SYSTEM OPERATIONAL REQUEST: #2007-2

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, Shoshone-Bannock Tribes, and the Columbia River Inter-Tribal Fish Commission[1].

TO:	**Brigadier General Gregg F. Martin**	**COE-NWD**
	James D. Barton	**COE-Water Management**
	Cathy Hlebechuk	**COE-RCC**
	Witt Anderson	**COE-P**
	Col. Thomas E. O'Donovan	**COE-Portland District**
	LTC Anthony Hofmann	**COE-Walla Walla District**
	J. William McDonald	**USBR-Boise Regional Director**
	Stephen J. Wright	**BPA-Administrator**
	Greg Delwiche	**BPA-PG-5**

FROM: Paul Wagner, Chairperson, Salmon Managers

DATE: February 27, 2007

SUBJECT: Spill at Bonneville Dam for the March Spring Creek Hatchery Release Spill Evaluation Study

SPECIFICATIONS:

The Salmon Managers listed above are requesting the following fishery operations at the Bonneville Project:

1. Operation of the Corner Collector for four days beginning one-day following either one of the releases of coded wire tagged (CWT) tule fall Chinook from Spring Creek National Fish Hatchery (Spring Creek NFH), scheduled for March 5 and March 9, 2007;
2. Spill at 75 kcfs beginning one-day following either one of the releases of coded wire tagged tule fall Chinook from Spring Creek NFH scheduled for March 5 and March 9. Alternatively, operate with 75 kcfs of spill plus the corner collector for four days following either one of the releases from Spring Creek NFH.

JUSTIFICATION:

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[1] Due to the Agreement Regarding 2007 Federal Columbia River Power System Fish Operations between the CRITFC tribes and BPA, CRITFC cannot support the spill provision in this SOR, but does not oppose it. CRITFC fully supports all other operations requested in this SOR.

Spring Creek NFH, located upstream of Bonneville Dam on the Columbia River, annually produces tule fall Chinook (*Oncorhynchus tshawytscha*) that are released in the spring of each year as subyearlings. Half of the total production of 15 million fish is released in March, prior to the onset of the Biological Opinion spill program for ESA-listed salmonids. Historically, the March release of juvenile fish at Spring Creek NFH has produced 46% of the returning adults. Although Spring Creek NFH Chinook salmon are listed under the Endangered Species Act (ESA) as part of the Lower Columbia River Chinook ESU, they are deemed not necessary for recovery and therefore are available for harvest. The 7.5 million fish that are released in March are very important to United States/Canada treaty and domestic West Coast fisheries because these fish make up a significant portion of the Chinook caught in West Coast Vancouver Island (WCVI) fisheries, near shore fisheries off the Washington and northern Oregon coast, and local fisheries in the Columbia River. Historically, Spring Creek NFH fish contributed up to 9% of the Chinook catch in the WCVI fisheries and 27% of the Chinook catch off of the Washington and northern Oregon coasts. Spring Creek NFH has contributed as many as 65,600 fish to treaty Indian fisheries (1976) and 41,500 fish to non-treaty commercial fisheries (1977) in the Columbia River (PFMC, 1996). More recently, the 2002-2004 average catch of Spring Creek NFH origin fall Chinook in the fall season treaty Indian fisheries above Bonneville Dam was 54,900 Chinook, while non-treaty in-river commercial and sports fisheries averaged another 12,600 Chinook (PFMC 2006).

Spring Creek NFH tule salmon are important components of Columbia River Indian treaty and sport fisheries and provide a significant benefit for West Coast fisheries, outside the Columbia River, including Canada and Alaska. Every additional adult salmon available for tribal harvest is critical from a tribal cultural and use perspective. Tribal members are dependent on these salmon for ceremonial and subsistence uses. These salmon comprise a critical portion of sustenance for tribal members. In particular, because Spring Creek Hatchery tule fall Chinook have a lower oil content than other salmon, they are dried and become an important source of winter protein for tribal members.

Since much of the salmon wealth has been taken away from the tribes and redistributed to non-tribal people in the form of flood control, navigation, irrigation and municipal development, tribal people have experienced elevated poverty and death rates well in excess of the general population and are very dependent on harvested salmon, or indirectly, on the small income that salmon harvest provides for survival. Also, salmon are the main stay of tribal religious and cultural practices. Every juvenile salmon that survives hydrosystem passage brings back some of the river's wealth to the tribal economy and culture.

