Chief Joseph Hatchery Program

Monitoring and Evaluation Plan for

Spring Chinook Salmon

November 12, 2009

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1 INTRODUCTION

This monitoring and evaluation (M&E) plan for spring Chinook is a critical component of the Chief Joseph Hatchery Program (CJHP). It is composed of several monitoring elements: hatchery production and operations, natural escapement and tracking the progress being made toward conservation and harvest 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 over time will also be monitored using the existing Okanogan Basin Monitoring and Evaluation Program (OBMEP) to track changes and confirm that habitat actions are effective.

2 OVERVIEW OF THE CJHP SPRING CHINOOK PROGRAM

The Colville Tribes are proposing to implement a spring Chinook hatchery program that has both an integrated and segregated component. The program will release 900,000 juvenile spring Chinook each year. The goal of the program is: 1) to restore ceremonial and subsistence fishing for the Colville Tribes, and 2) to restore naturally spawning spring Chinook in historical habitats of the Okanogan subbasin. An additional long-term goal is to assist in recovery of the Upper Columbia River Spring Chinook ESU which would contribute to the goals of the Endangered Species Act. This goal cannot be achieved until a self-sustaining population of spring Chinook is established in the subbasin. A self-sustaining population will require substantial improvement in subbasin habitat quality and quantity and/or reintroduction into Canadian habitats.

A brief description of each of the two program components, segregated and integrated, is presented below.

Okanogan/Columbia River Segregated Harvest Program

This component of the overall spring Chinook program is designed to create a hatchery-origin run that will restore a Colville Tribal ceremonial and subsistence fishery and a local recreational fishery. Initially the program will use Leavenworth stock spring Chinook. The program will provide mitigation for spring Chinook runs in the Okanogan River and the upper Columbia River that were lost as a consequence of the construction and operation of Grand Coulee, Chief Joseph, Wells, Rocky Reach, Rock Island, Wanapum, Priest Rapids, McNary, John Day, The Dalles, and Bonneville dams.

The segregated component will release a total of 850,000 spring Chinook yearlings from the Chief Joseph Hatchery (650,000 fish) and from Tonasket Pond (200,000 fish) located on the Okanogan River. Over time, the program will use adults that return to the Chief Joseph Dam Hatchery as broodstock.

Omak Creek Integrated Conservation Program

The objective of this program component is to re-establish a naturally spawning spring Chinook population in Omak Creek using fish from the Leavenworth Hatchery. The program will be used to demonstrate the viability of spring Chinook in historical habitat and guide rehabilitation of that habitat. The program will also provide a small ceremonial harvest of spring Chinook for the Colville Tribes. In the longer term, the Leavenworth stock will be phased out and replaced with adults returning to the Okanogan River (i.e., Omak Creek). These fish are expected to be better adapted to the local environment, resulting in increased population productivity and abundance.

The integrated program will produce 50,000 yearling smolts each year for release to Omak Creek. The fish would be acclimated at St. Mary's Pond in the Omak Creek subbasin.

This integrated component will be implemented in three phases, each with a different objective. In Phase 1, the hatchery program will accelerate spring Chinook re-colonization of stream habitat (primarily in Omak Creek). In Phase 2, the program will focus on local adaptation, and in Phase 3, the focus will be spring Chinook conservation. The criterion for moving from one phase to the next is determined by the NOR run-size to Omak Creek (Table 1).

Table 1. Strategy for Okanogan spring Chinook conservation program

Omak Creek Integrated Program Strategy	NOR Runsize Criterion	Natural Escapement	Hatchery Broodstock	Size of Hatchery Program
Phase 1 - Re-colonization	0-50 fish	All fish not used for brood are passed upstream past weir.	Use HORs collected at the Omak Creek weir.	50,000 smolts
Phase 2 - Local Adaptation	50-100 fish	Only NORs are passed upstream above the weir-subject to weir efficiency	Use HORs and NORs collected at the weir (pNOB 20%)	50,000 smolts
Phase 3 - Conservation	> 100 fish	Only NORs are passed upstream above the weir-subject to weir efficiency—pHOS maximum is 30%	Use 50% NORs and 50% HORs from this integrated program (i.e., pNOB=50%)	Up to 50,000 smolts depending upon availability of NORs and pHOS to meet PNI goal of 0.50

The Phase 1 emphasis is on the re-colonization of stream habitat by spring Chinook. As a sustainable population of natural-origin (NOR) spring Chinook does not yet exist, the program will be operated as a segregated type, relying on hatchery-origin (HOR) returns for broodstock (Table 2).

