2010-2011 Kelt Management Plan

Final December 30, 2010

2010-2011 Kelt Management Plan

INTRODUCTION

As a strategy to improve steelhead survival in the Columbia Basin through the Federal Columbia River Power System (FCRPS), NOAA Fisheries identified actions to improve the productivity and abundance of steelhead kelts in two Reasonable and Prudent Alternatives (RPAs) in the 2008 FCRPS Biological Opinion (BiOp). These two RPAs focus on a combination of hatchery (reconditioning) and hydrosystem operations at projects on the Lower Snake and Columbia Rivers to benefit Snake River B-run Steelhead (RPA #33), and hatchery operations to benefit upper and middle Columbia River Stocks (RPA#42).

RPA Action #33 requires the U.S. Army Corps of Engineers (Corps) and the Bonneville Power Administration (BPA) to "prepare a Snake River Kelt Management Plan (Plan) in coordination with NOAA Fisheries and the Regional Forum. BPA and the Corps will implement the plan to improve the productivity of interior basin B-run steelhead populations as identified in Sections 8.5." RPA #33 requires a Plan that will focus on the wild component of the B-run steelhead and should include:

1. Measures to increase the in-river survival of migrating kelts,
2. Potential for collection and transport (either with or without short-term reconditioning) of kelts to areas below Bonneville Dam,
3. Potential for long-term reconditioning as a tool to increase the number of viable females on the spawning grounds, and
4. Research as necessary to accomplish the plan elements.

In Chapter 8.5 (FCRPS Biological Opinion, 2008), it is stated that NOAA's analysis of Prospective Actions (Supplemental Comprehensive Analysis Hydro Modeling Appendix) indicates that a combination of transportation, kelt reconditioning, and in-stream passage improvements (e.g. spill-flow modifications) could increase kelt returns enough to increase the number of returning Snake River B-run steelhead spawners to Lower Granite Dam by about 6% (Supplemental Comprehensive Analysis Steelhead Kelt Appendix-Bellerud et al. 2007). Based on Table 1 in Bellerud et al. (2007), the Action Agencies interpret this 6% increase to be a 6% increase to the average B-run steelhead run abundance. Considering the potential gains in B-run spawners listed in Table 1 in Bellerud et al. (2007) and the caveats discussed for each enhancement strategy, NOAA believes that an estimate of increased B-run returns could be somewhere in the 0.4 –9% range depending on the strategies adopted. Assuming a successful long-term recondition program and after adding a likely but unspecified survival increase from in-river survival improvements, NOAA believes that it is reasonable that an estimated average increase of 6% in B-run Snake River steelhead returns to Lower Granite Dam is possible.

RPA Action #42 requires Action Agency funding of steelhead kelt reconditioning programs for middle and upper Columbia River steelhead populations. RPA #42 requires:

1. Funding a program to recondition natural origin kelts for the Entiat, Methow and Okanogan subbasins (Upper Columbia) including capital construction, operation, and monitoring and evaluation costs; and
2. Funding a program to recondition natural origin kelts in the Yakima subbasin (Mid-Columbia) including capital construction, implementation, and monitor and evaluation costs.

Unlike RPA #33, RPA #42 does not specify a numerical target for an increased number of returning steelhead spawners; it only mandates funding for hatchery based reconditioning programs that conserve and build genetic resources for the recovery of ESA listed steelhead populations in the Upper and Middle Columbia Distinct Populations Segments (DPS). Similar population-level benefits could be expected for the Mid- and Upper Columbia DPS per employment of collection & transportation, kelt reconditioning, and in-stream improvements, assuming logistical difficulties associated with collection of kelts at the hydro projects can be resolved (Chapter 8.5, FCRPS Biological Opinion, 2008).

NOAA (2008) concluded that rates of productivity for upper Columbia River (UCR) naturally-reproducing steelhead populations must increase by 2 to 6 fold in order to escape imminent risk of extinction.

Increasing the survival of kelts and their eventual return as repeat spawners can be considered one component in improving the abundance and productivity of ESA listed steelhead populations in the Snake River and Upper and Middle Columbia River. A value greater than 1.0 for *adult progeny* (Recruits) to *repeat spawner* (surviving kelt) ratio of a steelhead population could be used as a partial measure of productivity improvement in a steelhead population. Therefore in this plan, a recruit per spawner (R/S) ratio greater than 1.0 is considered as an improvement in population productivity that conserves and builds genetic resources of Mid- and Upper-Columbia River populations; and a 6% increase in the abundance of adult steelhead returning to Lower Granite Dam will be assumed to represent a concurrent increase in productivity for an aggregate of the B-run component of the Snake River DPS.

It is reasonable to develop an integrated Kelt Management Plan that includes both the Snake River and the upper and middle Columbia River DPS since (1) the overall objective to increase the abundance of steelhead populations is consistent, and (2) measures that either are, or will be, employed to increase kelt survival are similar and pertinent to both the Snake River and the upper- and mid-Columbia River populations. Strategies in this plan are categorized as either “Operational” (e.g. improving the in-river migration conditions or transportation) or “Kelt Reconditioning” (e.g. short term or long term reconditioning), as well as combinations of these categorical strategies.

The BiOp states that a Kelt Management Plan should be prepared every year, along with annual progress reports citing the status of project implementations and milestones. Progress toward achieving the objectives of the Kelt Management Plan will be detailed in the 2013 and 2016 Comprehensive RPA Evaluation Reports. To reflect ongoing efforts, knowledge, and management priorities, the Kelt Management Plan will adapt and/or may change significantly in scope and format over time in order to maintain effectiveness and relevance in achieving plan objectives.

The Plan will also assist in coordinating approaches implemented under the BiOp Actions (#33 and #42) with those implemented in the kelt reconditioning programs that were committed to under the 2008 Fish Accords with the Three Lower River Treaty Tribes and the Columbia River Inter-Tribal Fish Commission (CRITFC).

INTENT AND OBJECTIVES OF THE 2010-2011 PLAN

The Kelt Management Plan for 2010-2011 builds on the framework provided by the 2009-2010 plan. Relevant research results and future plans are updated. As results of ongoing research continue to provide additional insights into the effectiveness of various kelt management strategies, this plan will provide a framework for planning and implementation. Successive plans will necessarily be more detailed in content, in order to fully meet the mandates of RPA #33. Since BPA is already funding the Mid-Columbia and Upper Columbia kelt reconditioning actions called for in RPA #42, implementation progress for these actions will be reported in the Annual Progress Reports to NOAA Fisheries. The objectives of this version of the Kelt Management Plan are chiefly to (1) provide an updated synopsis of current understanding about operational and kelt reconditioning measures employed to benefit kelt survival and iteroparity (repeat spawning) in the Snake and Columbia Rivers, (2) identify critical uncertainties/data gaps and document progress towards filling those gaps, and (3) recommend strategies to increase kelt survival/ iteroparity rates and ultimately the abundance of steelhead populations.

BACKGROUND AND CURRENT KNOWLEDGE

Steelhead Iteroparity (Repeating Spawning)

Unlike most Pacific salmonids (*Oncorhynchus* spp.), steelhead (*O. mykiss*) may spawn more than once during their lifetime. Repeat spawning (iteroparity) is considered to be a hedge against catastrophic reproductive failure and a life history strategy that provides population level genetic and demographic benefits (Crespi and Teo 2002; and Fleming and Reynolds 2004). The rate of repeat spawning for steelhead prior to construction of mainstem dams in the Columbia and Snake Rivers is not well documented. The iteroparity rates in the 1930s (pre-Bonneville Dam) were estimated as 2% for summer-run, 4% for fall-run, and 12% for winter-run steelhead (Long and Griffin 1937). Table 1 summarizes the limited information on the iteroparity rates for steelhead populations of the Columbia Basin and Washington Coast.

Boggs et al. (2008) report that "Iteroparity estimates for the aggregate Columbia River samples (5-6%, across years) were comparable to rates for British Columbia steelhead (Withler 1966), but were generally lower than those reported across a variety of life history types in Washington (7-11%), Oregon (11-21%), California (17-23%), and Alaska (21-51%) (Shapovalov and Taft 1954, Busby et al. 1996, Lohr and Bryant 1999). Four or more spawning events have been noted in some of these populations, whereas only two steelhead were recorded on a third spawning migration in the Columbia River study. The aggregate iteroparity estimate for Snake River fish (~1%) was among the lowest recorded for any steelhead population, and places this group at the low end of the iteroparity continuum for anadromous salmonids (i.e., Fleming 1998). The relatively low rate may be attributable to long, energetically demanding migrations that favor high single episode reproductive investment (Crespi and Teo 2002; Fleming and Reynolds 2004). Low repeat spawning may have been the norm historically, particularly for those interior Columbia and Snake River populations that have among the longest freshwater migrations recorded for the species (Busby et al. 1996)." However, an estimated 22% of the upriver wild steelhead run pass downstream as kelts through the juvenile bypass system at Lower Granite dam during no spill conditions (Dygert 2007). This suggests that Snake River steelhead populations have not lost the ability to repeat spawn.

