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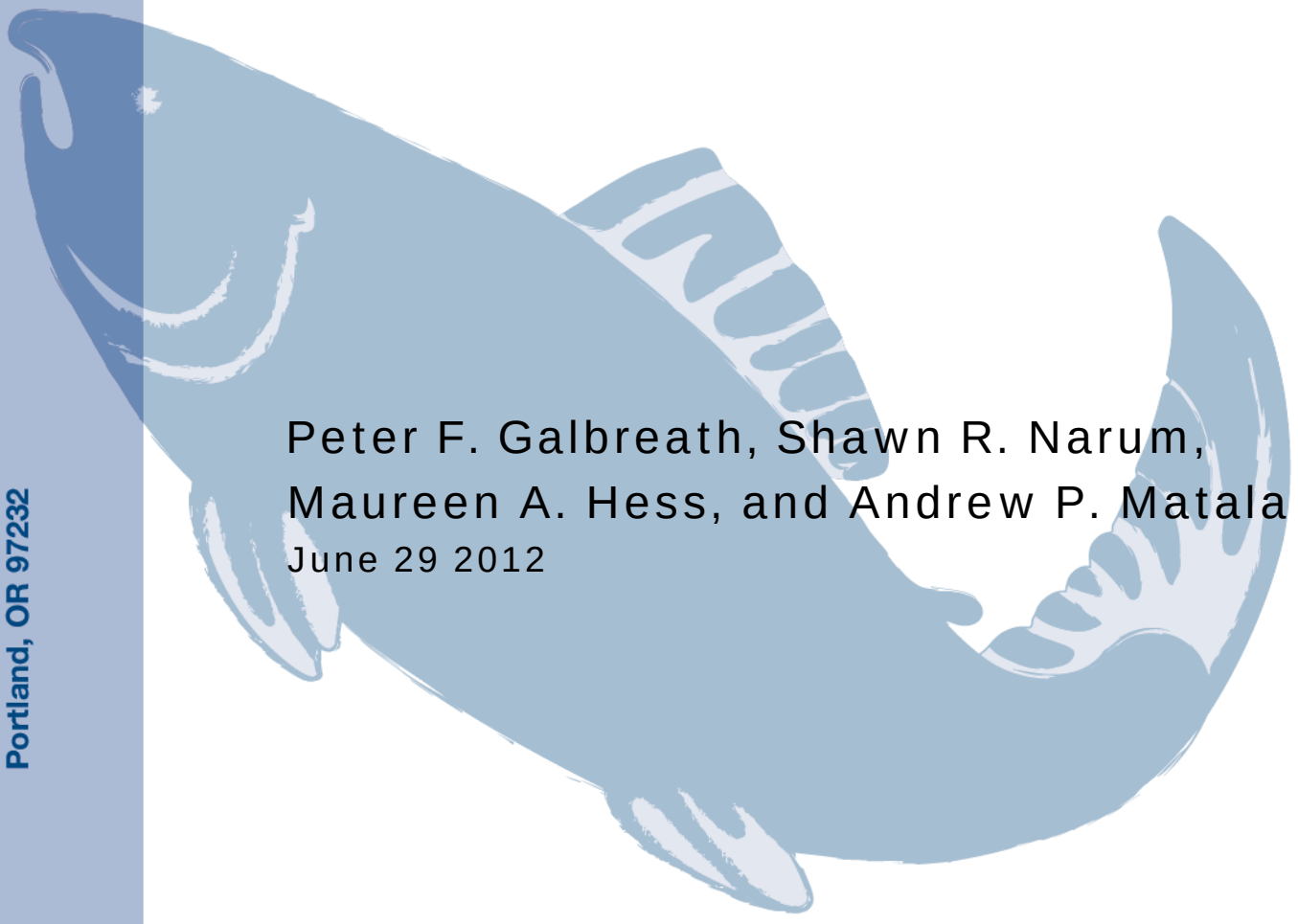
CRITFC

TECHNICAL REPORT 12-16

Basinwide Supplementation Evaluation Project: 2011 Annual Progress Report



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Annual Progress Report

Contract Year #3 (May 1, 2011 to April 30, 2012)

Basinwide Supplementation Evaluation

Contract No. 53108
Project No. 2009-009-00

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Executive Summary

This report reviews activities and results for contract year #3 (May 1, 2011 to April 30, 2012) of the multi-year Basinwide Supplementation Evaluation project (hereafter, the Project). In addition to activities involving administration of the Project, work elements for this contract year were organized under six project objectives, with results for each summarized briefly as follows:

Project Administration:

Activities to administer the Project involved production of the annual progress report for contract year #2, quarterly and final status reports and monthly project expense summaries for contract year #3, and an equipment inventory and a line item budget proposal for contract year #4.

Project Objective #1: Support an RRS study of Johnson Creek spring/summer Chinook

As per the agreement reached with the Nez Perce Tribe (NPT) Department of Fisheries Resource Management in contract year #2, the Project provided supplemental financing to an ongoing relative reproductive success (RRS) study of spring Chinook (*Oncorhynchus tshawytscha*) associated with the Johnson Creek Artificial Propagation Enhancement Project (JCAPE). The funding served to genotype a portion of the samples collected in 2010 (n≈2,865). The 2010 collection involved a substantially increased number of juvenile samples relative to prior years, as requested by CRITFC to provide greater power for assessing RRS based on juvenile recruits-per-spawner (R/S).

Project Objective #2: Support RRS studies of reintroduced salmon populations

The Project financed genotyping of adult and juvenile spring Chinook samples as part of ongoing RRS studies in the Hood River (n≈530), Newsome Creek (South Fork Clearwater River; n≈1,400), and Lookingglass Creek (Grande Ronde River; n≈1,455). The Project also financed genotyping of juvenile and adult samples of reintroduced sockeye/kokanee (*Oncorhynchus nerka*) in Cle Elum Lake (Yakima River; n≈680), Suttle Lake and Lake Billy Chinook (Deschutes River; n≈1,490), and of Deschutes River steelhead collected at Shearer's Falls (n≈750).

An additional RRS study was proposed for spring Chinook reintroduced to Lolo Creek (Clearwater River), but efforts had to be abandoned due to high spring flows which precluded collection of adult samples required for the study. Initiation of a study will likely not begin until after construction of a permanent weir, scheduled for 2013. An RRS study was also proposed for Crooked River spring Chinook - a neighboring population to Newsome Creek. However, this study was also put on hold due to inability to locate a portion of the associated archived samples. Whether to initiate a study beginning with current collections remains under discussion. An RRS study proposed for reintroduced coho in the Wenatchee River also had to be abandoned, due to inability to systematically sample in-migrating adults. Discussions have been initiated regarding the possibility of an RRS study of reintroduced coho in Lapwai Creek (Clearwater River), which may be feasible following planned construction of a weir in 2012.