In Phase 2, NOR returns are expected to be sufficient to begin developing a locally adapted population in Omak Creek. The program will starts the transition to a properly integrated program by incorporating NOR adults into the hatchery broodstock. The target proportion of natural broodstock (pNOB) for the program is set at 20%.

Full hatchery integration occurs in Phase 3 with increased NOR spring Chinook production. At this time, pNOB is set at a minimum of 50%, and spawning escapement is managed such that the proportion of hatchery fish on the spawning grounds (pHOS) does not exceed 30%. The resulting proportionate natural influence (PNI) value will be greater than 0.50. The pNOB and pHOS parameters would be calculated as three-year running averages.

Table 2. Program purpose and type for the three phases of the spring Chinook hatchery program

	Phase 1 Re-colonization	Phase 2 Local Adaptation	Phase 3 Conservation
Okanogan River Component	Segregated Conservation	Integrated Conservation	Integrated Conservation
Chief Joseph Hatchery Component	Segregated Harvest	Segregated Harvest	Segregated Harvest

The expected outcomes for each phase of the spring Chinook hatchery program (based on modeling) are shown in Table 3.

Table 3. Expected outcomes for each phase of the spring Chinook program

	Outcomes	Phase 1 Re-colonization	Phase 2 Local Adaptation	Phase 3 Conservation
Natural Production	Average NOR escapement	<50	132	1,056
	pHOS average	100%	32%	18%
	PNI	0	0.38	0.74
Harvest	Terminal harvest *	2,795	3,005	2,833
	Total harvest	3,441	3,663	3,560
Hatchery	Return of integrated HORs to Wells Dam	298	298	298
	Return of segregated HORs to Wells Dam	5,071	5,071	5,071

* Estimated harvest from on-station releases at Chief Joseph Hatchery

Total NOR production in Phase 2 and Phase 3 assumes that suitable habitat conditions increase substantially over current conditions as a result of actions being implemented in the subbasin by the Colville Tribes. It is assumed that habitat quality is consistent with properly functioning conditions as defined by the Snake River Salmon Recovery Board (SRRB 2006).

In the longer-term, these same three phases will be adapted for spring Chinook reintroduction into Salmon Creek (tributary of the Okanogan) once the full flow restoration program is

achieved[1]. A similar phasing will also be adapted when a reintroduction program is extended into Canada, using Zosel Dam as the control weir.

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 spring Chinook program will occur in December of each year. The agenda will follow the ISMP steps described in Section 3.4. 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 and staff representing the Colville Tribes in hydropower system operations (particularly flow and spill timing). 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 program (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, and (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

[1] The Colville Tribes are currently in the process of restoring stream flow to Salmon Creek as part of habitat improvement project.

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 include policy and technical personnel. The M&E lead scientist will present his conclusions from Day 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 CJH 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 spring 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 spring Chinook throughout the Okanogan subbasin.

The Colville Tribes will attempt to initially achieve a Contributing population status for spring Chinook in the Okanogan subbasin. Elevation to the status of a Primary population will depend largely on future habitat improvement actions in the U.S. and Canada.

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).

There is uncertainty about the future natural production potential of Okanogan River spring 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

[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.

extent those investments will be effective. Also there is uncertainty as to when reintroduction efforts will extend into Canada. 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 Re-colonization, Local Adaptation, and Long-term Conservation phases of the Omak Creek program

	Phase 1 Re-colonization	Phase 2 Local Adaptation	Phase 3 Conservation
Natural Escapement			
Minimum natural-origin (NOR) escapement	0	50	100
Proportion hatchery-origin spawners (pHOS)-maximum target for integrated program[3]	100%	5%	30%
NOR escapement at which pHOS must be achieved	NA	50	100
Maximum pHOS for Chief Joseph segregated program (and HOR strays from other basins)	5%	5%	5%
Minimum hatchery-origin spawners (HOS) + natural-origin spawners (NOS)	No Minimum	50	100
Integrated and Segregated Hatchery Program			
Proportion natural-origin brood (pNOB) target	0	20%	50%
Run size at which pNOB will be reached	NA	58	120
Adjust segregated program to reduce strays?	Yes	Yes	Yes

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 minimum PNI > 0.50[4] once the Phase 3 abundance target is achieved.

[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.

[4] 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 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 spring 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 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 to prepare 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.

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).