Over the past 12 years, fish hatchery programs for Columbia River production have been reduced significantly due to Congressional reduction or flat funding for Mitchell Act programs. These funding cuts have resulted in a very substantial reduction (approximately 25.0 million since 1995) in the production of tule fall Chinook salmon at both state and federal fish hatcheries and have caused the closure of some facilities. The State of Oregon has drastically reduced its production of tule fall Chinook salmon in the Columbia River system. Spring Creek NFH, is now the only facility producing tule fall Chinook above Bonneville Dam. Nearly all of the remaining Columbia River tule production is released from hatcheries in the State of Washington below

Bonneville Dam. These reductions and hatchery closures make maximizing survival and production at Spring Creek NFH even more important for maintaining and improving fisheries in the Pacific Ocean and Columbia River, especially in years of low ocean productivity. Early projections for 2007 adult returns of Spring Creek Chinook to the Columbia River indicate a continual decline with a forecasted run size likely of less than 21,800 fish to the Columbia River mouth (Figure 1).

Spill is generally accepted as the safest route for fish passage at Federal Columbia River Power System (FCRPS) facilities in terms of both immediate and delayed survival effects and the Action Agencies historically allowed spill at Bonneville Dam coinciding with the timing of the Spring Creek NFH releases in March to provide a non-turbine/bypass passage route and improve their survival past Bonneville Dam (Figure 2). The duration and volume of spill that has been allowed at Bonneville Dam for the Spring Creek March releases has varied over time. Since 1992, there have been three general categories of the duration and volume of spill allowed at Bonneville Dam during the March releases (Figure 2). During 1992-2000, spill duration and volume averaged 178 hours (7.4 days) and 1200 KAF. During 2001-2004, average spill duration and volume were reduced to 59 hours (2.5 days) and 177 KAF. During 2005 and 2006, BPA did not allow spill for the March releases. However, beginning in 2004, the Bonneville Dam corner collector was operated during the March releases, providing a non-turbine/bypass passage route through the dam. During 2004-2006, the corner collector was operated for 81 hours using 34 KAF, on average, during the March releases. These recent volumes using the corner collector are 2.8% of the volumes allowed using spill during 1992-2000. While ocean productivity has likely varied over time, the recent declines in returns has coincided with reduced levels of spill during the March release at Bonneville Dam (Figures 1 and 2).

In March 2004, the U.S. Fish and Wildlife Service (FWS) released over 220,000 subyearling fall Chinook from Spring Creek NFH with coded wire tags (CWT) to evaluate smolt-to-adult return rates (SAR) back to the hatchery under two operations at Bonneville Dam. Tagged fish were released in two groups: one group released during four days of spill operation at Bonneville Dam and one group released during four days of corner collector operation at Bonneville Dam. A continuation of this evaluation would help resolve uncertainties from a single year evaluation.

The FWS is scheduled to release a total of 250,000 coded wire tagged tule fall Chinook from Spring Creek Hatchery on two dates, March 5 and March 9, 2007. To continue the evaluation of the 2004 study conducted by FWS (Attachment 1) that showed significantly higher SARs for hatchery tule fall Chinook release during spill operations, we are requesting a spill period of four days.

We propose to reverse the order of experimental treatments from the 2004 experiment, and begin the spill operation or spill plus corner collector operation, followed by the corner collector operation. The projected hydrologic conditions should be taken into account and the Action Agencies are invited to make the final selection on order. To minimize potential effects of total Bonneville discharge on the resulting SARs, the total Bonneville Dam discharge should be the same during both operations. As the corner collector was designed to operate in conjunction with a minimum of 75 kcfs spill and 75 kcfs of spill would provide greater contrast in the operational conditions than reduced levels of spill, we request that specifications for the two operations be 75 kcfs of spill versus 5 kcfs of corner collector.

Four days of spill or corner collector operations are capable of achieving 90-95% passage. Typically, the fish begin to arrive at Bonneville Dam 24h following their release. To minimize the potential for temporal effects, the releases from Spring Creek NFH in 2007 will be only four days apart. One group of fish is scheduled to be released from the hatchery on March 5th. The second group of fish is scheduled for release on March 9th. The corner collector will already be in operation for other study purposes (kelt passage) and will continue throughout the operation. Spill operation of 50-75 kcfs should begin about 24 hours after the release chosen for spill (March 5 or March 9) and continue for four days.

Current projections for the first week of March are for flows of 144-155 kcfs at Bonneville Dam (Feb. 20th STP run). Flows of 160 kcfs would translate to a 14.5 ft. tailwater elevation. This would provide 1.5 ft. of depth compensation for chum redds located at the current management level of a 13 ft. Bonneville Dam tailwater elevation. Based on the SYSTDG modeling provided by the COE, a 75 kcfs level of spill under a total discharge of 150 kcfs would result in dissolved gas levels of 106.4-108.3%. The COE modeling suggests that flows of 160 kcfs would provide sufficient depth compensation for the chum redds below Bonneville Dam. Flows of 160 kcfs or greater would additionally lower gas levels and provide more protection against gas supersaturation than the COE model runs using 150 kcfs.

The COE has stated that the John Day pool is expected to maintain its current full pool elevation through the March release. Using the available storage in the John Day pool between full pool elevation and minimum irrigation pool (MIP) over the first four days of the study would result in flows of 183-194 kcfs at Bonneville Dam. This would require no usage of the storage behind Grand Coulee Dam. If John Day pool storage was utilized down to minimum operational pool (MOP), flows at Bonneville Dam would be expected to be 212-222 kcfs for four days. Again, this would require no alteration or usage of the storage behind Grand Coulee Dam.