Project Objective #3: Organize Fisheries Genetics Training Program for tribal fisheries personnel

Three 2-day "Introduction to Molecular Genetics Analyses in Tribal Fisheries Management" training programs were held at the Hagerman Fish Culture Experiment Station (HFCES), in collaboration with CRITFC personnel working at the HFCES molecular genetics laboratory. Participants in the programs included tribal technicians and biologists - 8 from CRITFC in the first training program, 2 from CTWSRO and 4 from YN in the second, and 4 each from NPT and CTUIR in the third.

Project Objective #4: Prepare manuscripts for publication in scientific journals

A likelihood model (MRmix) that uses mark-recapture data to provide robust estimates of both population abundance and tag loss rate (and associated uncertainty of each estimate) was developed by CRITFC

scientists and described in the manuscript, "Accounting for tag loss and its uncertainty in a mark–recapture study with a mixture of single and double tags" (Hyun et al. 2012), published during contract year #3. Additionally, the model was adapted to a web-based interface in contract year #3 and this "user-friendly" version was made available to the public at: http://www.critfc.org/mrmix.

A manuscript describing RRS results based on adult R/S for the initial broodyears of the JCAPE spring Chinook supplementation project (see Project Objective #1) was submitted for publication in Molecular Ecology in early 2012. The manuscript, entitled "Supportive breeding boosts natural population abundance without inflicting negative fitness impacts on a wild population of Chinook salmon", is currently in review with publication anticipated later in contract year #4.

A draft of the manuscript, "Tribal reintroduction of extirpated coho salmon to the interior Columbia River basin", was nearing finalization at the end of contract year #3. Submission for publication in the journal Fisheries is anticipated within the first quarter of contract year #4.

Project Objective #5: Participate in regional forums for review of hatchery effects on natural populations

Project scientists participated in a variety of inter-tribal and inter-agency meetings, workshops and symposia in which issues related to hatchery management were discussed, including the nature and magnitude of effects that hatchery origin salmon and steelhead may have on the natural populations with which they interact or interbreed.

Project Objective #6: DIDSON Escapement Estimation

A Dual-Frequency Identification Sonar (DIDSON) was operated at the Castile Falls Fishway (rkm 103) on the Klickitat River from July to October 2011. Observation of fish passage events in the recorded video files provided an estimate for the 2011 escapement of spring Chinook to the upper basin. However, this estimate (n=38) is highly uncertain due to the relatively low number of recorded files and the non-systematic manner in which they were collected, caused by frequent power outages that occurred over the study period. The estimate is nonetheless of a magnitude similar to estimates obtained using DIDSON sonar in 2009 and 2010. Also, as in the previous two years, the estimate was substantially greater than the estimate based on an expanded redd count (in fact, no redds were observed in 2010).

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1.0 Introduction

In their 2005 report submitted to the Northwest Power and Conservation Council (NPCC) entitled "Monitoring and Evaluation of Supplementation Projects" (ISRP and ISAB 2005), the Independent Scientific Review Panel (ISRP) and Independent Scientific Advisory Board (ISAB) recommended that an interagency workgroup be formed to design a monitoring and evaluation approach to obtain a basinwide understanding of the critical uncertainties regarding use of hatchery supplementation for rebuilding depressed populations. In response, the Ad Hoc Supplementation Workgroup (AHSWG) was formed – a group of volunteer scientists and managers associated with tribal, state and federal fisheries agencies, power companies, and other non-governmental agencies. Following a series of workshops and ancillary discussions, the AHSWG recommended a three-pronged approach: 1) conduct treatment/reference (T/R) comparisons of long-term trends in the abundance and productivity of multiple supplemented (treatment) populations relative to un-supplemented (reference) populations, 2) conduct a series of relative reproductive success (RRS) studies to quantify short-term impacts through comparisons of productivity within broodyears of hatchery-origin (HO) and natural-origin (NO) fish observed in programs to supplement depressed natural populations, and in programs where an extirpated stock was reintroduced and supplemented with hatchery-reared fish, and 3) develop a request for proposals to fund several intensive small-scale studies designed to elucidate various biological mechanisms by which introduction of hatchery-produced fish may influence natural population productivity (AHSWG 2008).

The Basinwide Supplementation Evaluation project, submitted as part of the Columbia Basin Fish Accords (2008), was designed to implement actions in support of the AHSWG recommendations, including: 1) improve abundance and productivity estimation procedures used in monitoring supplemented and reference populations (contract year #3, project objective #6), and 2) derive RRS information from supplemented populations (contract year #3, project objective #1) and from reintroduced/supplemented populations (contract year #3, project objective #2). The remaining project objectives under contract year #3 (# 3, #4, and #5), support personnel training, project reporting and participation in regional forums for review of hatchery management and supplementation effects.

Note: Details for the laboratory protocols and methodologies used in the RRS studies described in the following sections are available at http://www.monitoringmethods.org/Protocol/Details/309, and http://www.monitoringmethods.org/Method/Details/1329.

2.0 Project Administration

Activities involved in administration of the Project by CRITFC during contract year #3 included: production and posting in Pisces of the annual progress report for contract year #2, completion of quarterly and final status reports in Pisces that record progress associated with each work element within the statement of work, submission of monthly project expense summaries to BPA, production and posting in Pisces of an end-of-the-contract-year capital and non-capital equipment inventory, and production and posting in Pisces of a line item budget proposal for contract year #4. Additional reports and presentation documents summarizing results from various work elements were also posted to the project's PISCES web site.

3.0 **Project Objective #1:** Support an RRS study of Johnson Creek spring/summer Chinook

Studies currently underway to assess RRS of supplemented Columbia basin Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) include the Johnson Creek Artificial Propagation Enhancement Project (JCAPE; Project No. 199604300; Rabe and Nelson 2010). Beginning with the first year of supplementation (1998) of the spring/summer Chinook population in Johnson Creek (a tributary of the East Fork South Fork Salmon River), Nez Perce Tribe (NPT) biologists have collected tissue samples and biodata on all returning adults intercepted at a weir (rkm 8), as well as tissues from a limited number of out-migrating natural origin juveniles collected at a rotary screw trap operated just downstream. The tissues have been sent to CRITFC geneticists at the Hagerman Fish Culture

Experiment Station (HFCES), to be genotyped for parentage analyses conducted as part of an RRS study. In the initial years, the NPT had a variable amount of funding to cover the associated laboratory and analytical expenses. Currently, the NPT is able to commit $60,000 annually from available monitoring and evaluation funds, which is sufficient for analysis of approximately 1,500 samples per year. However, the number of samples collected annually has often exceeded this number, especially in recent years when the NPT has seen substantially increased escapement. Additionally, CRITFC recommended to NPT biologists during contract year #1 that the number of juvenile samples collected annually be increased to boost resolving power of RRS analyses based on juvenile recruits-per-spawner (R/S). These discussions culminated in a commitment made by the Project to provide supplemental funding to the JCAPE RRS study, sufficient to genotype a backlog of juvenile and adult samples, and to assure analysis of the adult samples and an increased number of juvenile samples collected annually beyond the 1,500 samples financed by the NPT. In contract year #3, funds from the Project were used to genotype 2,865 juvenile samples collected in 2010.