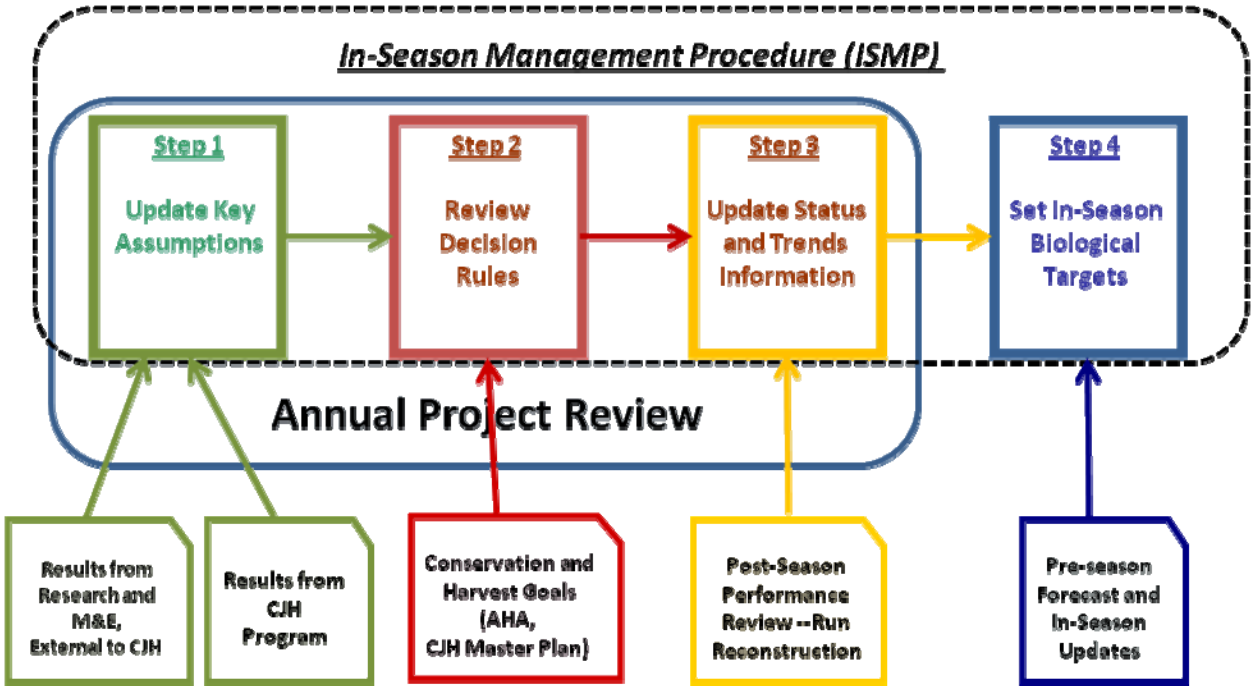

Figure 1. In-Season Management Procedure Framework

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 (primarily Omak Creek)
- 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 at removing hatchery fish from the spawning environment without killing substantial numbers of wild spring Chinook
- Productivity of both NOR and HOR adults spawning naturally

Table 5 identifies the current and estimated future values for each of these parameters. Note that habitat conditions (as expressed by smolt productivity and capacity) in Table 5 are expected to increase over time from the implementation of habitat actions being undertaken by the tribe. Modeling assumes that habitat achieves properly functioning conditions (SRRB 2006).

Table 6 lists key assumptions about the expected spring Chinook performance in each operational phase.

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 of 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	Phase 1 Re-colonization	Phase 2 Local Adaptation	Phase 3 Conservation
Natural Production (Spawner and Smolts)	Smolt Productivity-Habitat Potential per adult	172	274	376
	Smolt Capacity-Habitat Potential	48,246	131,675	215,103
	Fitness factor from (AHA) (Fit)	50%	50%	81%
	Fitness Floor (FF)	0.50	0.70	0.90
	Adjusted Smolt Productivity (Prod) per adult	86	137	305
	Adjusted Smolt Capacity (Cap)	24,123	65,837	174,233
Smolt to Adult Survival	Juvenile Migration Survival	0.490	0.490	0.490
	Ocean Survival	0.013	0.025	0.025
	Adult Migration Survival	0.830	0.830	0.830
	Total SAR (SAR)	0.00529	0.01017	0.01017
Pre-terminal Harvest on Marked Fish	Marine	0.010	0.010	0.010
	Lower Mainstem	0.080	0.080	0.080
	Upper Mainstem (Zone 6)	0.080	0.080	0.080
Pre-terminal Harvest on Unmarked Fish	Marine	0.010	0.010	0.010
	Lower Mainstem	0.020	0.020	0.020
	Upper Mainstem (Zone 6)	0.080	0.080	0.080
Terminal Harvest and Weir	Max Rate on Int HORs (TermHRM)	0.010	0.010	0.010
	Induced NOR Loss (TermHRU)	6%	6%	6%
	Max Rate on Seg HORs (TermHRM)	0.50	0.50	0.50
	Induced NOR Loss (TermHRU)	6%	6%	6%
	Weir Factor (Efficiency) (WeirEff)	0.50	0.90	0.90
	Mark Rate Integrated HORs (MarkR)	0.95	0.95	0.95
	Mark Rate Segregated HORs (MarkR)	0.95	0.95	0.95
	Weir Mortality on NORs (WeirMort)	0.00	0.00	0.00
	Terminal NOR rate	0.030	0.030	0.030

