Appendix B
Klickitat spring Chinook: Integrated program description, analysis, and implementation schedule

Overview of Klickitat spring Chinook and future program

The existing hatchery/wild composite population has substantially diverged from the original native population due to extensive hatchery introgression over many years. The goal of the Yakama Nation since taking over management of the Klickitat Hatchery is to implement actions that will, over time, improve the quality of the natural-origin population, and by using these fish for brood stock, to also improve the quality of hatchery-origin fish that escape to the natural spawning grounds.

We surveyed spring Chinook carcasses on the spawning grounds from 2007-2016 and observed an average proportion of hatchery-origin spring Chinook spawning naturally of 43% (36 of 81 carcasses). Radio telemetry results indicate that 25.7% of hatchery-origin spring Chinook (26 out of 101 known-fate fish tagged at Lyle Falls in 2010-2013) spawned in the wild. Very few, if any, natural-origin fish are presently used for brood stock. Therefore, we estimate that present PNI levels are likely less than 0.10 (Figure 1). In addition, hatchery-origin brood stock currently used in the Klickitat program have many generations of hatchery ancestry. Present levels of pHOS suggest the program will require 40-60% natural-origin fish in our brood stock to achieve the stated target proportionate natural influence of 0.67. Monitoring data (see Table 6-5 in 2017 Master Plan) indicate that collection of the number of natural-origin spring Chinook required to achieve the target PNI at Lyle Falls trap is neither possible nor desirable at the present time. Therefore, we intend to implement a phased approach and the following actions beginning in the spring of 2020, to reduce pHOS and move us toward our goal of improving the quality of natural-origin fish and ultimately increasing the natural population.

- Increase the harvest rate in recreational and Tribal fisheries above Lyle Falls. The increase in harvest is expected to reduce pHOS initially by about 10% given current levels of natural escapement.
- Maintain or increase existing hatchery-origin adult returns from a reduced juvenile release by implementing actions to increase smolt survival which should in turn increase adult returns. This is an interim measure that we believe is required to affect an immediate increase in the proportion of hatchery-origin fish returning from a relatively small number of natural-origin parents incorporated into the hatchery program brood stock. Table 6-2 in the 2017 Master Plan indicates that only 420,000 smolts were released in 2010; yet adult returns from this release in 2012 were comparable to returns from the average release of about 600,000 smolts in most recent years. While the mechanism responsible for the

improved survival observed for the 2010 release is unknown, we hypothesize that smolt survival can be improved substantially by releasing spring Chinook yearlings at a more normative release time (on or about April 15) compared to late-February-to-mid-March releases presently. A more normative release timing will coincide with Bonneville Dam spring spill schedules thus allowing quicker migration past any predatory barriers and more timely arrival to feeding grounds in the lower Columbia River and estuary. Implementing a more normative release timing will require increased rearing capacity at the Klickitat hatchery. Spring Chinook yearlings are pushed out in mid-March due to the need to accommodate rearing space for other stocks. Improved survival of hatchery releases should allow us to begin increasing the proportion of one-generation hatchery parents incorporated into broodstock beginning in 2023. As the proportion of returning hatchery-origin fish with reduced hatchery-influence increases, the effects of hatchery-origin fish on the natural spawning grounds should be reduced (Araki et al. 2007a).

Description and analysis of phased approach to program reform

The All-H-Analyzer (AHA model) was used to quantify the progressive phases that will be required to transition the current hatchery stock to one more compatible with natural production while simultaneously providing sustained harvest opportunities. A total of 4 phases have been identified to fully transition the current hatchery program to the proposed long term program. While an implementation schedule is provided in this analysis, the actual timeline for transitioning from one phase to the next will rely on performance standards for one or more metrics such as adult return rates for hatchery origin Chinook, and abundance trends for the natural population. Thus, the timeline (Tables 3-5) provided represents the quickest possible transition period assuming all performance standards are being met. Included in the modeling analysis is a baseline conditions scenario that depicts the performance of hatchery and natural populations given the state of the habitat conditions as of 2005, historical hatchery practices and harvest. The baseline conditions scenario is an essential part of the analysis that provides a reference point for which performance parameters and metrics of the hatchery and wild composite population can be evaluated against as a result of future hatchery reform efforts, re-colonized habitat, future restoration activities, and recent changes in harvest management. A synopsis of the program's phased approach is provided below followed by the modeling analysis for each phase describing assumed changes in habitat conditions, hatchery practices, and performance metrics.