During contract year #3, genotyping of the adult samples collected since initiation of the supplementation project in 1998 through 2010 was completed. This permitted parentage and statistical analyses to be conducted to assess relative productivity in the wild environment (based on adult R/S) of hatchery and natural origin fish within sexes for the initial four broodyears of the project. Results showed only limited evidence that hatchery-reared fish had lower fitness than their wild-origin counterparts. While average reproductive success of adult (age 4 and 5) males in 2002 and of "jack" (age 3) males in 2003 was significantly lower ($p < 0.01$), the other male comparisons and none of the female comparisons were significant. Additionally, average R/S of hatchery-reared fish (H) that mated in the wild with either hatchery or wild origin fish was generally equivalent to that of matings between two wild fish (W); overall RRS of HxH and HxW matings relative to WxW was 0.94 ($p = 0.95$) and 1.07 ($p = 0.92$), respectively. Thus, for the years analyzed, fish chosen for hatchery rearing did not have a detectable negative impact on the fitness of wild fish by mating with them for a single generation. A manuscript describing these analyses and results, "Supportive breeding boosts natural population abundance with minimal negative impacts on fitness of a wild population of Chinook salmon", was recently submitted for publication in Molecular Ecology. The manuscript is currently in review, with anticipation that publication will occur later in contract year #4.

4.0 **Project Objective #2**: Support RRS studies of reintroduced salmon populations

Factors such as overfishing, freshwater habitat loss and degradation, and increased mortality during migration within the hydrosystem have been responsible for the current depressed state of natural salmon and steelhead populations in the Columbia basin. In some cases, however, the effect was even more dramatic, and lead to the extinction of the affected populations. This obviously included extirpation of all populations whose natal streams were above the impassable mainstem Chief Joseph (Columbia River) and Hells Canyon (Snake River) dams. However, many populations downstream of these dams were also lost, including spring Chinook in the Hood, Umatilla, Okanogan and Clearwater River basins, and 100% of the native coho salmon populations within the Columbia basin upstream of The Dalles Dam, etc. (Fulton 1968; Mullen 1983; Nehlson et al. 1991; O'Toole et al. 1991).

Tribal fisheries management agencies have engaged in efforts to recreate naturally spawning populations in some of the Columbia basin rivers where the indigenous fish were extirpated, primarily through stocking of juveniles produced from out-of-basin hatchery stocks (e.g., Bowles and Leitzinger 1991; Phillips et al. 2000; Underwood et al. 2003; Lutch et al. 2005; Murdoch et al. 2006; Bosch et al 2007; Narum et al. 2007). Results from these reintroduction programs have been encouraging in regard to population viability. Substantial numbers of the HO fish released as juveniles have returned as mature adults, and increasing numbers of NO juveniles (fry, parr and smolts) have been observed, indicating successful natural spawning of HO fish. Additionally, observation of NO adults in subsequent run years indicates that these fish have undergone a full generation or more of strictly natural production (Phillips et al. 2000; Underwood et al. 2003; Lutch 2005; Murdoch et al. 2006; Bosch et al 2007; Narum et al. 2007). However, what are the possibilities that these reintroduced fish will successfully establish a population that is naturally self-sustainable? As is true in programs that supplement extant populations, questions regarding the quality and quantity of available freshwater habitat and anticipated levels of hydrosystem

survival during migration will influence eventual self-sustainability. Beyond these questions, concern has been expressed regarding the deleterious effects that artificial production may have on natural fitness of hatchery reared fish and of the natural populations with which these fish interbreed (or, of the naturalized population derived from these fish, in the case of a reintroduction program). Concerns center on the fact that stocks reared in hatcheries over multiple generations may experience genetic selection for characters that are advantageous in the hatchery but disadvantageous in a natural environment. The concern relates to the belief that these traits are heritable (genetic) in nature, and may not be readily reversible (e.g., Ford 2002; ISRP 2005; Araki et al. 2008). If such is the case, there is reason to question whether an out-of-basin stock used for reintroduction purposes will retain the genetic diversity and adaptive potential needed for the stock to thrive in variable natural environments.

Broodstock management protocols for these reintroduction programs involve the progressive phasing out of stocking juveniles from the out-of-basin hatchery. Instead, returning adults are collected in-basin for use as broodfish, to produce the juveniles with which to continue supplementation of the newly reintroduced population. The initial generations of such "local origin" broodstock are comprised of mature HO adults. In subsequent generations, as returning NO adults increase in number, they are incorporated into the hatchery broodstock in greater proportion. The rationale is that the genetic characters which facilitated successful return and natural spawning of the original HO fish will be passed on to their progeny, and that over generations a population that is progressively better adapted to the local environment will be established and become increasingly abundant and productive.

In a recent meta-analysis, Fraser (2008) reviewed published reports for 31 different salmonid reintroduction programs, including several within the Columbia basin. For many of these programs, particularly those for which effects of hydrosystem blockages and habitat degradation which contributed to the extirpation of the original populations have been substantially reversed, new naturally reproducing populations appear to be re-establishing themselves. However, hatchery supplementation is ongoing, and uncertainty therefore remains as to whether the observed production in each is supported by spawning of a progressively better adapted naturalized population, or simply by natural production of some number of returning adults from the annual stocking of supplementation juveniles.

The Project has therefore included as a primary objective, the financing of RRS studies of several of these reintroduction/supplementation programs. If results show that the NO fish consistently demonstrate higher productivity relative to HO fish within broodyears, it would infer that adaptation to the new environment is indeed occurring. In contract year #3, the Project continued support of ongoing RRS studies of reintroduced spring Chinook in the Hood River, Lookingglass Creek (Grande Ronde River) and Newsome Creek (South Fork Clearwater River). The Project also supported genotyping of reintroduced sockeye/kokanee (*Oncorhynchus nerka*) in Cle Elum Lake (Cle Elum/Yakima Rivers) and Suttle Lake and Lake Billy Chinook (Metolius/Deschutes Rivers). Support of three additional RRS studies of reintroduced stocks was anticipated to begin in contract year #3: spring Chinook in the Crooked River (South Fork Clearwater River) and Lolo Creek (Clearwater River), and coho salmon in the Wenatchee River. However, logistical constraints precluded these three studies from being initiated. An RRS study in the Crooked River was to have begun with analysis of adult and juveniles samples collected over the past several years. However, Idaho Fish and Game was unable to locate the archived adult samples. The option to initiate a study with samples from the current broodyear onward remains under discussion. In Lolo Creek, high spring flows precluded collection of the needed adult samples in spring 2011. A study in Lolo Creek has put on hold until 2014, following construction of a permanent weir scheduled for 2013, which will assure reliable sampling of returning adults. An RRS study proposed for reintroduced coho in the Wenatchee River also had to be abandoned due to inability to systematically sample in-migrating adults. Discussions were recently initiated with the NPT regarding the possibility of an RRS study of reintroduced coho in Lapwai Creek, which may be feasible following construction of a weir located near its confluence with the Clearwater River, scheduled for completion in 2012. This possibility will be further studied during contract year #4.