Table 6. Key assumptions about the two components of the spring Chinook hatchery program and their performance

	Parameter Name	Phase 1 Re-colonization	Phase 2 Local Adaptation	Phase 3 Conservation
HORs Spawning in Nature	Relative Reproductive Success of HORs (RRS)	0.80	0.80	0.80
	Stray Rate of Integrated HORs to Segregated Hatchery (1-RecOk)	2%	2%	2%
	Stray Rate of Segregated HORs to Natural Spawning[1] (StCJ)	0%	2%	2%
Okanogan (Omak Creek) Hatchery Release	Purpose	Conservation	Conservation	Conservation
	Type	Segregated	Integrated	Integrated
	Maximum Local Broodstock	40	40	40
	Maximum Imported Broodstock	40	0	0
	Pre-spawning Mortality	0.05	0.05	0.05
	Eggs per Female	4,200	4,200	4,200
	Percent Females	50%	50%	50%
	Egg to Smolt-yearlings	0.63	0.63	0.63
	Maximum Smolt Release (Yearling)	50,000	50,000	50,000
	Maximum Smolt Release (Sub-yearling)	0	0	0
	Recruits/Spawner	8.0	8.0	8.0
	Percent Hatchery Spawning below Weir	2%	2%	2%
Chief Joseph Segregated Hatchery Releases	Purpose	Harvest	Harvest	Harvest
	Type	Segregated	Segregated	Segregated
	Stepping Stone?	no	no	no
	Maximum Local Broodstock	658	658	658
	Maximum Imported Broodstock	658	0	0
	Pre-spawning Mortality	0.05	0.05	0.05
	Eggs per Female	4,200	4,200	4,200
	Percent Females	50%	50%	50%
	Egg to Smolt-yearlings	0.63	0.63	0.63
	Maximum Smolt Release (Yearlings)	850,000	850,000	850,000
	Maximum Smolt Release (Sub-yearling)	0	0	0
	Recruits/Spawner	8.0	8.0	8.0

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 Tables 1 and 4) 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 scientific discoveries or other dramatic changes in salmonid management in the basin or the region. The primary purpose of Step 2 is to reaffirm the existing Decision Rules and to assure that all involved with program management and operation are aware of these rules and understand their importance. It should also be noted that in addition to the rules described in Table 1 and 2, the on-station harvest program will be reduced in Phase 2 and 3 if this program contributes more than 5% of the spawning escapement in the Okanogan natural population.

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.

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. 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.

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 appropriate project phase will be based on dam counts and early returns to the weir.

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 CJH data collection program is presented under the following headings:

- Variables Monitored at Wells Dam
- Variables Monitored in Fisheries and at the Omak 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 summarize 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 spring Chinook at Wells Dam is used for in-season management decisions (Step 3 and Step 4). These variables are used to determine spring Chinook run size, stock composition (HOR and NOR) and run-timing.

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

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

Direct enumeration of adults at Wells Dam will be used to develop NOR and HOR counts of spring Chinook at this facility.

4.1.1.1 Direct Enumeration

Spring 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. For the ISMP, the number of spring Chinook NORs destined for the Okanogan River is a critical value as it determines escapement levels, hatchery production levels and the number of ESA listed Methow River-origin spring Chinook that can be taken each year.

Chinook adults arriving at Wells Dam from May 1 through June 28 are classified as spring Chinook. Fish counters will develop daily estimates of the number of HOR and NOR adults (and jacks) that pass this facility.