Phase I- Implement collection of NOR adults for new hatchery stock (N_1 line).

Approximately 68 NOR adults will be collected during this phase of the program thus, producing a smolt release of ~100,000 yearling smolts. NOR adults will be spawned with NOR adults and differentially marked from the existing hatchery line (H_1 line) to allow unique identification and improved survival through mark-selective fisheries (no adipose clip will be applied). The 2012 Master Plan indicated the broodstock collection rate will not exceed 25% of the natural run, per guidelines recommended by the HSRG. The most recent 10 years of NOR run size estimates at Lyle Falls suggest that collection of 68 adults would result in a collection rate of about 14.1% (10.3% to 22.0%) of the natural population for broodstock annually (Table 1).

Table 1. Estimated natural-origin (NOR) spring Chinook run size and brood collection rate at Lyle Falls adult trap to support an initial integrated hatchery program release of 100,000 smolts (we estimate that 68 adults are required to support this initial program size).

Year	Est. Run	NOR brood collection rate
2007	393	17.3%
2008	449	15.2%
2009	620	11.0%
2010	508	13.4%
2011	685	9.9%
2012	579	11.7%
2013	462	14.7%
2014	309	22.0%
2015	663	10.3%
2016	442	15.4%
Mean Nat Orig. Brood Take: 14.1%		

Returning adults from the N_1 line will be used as the founder broodstock for the new, H_2 line (long-term harvest component of the program) during phase II of the program. In addition, adults from the N_1 line may be used for re-colonization of the upper watershed above Castile Falls if returning adult numbers allow.

The N_1 program is designed to minimize the broodstock collection rate on the NOR population while providing a minimum number of returning adults to begin propagation of the new H_2 hatchery line while terminating the existing H_1 hatchery line as quickly as possible. Recent improvements in hatchery SARs from an average of 0.32% to 0.50% will greatly assist in the programs ability to expedite transition into the next phase. Furthermore, both current and near future hatchery reform efforts are expected to bolster the SARs of the hatchery program Chinook. The recent changes to hatchery culturing practices (reduction in mini-jacks, reduced rearing densities) combined with a shift in release timing to a more normative spring period is hypothesized to improve outmigration survival and translate to improved SARs. Currently, spring Chinook smolts are released directly into the Klickitat River from the hatchery on or about March 1st. The release timing is typically prior to any spring freshets in the Klickitat River, or commencement

of spill schedules at Bonneville Dam. Maintaining a SAR of 0.50% or greater is a viable goal considering the SAR values recently observed in other neighboring Columbia Gorge spring Chinook programs (Table 2). In order to accommodate a shift in release timing, a reduction in release numbers will be necessary due to temporal space constraints of existing hatchery infrastructure. The projected total release number of yearlings will be temporarily reduced from 600,000 to 400,000-450,000 (100,000 N_1 line and 300,000 to 350,000 H_1 line). The broodstock collection and release numbers for phase I of the program transition are summarized in Tables 3 and 4.

Table 2. Estimated SARs for mid-Columbia River spring Chinook hatchery programs. Values are percent SAR for juvenile (assumed yearling) release to Bonneville Dam adult return without Jacks from Appendix B in the 2017 CSS Annual Report. For Klickitat, values are yearling release to Klickitat River mouth return (age-4 to age-6 only) from YN databases.

Brood Year	Klickitat	Carson NFH	Warm Springs
1998	0.31	2.85	
1999	0.33	1.49	
2000	0.19	1.01	
2001	0.22	0.23	
2002	0.22	0.62	
2003	0.09	0.30	
2004	0.14	0.42	
2005	0.23	0.54	0.30
2006	0.35	1.48	0.84
2007	0.27	1.42	0.65
2008	0.45	0.75	0.21
2009	0.22	0.33	0.19
2010	0.43	0.54	0.66
2011	0.48	1.05	1.18
2012	0.29	0.56	0.89
2013	0.32	0.39	0.36
Geo. Mean	0.22	0.69	0.49

Phase II- Implement harvest augmentation hatchery stock conversion (H_2 line)