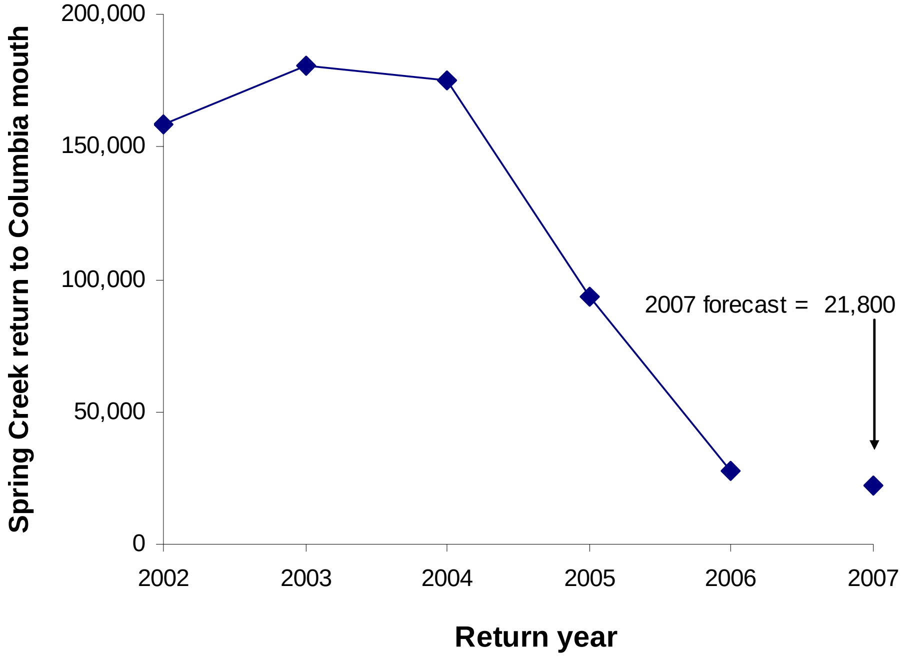

Figure 1. Returns of Spring Creek NFH fall Chinook to the Columbia River mouth 2002-2006 and projected return for 2007.

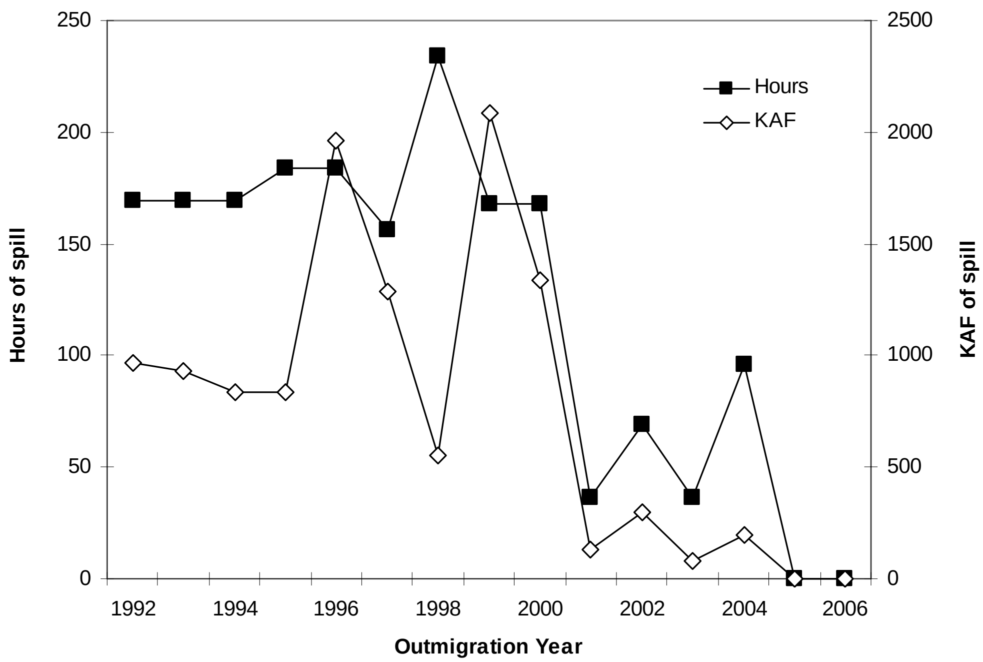

Figure 2. Hours and volume (KAF) of spill at Bonneville Dam during the March release from Spring Creek NFH, 1992-2006.