Little is known about the biological effects of the FCRPS operations on various steelhead populations as a result of reduced iteroparity in present day steelhead. Table 1 infers that kelt iteroparity appears to decrease in populations with a greater number of hydropower dams that are navigated during their emigration from natal spawning areas to the Columbia River estuary. Implicit in this inference is the fact that as the number of dams navigated by kelts increases so does travel distance to the estuary/ocean and residence time in the freshwater environment.

Radio telemetry studies indicate that mortality rates of emigrating kelts range from 20-40% at lower Columbia River dams and from 84-96% for kelts tagged at Lower Granite Dam on the Snake River (Wertheimer and Evans 2005). Estimates of repeat spawning rates of steelhead vary from 2.9 – 9.0% for kelts tagged at lower Columbia River dams and from 0.5 – 1.2% for kelts for Snake River (Keefer et al. 2008).

Keefer et al. (2008) reported that kelts in good or fair condition were > 25 and > 10 times respectively more likely to return as repeat spawners than those in poor condition. They also reported that early-timed emigrating, bright colored, wild and smaller bodied kelts were also significantly more likely to return as repeat spawners.

During the 2001-2005 period, the emigration time for steelhead kelts through the hydro projects (Lower Granite, McNary, and John Day) occurred from mid-March through early June (based on an interpretation of Keefer et al. 2008). In 2001-2004 kelt studies, earlier emigrating kelts returned at relatively higher rates than later emigrants (Boggs et al. 2008). 'Consecutive' spawners (returning year after kelt emigration to estuary/ocean) appear to emigrate earlier as kelts than 'skip' spawners (remain in ocean one or more years longer that 'consecutive' spawners) (Keefer et al. 2008). Overall, 57% of repeat spawning steelhead in this study were consecutive spawners, whereas 43% were skip spawners, and the proportion of skip spawners increased with increasing migration distance, reaching 62% at Lower Granite Dam.

Post-spawned kelts examined in juvenile bypass systems at Columbia and Snake rivers dams are disproportionately females (more than 80%) and the majority were wild in origin (Keefer et al. 2008).

Like juvenile steelhead, kelts appear to travel near the surface of the water column during their emigration past Lower Granite Dam project (Johnson et al. 2000, and Wertheimer and Evans 2005). Passage evaluations at dams generally indicate that surface-oriented passage routes at hydro projects provide the best passage efficiency and are assumed to have higher survival rates. Conversely, turbine intakes, typically deeper in the water column, appear to be associated with the highest kelt mortality rates. The effects of passage over spillways are unknown (Evans et al. 2008).

Hydro projects and associated storage pools can slow the emigration of kelts to the estuary and ocean by reduction in water velocities and increase time in search of passage routes around said projects (Wertheimer and Evans 2005; Wertheimer 2007). These delays may pose direct energetic costs and postpone resumption of ocean feeding and gonadal recrudescence of emigrating kelts (Boggs et al. 2008).

The proportion of kelts passing through spill routes, either conventional deep spill or surface spill, has not been measured at most mainstem Snake or Columbia River dams due to lack of PIT tag detection. By default, the Action Agencies have been treating kelt passage as a spread-the-risk probability with some lesser degree of transport afforded through RM&E projects

The importance of repeat spawning kelts to steelhead populations varies widely, with the fraction of repeat spawners in spawning steelhead populations ranging from 1 to 51% (Wertheimer and Evans 2005). Boggs and Peery (2004) cite an estimated 2% kelt rate for the Clearwater River in 1954. It is estimated that 17-25% of the steelhead run that pass Lower Granite Dam, return downstream as kelts (Boggs and Peery 2004; Wertheimer and Evans 2005). Thus, while there is a relatively large number of kelts present, their relatively poor survival through the FCRPS may limit the contribution that they can make to steelhead populations.

Methods to Increase Kelt Post-Spawning Survival and Iteroparity

Effects of the FCRPS on outmigrating adult steelhead kelts are not well known but are thought to be significant as both turbine passage survival and passage through juvenile collection and bypass systems are poor. Comparing recent juvenile bypass system kelt counts before and after increases in spring spill and the installation of surface bypass facilities (e.g., RSWs) suggest that steelhead kelts may benefit from spring spill and surface bypass improvements included in the Prospective Actions of the FCRPS BiOp (NOAA 2008). However, no definitive information is available to clearly demonstrate such effects. The prospective kelt reconditioning program is likely to increase the number of spawning adult steelhead, but it is not possible to estimate a survival rate change at this time because of uncertainties regarding the percentage of the run that can be collected, reconditioning survival rates for Snake River B-run and Upper Columbia River kelt steelhead, the proportion of rematurining and non-rematuring (i.e. skip spawning) fish in reconditioning programs, and the development of an effective strategy for managing the skip spawning life history type.

Prospective passage improvements for juvenile salmon and steelhead, including surface passage such as RSWs and sluiceways, are also likely to benefit downstream migrating kelts. This should lead to improved survival through the FCRPS. Reduced forebay residence times which lead to a reduction in total travel time may also contribute to an improvement in kelt return rates. It is not possible to calculate the precise amount of improvement expected, because the interaction between improved surface passage and improved kelt survival and return rates is poorly known. However, some improvement is likely.

It is possible that a combination of operational and biological measures could be used to increase the iteroparity rates of ESA listed steelhead populations migrating through the FCRPS. Further, these measures could contribute to the recovery of these populations through the accrual of genetic, demographic and productivity benefits. The suite of strategies for increasing post-spawning survival and iteroparity rates of steelhead kelts are categorized as “Operational Strategies” or “Kelt Reconditioning Strategies.” Operational strategies are subcategorized as *Enhanced In-river Migration* and *Collection-Transportation*. The Kelt Reconditioning strategy is sub-categorized into four treatments: *In-River Migration*, *Transport Only (without Reconditioning)*, *Short-Term Reconditioning*, and *Long-Term Reconditioning*. These categorical strategies are described in the following text.

<u>Operational Strategies</u>

Enhanced In-river Migration

This strategy includes operational or structural modifications of hydro facilities that create conditions that could enhance survival rates of kelts passing a hydro facility. These modifications may physically guide or passively attract kelts towards either a collection-passage system or spillways.

Collection and Transportation

Transportation of kelts around the hydro-system is hypothesized as a means of increasing kelt survival and iteroparity of natural populations by decreasing dam and reservoir passage mortality and conserving the already taxed energy reserves of emigrating kelts (Wertheimer and Evans, 2005). This strategy involves the collection and transportation of kelts by either barge or tank truck around the mainstem hydro projects, prior to release downstream of Bonneville Dam. This measure has been tested with Snake River kelts collected at Lower Granite Dam and is analogous to the transport only (without reconditioning) treatment described below as a kelt reconditioning strategy. In recent years' tests at Prosser Dam on the Yakima River, all transported fish have received PIT tag and radio-tags to assess fish survival, movement, distribution, travel time, as well as residence time in the estuary. This treatment, when results are compared to those of in-river and short-term reconditioning treatments, helps to isolate and identify the effects of downstream passage through the hydro system on kelt survival.

Kelt Reconditioning Strategies

Kelt reconditioning is used as a means of increasing post-spawning survival and repeat spawning. This strategy includes two variations based on the length of time that the post-spawned fish are held to aid their recovery. To assess their effectiveness, these two variations: *short-term reconditioning* and *long-term reconditioning* are traditionally compared to either a group of in-river migrants or a group of kelts that was transported around the hydrosystem.

In-River Migration

The in-river migration strategy is defined as collecting, PIT-tagging, and immediately releasing steelhead kelts at the point of collection. This strategy serves as an experimental control when comparing other operational or reconditioning strategies (transported only, short-term reconditioning, and long-term reconditioning) and is essentially the same as the "Enhanced In-River Migration" operational strategy.

Transport Only (Without Reconditioning)

The transport only strategy is defined as collecting and immediately transporting kelts around the hydroelectric projects for release into the Columbia River estuary downstream of Bonneville Dam without reconditioning. As mentioned above in the operation strategies section, results from this method are compared to those of in-river and short-term reconditioning treatments. This comparison helps to isolate and identify the effects of downstream passage through the hydro system on kelt survival. This strategy is also referred to as "transport unfed" or "transport (no term)" in various reports.