4.1 Hood River spring Chinook

Many factors led to the extirpation of spring Chinook in the Hood River basin by the mid-1970s. Within a decade, however, plans were being made to reintroduce spring Chinook as part of a program to be co-managed by the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) and the Oregon Department of Fish and Wildlife (ODFW). The program began in 1986 with the stocking of Carson National Fish Hatchery (NFH) juveniles. Annual stocking has continued since then, although in 1992 the co-managers switched to use of Deschutes River stock from Round Butte Hatchery, with occasional input from the nearby Warm Springs NFH as needed (Underwood et al. 2003). Beginning in 1992, scales and ancillary biodata (sex, size, date, etc.) were collected annually on every in-migrating adult Chinook salmon intercepted in Hood River at the Powerdale Dam fish trap (rkm 6), along with information as to whether the fish was passed upstream for natural spawning, collected for hatchery broodstock, or recycled downstream to the sport fishery. Availability of several generations of archived scales that could be used as a source of DNA made initiation of an RRS evaluation of reintroduced spring Chinook possible. An updated version of the monitoring and evaluation program for the Hood River Production Program, including a description of the genetics study is available in ODFW and CTWSRO (2008).

From each of the envelopes containing the archived spring Chinook scales, a few scales were sub-sampled and sent to HCFES for DNA extraction, genotyping at suites of microsatellite DNA loci, parentage analysis, and estimation of RRS. Genotyping was performed for the large majority of available scales (n≈7,750) by the end of contract year #2, and analyses were performed on these data in contract year #3. Results indicate that the reintroduced stock of spring Chinook has indeed established a natural population, and that the NO fish demonstrate improved productivity relative to HO fish of the same stock. Interestingly, the data also indicates that an additional number of NO fish are of an alternative lower Columbia genetic lineage which appears to have colonized the Hood River, with fish of this genetic signature apparent in all run years. The source population(s) for these Lower Columbia colonizers cannot be determined. While interbreeding does occur between stocks, the genetic signature for many of these fish remains distinct; whether this is due to continued straying of fish into the Hood River, or to assortative mating between stocks is also unknown. While the number of lower Columbia lineage fish is low relative to the reintroduced stock, the data indicates that they demonstrate an even higher productivity than the NO fish of the reintroduced stock. This information is summarized in the poster “Reproductive success of reintroduced spring-run Chinook Salmon in the Hood River, Oregon” produced for the Feb 29-March 2 annual meeting of the Oregon Chapter of the American Fisheries Society (see Attachments within Pisces).

The parentage analyses also indicated possible interbreeding and/or misidentification of some spring-run versus fall-run Chinook. Therefore during contract year #3, samples for an additional 530 individuals labeled as fall-run Chinook were collected, so as to detect any that might prove to be parents of sampled spring-run progeny. These samples were genotyped, and reanalysis of the full dataset of genotypes is planned for contract year #4, to be followed by production of a manuscript for publication in a peer-reviewed scientific journal.

4.2 Lookingglass Creek (Grande Ronde River) spring Chinook

Spring Chinook populations within the Grande Ronde and Imnaha River subbasins declined dramatically in abundance by the 1980s. As part of the Lower Snake River Compensation Plan (LSRCP), a hatchery was constructed at rkm 3 along Lookingglass Creek (a tributary to the Grande Ronde at rkm 136) for the purpose of rearing fish with which to supplement populations in these subbasins. However, the spring Chinook population in Lookingglass Creek itself had already been extirpated. Efforts to reintroduce spring Chinook into Lookingglass Creek were implemented over the following two decades, by stocking juveniles produced in the hatchery at upstream locations. The successively used different hatchery stocks during the initial years – Carson NFH, Wind River, and Imnaha River – before switching to Rapid River Hatchery stock (located in the Little Salmon River subbasin in Idaho). However, a naturally spawning population never fully established itself during this period, and co-managers (CTUIR and

ODFW) decided to cease use of an out-of-basin stock. Beginning in 2001, reintroduction was attempted again using Catherine Creek stock from within the Grande Ronde subbasin for broodstock (Boe et al. 2010). Since 2004 (the year the first adults from the new program were expected to return), tissue samples from all adults passed upstream of the Lookingglass weir (½ km upstream of the hatchery) have been collected and archived (n ≈ 1,400), in anticipation of eventual genetics monitoring to help assess return rates and productivity of the reintroduced fish. Additionally, samples from out-migrating juveniles (captured in a rotary screw trap located ¼ km downstream of the weir) have also been collected, although not on a systematic annual basis until 2008 (Boe et al. 2011).

In contract year #2, an agreement was reached with the CTUIR, which runs the monitoring program in Lookingglass Creek, in which the Project would finance the laboratory analyses required for an RRS study of the newly reintroduced spring Chinook. The archived samples (n≈2,800) were sent to HCFES for genotyping. In contract year #3, an additional 1,455 samples were sent and genotyped at HFCES. Beginning in 2010, the number of juvenile samples collected annually was increased from approximately twice to three times the number of out-planted adult within broodyears. The higher sampling rate was requested by CRITFC, so as to increase the power of RRS analyses based on juvenile R/S. In contract year #4, genotyping will be performed on the juvenile samples collected in spring 2012, which will permit adult-to-juvenile R/S parentage estimates and NO versus HO RRS analyses for three consecutive broodyears (BY 2008-2010).

4.3 Newsome Creek (South Fork of the Clearwater River) spring Chinook

Spring Chinook were functionally extirpated from the entire Clearwater River subbasin following construction of the Lewiston Dam (rkm 6) in 1927 (Fulton 1968). Renovation of the defective fish ladder in 1940 permitted limited upstream movement, but it was not until removal of the dam in 1973 that access to the subbasin for anadromous fish was once again fully open. Spring Chinook were reintroduced to the basin, primarily through stocking of Rapid River hatchery stock juveniles in various tributary streams beginning in the 1960s. This did not include, however, Newsome Creek, a tributary to the South Fork of the Clearwater River (rkm 84), and surveys conducted from 1987 to 1992 indicated that no fish had volunteered into the stream. Soon thereafter, co-managers (NPT and IDFG) began a reintroduction/supplementation program in Newsome Creek with spring Chinook juveniles (Backman et al. 2009; Bradley et al. 2009). Beginning in 2003, the NPT initiated tissue sampling of returning adults and out-migrating juveniles for the purpose of monitoring productivity of the natural spawning population. The adults are intercepted at a weir located approximately 100 m upstream of the creek's confluence with the South Fork. Samples from out-migrating juveniles are collected in a rotary screw trap located just downstream of the weir site, and operated in both the fall and spring. The samples have been sent to CRITFC geneticists at HCFES, and using "year-end" monies, NPT was been able to partially finance genotyping of the samples and data analysis. As of 2009, the NPT funded analysis of all adult samples, and an initial adult-to-adult R/S assessment of productivity was performed for BY 2002, with results reported in "Genetic pedigree analysis to evaluate natural productivity between natural origin, and stray origin Chinook salmon in Newsome Creek, ID" by Matala et al., Appendix C in Bradley et al. 2009. However, funds have not been sufficient for analyses of their corresponding juvenile progeny, and numbers of samples (both juvenile and adult) collected annually have generally been increasing. To assure full funding of the study, an agreement was reached with the NPT during contract year #2, for the Project to take over responsibility for financing the genotyping and productivity analyses in coming years. During contract year #3, a total of 1,400 samples were genotyped – including a backlog of juvenile samples and all samples (juvenile and adult) collected in 2010. Similar to the previously described projects, CRITFC also requested an increase in the annual rate of juvenile sampling to increase the power of RRS analyses based on juvenile R/S.

