstock.

5.5   Natural Production Variables

The following parameters and definitions are used in calculating natural production variables.

Parameter	Definition
Spawner Abundance (NatSp)	Total number of adult spawners each year
Total NOR Recruitment (NRec)	Annual number of adult recruits (catch plus escapement)
Smolt Abundance (Smolt)	Annual abundance of out-migrant smolts as measured mouth

Parameter	Definition
	of the Okanogan River
Recruits per Spawner (NatRS)	The number of adult recruits produced per natural spawner
Spatial Distribution (SD)	The fraction of NatSp that spawned in each of four defined spawning areas
Diversity (Div)	The composition of the spawning population in terms of sex, age, spawn-timing
PNI	An indicator of the influence of natural and hatchery environments on population adaptation
pHOS	The proportion of HORs in the natural spawning population

5.6   Hatchery Production

The following parameters and definitions are used in calculating hatchery production.

Parameter	Definition
Broodstock (HatSp)	The number of fish collected for hatchery broodstock for each hatchery program (integrated and segregated)
Total HOR Recruitment (HRec)	Annual number of adult recruits (catch plus escapement) for each program
Hatchery Productivity (HatPr)	The number of adult recruits per spawner (brood collected) from a given brood year
pNOB	The proportion of NORs in integrated hatchery broodstock

5.7   Migration

The following parameters and definitions are used in calculating migration variables.

Parameter	Definition
Juvenile Passage Survival (JuvPass)	Annual survival in river
Adult Passage Survival (AdPass)	Annual survival over dams
SAR	Annual survival from outmigrant smolts to returning adults

5.8   Biological Targets

The following parameters and definitions are used in calculating biological targets.

Parameter	Definition
Escapement Target (EscTarg)	Number of fish of all origins targeted to reach spawning grounds
pHOS Target	Target proportion of HORs in escapement
Spawning Distribution	Proportion of the escapement expected to spawn in defined

Parameter	Definition
	spawning areas
Broodstock for Integrated Program	Target number of spawners for the integrated program
pNOB for Integrated Program	Target proportion of NORs in broodstock
Broodstock for Segregated Program	Target number of spawners for the segregated program
Weir Mortality	Max NOR mortality due to weir