Attachment 1

Preliminary evaluation of two operations at Bonneville Dam on the return rate of fall Chinook salmon to Spring Creek National Fish Hatchery

By

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Introduction

Spring Creek National Fish Hatchery (SCNFH), located upstream of Bonneville Dam on the Columbia River, annually produces tule fall Chinook (*Oncorhynchus tshawytscha*) that are released in the spring of each year as subyearlings. Half of the total production of 15 million fish is released in March, prior to the onset of the Biological Opinion spill program for ESA-listed salmonids. Although SCNFH Chinook salmon are listed under the Endangered Species Act (ESA) as part of the Lower Columbia River Chinook ESU, they are deemed not necessary for recovery and therefore are available for harvest. The 7.5 million fish that are released in March are very important to United States/Canada treaty and domestic West Coast fisheries because these fish make up a significant portion of the Chinook caught in West Coast Vancouver Island (WCVI) fisheries, near shore fisheries off the Washington and northern Oregon coast, and local fisheries in the Columbia River. Historically, Spring Creek NFH fish contributed up to 9% of the Chinook catch in the WCVI fisheries and 27% of the Chinook catch off of the Washington and northern Oregon coasts. Spring Creek NFH, historically, has contributed as many as 65,600 fish to treaty Indian fisheries (1976) and 41,500 fish to non-treaty commercial fisheries (1977) in the Columbia River (PFMC, 1996). More recently, the 2002-2004 average catch of Spring Creek NFH origin fall Chinook in the fall season treaty Indian fisheries above Bonneville Dam was 54,900 Chinook, while non-treaty in-river commercial and sports fisheries averaged another 12,600 Chinook (PFMC, 2006).

In addition to supplying large numbers of fish for harvest, the high abundance of tule fall Chinook stocks arguably has provided some level of stock protection for other depressed stocks of concern. Under the Chinook harvest ceiling management regime implemented by the initial Pacific Salmon Treaty in 1985, abundant Columbia River tule and upriver bright fall Chinook stocks had the effect of buffering impacts on other Chinook stocks of concern in certain Canadian and south east Alaskan ocean fisheries. With the adoption of an aggregate abundance based management (AABM) regime for these ocean fisheries under the renegotiation of the Pacific Salmon Treaty in 1999, the buffering effect of these Columbia River stocks only occurs when harvest for a particular fishery is constrained to a level substantially less than allowed under the AABM regime for that particular fishery. This management scenario has, in fact, been the case for the WCVI Canadian troll fishery in several recent years where Columbia River tule fall Chinook stocks are a significant contributor to the overall stock mix of this fishery. Up until 2003, the WCVI troll fishery has been managed by Canada to harvest a much lower number of Chinook than allowed under the AABM regime, primarily to address domestic concerns for depressed WCVI naturally spawning stocks and the need to rebuild this stock group. Beginning in 2003, the WCVI troll fishery again expanded up to AABM quota limits as the fishery ostensibly found ways to maximize total catch, including significant numbers of Columbia River stocks, while minimizing impacts on their depressed local wild stocks through intensive time and area management actions.

However, even when AABM fisheries are harvested at their full allowable levels, harvest rate ceilings for particular stocks of concern (e.g., threatened Snake River fall Chinook and lower Columbia River Chinook) are now in place under ESA management constraints to provide an appropriate level of protection for these stocks while providing the opportunity to shape coastal and in-river fisheries to optimize the harvest of co-mingled healthy stocks when abundance levels for these stocks are high. For example, in addition to the AABM framework of the Pacific Salmon Treaty in Canadian and southeast Alaskan ocean fisheries, Washington, Oregon, and California ocean fisheries are managed under an ESA constraint that limits the annual allowable ocean fisheries impact on Snake River fall Chinook (including Canadian and Alaskan impacts) to 70% of the 1988-1993 base period average impacts. A similar 30% base period reduction in impacts for this stock in Columbia River fisheries is also required to provide an appropriate level of protection while allowing for management flexibility for other stocks. These impact rates are currently being reviewed by NOAA Fisheries relative to Snake River fall Chinook stock status and fisheries impacts.

Over the past 12 years, fish hatchery programs for Columbia River production has been reduced significantly due to Congressional reduction or flat funding for Mitchell Act programs. These funding cuts have resulted in a very substantial reduction (approximately 25.0 million since 1995) in the production of tule fall Chinook salmon at both state and federal fish hatcheries and have caused the closure of some facilities. The State of Oregon has drastically reduced its production of tule fall Chinook salmon in the Columbia River system. Spring Creek NFH, is now the only facility producing tule fall Chinook above Bonneville Dam. Nearly all of the remaining Columbia River tule production is released from hatcheries in the State of Washington below Bonneville Dam. These reductions and hatchery closures make maximizing survival and production at Spring Creek NFH even more important for maintaining and improving fisheries in the Pacific Ocean and Columbia River, especially in years of low ocean productivity. Early projections for 2007 adult returns of Spring Creek Chinook to the Columbia River indicate a continual decline with a run size likely less than 40,000 fish.