4.4 Crooked River (South Fork of the Clearwater River) spring Chinook

In contract year #3, plans were in place to initiate an RRS study of spring Chinook in the Crooked River – a neighboring stream to Newsome Creek (2 km upstream on the South Fork Clearwater), with a spring Chinook population of similar size and life history characteristics. From the early 1990s through 2003,

Crooked River had been supplemented annually with Clearwater stock spring Chinook juveniles as part of the Idaho Supplementation Study (ISS; Bowles and Leitzinger 1991). In 2004, supplementation ceased and since then only NO adults have been passed upstream for natural spawning. Beginning in 2004, tissue samples from all adults captured at the Crooked River weir, and from a limited number of out-migrating juveniles have been collected annually. Sampling was performed in anticipation of an eventual genetics study to assess productivity of the fish, although funds were never obtained for this purpose. With several years of samples already collected and archived, it would be feasible to derive productivity estimates and make a series of within-broodyear comparisons to estimates observed in Newsome Creek. Additionally, the analyses would clarify the extent to which there might be exchange (straying) of fish between subbasins. An agreement was therefore reached with IDFG during contract year #3, for the Project to finance genotyping of the Crooked River samples. The archived juvenile samples were sent to HCFES for this purpose, however, IDGFG biologists have been unable to locate the adult samples. In consequence, the study has not progressed, and a decision as to whether it would be of sufficient interest to initiate the study with samples collected in 2011 and beyond remains under discussion

4.5 Lolo Creek (Clearwater River) spring Chinook

Another Clearwater River tributary in which the NPT operates a spring Chinook reintroduction/ supplementation program is Lolo Creek (rkm 87). The NPT began reintroduction into Lolo Creek with out-plants of Dworshak NFH adults in 1997, followed by stocking of juveniles from the Clearwater Anadromous Fish Hatchery in 1999. Since 2004, the stream has been supplemented annually with progeny of adults collected in Lolo Creek that are produced and reared at the Nez Perce Tribal Fish Hatchery (Backman et al. 2009; Bradley et al. 2009). Escapement into Lolo Creek is monitored at two weirs: an upper weir at rkm 51 above which is located roughly half of the available spawning area, and a lower weir at rkm 21 above which is located essentially 100% of the spawning area. Due to flow conditions, the upper weir can generally be installed 1-2 weeks before the lower weir, and if installed early enough the upper weir can intercept most spring Chinook accessing the upper basin. In contrast, the lower weir typically cannot be installed until after a substantial portion of the migrating adults have already passed upstream.

While adults captured at the upper weir comprise only a portion of the population, it is feasible that juvenile R/S productivity estimates could be performed on these fish (their progeny sampled as juveniles via trapping or electroshocking) and provide an RRS comparison for NO versus HO fish. In contract year #1, an agreement was reached with NPT for the Project to finance an RRS study of the spring Chinook in upper Lolo Creek. However, in both 2010 and 2011 (contract years #2 and #3), atypically high flows in late spring delayed installation of the upper weir and the proportion of adults sampled was insufficient for a meaningful RRS study.

A long-standing NPT proposal for construction of a permanent weir at the location of the lower temporary weir was finally approved in 2011, with completion anticipated in time for operation in spring 2014. Managers therefore decided to forgo another attempt to estimate RRS in upper Lolo Creek in 2012, but instead to await completion of the permanent weir and implement RRS monitoring for the whole basin from that time forward.

4.6 Wenatchee River coho salmon

Coho salmon were extirpated from the entire Mid-Columbia basin by the mid-1900s. The Yakama Nation (YN) initiated a reintroduction program for coho salmon in the Wenatchee River in 1999, with annual stocking of out-of-basin hatchery origin juveniles. These fish were from a lower Columbia stock which had undergone 15 or more generations of segregated hatchery rearing. Despite their hatchery background, adult returns from the initial years of reintroduction were sufficiently abundant that by 2003, the tribe was able to meet 100% of their broodstock needs with adults collected in-basin, to create a localized Mid-Columbia River (MCR) stock. A large portion of the hatchery coho releases in the initial years were at sites in Icicle Creek in the lower Wenatchee, and subsequently the majority of adults have returned to the lower river. With the creation of the MCR broodstock, the YN is now shifting more of the

juvenile releases to acclimation sites in the upper basin, which contains greater amounts of spawning and juvenile rearing habitat (Murdoch et al. 2006).

Assessing productivity of the reintroduced coho is of interest to the YN, but logistical constraints (primarily an inability to systematically sample the returning adults) has precluded design of an RRS study for the entire population. However, it would be potentially feasible to assess productivity of fish in the upper part of the Wenatchee River Basin. YN operates an adult trap at Tumwater Dam (rkm 52) where it is possible to interrogate adults returning to the upper basin. They also operate a smolt trap just upstream of Tumwater Dam, which provides a means to sample natural origin juveniles outmigrating from the upper basin.

While a tentative agreement was reached between YN and CRTFC to have the Project finance an RRS study of reintroduced coho salmon above Tumwater Dam, logistical and financial constraints were preventative. The YN lack the personnel and regulatory authority to operate the Tumwater trap consistently across the season, and thus are unable to obtain the necessary adult samples. In view of these difficulties, it was decided to abandon the proposed study.

4.7 Cle Elum sockeye salmon

Sockeye salmon are native to Cle Elum Lake in the upper Yakima River basin, which historically supported a thriving population. However, construction of a dam at the lake outlet in the early 1900s resulted in extirpation of the population. As a first step toward investigating feasibility of reintroducing sockeye salmon, a flume was constructed on the dam spillway and testing with coho salmon smolts indicated that it worked effectively as a route for juvenile out-migration from the lake (Bureau of Reclamation 2007). Subsequently, in 2009 the YN began an annual program of out-planting of adult sockeye salmon, using fish selected from among in-migrating sockeye captured in July at Priest Rapids Dam (PRD) on the Columbia mainstem. The fish were transported by truck and released in the Cle Elum River just upstream of the lake. The adults at PRD represent a mix of fish originating from two regions in the Mid-Columbia: the Wenatchee River and Lake Wenatchee system, and the Okanogan River and Osoyoos and Skaha Lakes system. Waters in the two systems have very different thermal regimes (characterized by source and flow), and the two stocks exhibit variation in life history characteristics, including differences in run timing and spawn timing coincident with those regimes.