Short-Term Reconditioning

Short-term reconditioning is conducted over the 3-12 weeks needed for kelts to initiate post-spawn feeding, followed by transportation of kelts around mainstem hydro projects for release into the Columbia River downstream of Bonneville Dam and maturation in the Pacific Ocean (Branstetter et al. 2007). Short-term reconditioning may increase iteroparity rates by initiating a sustained feeding response after spawning, and allowing kelts to resume the natural process of gonadal development in the estuarine and marine environments. In recent years, PIT tag and radio-tags have been used to assess survival, movement, distribution, travel time, as well as residence time of kelts in the Columbia River estuary.

Long-Term Reconditioning

Long-term reconditioning is defined as holding post-spawned kelts for 6-10 months while they reinitiate feeding, and subsequently display positive growth rates and gonadal development. The only proposed transportation component would be that level of truck transport required to convey pre- and post-reconditioned kelts to and from the location of collection and release. Kelts that have experienced long term reconditioning are released in the fall, typically in mid-to-late October, coincident with run-timing of adult steelhead migrating into upper Columbia tributaries as stream temperatures are declining. Reconditioned fish are typically released near or downstream of their collection location so that they may over-winter and return to spawning locations on their own volition.

Results of Previous Kelt Studies and Projects

<u>Operational Strategies</u>

The Corps of Engineers has funded several years of research on survival and passage rates of kelts that are either migrating in-river through the hydrosystem or those that have been transported around the hydrosystem. The following information for enhanced in-river migration and collection and transportation provides insight to the current understanding of these operational measures as candidates for increasing kelt survival and iteroparity rates, which are assumed as population attributes that could contribute to improvement in the abundance and productivity of Snake River and Upper-Middle Columbia River steelhead populations.

Enhanced In-River Migration

Spillway and Surface Route Passage

Kelts appear to pass preferentially via spillways or surface passage routes if available. Wertheimer and Evans (2005) reported that dam passage of kelts was predominantly via spillways and surface flow routes; and that during spill periods, 90% or more kelts passed the projects via non-turbine routes.

Boggs et al. (2008) report that (1) repeat spawners were generally highest for kelts that passed via juvenile bypass system at Bonneville Dam, whereas unknown/other routes were highest at John day and The Dalles dams; (2) for the lower Columbia River tagged kelts, return rates were relatively higher for kelts tagged in the low flow year of 2001 that returned to McNary and John Day dams when there was little or no spill during much of the kelt outmigration; (3) returns of in-river kelts to McNary and John Day dams always exceeded returns of in-river kelts to Lower Granite Dam during the comparable release years studied; and (4) kelt passage via bypass systems may be preferable to passage through spillways as configured and operated during the study period.

The relationship between kelts' apparent affinity for spill and surface passage routes and the fact that return rates have been higher from bypassed fish is a question that merits further investigation. It remains unclear if this relationship will continue since the installation of additional surface passage routes since these earlier studies were conducted. The recent installation of surface passage routes on the mainstem Columbia and Snake Rivers should benefit kelts both by bypassing them through potentially safer routes and reducing their retention time in the dam forebays (Chapter 8.5, page 30, FCRPS Biological Opinion 2008). The following sections detail recent investigations of kelt passage at surface passage outlets at Bonneville and The Dalles dams.

Bonneville Dam 2nd Power House Corner Collector (B2CC)

Since 2004, the corner collector at the Bonneville Dam Second Powerhouse has been routinely operated as a surface flow outlet to pass juvenile salmonids. Because surface flow outlets (SFOs) readily pass juvenile salmonid migrants (Johnson and Dauble 2006), they may also be an effective non-turbine passage route for steelhead kelts moving downstream in early spring prior to the main juvenile emigration season. Operation of the B2CC, however, reduces the amount of discharge (5,200 cfs) available for hydropower production.

In 2007 and 2008 research was carried out to estimate the number of kelt using the B2CC for downstream passage at Bonneville Dam prior to the juvenile spring migration season. Estimates of steelhead kelt passage were 172 ± 8 and 223 ± 7 fish (95% confidence intervals) during the 2007 and 2008 sampling periods, or 4 and 7 fish per sample day, respectively (Weiland et al., 2009). These values generally agreed with a count conducted in 2003 at the 2nd powerhouse juvenile bypass system (JBS). During the 2003 kelt outmigration season a total of 595 kelts were counted before the new B2CC became operational. A decline in bypass counts after the B2CC became operational is circumstantial evidence that the B2CC is passing steelhead kelts. The detection rates of PIT-tagged kelt in the B2CC during the 2007 and 2008 study periods confirmed that kelt were passing through the B2CC. Wertheimer (2007) estimated that over 80% of total kelt passage at B2 during spring 2004 was through the B2CC.

Daily kelt passage rates were sporadic ranging from 0 to 18 and 0 to 31 fish per day in 2007 and 2008, respectively. Kelts were observed passing the dam from the beginning of the sampling periods in early March through the end of sampling periods in mid-April, although passage peaks occurred in April each year. There was no clear diel pattern in passage rates.

The Dalles Dam Sluiceway

Like the corner collector at Bonneville Dam, The Dalles Dam (TDA) has a surface passage route that can be used to pass kelts. At The Dalles Dam, an ice and trash sluiceway can be operated at varying flow rates as an alternate to turbine passage. Operating the sluiceway reduces hydropower production; however the sluiceway could be the optimal non-turbine route for kelt passage in the early spring before the start of the voluntary spill season. To quantify passage rates of steelhead during this period, a study was started in 2008 and continued through March 2010 to characterize adult steelhead spatial and temporal distributions and passage rates at the sluiceway and turbines (Khan et al, 2009, Khan et al, 2010). The study period for the kelt component of this study was from March 1 to April 9, 2009 (40 days). The study was repeated over the same time frame in 2010. The study objectives were to 1) estimate the number and distribution of kelt-sized acoustic targets passing into the sluiceway and turbines at TDA during the study period, and 2) assess the behavior of these fish in front of sluice entrances.

For the early spring study, overwintering summer steelhead and early out-migrating steelhead kelt downstream passage occurred throughout the 40-day study period.

	Mar 1 – April 10, 2009	Mar 9 – April 10, 2010[1]
Sluiceway Passage	1,673	1,958
Turbine Passage	93	27

Summary of research results from Khan et al 2009, and Khan et al 2010 detailing steelhead and kelt passage at The Dalles Dam sluiceway.

The sluiceway was highly efficient at passing kelts in both years of the study, passing 95% of the kelts in 2009 and nearly 99% of the kelts in 2010. Sluiceway passage efficiency was higher in 2010 even though the amount of water passing through the sluiceway was reduced by 1/3rd compared to 2009 (i.e. only 4 openings into the sluiceway were operated in 2010 compared to 6 in 2009). There was a single peak in passage in 2009 when run timing peaked in late March but kelt-sized targets did pass the dam on March 2 and March 6 (162 and 188 fish, respectively). In 2010, run timing peaked twice, once on March 20/21 and again in early April. No clear pattern was observed in early out-migrating kelt passage in either year.

During both years of study, turbine passage was extremely low and was represented by discrete passage events rather than low, continuous passage. In 2010, the 27 fish all passed on the same day (March 20) in-spite of the fact that the sluiceway did not operate until March 9.

<u>Traditional Bypass System Passage</u>

Wertheimer and Evans (2005) also reported that during non-spill periods, only 47.2% of the kelts were guided away from the turbine intakes by screening systems. They concluded that turbine passage was a “substantial” source of kelt mortality during non-spill periods. The presence of spill can also affect the rate of bypass passage. Dygert (2007) indicated that approximately only 7% of the wild Snake River steelhead run passed into the bypass system at Lower Granite Dam when spill was available. The bypass passage rate climbed to 22% during periods without spill. The kelts that pass into the bypass system at Lower Granite would be available for removal for kelt enhancement measures such as reconditioning or transportation.

Collection and Transportation

[1] Due to an oil spill near the exit of the sluiceway in 2010, the sluiceway was not opened until March 9th.

Evans et al. (2008) tested the feasibility of transporting steelhead kelts around hydroelectric dams on the Snake and Columbia Rivers to increase returns of repeat spawners. Kelts were collected, tagged with PIT-tags, and assigned to groups that were either transported or returned to migrate in-river. 5,320 kelts were tagged at Lower Granite Dam between 2002 and 2004, and 558 kelts were tagged at John Day Dam in 2002. Though the findings were only statistically significant in 2002 (possibly due to sample sizes) with a net iteroparity increase of just 0.73%, the results of these transportation tests indicated that kelts transported from Lower Granite Dam to below Bonneville Dam were approximately 2.3 times (a calculated simple mean across the years studied) more likely to return to the Columbia Basin than the kelts that emigrated in-river through the hydro projects. 2002 was an exceptional year for kelt survival at all locations monitored including Lower Granite Dam, John Day Dam, and the Yakima River. A mean weighted on the different collection sizes would be 2.1 times greater benefit to survival for those kelts transported. There was no significant benefit for kelts transported from John Day Dam, although transported fish returned at a slightly higher rate (1.1 times greater). In 2004, although the results were not significant, the in-river treatment group actually returned repeat spawners at a higher rate than the transported group.