Spill is generally accepted as the safest route for fish passage at Federal Columbia River Power System (FCRPS) facilities in terms of both immediate and delayed survival effects. However, neither spillway nor delayed survival studies have been conducted on March releases from Spring Creek NFH. Various survival studies looking into these questions have targeted later times of the year and/or different fish species or stocks. Historically, the March release of juvenile fish at Spring Creek NFH has produced 46% of the returning adults (based on a recent 5-year average). The Service has released juvenile fall Chinook in March, April, and May to maximize the rearing capacity of the facility by splitting the April and May releases into available empty pond space after the March release has occurred. Along with maximizing rearing capacity, this release strategy also balances the risks associated with the possibility of low survival from a particular release month. Maximizing the survival of the March release fish is important for international and domestic fisheries operating both in the ocean and in-river.

Historically, the Bonneville Power Administration (BPA) allowed spill at Bonneville Dam, coinciding with the timing of the SCNFH releases in March to provide a non-turbine/bypass passage route and improve their survival past Bonneville Dam. The duration and volume of spill that BPA has allowed at Bonneville Dam for the Spring Creek March releases has varied over time. Since 1992, there have been three general categories of the duration and volume of spill allowed at Bonneville Dam during the March releases (Figure 1). During 1992-2000, spill duration and volume averaged 178 hours (7.4 days) and 1200 KAF. During 2001-2004, average spill duration and volume were reduced to 59 hours (2.5 days) and 177 KAF. During 2005 and 2006, BPA did not allow spill for the March releases. However, beginning in 2004, the Bonneville Dam corner collector was operated during the March releases, providing a non-turbine/bypass passage route through the dam. During 2004-2006, the corner collector was operated for 81 hours using 34 KAF, on average, during the March releases. These recent volumes using the corner collector are 2.8% of the volumes allowed using spill during 1992-2000.

The provision of spill at Bonneville Dam for the SCNFH March releases has been an important issue among the FWS, other fishery management agencies, and the Action Agencies. In 2004, the FWS developed and distributed a research proposal to rigorously evaluate the effects of Bonneville Dam operations on the survival of SCNFH March releases (USFWS 2004). This study consisted of three years of CWT marking and releases under three operations at Bonneville Dam: a spill-only operation, a spill plus corner collector operation, and a corner collector-only operation. Partitioning the March release into three groups would help balance the risk caused by the uncertainty of the newly-constructed corner collector route, and this balanced block design would aid in understanding the additive and or multiplicative effects of the components of spill and corner collector operation on efficiency (through hydroacoustics) and long-term survival (through coded wire tag recovery rates). To achieve this balanced design, FWS requested that the treatment operations be: 75 kcfs spill-only, 75 kcfs spill with the corner collector, and the corner collector-only. Spill levels for the spill and spill with the corner collector needed to be similar in this study design to assess whether the effect of the corner collector is additive or not. FWS believed that spill levels at 75 kcfs would provide adequate survival conditions and would provide a level of precaution against the unknown survival rates associated with the other passage routes. The proposal to conduct the study over three years was made to ensure confidence and reliability in the results.

Following the distribution of this proposal, discussions between the FWS and the Action Agencies resulted in a single year of CWT-marking, only two operations being evaluated (spill versus corner collector), reduced levels of spill (50 kcfs instead of the proposed 75 kcfs), and no spill requests for two years. For the most part, this is what occurred. A major exception was that calibration errors in spill rates resulted in actual spill rates of 25 kcfs instead of the target of 50 kcfs in 2004.

In March 2004, the U.S. Fish and Wildlife Service (FWS) released over 220,000 subyearling fall Chinook from SCNFH with coded wire tags (CWT) to evaluate smolt-to-adult return rates (SAR) back to the hatchery under two operations at Bonneville Dam. Tagged fish were released in two groups: one group released during four days of spill operation at Bonneville Dam and one group released during four days of corner collector operation at Bonneville Dam. In determining the number of tagged fish to release (220,000), sample size calculations were conducted which found that a 25% reduction in the hatchery SAR of fish released during corner collector operation could be detected with 80% power ($\beta = 0.2$) and $\alpha = 0.1$, assuming the hatchery SAR for fish released during spill was 0.0016 (the average hatchery SAR for March-released fish over brood years 1992-1996). The releases were conducted to test the following null hypothesis:

$$H_0 : SAR_{Spill} = SAR_{CC}$$, versus

$$H_A : SAR_{Spill} \neq SAR_{CC}$$,

where SAR_{Spill} is the hatchery SAR for fish released during spill operations at Bonneville Dam and SAR_{CC} is the hatchery SAR for fish released during corner collector operations at Bonneville Dam. At this point in time, we call this evaluation preliminary because age-4 adults from the 2004 releases (brood year 2003) will not return until fall 2007. Age-4 adults typically constitute 24% of the total brood year returns to the hatchery.