Phase II will begin propagation of the new H_2 hatchery line while simultaneously terminating brood collection for the H_1 hatchery line. The founder stock to be used for the new H_2 hatchery line will consist of returning adults from the N_1 hatchery line. Collection of N_1 adults for the H_2 line will be triggered by the first year when sufficient numbers of adults return with all age classes present from the N_1 line. Phase II will terminate the H_1 line when N_1 returns are sufficient to maintain a release number equivalent to 300,000-350,000 smolts. Actual release numbers may vary during the transitional phase II due to adult return rates of the N_1 line, and trapping efficiencies from

combined efforts at the Lyle Falls adult trap and volunteer trap at the Klickitat hatchery. The initial size of the N_1 program was specifically designed to minimize the NOR broodstock collection rate while producing enough adults to maintain the reduced smolt release of 300-350,000 thus, allowing for a quick transition from the H_1 to H_2 hatchery line. Depending on adult return rates and trapping efficiencies of the Lyle adult trap, any surplus N_1 line adults collected will be released into the natural habitat above Castile Falls to aid in the re-colonization process of the upper Basin. Further, the survival rates of the N_1 line and the status of NOR population will be continuously evaluated for possible, or necessary refinements to the number of NOR adults collected for the N_1 line. A summary of the implementation schedule, number of adults to be collected, and number of yearlings to be released are summarized in Tables 3and 4.

Phase III- Complete hatchery stock conversion; begin increasing total hatchery release numbers toward project's final release numbers.

The beginning of phase III should mark a point in time when H_1 line adults are no longer returning to the basin, and increases in natural production are potentially realized due to the initial recolonization of habitat above Castile Falls. This phase of the program will begin increasing the number of hatchery releases toward the Master Plan's stated release goals. Information to be analyzed in the decision framework to initiate phase III will include a stock status review of the natural population, and performance (adult return rates) of N_1 and H_2 hatchery lines. Improved performance of the natural and hatchery populations may allow the program to transition from phase II to III based on the following:

- **Increased natural production of the NOR population-** This will allow for the option of the N_1 line to increase production from 100,000 (68 adults) to 150,000 (102 adults) while keeping the NOR broodstock collection rate below 25%. A small proportion of NORs could also be included in the H_2 line to help bolster PNI values of the composite population.
- **Improved Smolt-to-adult return rates of hatchery fish-** Additional N_1 line adults may be available for broodstock if smolt-to-adult return rates meet or exceed 0.50%. Surplus N_1 line adults released into the upper watershed during phase II of the program could also be re-prioritized for H_2 line broodstock needs, thus eliminating the need to collect additional NORs.

Phase IV- Final increase of N_1 hatchery line and/or H_2 hatchery line release numbers to meet stated project objectives.

The final phase of the program will increase hatchery releases to the full extent as outlined in the Master Plan. Similar to phase III, information to be analyzed in the decision framework to initiate phase IV will include a stock status review of the natural population, and performance (adult return rates) of N_1 and H_2 hatchery lines. The

following elements are necessary to achieve the project's long term conservation goals for a PNI 0.67%:

- **Improved habitat conditions and survival-** A combination of seeded habitat in the upper basin, habitat restoration actions, and slight improvements in NOR smolt-to-adult survival rates may be required to increase NOR abundance for the Klickitat spring Chinook population.
- **Increased harvest of HORs-** A reduction in pHOS through harvest management practices will improve the PNI. In particular, increasing the harvest and reducing escapement of the H_2 hatchery line will have a greater positive effect on improving the PNI due to the small proportion of NORs used for this program, as opposed to the N_1 line that uses 100% natural-origin broodstock. Current WDFW regulations do not allow spring Chinook fishing until June 1st. The majority of the spring Chinook run enter the Klickitat and migrate upriver toward the hatchery between mid-April and the end of May. The fishery is restricted until the hatchery has met the majority of its broodstock needs from adults volunteering into the hatchery. Collection of broodstock at Lyle Falls will allow the fishery to be open during the month of May.

Table 3. Broodstock collection schedule for Klickitat spring Chinook Integrated hatchery program. N_1 line = NOR x NOR crosses; H_1 line = current/historical hatchery stock; H_2 line = New hatchery line consisting of F_1 hatchery adults (from N_1 line) that may include some proportion of NORs in phase III and IV.