The Yakima kelt reconditioning project (BPA Contract No. 2007-401-00) provides some additional insight into survival rates of transported and non-transported kelts. This project included two treatment groups, an ‘in-river’ control group and a ‘transported only’ group. The ‘in-river’ control group was collected and PIT tagged, and then returned to the river to complete their downstream emigration to the Columbia River estuary. The transported group (non-reconditioned) was collected and PIT tagged at Prosser Dam (Yakima River) and then transported by truck for release below Bonneville Dam.

Between 2005 and 2008, the average rates of kelts that returned were 4.0% for the in-river group and 2.0% for the transported group. In 2004, 7.0% of the transported group were detected below Bonneville returning as repeat spawners, but there was not an in-river control group that could be used as a comparative measurement (Table 1). As illustrated later in the discussion of Kelt Reconditioning Measures, the transported Short-Term reconditioned kelts returned to Bonneville Dam at an average rate of 2.5% during the 2005-2008 tests.

A two-fold difference in survival between in-river group and transported groups (non-reconditioned and short-term conditioned) raises questions about the efficacy of transporting kelts and releasing them downstream of Bonneville Dam considering the ‘in-river’ group emigrated through four hydro projects (McNary, John Day, The Dalles, and Bonneville). It is assumed that these groups emigrated under similar conditions (environmental, temporal, and spatial) downstream of Bonneville as well as in the estuary and ocean. However, while there may be a tendency to discount transporting kelts (non-reconditioned and short-term reconditioned) around the hydro projects for release downstream of Bonneville Dam, as a viable option, discounting the use of kelt transportation around the hydro system may be premature in light of the 7% survival rate of the transported non-reconditioned group in 2004. More research may be needed to determine whether or not this data point is an anomaly because 2002 had the highest return rates at all locations for transported groups observed in the Yakima Rivers and for those reported by Evans et al. (2008) based on John Day and Lower Granite dam collections. Cold sea surface temperatures during 2002 indicate that ocean conditions were likely best in 2002 compared to other years studied and may have disproportionally influenced the higher returning repeat spawners from the transported group. Additionally, adjusting the release site to further downriver may improve survival of transported kelt steelhead. All kelts were released at the Hamilton Island Boat Ramp located immediately downstream of Bonneville Dam. Survival of kelts from the Hamilton Island Boat Ramp to ocean entry has averaged 49% for Short-term reconditioned treatment kelts.

Inherent flaws in kelt transportation protocols and procedures may be contributing factors to lower survival in transported groups as compared to the in-river control group. One flaw may exist in the direct release of kelts downstream of Bonneville without a significant acclimation period prior to release. In the case of short-term reconditioning, transporting kelts downstream and then reconditioning-releasing kelts at some facility (e.g. Bonneville Captive Broodstock Facility) downstream of Bonneville may significantly enhance the survival and repeat spawning rates of these fish.

One major problem with either short term reconditioning and transport, or transport alone, is that in years with poor river conditions for adult passage survival (e.g. high temps, high uncontrolled spill/flow years), adult returns originating from either in-river migrating smolts and/or transported smolts could be reduced considerably. If we are anticipating this short-term reconditioning and transport effort to have some certainty of benefits in a predicted future that may include longer, warmer Snake River conditions, a long term reconditioning effort that does not include a prolonged upstream migration may make it much more of a benefit and more of a safety net possibility. However, total capacity constraints for the short- and long-term reconditioning scenarios are highly probable. Given that up to 30,000 to 40,000 kelt steelhead could potentially return to Lower Granite Dam in 2010 as a result of high steelhead escapement in 2009; there is a high likelihood that there will be too many kelts to place them all in a single or multiple reconditioning facilities. Even with the grandest plans in place for kelt reconditioning, the capacity of a kelt reconditioning facility will realistically be capped around a few thousand individuals leaving many kelts to migrate in-river by default in most years. Developing and implementing management strategies that improve in-river survival and optimize returns of transported kelts to successful repeat spawning will remain beneficial to recovery of steelhead DPSs.

There were no additional kelts tagged for transportation evaluations in 2009, but monitoring for both PIT tagged and acoustic tagged returning kelts continued.

Kelt Reconditioning Strategies

BPA has funded several years of kelt reconditioning research, providing insight into the potential efficacy of the various kelt reconditioning strategies. Tables 2 and 3 provide summaries of the project study results for various treatments of the kelt reconditioning strategy. As an extension of the Yakima River studies, study on Snake River A- and B-run steelhead kelt reconditioning was initiated in 2009/2010 with dependency on the retrofit of the juvenile salmon smolt facility for a small to moderate capacity for kelt sampling, handling, and holding facility at Lower Granite Dam. The following discussion provides an overview of results from various kelt treatment applications in mid-Columbia (Yakima River and Deschutes River (Shitike Creek) and the upper-Columbia (Okanogan River (Omak Creek) subbasins. As the following discussion illustrates, there can be considerable variation in the success rates of these strategies between locations and also between years at the same location.

In-River and Transport Only Strategies

Yakima Subbasin

The in-river release (control) group of kelts has consistently averaged a return-rate of 4% since its implementation in 2005, with its best year (6%) in 2007 and worst (2%) in 2006. The return of transport-only treatment group had a detection rate at Bonneville Dam as high as 7% for the 2004 emigration and as low as 0% in 2007 emigration (Branstetter et al., 2008). Survival from release below Bonneville Dam to ocean entry averages 47% for transport-only treatments in 2004-2008 (Branstetter et al., 2008).

Short-Term Treatment

Yakima Subbasin

Data from short-term reconditioned kelts collected during 2005-2008 can be compared to the transport only treatment group and a reference group of kelts that migrated in-river. The transport only treatment group was not reconditioned, only transported below Bonneville Dam. The in-river reference group was PIT tagged and returned to the river to complete their downstream emigration. The 2005-2008 mean percent of kelts returning to Bonneville Dam (Table 2) from these groups was 2.5% from the short-term reconditioned group, 1.75% from the transport only group, and 3.75% for the in-river migrants (Table 2), whereas the mean of the total multi-year estimates for each treatment (not equal) are 4% (0-9%, 2002-2008) for short-term reconditioning, 3% (0-7%, 2003-2008) for transport only, and 3.75% (2-6%, 2005-2008) for in-river migrants (Table 2). Survival from release below Bonneville Dam to ocean entry averages 49% for short-term treatments in 2004-2008 (Branstetter et al., 2008).

Long-Term Treatment

Yakima Subbasin (Prosser Hatchery- Yakima River)

To date, the long-term reconditioning treatment has shown the greatest potential to contribute spawners to the local populations in the Yakima subbasin (Branstetter et al., 2008). Over the period of 2000 through 2009, this treatment was applied to a total of 4,696 kelts (ranging from 512 to 662 fish per season). Between 2005 and 2009, the percent of long-term reconditioned kelts that survived to maturation and release ranged from 22% to 57% with an average survival of 38% (Tables 2 and 3), which is consistent with the average of 38% for the entire 2000-2008 dataset.

Survival to release in 2009 was 27% which was lower than the average and may have been due to the elimination of antibiotic treatments. The practice of providing antibiotics was discontinued in 2009 in response to a lack of documented benefit in several published research publications (Branstetter et al., 2010); however, antibiotic treatments were resumed in June 2009 after mortalities increased well beyond historic levels at the Prosser facility.

In comparing survival rates of short-term versus long-term treatments, one must be cautious in deriving conclusions of the effectiveness of the two treatments. The effectiveness of each treatment must be considered in terms of reproductive success of spawning adults in nature. Reproductive success and gamete and progeny viability of these various kelt measures are still considered to be critical uncertainties that will be discussed later in this plan.

Deschutes Subbasin (Warm Springs NFH- Shitike Creek)

Over the period of 2005 through 2008, the long-term treatment was applied to a total of 38 kelts (ranging from 4 to 14 fish per season). During this period, the percent of long-term reconditioned kelts that survived to maturation and release ranged from 0% to 11% with an average survival of 5% (Table 3).

Okanogan Subbasin (Cassimer Bar Hatchery- Omak Creek)

Over the period of 2005 through 2009, the long-term treatment was applied to a total of 136 kelts (ranging from 17 to 43 fish per season). During the years 2005-2009, the percent of long-term reconditioned kelts that survived to maturation and release ranged from 7% to 28% with an average survival of 17.7% (Table 3).