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

Table 7. Tribal incidental take thresholds for unmarked spring Chinook

Wells Dam Count Unmarked Spring Chinook	Maximum CCT Take
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%

4.2 VARIABLES MONITORED IN FISHERIES AND AT THE OMAK WEIR

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

- Count of dead fish handled/harvested and live fish released at the weir
- Fishing gear effectiveness
- Counts of NOR and HOR fish at the Omak weir
- Terminal catch sampling
- Coded wire-tag and PIT-tag recoveries

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

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 spring 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, Omak Creek and CJH-released 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)

4.2.1 Methods

4.2.1.1 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 Omak 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)[5]. 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.

[5] 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%).

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[6].

Data needed for calculating TermHRN will be developed as follows:

- All NOR fish collected in live-capture fisheries will be enumerated and classified as 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 (spring Chinook, summer/fall Chinook, sockeye and steelhead) will be tagged with a unique external tag and released back to the river[7].
- Sampling for tagged fish will occur in all fisheries, at the weir and at hatchery facilities[8].
- 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.

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

HOR and NOR fish (all species) arriving at the Omak Creek weir will be enumerated on a daily basis. 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.

4.2.1.3 Counts of NORs and HORs at the Weir

The number of HOR and NOR spring Chinook and steelhead (and other species such as bull trout) arriving at the weir will be enumerated on a daily basis. For spring 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
- Weir efficiency

[6] Delayed mortality consists of the period from time of release to recapture/detection at the weir.
[7] 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.
[8] Sampling for tags will occur on the spawning grounds if weir efficiency is found to be less than 100%.

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)[9]. This latter group occurs when the adipose fin grows back due to clipping error associated with the tagging process.

All fish released above the weir will be given a unique mark so that they may be distinguished from any spring Chinook that may have been able to bypass the weir and spawn naturally. This information will assist in the development of a weir efficiency estimate.

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

4.2.1.4 Terminal Catch

The number of HOR and NOR spring 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
- HOR and NOR fish harvested at the Omak Creek weir

HOR and NOR fish harvested at the weir consist of:

- HOR spring Chinook caught at the weir that are surplus to broodstock needs and not released to spawn naturally, and
- 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 spring Chinook harvested on a daily basis; they will also document the number of non-target species 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. Fishing will not be allowed in Omak Creek. 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).

[9] 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.

4.2.1.5 Coded Wire-Tag Recoveries

All hatchery-origin fish released from the program will be coded wire-tagged 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.

Program HOR fish will be tagged as shown in Table 8.

Table 8. Marking protocols for program HOR spring Chinook

Stock	% CWT and Tagging Location#	Adipose Fin-Clip
Okanogan Segregated		
Tonasket Pond	100% -Snout	100%
Chief Joseph Segregated		
Direct Release from Hatchery	100%- Snout	100%
Omak Integrated		
St. Mary's Pond	100% -Right Cheek	100%

#- 100% marking to distinguish Okanogan fish from those originating in other basins (e.g., Methow)

Fish from the program will be differentially tagged depending on their release location (i.e., each release site will have a unique code).

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[10]
- 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).

[10] Management calls for placing wire in all hatchery spring Chinook released in the Upper Columbia River Basin.

4.3 VARIABLES MONITORED ON SPAWNING GROUNDS

Two variables will be monitored on the spawning grounds for spring Chinook:

- NOR and HOR Spawning Success: Number of NOR and HOR that spawned successfully, and
- 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 Spatial Distribution: Geographic distribution of spawners 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

- **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

Spring Chinook spawning ground and redd surveys will be conducted weekly from late August through October. Surveys will be conducted by foot. During the surveys, biologists will sample all recovered female spring 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 at the weir. 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 spring 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. Pedigree analysis may become more feasible and fundable when the Colville Tribes transition the reintroduction effort from unlisted Leavenworth stock Chinook to the endangered Methow Composite stock.

4.3.1.2 NOR and HOR Demographics and Spawning Habitat Location and Quality

During spawning surveys, 100 of recovered carcasses will be sampled for species, size and sex. 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. Redd surveys will be conducted throughout Omak Creek

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 that 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, are fully smolted, 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 variables will be monitored 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: 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: Total number of juvenile fish released at the 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 Bonneville Dam

An eighth variable, smoltification level, will also be monitored to evaluate hatchery release practices. However, this variable does not affect the ISMP.

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 (E to S1) and sub-yearlings 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

The seven variables that affect the ISMP 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. Approximately 10,000 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.