	Broodstock Collection Schedule			
Program Phase	Brood Year	# N_1 Line Brood	# H_1 Line Brood	# H_2 Line Brood
Phase I	**2018**	68	240	-
	2019	68	240	-
	2020	68	240	-
	2021	68	240	-
	2022	68	240	-
Phase II	**2023**	68	-	240
	2024	68		240
	2025	68		240
	2026	68		240
	2027	68		240
Phase III	**2028**	104		310
	2029	104		310
	2030	104		310
	2031	104		310
	2032	104		310
Phase IV	2033	138		411
	2034	138		411
	2035	138		411
	2036	138		411
	2037	138		411
	2038	138		411

Table 4. Juvenile release schedule for Klickitat spring Chinook Integrated hatchery program. N_1 line = NOR x NOR crosses; H_1 line = current/historical hatchery stock; H_2 line = New hatchery line consisting of F_1 hatchery adults (from N_1 line) that may include some proportion of NORs in phase III and IV.

Release year	# N_1 Line Releases	# H_1 Line Release	# H_2 Line Releases	Total Releases
2020	100,000	350,000		450,000
2021	100,000	350,000		450,000
2022	100,000	350,000		450,000
2023	100,000	350,000		450,000
2024	100,000	350,000		450,000
2025	100,000		300-350,000	400-450,000
2026	100,000		300-350,000	400-450,000
2027	100,000		300-350,000	400-450,000
2028	100,000		300-350,000	400-450,000
2029	100,000		300-350,000	400-450,000
2030	150,000		450-500,000	550-600,000
2031	150,000		450-500,000	550-600,000
2032	150,000		450-500,000	550-600,000
2033	150,000		450-500,000	550-600,000
2034	150,000		450-500,000	550-600,000
2035	200,000		600,000	800,000
2036	200,000		600,000	800,000
2037	200,000		600,000	800,000
2038	200,000		600,000	800,000
2039	200,000		600,000	800,000
2040	200,000		600,000	800,000

Table 5. Adult return schedule for Klickitat spring Chinook Integrated hatchery program. N_1 line = NOR x NOR crosses; H_1 line = current/historical hatchery stock; H_2 line = New hatchery line consisting of F_1 hatchery adults (from N_1 line) that may include some proportion of NORs in phase III and IV.

Adult Return Schedule			
Return Year	N_1 Line Adults	H_1 Line Adults	H_2 Line Adults
2022	-		-
2023	-		-
2024			-
2025			-
2026			-
2027			-
2028			
2029		Terminated	
2030			
2031			
2032			
2033			
2034			
2035			
2036			
2037			
2038			
2039			
2040			
2041			

Model parameterization and analysis

The analysis includes scenarios for baseline conditions and for each of the four phases of the proposed program. The analysis modeled the progressive changes in management actions and strategies linked to hatchery practices, habitat restoration actions and potential changes in harvest rates. As noted in preceding paragraphs and tables of this document, the projected timelines for each phase of the project hinge upon performance standards for both hatchery and wild spring Chinook, and should be viewed as the minimal timeframe needed for project progression. Actual timelines for each phase of the project may be delayed due to a number of factors. Similarly, modeling results for each phase of the project do not have a specified number of years tied directly to them. The

modeling results for each phase of the project demonstrate the responses in NOR and HOR abundances, harvest, and PNI values based on phase specific management actions regardless of projected timelines. In essence, the results for each phase can be viewed as the long-term projections and benefits of each phase of the program. A summary of model parameters influenced by changes in management actions and habitat conditions is summarized in Table 6 below.

Baseline Conditions:

Habitat- EDT modeled estimates of natural production potential for the state of the habitat prior to 2005 in the absence of harvest. "Baseline Conditions" is defined as a model run representing natural production potential prior to basin wide habitat restoration activities and passage improvements at Castile Falls completed as of 2005. The baseline conditions scenario serves as a reference point for natural production potential prior to re-colonization of the upper basin above Castile Falls, and habitat restoration activities occurring after 2005. While substantial habitat work has been completed subsequent to the baseline conditions model development, much work remains to meet “full restoration potential”.

Phase I- Implement collection of NOR adults for new hatchery stock (N_1 line).

Management Actions and translated changes in model attributes:

- **Implement collection of NOR adults for new, small scale hatchery program (N_1 line)**
  68 NOR adults collected from NOR population to maintain a smolt release of 100,000 yearlings. Returning adults will be unclipped and therefore subjected to lower harvest rates due to mark-selective fisheries. Adults escaping fisheries and not required for brood stock will be allowed to spawn with natural population.

- **Reduce H_1 line release numbers**
  The current hatchery line (H_1 line) release numbers will be reduced from 600,000 to 350,000 smolts.