For the 2005-2009, the average percent of matured kelts that survived to release shows great variability between the Prosser group (38%) and those of the Shitike Creek group (5%) and Omak Creek group (17.7%). The low percent maturation for the Shitike Creek and Omak Creek groups may be attributable to limited years of experience in treatment protocols and procedures, facility limitations, and bias resulting from smaller treatment groups as compared to the Prosser program which may benefit from more experience, facility upgrades, and larger treatment groups.

CURRENT EFFORTS TO ADDRESS KELT PROGRAM REQUIREMENTS

RPAs #33 and #42 require the Action Agencies to fund kelt reconditioning programs. RPA #42 specifically mandates funding programs in specific subbasins of the Upper Columbia (Entiat, Methow, and Okanogan) and Mid Columbia (Yakima). BPA is currently funding Project 2007-401-00 to implement the Mid-Columbia River steelhead kelt reconditioning program and working with the Yakama Nation to implement a new Upper Columbia River steelhead kelt reconditioning project (Project 2008-458-00).

RPA #33 does not specifically direct the Action Agencies to fund a kelt reconditioning program per se in the Snake Basin; but it is possible that such a program will be required in the Snake River Basin if operational measures alone will not increase the returns of Snake B-run steelhead by an average of 6% (Bellerud et al. 2007).

Recently, designs for a new kelt collection and holding system at the Lower Granite bypass facility were developed by the US Army Corps of Engineers, the University of Idaho, and CRITFC. This new system should provide the flexibility to incorporate any recommendations that may come out of this Plan to increase kelt survival and iteroparity rates in the Snake River. See Appendix B for more details of this planned kelt facility.

In addition, Tribal Accord funds are being used to implement kelt reconditioning related projects in the Mid and Upper Columbia. Tribal entities are currently generating plans for implementing new kelt reconditioning programs, and these program plans are going through the 3-Step Independent Science Review Process (ISRP). The following section describes the program plans and their status.

Snake River Basin

In late October 2009, CRITFC subcontracted the Nez Perce Tribe to develop a kelt reconditioning master plan for Snake River B-Run steelhead program within the framework of BPA Project No. 2007-401-00. Details of this master plan are pending development and submittal of a draft plan. The draft plan will be submitted to the 3-Step ISRP process.

As part of the same contract that will develop a kelt reconditioning master plan, a joint effort between CRITFC, the University of Idaho, and the Nez Perce tribe began in 2009. This effort will study the physiology, health and condition of both A and B-run steelhead kelts with a goal of evaluating the feasibility and success of strategies for rehabilitating and handling kelts in the Snake River system (Branstetter et al., 2010).

In 2010, this project intended to barge approximately 100 kelts per week from Lower Granite Dam, below Bonneville Dam, after tagging them with both acoustic and PIT tags. A similar effort in 2009 was complicated by a lack of suitable handling facilities at Lower Granite Dam. With the completion of the new kelt handling facility, these limitations should be improved.

In addition to the fish tagged and transported from Lower Granite Dam, this study also intended to capture and tag up to 250 kelts per day and release them back into the river to study in-river survival rates.

Studies of Long Term reconditioning continued at Dworshak National Fish Hatchery (DNFH) using hatchery origin fish collected at Lower Granite Dam. Some challenges associated with high TDG levels that led to increased mortality in 2009 were addressed prior to the 2010. Hourly monitoring of water quality in kelt tanks at DNFH indicated no problems with TDG, oxygen saturation, temperature, pH, or conductivity during the 2010 season. However, a number of issues were found with fish collection from Lower Granite Dam. First, the number of fish available for collection in the juvenile bypass was far lower than anticipated. The reasons for the reduced number of fish are not known, but may relate to increased spill and unusual flow conditions during the 2010 kelt migration season. Second, many of the fish collected at the Lower Granite Dam kelt handling facility and transported to DNFH had fresh head wounds and other injuries. The cause of the injuries is not known. Kelts with injuries do not survive well in long term reconditioning programs.

Upper Columbia

Okanogan Subbasin (Colville Tribes)

The Colville Tribes recently initiated a local steelhead broodstock program and a kelt reconditioning program (BPA Project No. 2007-401-00) to recover steelhead populations listed under the ESA. The Tribes incorporated the kelt reconditioning program as a component of their Cassimer Bar Hatchery Master Plan; and the Plan is currently in the final stage of the 3-step ISRP review/comment process.

Kelt selection in the Colville's program is focused on naturally-produced females, collected at weir locations on several tributaries throughout the U.S. portion of the Okanogan subbasin. After collection, these fish are transported to and reconditioned at the Cassimer Bar Hatchery located at the confluence of the Okanogan and Columbia Rivers below Chief Joseph Dam. After the reconditioning process, the fish are returned to the Okanogan River in the fall, so that they can spawn during the following spring. The full kelt reconditioning program within the U.S. portion of the Okanogan River Subbasin is estimated at 100 adults. With inclusion of the Canadian portion of the subbasin, the reconditioning program could accommodate up to 200 adult fish.

Okanogan/Methow/Entiat/Wenatchee Populations (Yakama Nation)

The Yakama Nation has completed a proposal for an Upper Columbia Kelt Reconditioning Program (BPA Project # 2008-458-00). The proposal describes a program for increasing the abundance of natural origin (NOR) spawners by enhancing the survival of kelts that have been live-spawned at Wells Fish Hatchery, or intercepted at various locations in the UCR during seaward emigration. The proposal was recommended for funding by the Northwest Power and Conservation Council in 2010.

CRITICAL UNCERTAINTIES AND DATA GAPS

This section provides information on current, on-going projects for resolving critical uncertainties and data gaps relative to (1) Increasing kelt survival and iteroparity rates; (2) Achieving the 6% gain in B-run steelhead abundance (RPA #33); (3) Understanding the dynamics and importance of kelt iteroparity to the productivity and conservation of ESA listed steelhead populations in the Columbia Basin; and (4) Planning and implementing new kelt programs in the Upper and Mid Columbia. Table 4 provides a summary of projects that have been funded to implement kelt measures (operational and reconditioning) and to resolve uncertainties and data gaps associated with said measures.

Critical Uncertainty of Operational Measures

Facility (e.g. bypass systems) and operational (e.g. increased spills) changes of the FCRPS employed for smolt migration in recent years may also benefit kelts, but uncertainty in accruing similar benefits to kelts remains. Relative use patterns and mortality risks for kelts associated with passage routes at each dam are largely unknown. These are largely qualitative conclusions, however, and further assessment of route-specific survival differences may help mitigate dam-related kelt mortality (Boggs et al. 2008).

It remains unclear if spill operations will need to be modified in the future to facilitate the collection of kelts. Given their affinity to surface passage routes, and with surface passage routes now installed on each project that kelts must pass through the lower Snake River, it is unknown how many kelts will be available for collection at each project. Although the potential impact is unknown, spill operations may need to be modified in the future (e.g. shutting off the TSW for a period of time, or modified spill operations to take advantage of any crepuscular migration timing of kelts) to allow the collection of enough kelts to fully utilize the handling and transportation facilities at Lower Granite. The need for any modified operations to aid in kelt collection will be assessed after operations at the new temporary kelt facilities at Lower Granite have completed for the 2010 fish passage season. Any potential change in the FCRPS spill program made to benefit kelts, will necessarily be weighed against the impacts to juvenile salmonid survival and passage. It is highly likely that due to the very high escapement of adult steelhead past Lower Granite Dam in 2009, downstream passage of kelts will overwhelm the capacity of the temporary facility making this issue moot for 2010, but one that may need to be revisited in future kelt management plans.

Summary of total number of fish diverted into kelt holding tanks at Lower Granite Dam 1 April – 6 June separated by origin, and stock. The proportion of each group separated by natural and hatchery origin, and between A and B run types is provided.

Description	Number of kelts	Percent of total

Natural	1652	66.4 (all)
A	1478	89.5 (natural)
B	174	10.5 (natural)
Hatchery	836	33.6 (all)
A	782	93.5 (hatchery)
B	54	6.5 (hatchery)

A question remains as to whether the relative benefit of either transportation or reconditioning compared to in-river survival through the Snake River remains unchanged after the implementation of many improvements for juvenile salmonid passage. These improvements include new surface flow outlets, so that now, each of the 8 dams that kelts pass from Lower Granite to Bonneville Dam, and all 9 dams that upper Columbia River stocks potentially pass from Wells Dam to Bonneville Dam have some form of surface passage available to kelts. These surface flow routes are typically operated during the spill passage season for juvenile salmonids, which coincides with the peak of the kelt outmigration as well. Project 2007-401-00 PIT tagged and released in-river 176 kelts in 2009 at Lower Granite. None of these fish have been detected returning at Bonneville Dam. This effort was repeated in 2010 and included both in-river and transport groups. Fish returns from this effort will shed light on the value of the passage improvements for kelt steelhead.