Methods

Tagging and releases

Spring Creek NFH staff randomly selected nine rearing ponds and tagged approximately 25,000 fingerlings with CWT from each pond. Four ponds were randomly assigned for release during the spill operation and the remaining five were assigned to release during corner collector operation. Mean fish weight at tagging was 2.2 grams for the spill release group fish and 2.3 grams for the corner collector release group fish. The spill release group fish were released from the hatchery in the early afternoon of March 1 and had a mean weight of 2.7 grams. The corner collector release group fish were released from the hatchery in the morning of March 10 and had a mean weight of 3.2 grams. After accounting for tags that were shed, there were 98,932 CWT fish in the spill release group and 122,853 CWT fish in the corner collector release group. In total, 221,785 CWT fish were released.

Bonneville Dam operations

Following the March 1 release, spill began at Bonneville Dam at 20:00 hours on March 2 with a spill target of 50 kcfs (actual spill rate was 25 kcfs, after accounting for spillgate mis-calibration). After 96 hours, spill was terminated at 20:00 hours on March 6. Following the March 10 release, corner collector operation began in the afternoon of March 11 and continued for 96 hours, until the afternoon of March 15. Flow in the corner collector was approximately 5-6 kcfs.

Results

Hatchery Returns

Returning adults from the 2004 releases (2003 brood year) returned to Spring Creek NFH as age-2 adults in 2005 and age-3 adults in 2006. In both years, adults returning to the hatchery were randomly selected across the duration of the run for examination of CWT presence. Hatchery processing constraints limit the number of fish that can be sampled in any year for CWT presence to approximately 10,000 fish. In 2005, 34,291 adults returned to the hatchery, of which 9,770 (28.5%) were examined for CWT (Table 1). In 2006, 10,745 adults returned to the hatchery, of which 9,605 (89.4%) were examined for CWT (Table 1). Within the sample examined for CWT in 2005, six fish were from the spill group and zero fish were from the corner collector group. Within the sample examined for CWT in 2006, 31 fish were from the spill group and 34 fish were from the corner collector group. Variance tests for homogeneity of the binomial distribution on the returns from each pond (Snedecor and Cochran, p. 240-241) within each treatment group (i.e., pond effects, Table 2) showed no differences among ponds for fish released under the spill treatment ($P = 0.58$ for age-2 fish and $P = 0.24$ for age-3 fish) or the corner collector treatment (test not applicable for age-2 fish and $P = 0.90$ for age-3 fish). Therefore fish from the individual ponds were combined and analyzed as two treatment (spill operation and corner collector operation) groups. Within each experimental unit (release group), we make the assumption of independence at the individual fish level. The results above on the lack of group (i.e., pond) effects suggest that assuming independence at the individual fish level is appropriate. Our knowledge of the pond layout and operations at SCNFH, and the lack of any apparent systematic factor that could cause pond effects, further supports this assumption.

SARs and analysis

The objective of this study was to compare the hatchery SARs for the two release groups. Because the entire hatchery returns were not sampled for CWT examination, the numbers of tags observed in the sample required expansion factors to account for the number of tags in the un-sampled component of the hatchery returns. In 2005 the expansion factor was 3.51 (1/.285) and in 2006 the expansion factor was 1.12 (1/.894). Therefore the SARs for the two groups were calculated as:

$$SAR_{Spill} = \frac{3.51(6) + 1.12(31)}{98932} = 0.00056 \text{ , and}$$

$$SAR_{CC} = \frac{3.51(0) + 1.12(34)}{122853} = 0.00031.$$

The SAR_{CC} is a 45% reduction compared to the SAR_{Spill}. We used bootstrapping (Efron and Tibshirani 1993) to calculate 95% confidence intervals for the SARs. The return data for the two groups of fish were re-sampled 1000 times with replacement, using the same expansion factors, to generate 1000 estimates of the SARs for the two groups. We used the 2.5th and 97.5th percentiles of the bootstrap estimates define the 95% confidence limits. The 95% confidence interval for the spill group was (0.00037, 0.00077) and the 95% confidence interval for the corner collector group was (0.00021, 0.00041) (Figure 2).

We used a randomization test to compare the SARs for the two release groups (Manly 1997). Randomization tests provide high statistical power and are especially useful in non-standard situations such as this one where the SARs were the sum of CWT returns over two years, with different expansion factors in each year. In this case, we tested whether the difference between the SARs, $SAR_{diff} = SAR_{Spill} - SAR_{CC}$, could have arisen by chance if there was no difference between the treatment effects. To generate a distribution of SAR_{diff} under the null hypothesis, we generated 5000 replicates of SAR_{Spill} and SAR_{CC} using the across-treatment mean SARs within the samples for the returns in each year. The across-treatment mean SAR in the 2005 sample was