4.4.1.1 Smoltification Levels

Smolt development in hatchery juveniles will be determined by measuring gill Na+, K+-ATPase activity over time. Tracking enzyme levels will help determine the migratory status of hatchery juveniles released from acclimation sites. Gill Na+, K+-ATPase samples will be collected from the gill tissue of hatchery fish using the techniques described in Schrock et al. (1994). Sampling will begin approximately six weeks prior to the expected release time for each species[11].

Results obtained from the hatchery (and natural fish populations) will be tracked over time and compared to one another. Hatchery managers will use information on the physiological condition of the fish to refine the hatchery release schedule. Fish-rearing practices would be adjusted so that the timing and migratory status (as indicated by gill Na+, K+-ATPase levels) of the two groups match to the extent possible. The assumption is that the more hatchery fish reflect the wild fish template, the more likely they are to survive in the natural environment.

4.5 VARIABLES MONITORED DURING JUVENILE OUTMIGRATION

Hatchery fish released into basin waters potentially may compete for food and space with naturally produced spring Chinook and summer/fall Chinook. In addition, hatchery yearlings released each year may prey on wild 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 at Omak Creek and the Mouth of Okanogan River: Number of juvenile HOR and NOR collected at the 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 five parameters:

- Smolt Abundance: Annual abundance of out-migrant smolts as measured at mouth of Omak Creek and Okanogan River mouth
- 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
- Predation Index: An index of the percentage of the natural juvenile population consumed by hatchery fish

[11] ATPase data will also be collected from NOR juveniles captured at traps.

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

Juvenile Trap Counts at Omak Creek and 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 Spring Chinook Natural Production

An index of juvenile spring Chinook NOR production will be developed each year based on the results of rotary screw trap operations in Omak Creek and 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). 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.

Additionally, up to 5,000 NOR juvenile Chinook captured in the traps will be marked with a PIT-tag and CWT. The tags will allow managers to estimate PIT-tag loss and juvenile and adult survival rates and timing through the mainstem Columbia River.

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-tag data will be used to determine the amount of time hatchery fish spend in the Okanogan River after release from facilities.
- 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 spring 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 date and time when each PIT-tagged fish began its migration. Screw traps located near the mouth of the Okanogan River and Omak Creek 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 PIT-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 recapture at the mouth of Okanogan River (or Omak Creek)

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 estimates for summer/fall Chinook (and other species), 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 9. 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 9. Rotating panel design for status/trend monitoring within a given status/trend monitoring zone, e.g., Okanogan subbasin.

	Year																			
Panel	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 2 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.