As mentioned above, there have been several recent studies on the lower Columbia River at Bonneville Dam and The Dalles dam that investigated kelt passage outside of the current spill season. Because of the relatively low numbers of kelts passing during the study at Bonneville Dam, it was unclear if the benefits were enough to justify the additional non-turbine passage of water during no-spill periods. From looking at historical counts of kelts passing through the JBS at Bonneville, it appears that, in some years, kelts may be present in higher numbers than were seen in 2007 and 2008.
In 2010, an interim trigger was developed by the Action Agencies and approved by NOAA Fisheries for use at Bonneville Dam. The interim trigger used a combined approach of 20 fish total through the JBS system as well as at least 2 fish a day for 2 consecutive days. This trigger was developed as an initial effort to provide for the operation of the corner collector after kelts were demonstrated to be present in enough numbers to justify the operation. The 2 fish for 2 days and 20 fish cumulative trigger allowed the Corner Collector to open on March 14, 2010. Elevated TDG levels caused due to the corner collector operation caused for several open and closed periods throughout the month, but it appeared to be a successful operation. Over the period of the month, 81 kelts were observed in the JBS indicating a strong run of kelts passed Bonneville in 2010. It appeared the bulk of the kelt migration went past Bonneville while the Corner Collector was open. In 2011, a study will be conducted to determine if the sluiceway at the 1st Powerhouse at Bonneville Dam is a suitable route for kelts. This study will look at both direct injury of fish passing through the sluiceway as well as

predation downstream by pinipeds. If the sluiceway is an acceptable route, the TDG issues associated with the Corner Collector operation would be moot. As noted throughout this document, the RPAs in the 2008 BiOp are specific to the Snake River and the Upper Columbia River DPSs. It is unclear if kelts from either of these stocks are present at Bonneville Dam in March, but it is likely that kelts from other ESA listed stocks are present, such as those from tributaries in the Bonneville Dam reservoir. How a benefit is assigned to a DPS not specified in an RPA still needs to be addressed.

The Dalles Dam (TDA) is unique in the FCRPS dams in that it is the only Columbia River mainstem dam without a specific bypass system designed for downriver migrants. During the fall and winter months (September through March) when there is no spill for fish passage, the ice and trash sluiceway is the only non-turbine passage route at TDA. Operation of this sluiceway during the fall and in winter months for fish passage purposes has been debated in the O&M committees for many years.

Studies at The Dalles were conducted over two periods of time (Nov 1-Dec 15, and Mar 1- Apr 9) in both 2009 and 2010 and targeted two different populations of steelhead. The fall/winter operation was targeted primarily at overwintering steelhead that have been shown to fallback in high numbers at The Dalles dam. The spring component of this study targeted any overwintering steelhead that were still present at The Dalles, as well as any kelts that may be emigrating at that time. While study results from both years showedsignificant numbers of fish using the sluiceway in each time period, it remains unclear if any fish in the spring time period were kelts or if they were steelhead that had overwintered and were eventually moving upstream to their spawning grounds. A critical uncertainty of The Dalles sluiceway operation remains in that it is unclear if the operation benefits only overwintering steelhead or if any kelts benefit from the operation as well. If kelts do benefit, it remains to be determined how that benefit will be calculated and which stocks it would apply to.

The benefit of this sluiceway operation to overwintering steelhead may well apply to the same Snake River B-run populations that are targeted for kelt improvements in RPA 33. Some of these steelhead that are overwintering in The Dalles pool, may be kelts returning from previous outmigrations. It is possible that this operation could have an indirect benefit to returning kelts that have already completed their downstream migration and are now returning to spawn again for the 2nd (or 3rd) time.

Critical Uncertainty of Kelt Reconditioning Measures

An overarching critical uncertainty is whether transportation and kelt reconditioning measures can significantly increase the abundance and productivity of ESA listed steelhead populations in the Columbia Basin.

Boggs et al. (2008) report that small numbers of repeat spawners returning from in-river and transported kelt groups limit the ability to ascertain complex trends and interactions affecting returns. Benefits from the transportation measure are variable, and could be considered marginal if solely based on consistent increases in kelt return rates, particularly those of the John Day group. Additional data is needed to either accept or reject kelt transportation around the hydro system as an effective measure to increase steelhead abundance and productivity.

While CRITFC studies have not shown conclusive evidence that kelt reconditioning has a net positive effect on steelhead fitness, neither have they seen any compelling evidence to suggest that reconditioning has a negative effect on steelhead fitness (Branstetter et al. 2009). The life history of steelhead makes their study very difficult. Migration and spawning occur during high water periods making direct observations extremely difficult. The operation of simple weirs and traps are often compromised by spring flow regimes, and also rarely catch a large proportion of the spawning population. Wild origin kelts in reconditioning programs are endangered and cannot be lethally sampled to assess reproductive status. The number of kelts released is small, and the area in which they spawn is large. Since reconditioned kelts have presumably previously spawned in the tributaries where juveniles are collected, it is necessary to separate juveniles by age class to conclusively show kelt contribution to production. Logistical issues related to the complexity of steelhead life history, and incomplete understanding of all variables has limited the success of obtaining easily quantifiable results. However, the difficulty in quantifying the benefit of kelt reconditioning does not imply that kelt reconditioning does not benefit steelhead populations.

To date, reconditioning of steelhead kelts has shown to substantially increase the survival of steelhead kelts when compared to expected survival rates of non-reconditioned kelts. Radio tagged kelts have been documented returning to known spawning areas, along with PIT tag detections of reconditioned kelts that have demonstrated both upstream migrations, and entry into spawning tributaries.

The most important result from the gamete and progeny viability study in the Yakima River is that steelhead kelt reproduction is possible and that viable gametes and progeny have been produced (Branstetter et al. 2008, Branstetter et al. 2009, and Branstetter et al. 2010). Average keel rates in the three steelhead that have been air spawned as both first time spawners and reconditioned kelt spawners, was lower (44%) in the second spawning event than the first spawning event (57%), but differences were negligible given the low sample size and lack of statistical power. Egg numbers have been observed decreasing (40%) in one fish while another one (skip spawning kelt) had an egg increase of 26% from the initial spawning. In 2009, one female kelt that had initially spawned in 2007 increased her egg clutch by 2000 egss for a total of 6,604 estimated eggs (Branstetter et al. 2010). Three kelts that initially spawned in 2008 survived to spawn again in 2009 (although 2 of these fish did not recover from the spawning experience in 2009) with an average increase of 500 eggs each from the maiden spawning event.
As noted in Bransetter et al. 2010, when comparing the long-term reconditioning kelts against the incoming maiden brood, the kelts perform as well as the best spawners. Kelt spawners produced on average 1500 more eggs than maiden spawners and variation was also less. In additional to increased eggs, there was also no difference in fertilization rates or juvenile survival between kelt progeny and maiden steelhead progeny.

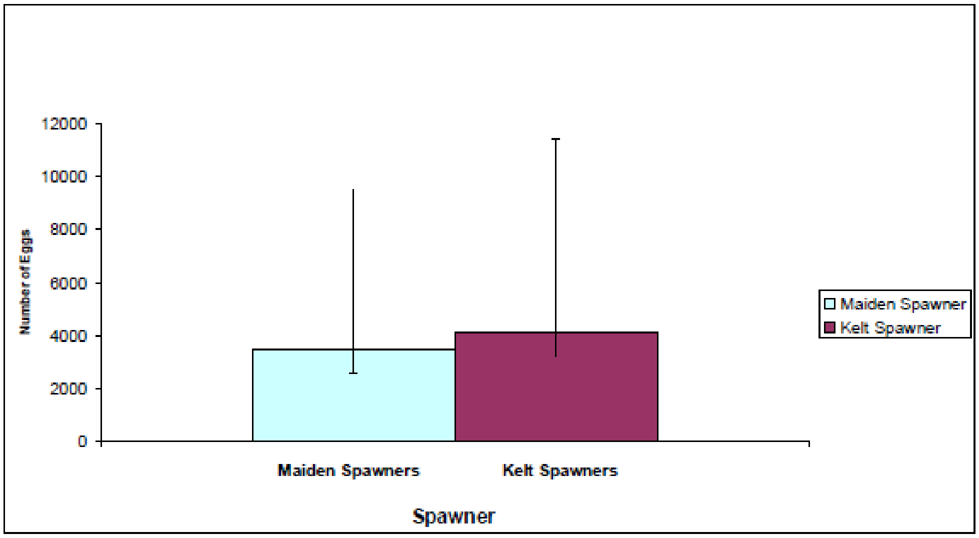


Figure 1. Egg production Maiden vs. Kelt Spawners 2006-2009.