- **Reduce rearing densities and change release timing of yearling smolts from approximately March 1st to mid-April**
  Combining these hatchery reform efforts with recently improved culturing practices (reduction in mini-jacks and disease culling) will yield a higher quality smolt and improved out-migration survival. The analysis assumed these changes will yield an improved mean SAR to meet or exceed 0.50%

- **Increase terminal harvest on H_1 hatchery line**

Terminal harvest of spring Chinook has been constrained historically due to the need for adequate adult escapement to the hatchery to meet broodstock requirements (via volunteer trap). Therefore, harvest between Lyle falls (rm .05) and the hatchery (rm 45) has been minimal during the migration period when the majority of spring Chinook are moving through the lower and middle parts of the Klickitat River. With recent improvements to the Lyle Falls trapping facility, the program will attempt to collect 100% of the spring Chinook broodstock for all phases of the project at Lyle Falls rather than relying on hatchery rack returns at rm 45. This management action will allow for an increase in the terminal harvest rate on hatchery spring Chinook. We assumed an initial increase of 15% for a fishery that has been minimal during the peak migration month of May through the lower River.

- **Other Phase I analysis assumptions**
  We assumed no changes in habitat conditions had occurred at this point in time due to the minimal time frame projected for phase I.

Phase II- Implement harvest augmentation hatchery stock conversion

Management Actions and translated changes in model attributes:

- **Terminate broodstock collection and juvenile releases of the H_1 hatchery line; begin collection of N_1 line returning adults for new H_2 hatchery line.**
  This management action directly replaces the broodstock and 350,000 H_1 line juvenile release with the new H_2 line hatchery stock. Performance differences between the two hatchery stocks were modeled as differences in the relative reproductive success (RRS). The HSRG has consistently used a RRS value of 0.8 for all spring Chinook hatchery stocks regardless of differences in types of programs (low vs high pNOB values) or the number of generations the hatchery line has been subjected to the hatchery environment. The Klickitat hatchery stock has a distinct propagation history that not only excluded natural-origin adults for the majority of its 60+ years of culturing, but also mistakenly mixed out of basin Ocean-type ancestral lineages with the Klickitat Stream-type stock during historic brood collection practices (Hess et al. 2011). Due to these compounded effects and unique circumstances, a survival difference at one or more life-stages may theoretically exist between the historic H_1 hatchery line and the future H_2 hatchery line. Therefore, we assumed a RRS value of 0.5 for the historic H_1 line, and a RRS value of 0.8 for the new H_2 line. While there continues to be a lot of scientific study about relative reproductive success, we believe the assumptions we used for RRS in our models remain within the bounds of published studies. Furthermore, reducing the RRS assumption of 0.8 for the new H_2 line using some recently published study results would actually result in fewer hatchery-origin effective spawners on the spawning grounds thereby increasing PNI values.

- **Continue re-colonization of upper basin**
  We assumed that some amount of natural production will be realized by the end of Phase II given that:
    a) Passage improvements were completed at Castile falls in 2005, allowing spring Chinook 3 to 4 generations to begin the re-colonization process of the upper Basin.
    b) Surplus adults captured from the N_1 hatchery line will be released into the natural environment of the upper basin during this phase.

  In order to evaluate the natural spawning of the additional N_1 line adults in the wild, the total proportion of N_1 line returning adults that are trapped and removed from the natural environment were reduced (Table 1), thus increasing escapement of N_1 hatchery adults to the natural spawning grounds. We also assumed that re-colonization by NOR spring Chinook, combined with additional escapement of the N_1 hatchery line adults will lead to an approximate 50% increase in utilization of the upper basin's habitat potential by the end of phase II. Therefore we estimated an increase of 50% utilization of the upper basin's habitat capacity and a 50% increase in intrinsic productivity in the phase II habitat model parameters (Table 6).

- **Other Phase II analysis assumptions**
  Smolt-to-adult return rates and assumed harvest rates were maintained (Phase I values) for both hatchery and wild spring Chinook.

Phase III- Complete hatchery stock conversion and begin increasing total hatchery release numbers toward project's final release numbers.

Management Actions and translated changes in model attributes:

- **Increase hatchery production**
  The analysis increased production of the N_1 line from a release of 100,000 (68 adults) to 150,000 smolts (102 adults), and production of the H_2 line from 350,000 (240 adults) to 450,000 smolts (310 adults). In order to accommodate the additional broodstock needs for the H_2 line program, the N_1 line adults that were captured and artificially released for natural spawning during phase II will now be retained for the H_2 line broodstock. This was accomplished in the analysis by increasing the trapping rate of the N_1 hatchery line from 68 to 104. This phase also begins to incorporate a small proportion of natural-origin broodstock 10% (31 adults) into the H_2 line to further increase the PNI of the composite hatchery/wild population.