In each year of adult out-planting, spawning activity has been observed during September and October. The spawning appears to be temporally bimodal. Spawning during the early pulse occurs to a greater extent nearer headwaters of tributary streams to the lake (Cle Elum and Cooper rivers), and these fish are suspected to be primarily from the Wenatchee stock which has an earlier return time than the Okanogan stock. A later pulse of spawning occurs lower in the tributary streams and in near-shore gravel in the upper reaches of the lake. These fish are suspected to be primarily of Okanogan stock. In the spring of 2011, age 1+ out-migrating *O. nerka* smolts - progeny of fish from the initial out-planting - were observed among fish captured in the juvenile bypass facilities at Roza Dam (rkm 206 on the Yakima River) and at the Chandler smolt collection facility adjacent to Prosser Dam (rkm 76).

Questions of interest to the tribe for management of the Cle Elum sockeye reintroduction program include: 1) Are the differences in spawning timing between Wenatchee and Okanogan stocks reflected in the bi-modal spawning activity of out-planted adults in Cle Elum River and Lake? 2) What is the relative natural productivity of fish from the two stocks introduced to the Cle Elum environment? 3) Do fish from the two stocks interbreed, and at what rate? 4) Do naturally spawned juveniles from matings within and between stocks demonstrate differences in age, size and timing at out-migration, and in smolt-to-adult return rates? These are all questions that readily lend themselves to study using genetics-based stock identification and parentage analyses.

Prior genotyping of samples of Wenatchee and Okanogan stocks using a standardized panel of 96 single-nucleotide polymorphism (SNP) DNA markers has been performed by CRITFC scientists at HFCES as part of a project to establish baseline genetic profiles for *O. nerka* populations across the Columbia basin. Results from standard genetic structure analyses indicate that the two stocks display very distinct genetic

profiles (Matala, unpublished data). As such, a high degree of population assignment accuracy is expected for identifying the stock-of-origin of out-planted fish, and of their progeny. An agreement with YN was finalized during contract year #3, to collaborate on a genetics study of the reintroduced Cle Elum Lake sockeye salmon population. YN will conduct annual collection of tissue samples from a portion of the out-planted adults (temporally stratified) and ship the samples to HFCES. Samples will also be collected from post-spawned carcasses from early and late spawning pulses, from out-migrating juveniles sampled at the Chandler facility, and from natural origin adult progeny that return to the fish ladder at Roza Dam. In turn, the Project will cover the costs for genotyping, and subsequent analyses for stock identification and parentage.

As of the end of contract year #3, samples from 275 adults out-planted in Cle Elum Lake in 2011, plus another 405 samples of Wenatchee stock and Okanogan stock fish (to expand the *O. nerka* baseline collections to which the Cle Elum fish will be compared) have been genotyped. Sampling for three to four years beginning in 2012 is expected to include annually up to: 1,000 PRD adults, 200 carcasses (approximately half and half from the early and the late part of the spawning period), and from 1,000 juvenile out-migrants and from all in-migrating natural origin adults (up to a maximum of 2,000 fish) collected representatively across the run).

4.8 Deschutes River sockeye salmon/kokanee

Suttle Lake, a nursery lake in the Metolius River system of the upper Deschutes River, was one of only two locations in Oregon where sockeye salmon were indigenous, Wallowa Lake draining the Wallowa River in the Grande Ronde River Basin being the other. Adult passage to Suttle Lake was blocked by construction of a dam at the lake's outlet, and another in Lake Creek (the stream which connects Suttle Lake to the Metolius River) in the early 1900s, and the sockeye population went extinct. A limited amount of spawning of sockeye persisted in the Metolius River below these obstructions, with the juveniles apparently rearing in the lower Deschutes or the Columbia. Then in 1964, Round Butte Dam was constructed downstream of the Metolius on the Deschutes River, and the dam totally blocked upstream adult passage. The dam did, however, create a reservoir (Lake Billy Chinook, LBC) in which a large non-anadromous *O. nerka* (kokanee) population developed. These fish migrate from the lake into the Metolius River for spawning each year. Likewise, in Suttle Lake a kokanee population has continued since loss anadromy, with spawning occurring in Link Creek at its upstream end. Of note, however, stocking of both LBC and Suttle Lake with kokanee juveniles from multiple out-of-basin hatchery stocks occurred repeatedly through the mid-1900s (Nehlson 1995, Gustafson et al. 1997).

In recent negotiations for the relicensing of Round Butte Dam for hydropower generation, an agreement was reached to re-establish passage of anadromous fish to the upper basin, including sockeye salmon – presuming that juvenile *O. nerka* emanating from LBC and/or Suttle Lake will exhibit an anadromous life history. In 2010, the new fish transfer facility (FTF) at Round Butte Dam, constructed as part of the relicensing agreement, became operational, and tens of thousands of out-migrating *O. nerka* smolts have been passed downstream annually. CTWSRO is leading the monitoring program of upper Deschutes *O. nerka* (kokanee and sockeye), and questions of interest to the regional fisheries co-managers (ODFW, PGE, CTWSRO) include: What is the relative proportion of juveniles from the LBC and Suttle Lake stocks that are passed downstream at the FTF? What are the relative proportions that return as mature adults? Do fish from the two stocks exhibit differences in age, size or timing at migration? Presuming that LBC and Suttle Lake stocks are genetically distinguishable, these are questions that can be answered by analyses using genetic stock identification and parentage.

In contract year #2, an agreement was reached with CTWSRO for the Project to examine the magnitude of genetic differentiation between the stocks. Tissue samples collected in 2009 and 2010 from pre-spawning LBC kokanee and from juvenile out-migrants from Suttle Lake were sent to HFCES for analysis. Genetic structure results using a standardized panel of 96 SNP markers provided evidence of multiple origins in both stocks, including similarities to out-of-basin hatchery sources used in past stocking events. The two Deschutes Basin stocks showed some overlap in stock origin, but distinct genetic profiles were observed overall in these preliminary analyses (Matala, unpublished data). The agreement with CTWSRO was therefore extended through 2015 to cover costs for genetics analysis of additional annual

samples from the two stocks (up to 100 individuals per sample set), of a temporally representative sample of 200 fish of unknown origin from among the out-migrating juveniles collected at the FTF and passed downstream of Round Butte Dam, and of all (up to 600) in-migrating fish that eventually return to the Pelton trap as mature adults. Additionally, samples from kokanee populations in central Oregon lakes located within the upper Deschutes basin will be sampled. The latter could be sources of migrants to LBC, and may clarify the nature of genotypic differences observed between LBC and Suttle Lake kokanee.

In contract year #3 a total of 715 Deschutes basin samples were genotyped, plus 775 samples from various other Columbia basin *O. nerka* baseline populations, to which the Deschutes populations will be compared. Of particular interest among the 2011 Deschutes samples were 23 adults that were captured at the Pelton trap, 19 of which bore a right maxillary clip identifying them as Deschutes River origin (i.e. passed downstream through the FTF). These 19 fish were held at the Round Butte hatchery, and 12 of them survived for artificial spawning. Progeny these fish are currently being reared at the hatchery while awaiting a decision on when and where they will be released upstream of the dam. Co-managers have not yet finalized a sockeye management plan for the basin, but an interim agreement has been reached to retain half of the adults that return to the Pelton trap in 2012 for artificial spawning at Round Butte Hatchery, while the other half will be transferred by truck and released into LBC to continue their migration.