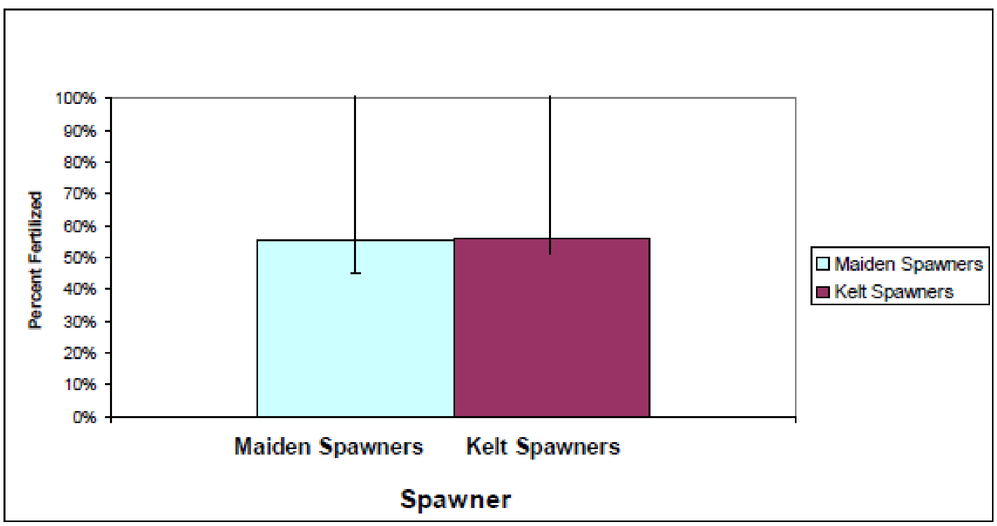


Figure 2. Fertilization Success 2006-2009

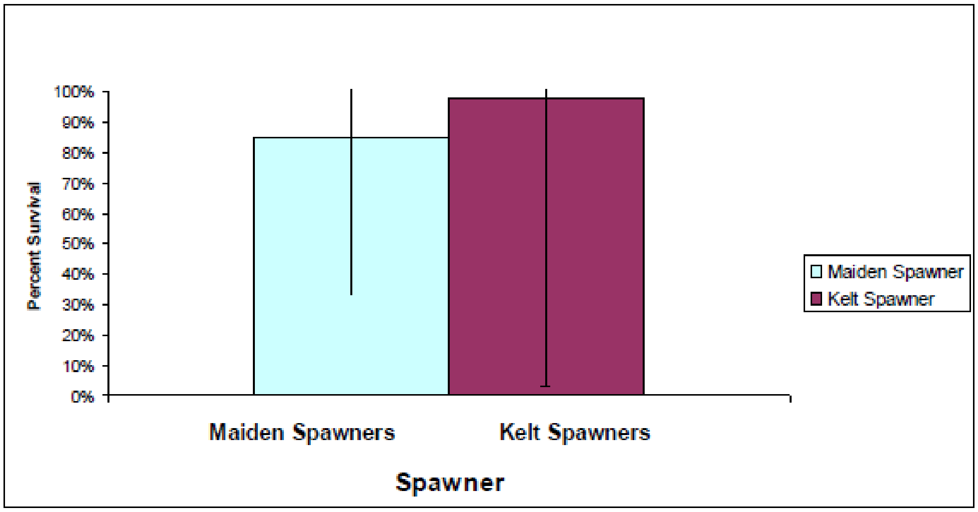


Figure 3. Juvenile Survival 2006-2009

Successful reproduction by two reconditioned kelts has been recorded in Omak Creek. This is the only creek we have been able to both detect the volitional migration of reconditioned kelts, and collect genetic samples for parentage analysis. This confirms reproductive success of reconditioned steelhead, although low sample numbers prevent accurate quantification.

Kelt reconditioning, particularly long-term reconditioning, requires further study in order to determine its effectiveness as a tool to increase abundance and productivity of ESA listed populations. Data gaps remain in completing the evaluation of questions relevant to the uncertainty inherent in kelt reconditioning measures:

Kelt Collection: ESU-specific Locales

Snake River

Assuming that data analyses indicates that the preferred or priority operations for increasing iteroparity rates for Snake River B-run kelt would be a reconditioning action requiring collection with or without transport, Lower Granite Dam's Juvenile Bypass System (JBS) is the obvious choice for a primary kelt collection point.

- Are A-run fish more likely to return as repeat spawners than B-run fish? Per Keefer et al. (2008), smaller bodied kelts are significantly more likely to return as repeat spawners than larger bodied fish.

- Are the current length based categories that segregate A-run steelhead from B-run steelhead appropriate? Moffit et al. (in Branstetter et al.2010) found that female kelts collected from Fish Creek in the Lochsa drainage (which is presumed to be a pure B-run stock) averaged 78 cm with a range of 62-86 cm. Males kelts captured at the Fish Creek weir averaged 74 cm (range 62-94cm). The current range for B-run fish used by IDFG is 78-86 km.

- Given that the Removable Spillway Weir and other operational improvements make Lower Granite Dam (LGR) "leaky" by passing higher proportions of kelts around the JBS, how far downstream is it reasonable to go for collecting kelts (e.g., to Little Goose)? The NOAA analysis assumes collection at both LGR and LGO. This will be a critical uncertainty that will be addressed over the next several years.

- Is the decreased number of kelts available for collection in the LGR juvenile bypass system in 2010 an anomaly due to unusual flow conditions? If not, can measures be taken to increase kelt collection capacity?

- Are head injuries found in a large percentage of kelts collected in the LGR juvenile bypass system? If so, where are these injuries occurring, and can this be corrected?

- What is the target collection number or percentage for this ESU or portion thereof (e.g., B runs, non-ad-clipped)?

- If the target population is B-run steelhead, how do you accurately identify them; and what do you do with A-run population fish that are incidentally collected (e.g. Transport them, or return them to river downstream of collection point)?

- Are there points upstream of LGR where collection of the target kelts is feasible (e.g., Fish Creek/Clearwater)? Note: Published GSI assignments of LGR kelts (Narum et al. 2008) indicate that >20% may come just from Asotin Creek, a non-target A-run population (with some B-run-sized fish) just upstream of LGR. This could disproportionately distribute the benefits of kelt collection and management among MPGs and populations of the Snake River ESU.

- Does the ESU include hatchery programs that could live-spawn and recondition their broodstock?

Upper Columbia

- Are there additional sites where it would be feasible to collect kelts? For example, the Rocky Reach JBS, which presently is permitted to sample/capture a very small percentage of the bypassed fish.

- What proportion of the Wells hatchery broodstock need to be lethally sampled for virology, and therefore not available for treatment? Can non-lethal sampling techniques be used to generate the same data?

Mid-Columbia

- Are there subbasins/populations other than the Yakima in which kelt collection might be feasible?

- In the Yakima, are there sites other than Prosser/Chandler where kelts might also be collected (e.g., Roza Dam- Upper Yakima River, Cowiche Dam- Lower Naches River, etc.), for more population-specific discriminating measures?

Kelt Reconditioning Strategies

Collection and Transportation (Operational) and Transport Only (No reconditioning)

- What are the remaining critical uncertainties, if any, or conditions that might warrant further testing of this option? To-date, results of this option have not been encouraging. Compared to in-river treatment groups, transportation has shown only a marginal benefit on the Snake River, while the transport only (no reconditioning) strategy has shown significant benefit for Yakima kelts. Both measures fall short of the survival /rematuration benefits of long-term reconditioning obtained in the Yakima River.

Short-Term Treatment

- Are there uncertainties or conditions with this treatment that warrant further testing? Survival results to-date in the Yakima River have been worse than in-river “reference” results in comparable years (2005-2008) and far less than the survival/rematuration results for long-term reconditioning.

Long-Term Treatment

- What is the relative reproductive success (RRS) of these fish, and under what conditions is it possible to quantify RRS with acceptable precision? It’s easy to fail at this, or to get no better results than reproductive success > 0 (e.g., Omak Cr.).

- In the absence of good RRS results, are there other tests or considerations that can help in addressing this uncertainty (e.g., gamete/fry viability studies, data from rainbow trout programs, RRS studies with reconditioned Atlantic salmon or other iteroparous anadromous salmonids)?

- What is the proportion of sequential spawning and skip spawning kelts produced by reconditioning programs throughout the Columbia Basin? When can fish following these two life history trajectories be separated? Initial results show that plasma levels of vitellogenin indicate reproductive status in kelts.

- When do steelhead kelts decide whether to follow a sequential spawning or skip spawning life history trajectory? What are the inputs to this decision? Can we influence which trajectory fish take by modifying reconditioning protocols?

- What is the best thing to do with LT treatment kelts that have reconditioned (e.g., fed, survived, and grown) but are not maturing at the time of release? These skip spawning fish have comprised 6% of the LT releases from Prosser in the past three years (2006-2008), but 25% over all nine study years (2000-2008). Where do these fish go if they are released into the river in the fall? Will skip spawning fish mature the following year if held and fed? Will skip spawning fish return if transported to the ocean and released?