$$SAR_{2005} = \frac{6 + 0}{98932 + 122785} = 0.0000271$$

and the across-treatment mean SAR in the 2006 sample was

$$SAR_{2006} = \frac{31 + 34}{98932 + 122785} = 0.000293.$$

We generated 5000 replicates of SAR_{Spill} and SAR_{CC} with random samples from binomial distributions using sample sizes of 98,932 and 122,785 with the probability of success (i.e., a CWT return) equal to the across-treatment mean SARs above, and with the above expansion factors that accounted for the sampling fraction. The 2.5th and 97.5th percentiles of the null distribution were -0.00022 and 0.00022. These represent the critical values at the 5% significance level. Because the observed difference (0.00025) exceeded the critical values, we reject the null hypothesis (*P* value = 0.028). We conclude that the SAR for fish released during the spill operation in 2004 is significantly higher than the SAR for fish released during the corner collector operation in 2004. The hatchery SAR was higher for the spill treatment than the corner collector treatment for both age-2 returns (0.00021 vs. 0.0) and age-3 returns (0.00035 vs. 0.00031).

Discussion

Using the above estimates for SAR_{Spill} and SAR_{CC} and the total number of subyearlings released on March 1st and 10th 2004 (7,331,523), we estimate that if this entire March release had occurred during the spill operation, the number of adults returning to the hatchery would have been 4,134. If the entire March release had occurred during the corner collector operation, the number of adult returning to the hatchery would have been 2,273. The difference between these two estimates, 1,861, is an estimate of the foregone loss of adults back to the hatchery (through age-3) associated with corner collector operations instead of spill operations at Bonneville Dam in 2004. The average proportion returning to the hatchery (hatchery return rate divided by total survival rate) for brood years 1992-2001 (data for most recent ten years) is 0.33 (Table 3). Therefore, the projected loss to intercepting fisheries from a corner collector operation versus actual spill of 25 KCFS for the 2004 release in March is 3,722 fish. When the expectations for age-4 returns is considered (i.e., that age-4 returns constitute 24% of the total brood year returns), the projected loss to intercepting fisheries increases to 4,545 fish. Had the originally-proposed operation of 75 kcfs spill been implemented, these differences may have been even more pronounced.

In a review of this draft report, Pereira (2007) provided several comments regarding this study. The two primary comments were that the study had a narrow scope of inference and that variation in the release groups (i.e., pond effects) may have influenced the confidence interval widths and *P* values. In terms of broadening the scope, Pereira (2007) suggests increased replication within the season (i.e., multiple treatment release groups in March) and increasing the number of release groups. We agree that additional replication would improve the confidence and reliability of the results. In our original study proposal, we proposed replicating the CWT releases over three years and three treatments. If the Action Agencies had implemented this original proposal, the additional replication proposed by the USFWS and suggested by Pereira (2007) would have been achieved, along with increasing the understanding the individual and combined effects of spill and corner collector operation on survival to the adult stage for March-released SCNFH tule fall Chinook salmon. We encourage the Action Agencies to reconsider these additional study years and treatments for the Spring Creek March release. The second primary comment of Pereira (2007) is that extra variation among the pond groups would tend to underestimate confidence interval width and cause *P* values to be too small. As described above in the section on hatchery returns, we found no evidence of pond effects, suggesting that our assumption of independence at the individual fish level was appropriate. We therefore believe that the confidence intervals and *P* values properly account for the uncertainty associated with the *SARs* and the statistical significance of the difference in hatchery *SARs* between the two operations. Still, these results are preliminary, as age-4 returns from the releases in 2004 will return in 2007 and fishery recoveries (ocean and in-river) for the 2004 release will be completed in upcoming years.

Table 1. Number of adult returns to SCNFH, number of adults sampled for CWT examination, and the number of CWT fish in the samples for the spill group fish and corner collector (CC) group fish.

			Number of CWT fish in samples			
			Age-2		Age-3	
Return Year	Adult Returns	Examined for CWT	Spill group	CC group	Spill group	CC group
2005	34,291	9,770	6	0		
2006	10,745	9,605			31	34

Table 2. Number of fish marked with CWT and the number of observed returns to SCNFH, for each of the nine pond groups randomly assigned to the spill and corner collector operations treatments.

Treatment	Pond	Number tagged	Age-2 returns in 2005	Age-3 returns in 2006
Spill	Pond 1	24,515	0	10
Spill	Pond 2	24,822	2	3
Spill	Pond 3	24,448	2	8
Spill	Pond 4	25,147	2	10
CC	Pond 5	24,573	0	6
CC	Pond 6	23,453	0	5
CC	Pond 7	24,815	0	7
CC	Pond 8	25,030	0	9
CC	Pond 9	24,982	0	7

Table 3. Total percent survival rate (fisheries interceptions plus hatchery returns), hatchery percent SAR, and the proportion of total survivors that returned to the hatchery (hatchery SAR divided by total survival rate) for Spring Creek NFH releases over brood years 1992-2001.