4.9 Deschutes River steelhead

The status of Deschutes River anadromous *O. mykiss* (steelhead) has been the subject of much discussion in light of observation of a high incidence of straying of out-of-basin fish into the river. To assess effects that strays may be having on native steelhead populations, ODFW and the US Fish and Wildlife Service Abernathy Fish Technology Center, CRITFC have initiated (2010) an RRS study (BPA Project No. 2007-299-00) of wild and hatchery stray steelhead in two lower Deschutes River tributaries, Buckhollow Creek (rkm 69) and Bakeoven Creek (rkm 84). In the control stream (Bakeoven) wild adults are passed upstream of a weir near its confluence with the Deschutes while all hatchery strays are culled. In the treatment stream (Buck Hollow), both wild and hatchery strays are passed upstream. RRS based both on juvenile R/S and adult R/S will be assessed in the coming years. CRITFC is cooperating on this project to help identify the source of the stray hatchery steelhead through the use of genetic stock identification (GSI) methods and a parentage based tagging (PBT) SNP database for Snake River hatcheries that CRITFC and IDFG have established. To further support this RRS project, CRITFC proposed to obtain additional information on out-of-basin stray steelhead. An agreement was reached for the Project finance genotyping and indentify to putative stock, steelhead sampled at an adult trap at Sherars Falls (rkm 71). The Project funded analysis of samples collected in 2011, including approximately 460 hatchery origin and 290 natural origin steelhead. Sampling for 2012 is slated to include 500 hatchery origin and 250 natural origin fish.

Beyond support of the ODFW/USFWS study, this effort addresses Project objectives and interests in relation to the recently initiated steelhead reintroduction program in the upper Deschutes basin (ODFW and CTWSRO 2008). ODFW manages a supplementation program in the lower river (below Pelton Dam) that has been in operation for several years. The program utilizes a segregated Round Butte broodstock. Beginning in 2007, juveniles from this same stock have been out-planted in streams upstream of Lake Billy Chinook, in anticipation of re-establishment of juvenile and adult passage at Round Butte Dam. In the event that an alternate broodstock source would be desired for reintroduction of a naturally spawning anadromous population in the upper basin, managers would benefit from information to aid selection of another Deschutes basin stock for broodstock collection. It will be important to understand the contemporary population structure of natural origin steelhead throughout the Deschutes River basin, including the scope of stray influences in spatial distribution throughout the primary east side and west side spawning tributaries of the Deschutes River, most of which are located above Sherars Falls (Matala et al. 2008, Hawkins et al. 2011). Such monitoring will help determine the most likely, or least impacted existing steelhead population(s) that is presumably characteristic of local Deschutes River origin. Moreover, the upper basin includes distinct resident redband trout populations (Matala et al. 2009), and

the impact of reintroduced steelhead on those populations should be closely evaluated (e.g., for biological and genetic compatibility between sources of the two life history stocks).

4.10 Lapwai Creek (Clearwater River) coho salmon

As for indigenous spring Chinook in the Clearwater basin, coho salmon were also extirpated from the subbasin following construction of the Lewiston Dam (Everett et al. 2006). With the desire to re-establish a population in the Clearwater, the NPT in the mid 1990s obtained access to an annual allotment of coho salmon eggs from a lower Columbia hatchery stock with which to initiate a reintroduction program. Since 1997, coho juveniles have been stocked annually at various locations within the subbasin (Everett et al. 2006). Beginning in 1999, managers began collecting returning adults at in-basin locations (primarily hatcheries from which the juveniles had been acclimated and released) for use as broodfish to develop a local Clearwater stock. As returns to the basin increased, the proportion of locally collected broodstock was also increased, and in 2009 NPT was able to meet 100% of the program's broodstock needs with in-basin returns.

In the mid-1990s, annual adult returns to the Snake/Clearwater basins were in the tens of fish, based on counts at the Lower Granite Dam (LGD; rkm 173) fish ladder. In addition to being few in number, these fish were likely strays from lower river hatchery programs. Since reintroduction into the Clearwater, coho returns to LGD have grown steadily and escapement in 2011 was in excess of 5,000 fish. Returns also appear to include an increasing proportion of NO fish. Despite the progress, funds for monitoring have been very limited, and little data for origin, redd number, redd distribution, and productivity of the reintroduced coho is available. Recently, the NPT acquired funds to construct a weir in Lapwai Creek, a tributary to the Clearwater River (rkm 19) in which naturally spawning of coho have been observed. The weir will substantially increase the opportunity to capture NO fish for incorporation into the program broodstock, and facilitate monitoring of population trends. Operation of the weir also presents the opportunity to obtain productivity estimates and an assessment of RRS for NO versus HO coho salmon within this tributary. Discussions initiated during contract year #3 regarding this possibility, will be followed up in the coming year while construction of the weir is underway. We anticipate agreement among parties to initiate the RRS study with sampling of returning adults in fall 2012, and of out-migrating juveniles in spring 2014.

5.0 **Project Objective #3:** Organize Fisheries Genetics Training Program for tribal fisheries personnel

Tribal fisheries personnel (CTWSRO, YN, CTUIR and NPT) are involved in numerous monitoring and evaluation programs that involve field tissue sampling of fish as part of standard management activities. These samples are sent to HFCES for molecular genetics analysis by CRITFC scientists, and the resulting data are analyzed to inform a variety of management questions. However, the field personnel involved in sample collection have little formal training in the principles of molecular and quantitative genetics, and limited knowledge of how the information derived from the genetics analyses is utilized. Further, a disconnect commonly occurs between field and laboratory personnel, such that respective groups have limited understanding of the logistical and working constraints within which the other group operates. For scientists, this has been somewhat ameliorated by occasional visits to project field sites, but the converse has rarely been available to field crews. To provide them this opportunity to obtain a better basic understanding of genetic principles and of the practicalities of how the tissue samples are processed and the genotypic data analyzed, CRITFC a curriculum for a 2-day training program entitled "Introduction to Molecular Genetics Analyses in Tribal Fisheries Management" (curriculum is posted within Attachments in the Project's site in Pisces). During contract year #3, a request was sent out to program managers at CRITFC and the four tribal fisheries agencies to identify filed personnel to participate in a training program. The Project would finance lodging and per diem for each participant, purchase of a reference manual (Genetic Guidelines for Fisheries Management – Kapuscinski and Miller, Sea Grant MN), and covered additional incidental expenses.

Three of these 2-day training programs were conducted in this contract year. The first program (November 8-9, 2011) was attended by eight technicians and biologists from the CRITFC Fish Science Department. A second training session (January 24-25, 2012) was by four technicians and biologists from YN and two from CTWSRO. A third session (February 7-8, 2012) was attended by four persons each from CTUIR and NPT. Participant responses to these programs were very positive, and an additional two trainings are planned for the coming year.