- **Continue re-colonization of upper basin**
  For the phase III analysis, we further assumed an even greater proportion of the upper basin’s habitat will have been seeded with natural production. By assuming

nearly complete re-colonization of the upper basin, the analysis used 100% of the estimated habitat capacity and intrinsic productivity of the entire Klickitat basin (Table 6).

- **Increase harvest**
  With an increase in hatchery production during Phase III, additional harvest opportunities within the Basin would be provided (e.g., fishery can be opened and sustained throughout the entire run-timing, including the month of May which currently has limited to no fishing opportunity in the River between Lyle Falls and the hatchery). We assumed the terminal harvest rate would increase by 5% which would also reduce pHOS.

- **Other Phase III analysis assumptions**
  Smolt-to-adult return rates were maintained (Phase I and II values) for both hatchery and wild spring Chinook. Harvest rates on natural-origin, and N_1 line hatchery-origin Chinook did not change.

Phase IV- Final increase of N_1 hatchery line and/or H_2 hatchery line release numbers to meet project objectives.

Management Actions and translated changes in model attributes:

- **Increase hatchery production to final release numbers**
  The analysis increased production of the N_1 line from a release of 150,000 (102 adults) to 200,000 smolts (138 adults), and production of the H_2 line from 450,000 (310 adults) to 600,000 smolts (411 adults). The additional broodstock needs of the H_2 line will be met from a combination of increased adult returns from the N_1 line (from increased release numbers in phase III) and a small number of additional NOR adults (increased from ~31 to 41 adults). The slight increase in NOR adults used as a broodstock source for the H_2 line will maintain a pNOB value of 10% for the H_2 hatchery line.

- **Continue to improve quality and quantity of habitat**
  For the phase IV analysis, we assumed that ongoing habitat restoration actions will have been realized. Specifically, we assumed restoration actions resulting in slight improvements in both quality (productivity) and quantity (capacity) will have matured prior to implementation of phase IV.

- **Increase harvest**
  With an increase in hatchery production, additional harvest opportunities within the Basin would be provided. We assumed the terminal harvest rate would increase by 5% which would also reduce pHOS.

- **Other Phase IV analysis assumptions**

Smolt-to-adult return rates were maintained (Phase I-III values) for both hatchery lines of Chinook. Harvest rates on natural-origin, and N_1 line hatchery-origin Chinook did not change.

Table 6. Critical model parameters that were varied based on management actions, habitat re-colonization, habitat restoration, and harvest.

		Baseline Condition	Phase I	Phase II	Phase III	Phase IV
Habitat	Capacity	607	607	939	1271	1360
	Productivity	6.2	6.2	6.35	6.5	7.7
Smolt-to-adult survival (SARs)	NORs	.043	.043	.043	.043	.053
	HORs (H_1 line)	.024	.0050	-	-	-
	HORs (N_1&H_2 lines)	-	.0050	.0050	.0050	.0050
Harvest (Total Exploitation)	NORs	.409	.277	.277	.277	.277
	HORs (H_1 line)	.409	.553			
	HORs (N_1 line)		.277	.277	.277	.277
	HORs (H_2 line)		.553	.553	.593	.634
Hatchery Broodstock and Juvenile Release #'s	# NOR adults (H_1 line)	~3-8	-	-	-	-
	# NOR adults (N_1 line)	-	68	68	104	138
	# NOR adults (H_2 line)	-	-	-	16	41
	H_1 line Juvenile release #	600,000	350,000	-	-	-
	N_1 line Juvenile release #	-	100,000	100,000	150,000	200,000
	H_2 line Juvenile release #	-		350,000	450,000	600,000
Relative Reproductive Success (HORs)	HORs (H_1 line)	0.50	0.50	-	-	-
	HORs (N_1 line)	-	0.8	0.8	0.8	0.8
	HORs (H_2 line)	-	-	0.8	0.8	0.8

Table 7. Model estimates of natural-origin broodstock collection rates based on the projected number of adults needed and estimated NOR abundances for each phase of the program.