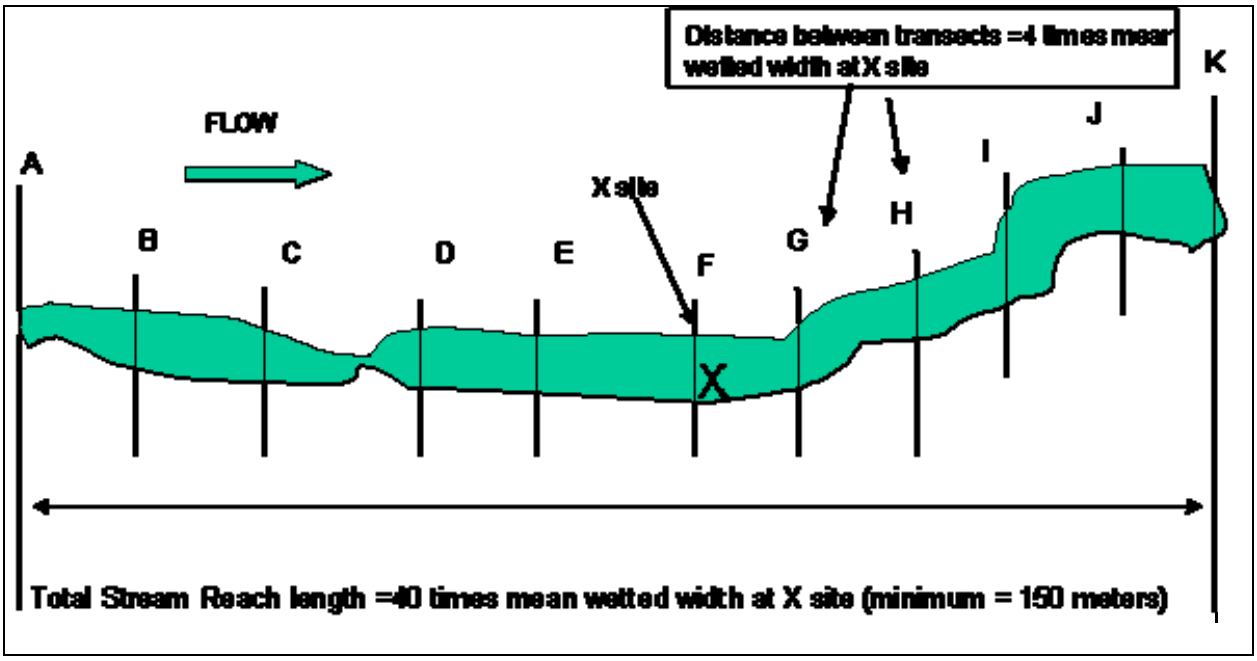

Figure 2. Typical EMAP habitat sampling site layout

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 spring 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 Omak Creek (and later in Salmon Creek and the Canadian Okanagan), and diversity will be addressed by managing escapement to assure that all temporal segments of the population are represented.

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 5.3.1). 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 (daily) 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 December.

A key element of this plan is that all assumptions will be reviewed and challenged each year at the annual meeting 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, 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[12]. 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, over time (Phase 3) 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.

[12] In Phase 2 and Phase 3 it is assumed that habitat approaches Properly Functioning Conditions.

Due to measurement imprecision (especially of juvenile abundance) and high variability in survival, the variance of estimates for smolt productivity and smolt capacity will likely 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=86 smolts per spawner

Smolt Capacity (Cap)

- **Definition**: Capacity parameter in the Beverton-Holt survival function
- **Assumed Value**: Cap=24,000 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 spring Chinook juveniles passing the weir at the mouth of the Okanogan and returning to the weir as adults will be estimated from PIT-tag recoveries. Up to 5,000 juveniles will be PIT-tagged at the screw traps (see Section 4.1.1).

TotSAR

- **Definition:** Survival from subbasin to subbasin in the absence of harvest under average conditions
- **Assumed Value**: SARave= <0.5%

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 4.2.1.5). 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 weir counts and carcass/spawning surveys conducted yearly.

The number of <u>unmarked</u> HORs that pass the weir will be estimated from the mark rate of HOR adults from the segregated program 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 a good estimate of the overall mark rate for hatchery fish. Carcass surveys conducted in Omak Creek 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=11% 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=4%

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 Omak Creek 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 that spawn in nature. The number and proportion of hatchery fish on the spawning grounds depends 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 and release numbers 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 Omak Creek (StCJ)

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

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

Rate of Return of Omak Creek Integrated Program HORs to Omak Creek (RetOk)

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

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

Omak Creek HOR Spawning Below Weir (OkBW)

- **Definition**: The probability that an HOR from the Omak Creek 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 life stages 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 Upper Columbia Spring Chinook programs. 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=5%

Eggs/Female (Fec)

- **Definition**: Average number of eggs per female spawned
- **Assumed Value**: Fec=4,200

% Females (%Fem)

- **Definition:** Proportion of females collected in the broodstock
- **Assumed Value**: %Fem=50%

Egg to Smolt Survival—Yearlings (EtoS1)

- **Definition**: In-hatchery survival from egg (at spawning) to release as yearling
- **Assumed Value**: EtoS1=0.60

Recruits per Spawner (RS)

- **Definition**: Mean number of adult recruits produced per HOR collected for broodstock
- **Assumed Value**: RS=8.0

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 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. Monitoring at the Omak Creek 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 at the mouth of the Okanogan River. Precision of adult abundance will be high (coefficient of variation of 5% is the 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**: 50 adults. This is the minimum value during the initial transition phase. This minimum target will increase to 100 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 capacity will increase seven fold in the long term (from approximately 25,000 to 175,000) as a result of improved fitness and habitat improvement.

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 100 adults will be sustainable, i.e., NatRS should be greater than one for escapements smaller than 100 fish.

Spatial Distribution (SD)

- **Definition**: The geographic spawning distribution of spring Chinook in Omak Creek
- **Biological Target**: Throughout the subbasin where spawning habitat has been documented

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

PNI

- **Definition**: An indicator of the influence of natural and hatchery environments on population adaptation
- **Biological Target**: In Phase 3 (Long Term), the minimum three year running average for PNI is 0.50. If habitat improvements meet expectations, PNI could exceed 0.7.

5.2.2 pHOS

- **Definition**: The proportion of HORs in the natural spawning population
- **Biological Target:** In Phase 3 (Long Term), the running five-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).