Brood Year	Total Survival Rate (%)	Hatchery SAR (%)	Hatchery proportion
1992	0.16	0.05	0.34
1993	0.22	0.06	0.28
1994	0.10	0.04	0.36
1995	0.05	0.02	0.33
1996	0.43	0.13	0.31
1997	0.11	0.04	0.33
1998	1.30	0.47	0.36
1999	1.44	0.42	0.29
2000	1.14	0.36	0.32
2001	0.98	0.35	0.35
		Average	0.33

Data from Annual Stock Assessment - CWT (USFWS)
BPA Project No. 1982-013-03

1980 through 1995 data from the 2004 Annual Report
1996 through 2001 data from the 2005 Annual Report

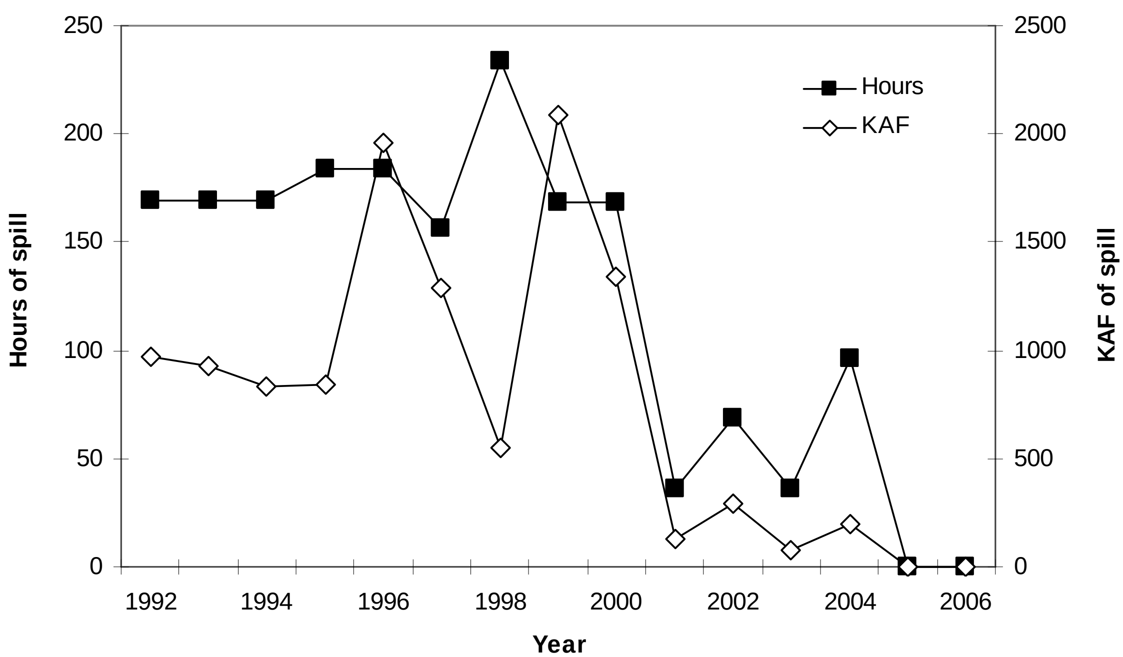

Figure 1. Hours of spill and KAF of spill at Bonneville Dam during the March release of Spring Creek NFH tule fall Chinook, 1992-2006.

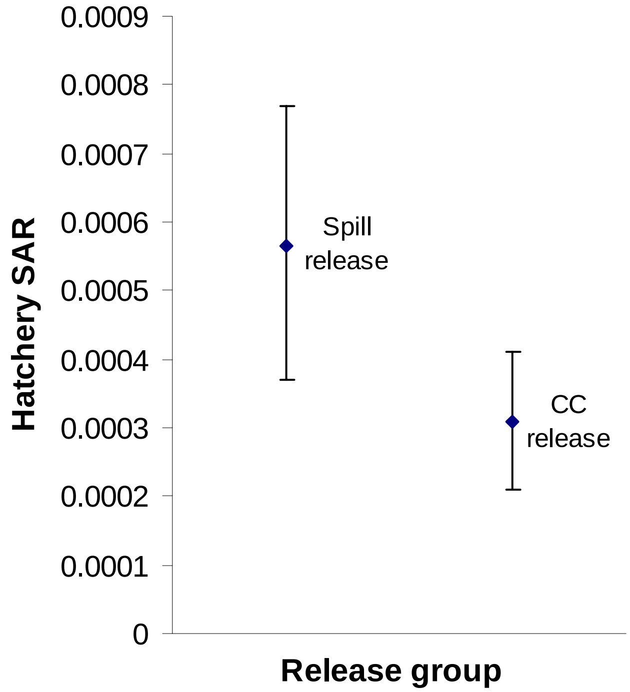

Figure 2. Bootstrap 95% confidence intervals of the hatchery return rate for Spring Creek NFH Chinook salmon released during spill operations and corner collector (CC) operations at Bonneville Dam in 2004.

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