Estimated % of NOR run taken for broodstock				
	Phase I	Phase II	Phase III	Phase IV
# NOR adults	68	80	135	179
pNOB	28%	28%	33%	33%
% of NOR run	18.6%	13.5%	17.3%	16.7%

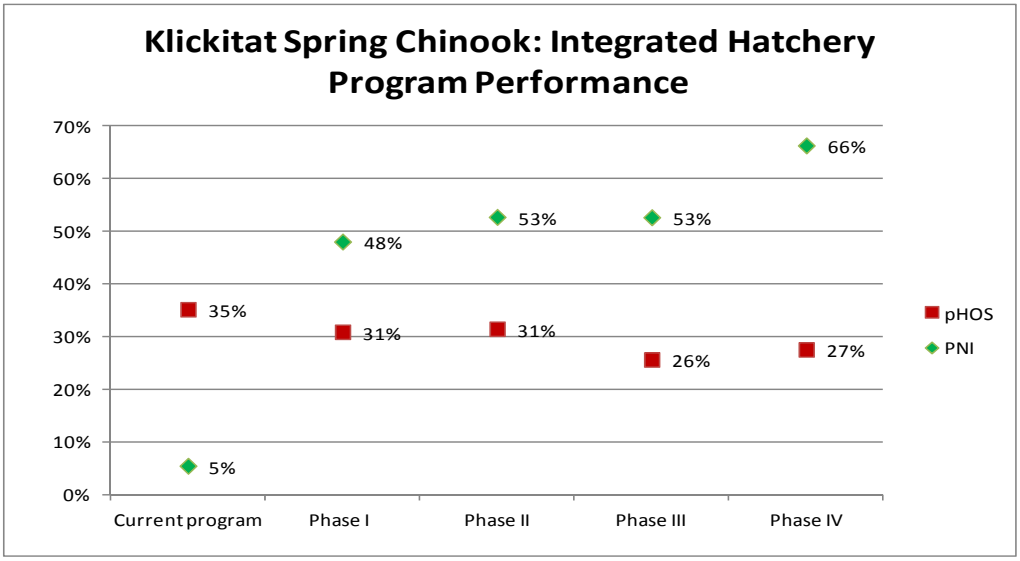

Figure 1. Model estimates of pHOS and PNI for each phase of the program.

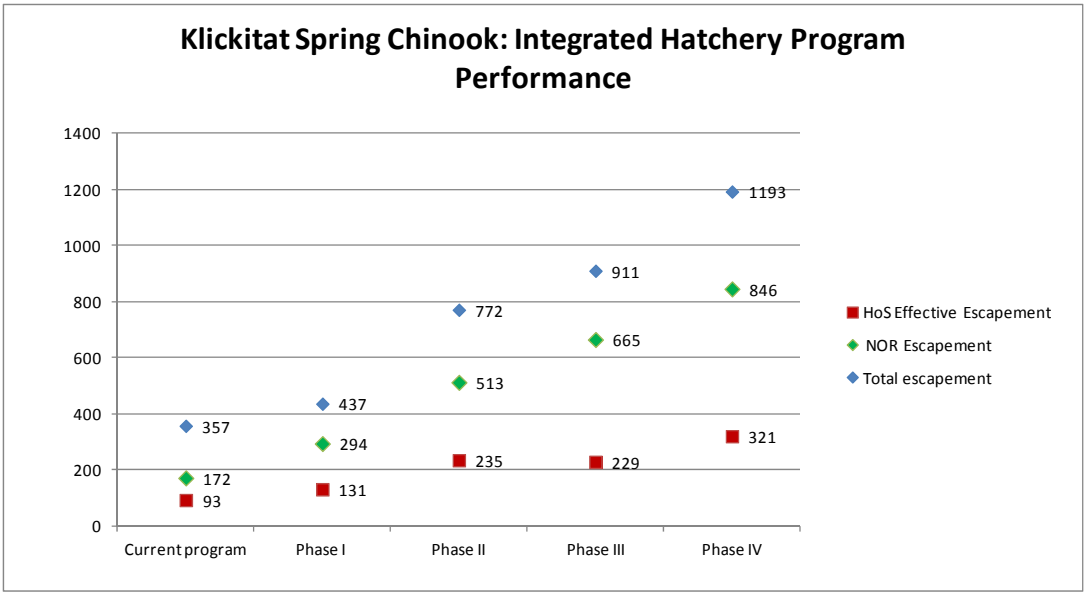

Figure 2. Model estimates for NOR, HOR, and Total Escapement for each phase of the program.