5.2.3 Hatchery Production

All hatchery fish will be marked with adipose fin-clips and CWTs in order to estimate 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**: Broodstock target for the segregated and integrated programs are 658 and 42 respectively.

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 340 recruits including pre-terminal harvest for the integrated program and 5,200 for the CJH on-station program.

pNOB

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

- **Biological Target**: pNOB is a management control variable that helps achieve the PNI target. pNOB will be 20% and 50% in Phase 2 and Phase 3, respectively.

5.2.4 Harvest

All hatchery fish will be marked with adipose fin-clips and CWTs in order to estimate 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 Omak Creek NOR adults in all fisheries

- **Target:** No target specified. The primary goal for the natural population is conservation. Harvest levels are expected to be minimal.

Total Exploitation Rate of NORs (NORExpl)

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

- **Biological Target**: Maximum NORExpl is 7% in the long term

Total Catch of HORs (HORCatch)

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

- **Target:** Total average harvest target of 2,500

Total Exploitation Rate of HORs (HORExpl)

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

- **Target**: 50% 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 (or Omak Creek trap) to adults returning to Wells Dam or the subbasin
- **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)

The upper Columbia spring Chinook run is dominated by hatchery populations. The Okanogan natural population will at best comprise 10 % of the returns to Wells Dam. Since no historical data exist to form a basis for predicting the return of NORs from the Okanogan from dam counts, estimates will have to be derived as data becomes available in the future. In the initial years of the program, early season weir counts will be weighted higher than dam counts when updating in-season NOR run size. The Colville Tribes selective fishing program also should provide a good indication of NOR run size based on the number of NORs released from fisheries using various gears. These fisheries will be at mouth and in lower reaches of the Okanogan.

Trigger points for transition from phase 1 to phase 2 and from phase 2 phase 3 are 50 and 100 NORs respectively. Thus, for example, when the predicted NOR run exceeds 50 adults, 8 of these NORs will be captured for broodstock; the remainder will be passed upstream to spawn. All HORs intercepted at the weir will be allowed to spawn upstream of the weir (see Table 1).

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 Omak Creek NORs returning to Wells Dam
- **Critical Value**: 50 adults. For run sizes greater than 50 NORs, the Okanogan conservation program becomes integrated--only NORs will be passed upstream of the weir and the hatchery program will incorporate NORs in the broodstock.

Segregated HOR Terminal Run Size (TermSHR)

- **Definition**: Number of Chief Joseph Hatchery HORs returning to Wells Dam
- **Critical Value**: When the Chief Joseph Hatchery HOR run size is greater than 50 times the Okanogan NOR run size, there is a risk that the pHOS for segregated HORs will exceed 5% - even with an effective weir and selective fishery. If this occurs, the segregated program will be reduced and/or more effective measures to selectively remove HORs will be implemented.

Integrated HOR Terminal Run Size (TermIHR)

- **Definition**: Number of HORs from the Omak Creek program returning to Wells Dam
- **Critical Value:** When the Okanogan integrated HOR return exceeds six times the NOR run, there is a risk that pHOS for integrated HORs will exceed 30% even with an effective weir and selective fishery. When this occurs, the proportion of NORs in the broodstock may be increased to maintain a PNI greater than 0.5.

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. Prior to the Annual Project Review (APR), each year, the following variables will be estimated.

Escapement Target (EscTarg)

- **Definition**: Number of fish of all origins targeted to pass upstream of the Omak Creek 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 Omak Creek program [this season]

pNOB for Integrated Program

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

Broodstock for Segregated Program

- **Definition:** Target number of spawners for the segregated (Chief Joseph on-station) and Okanogan River releases [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 spring 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 spring Chinook population can sustain a natural spawning escapement greater than 50 adults (with expected habitat improvements, this value increases to at least 100).

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 "Contributing" populations (HSRG 2009).

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 "Contributing" 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, 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 coefficient of variation 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 1.25 and 580 respectively (preliminary estimate based on EDT and some expected habitat improvements) before harvest. This results in adjusted productivity and capacity estimates of 1.11 and 516 respectively, which in turn implies that the Beverton-Holt survival (from escapement to escapement) is greater than 1 when escapement is less than 52.

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 50. First of all, escapements below 50 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 pre-season forecasts and in-season updates of run size, as well as 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. The major concern is overestimation of the NOR component of the run; however, this risk is mitigated by the fact that all fisheries 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 Omak Creek 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.

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