6.0 **Project Objective #4:** Prepare manuscripts for publication in scientific journals

During the first two years of the Project, CRITFC scientists developed a likelihood model (MRmix) to use mark-recapture data to provide an estimate of population abundance and of uncertainty of that estimate. The model is applicable to those studies in which a portion of the marked animals were double-tagged - data which is used to estimate tag loss rate and its uncertainty. Unique to this model, the tag loss values (rate and uncertainty) are incorporated with the data for single-tagged animals, to provide estimates of abundance and its uncertainty that are more robust than the values derived with standard Petersen estimators (Seber 1982). Development of the model was prompted by discussions with CTWSRO personnel relative to analysis of mark-recapture data they collect annually to estimate spawning escapement of kokanee from Lake Billy Chinook into the Metolius River. A manuscript describing the model, "Accounting for tag loss and its uncertainty in a mark–recapture study with a mixture of single and double tags", was submitted for publication in Transactions of the American Fisheries Society during contract year #2. Revision following review and final publication occurred the following year (Hyun et al. 2012). Additionally, the model was adapted to a web-based interface and this "user-friendly" version was made available to the public in contract year #3 at: http://www.critfc.org/mrmix.

Results from the RRS study of spring Chinook in the JCAPE project (see Project Objective #1), based on adult R/S for the initial broodyears, were summarized in a manuscript, "Supportive breeding boosts natural population abundance with minimal negative impacts on fitness of a wild population of Chinook salmon". The manuscript was submitted for publication in Molecular Ecology in early 2012. The manuscript is currently in review, with publication anticipated later in contract year #4.

A draft of the manuscript, "Tribal reintroduction of extirpated coho salmon to the interior Columbia River basin", was nearing finalization at the end of the contract year. This manuscript provides an overview of tribal programs to reintroduce coho into the Yakima, Wenatchee and Methow rivers (tributaries to the mid-Columbia), and into the Clearwater River (tributary to the Snake River). The intent is to submit the manuscript for publication in the journal Fisheries (anticipated within the first half of contract year #4), in order to expose a national audience to the pivotal role the tribes have played in re-establishing these extirpated stocks, and more generally to highlight the increasingly important role that the tribal agencies play in regional fisheries management.

7.0 **Project Objective #5:** Participate in regional forums for review of hatchery effects on natural populations

The Project coordinator (Galbreath) and collaborating CRITFC geneticists at HFCES (Narum, Hess and Matala) participated in a variety of inter-tribal and inter-agency meetings, workshops and symposia, in which were discussed issues related to hatchery management and to the nature and magnitude of effects that hatchery origin salmon and steelhead may have on the natural populations with which they interact or interbreed. The purpose was to exchange information acquired during studies conducted by CRITFC and by other participating agencies, as well as to develop and articulate the tribal perspective on how hatcheries can be appropriately managed to minimize possible negative effects on productivity and to benefit from the potential positive effects on the other three viable salmonid population (VSPs) parameters - abundance, spatial structure and diversity (McElhany et al. 2000). The following is a list of the primary meetings, workshops and symposia, and the nature of CRITFC's participation at each:

Attendance at various of the monthly Northwest Power and Planning Council meetings
Attendance at meetings concerning development of the Columbia River Hatchery Effects Evaluation Team (CRHEET) proposal
Attendance at the Age and Size at Maturity of Chinook Salmon and Other Pacific Salmonids (May 18-19, 2011, Portland OR)
Preparation of the agenda, and oral and poster presentations at the Future of Our Salmon conference (June 1-2, 2011, Portland OR)
Attendance at the Yakima Basin Science and Management Conference (June 15-16, 2011, Ellensburg WA)
Co-coordination of the "Colonization and Reintroduction of Anadromous Salmonids" symposium, and oral presentations at the annual national meeting of the American Fisheries Society (September 4-8, 2001; Seattle WA)
Attendance at the NW Fish Culture Conference (December 6-8, 2011, Victoria BC)
Coordination of the "Recolonization and Reintroduction of Anadromous Salmonids in the Columbia River Basin" symposium, and oral and poster presentations at the annual meeting of the Oregon Chapter of the American Fisheries Society (February 29-March 1, 2012; Eugene OR)
Attendance at the Klickitat and White Salmon Rivers Fisheries and Watershed Conference (March 20, 2012, The Dalles OR)
Attendance and oral presentations at the annual meeting of the Idaho Chapter of the American Fisheries Society (March 7-9, 2012; Coeur d'Alene ID)
Agenda preparation and participation at the Inter-Tribal Supplementation Technical Workshop (March 21-22, 2012, Pendleton OR)
Attendance at the Pelton-Round Butte Project Fisheries Workshop (March 27-28, 2012, Madras OR)

8.0 **Project Objective #6:** DIDSON Escapement Estimation

The Yakama Nation (YN) is actively involved in management and rebuilding of anadromous fish populations in the Klickitat River (YN 2008). Among these actions was the recent renovation of the Castile Falls fishway (rkm 103), which reopened passage for steelhead and spring Chinook to a substantial amount of unutilized habitat in the upper basin. The YN made the management decision to provide the opportunity for volunteers (stray individuals) of both species to repopulate the newly the upper basin of their own volition. It is therefore critical to obtain information to quantify annual escapement. In 2011 (contract year #3) a Dual-Frequency Identification Sonar (DIDSON) was operated for a third consecutive summer, to obtain an estimate of escapement for spring Chinook. The DIDSON was positioned in the water at the upstream outlet of the fishway to record passage of adult Chinook salmon migrating out of the fishway into the upper basin. Five of the six sections of trash rack that comprise the upstream opening of the fishway, were blocked with weir frames. The sonar was installed adjacent to the remaining unblocked section so that all fish migrating out of the fishway would pass through the sonar's field of view. The sonar was powered by a thermoelectric generator and programmed to record sequential hour-long files from July through October 2011. At the end of the field season, these files were processed and read, and the time of each upstream passage event was noted.

Observation of fish passage events in the recorded video files provided an escapement estimate of 38 spring Chinook salmon to the upper basin in 2011. However, it was determined that the estimate was highly uncertain. The sonar experienced repeated stoppages through the summer, caused by low power output from the TEG. By the time this was determined and the TEG had been serviced to restore full output, the migration season had ended. As a result, files were available for only about 30% of the migration period, and they did not represent a random sample from this period. While uncertain, the escapement estimate is nonetheless of a magnitude similar to estimates obtained with the sonar in 2009 (n=26-27; Galbreath et al. 2010) and in 2010 (24 ± 4; Galbreath et al. 2011). Additionally, similar to the previous two years, the 2011 DIDSON estimate was substantially greater than would be inferred from redd counts obtained during annual spawning surveys. In 2009 only four redds were observed, while in 2010 and 2011 no redds were counted. A full description of this project, including background information

and rationale, methods, results and evaluation of results is available in the CRITFC technical report (Galbreath et al. 2012), available at http://fishery.critfc.org/FiSci/02_12report.aspx.

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