- Can Snake River B-run steelhead be reconditioned? What survival and rematuration rates can be obtained with these fish?

- What predicts which fish are likely to survive and grow in captive reconditioning programs? Why do some fish not initiate feeding, or not feed enough to grow? Can protocols for selecting good reconditioning candidates, or increasing feeding and growth be devised?

- Specifically to address RPA 42, do live-spawned hatchery kelts respond better to reconditioning than natural kelts collected from the river, and does pre-spawn feeding show a benefit?

- Again, for RPA 42, would reconditioned kelts (especially natural kelts collected from the river) – if held until spawning – provide a gamete source for wild enhancement "production"?

The potential for kelt collection at the mid and upper- Columbia River projects is unknown; but it is likely to be restricted by lack of collection systems or existing physical plant limitations. The ability of the Action Agencies to address these limitations will be restricted since the 5 dams above McNary are not federal projects and are instead owned and operated by Public Utilitity Districts. Most of the passage and operational improvements currently being implemented for emigrating juvenile salmonids in the Columbia Basin may provide increased kelt survival through mainstem hydro projects. Further structural and flow/spill adjustments in operating these improvements could provide additional kelt survival benefits but at unknown economic costs.

The ultimate measure of increased productivity is (1) gamete and progeny viability and (2) reproductive success (RS) of steelhead kelts. Gamete and progeny viability is a measure of similarity between first spawning and the second spawning following artificial reconditioning. Viability is determined by endocrine function, gonadal processes, maturation rates, and juvenile survival (Branstetter et al. 2007). Reproductive success is defined as the ability of kelts to spawn successfully in nature and produce adult progeny that return and spawn in the natal stream. A goal for reproductive success for treated kelts is a Recruit/Spawner (R/S) of $\geq$ 1.0.

The following subsection describes current on-going projects that are providing informational data to close data gaps and resolve the critical uncertainty of kelt operational and reconditioning measures as tools in increasing the survival rates of steelhead kelts and productivity of steelhead populations affected by the FCRPS.

PERFORMANCE MONITORING AND EVALUATION

The current federally funded kelt projects in the Columbia River Basin incorporate a monitoring & evaluation (M&E) element. The monitoring and evaluation component of these projects is meant to measure progress toward achieving the stated objectives, and serves as mechanism to adapt/adjust the projects accordingly.

The Action Agencies (USACE, BPA, and USBR), NOAA Fisheries and the Northwest Power and Conservation Council generated a report (Anonymous, 2009) recommending the implementation research, monitoring and evaluation activities to address Reasonable and Prudent Alternatives (RPAs) mandated in the 2008 NOAA Fisheries FCRPS Biological Opinion. Within this plan, M&E elements are set forth to address particular project specific issues related to operational measures for increasing steelhead kelt survival. Descriptions of specific RPA actions (M&E elements) are listed in Appendix A.

RECOMMENDATIONS AND ACTIONS TO BE IMPLEMENTED IN 2011

The primary purpose of the 2009 Kelt Management Plan was to lay the framework for future plans by consolidating current knowledge of kelt operational and reconditioning measures. Although the 2009 plan was primarily informational in nature and did not proscribe sweeping programmatic changes, there was a great deal of ongoing work related to kelts in the Columbia Basin in 2010.

As noted throughout this document, a number of research projects have been conducted, over the past several decades related to steelhead kelts. Despite past and ongoing research efforts, the optimum strategy, or mix of strategies, that would increase kelt populations in the Snake and Columbia Rivers remains somewhat unclear as it did last year.. To this end, the Action Agencies will continue to study in-river conditions and passage routes for kelt in 2011, but will continue to focus the bulk of research efforts on addressing key questions regarding reconditioning programs, especially long-term reconditioning.

In order to increase knowledge of kelt reconditioning, while implementing and studying operations to improve the in-stream migration of kelts, the action agencies will execute the following actions in 2011:

Actions to Enhance In-river Survival

- Continued investigation into the potential benefits to various steelhead stocks if the sluiceway at The Dalles dam is operated prior to the start of spill for juvenile migrants.
- Study the safety of the Bonneville Dam's 1st powerhouse sluiceway as an alternative route to the corner collector..
- If the 1st powerhouse sluiceway at Bonneville Dam does not prove out to be a safe route for adult sized steelhead, continue to operation the Bonneville Dam Powerhouse 2 Corner Collector in March based on the trigger developed in 2010.

- Continued operation of surface passage outlets on all 8 federally owned mainstem dams on the lower Columbia and Snake Rivers consistent with BiOp (or Court Ordered) spill dates for the juvenile migration.
- Continue the implementation of an analysis to investigate kelt transportation from Lower Granite Dam
- PIT Tagging of kelts collected at Lower Granite Dam to assess future return rates of kelts that were returned to migrate in-river and those that are transported as part of the CRITFC efforts in 2011.

Actions to Enhance Kelt Reconditioning Efforts

- Continued funding of Snake River kelt reconditioning research
- Continued funding of upper Columbia River and mid- Columbia reconditioning research

The actions listed above are considered immediate, near-term actions designed to help spread the risk to the steelhead kelt populations while a long term strategy is developed. The operation of The Dalles Dam sluiceway could be implemented on a long term basis if warranted. The same applies to the operation of the Bonneville Dam Corner collector. Though passage rates of kelts through the Bonneville corner collector have been highly variable in the past, it does appear this operation has the potential to benefit kelts in some years. As more knowledge about the potential benefit of passing through the corner collector, or the sluiceway at The Dalles is gained, a suite of operational strategies may be developed as a package for future kelt management plans, rather than on a dam by dam basis.

Although the exact effect on in-river kelt survival of operation of surface passage outlets at all lower Snake and Columbia projects is presently unknown, NOAA assumes the overall impact will be positive. In the future, the Action Agencies will implement research to evaluate survival of kelts passing through the projects and the new surface passage outlets (i.e., JSAT survival testing at many of the lower Snake and lower Columbia dams continuing in 2011). Kelt research studies will be designed to take advantage of the many acoustic receivers in place at the mainstem dams, estuary, and potentially even into the ocean.

Kelt reconditioning projects in 2011 will continue to address critical unknowns and data gaps identified throughout this document. Specifically in 2011, BPA project 2007-401-00 will continue to: 1) evaluate the reproductive success of artificially spawned kelts in Omak Creek and the Warm Springs River, 2) evaluate and compare reconditioning rates between Omak Creek, Yakima River, Warm Spring River, and the Clearwater River, 3) continue to develop the background science on the physiology, nutrition, health, and behavior of steelhead kelts needed to address critical uncertainties surrounding appropriate reconditioning duration and techniques, release strategies,and whether transportation provides additional benefits under some circumstances, and 4) evaluate the progeny and gamete viability of post-spawned kelts. Results from this research will directly inform future kelt management plans and will become the base for long term kelt reconditioning efforts.

Additional efforts towards upper Columbia River kelt reconditioning will be funded through BPA project 2008-458-00. The scope of work for 2011 is currently in development with BPA, the Yakama Nation, and the NW Power and Planning Council.

To aid in kelt reconditioning and research projects on the Snake River, the Corps of Engineers constructed a temporary kelt holding facility at Lower Granite Dam during the late fall of 2009. This facility will be operational again for the 2010 kelt migration. This facility is a temporary structure until a permanent facility is designed and constructed, either as part of a larger effort to rehabilitate the existing juvenile bypass facilities, or as a stand alone physical plant. Because the funding for a permanent facility is uncertain at this time, the temporary facility will allow the aforementioned research on the Snake River to continue in 2011.

REFERENCES

Anonymous. 2009. Recommendations for implementing research, monitoring and evaluation for the 2008 NOAA Fisheries FCRPA BiOp. Based on AA/NOAA/NPCC RM&E workgroup assessment of actions called for under the BiOp reasonable and prudent alternative. Final draft- June 1, 2009.

Bellerud, B., R. Graves, and G. Fredricks. 2007. Assessment of the likely survival improvement resulting from enhancement strategies for steelhead kelts (B-run kelts in particular). NOAA Fisheries Kelt Analysis Memorandum to Bruce Suzumoto, September 25, 2007.

Boggs, C.T. and C. A. Peery. 2004. Steelhead (*Oncorhynchus mykiss*) kelt abundance, condition, passage and survival in the lower Snake and Columbia Rivers, 2003. Report to the U. S. Army Corps of Engineers by the Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow .

Boggs, C.T., M.L. Keefer, C.A. Peery, and M.L. Moser. 2004. Adult Chinook salmon and steelhead fallback at Bonneville Dam, 2000-2001. Technical Report 2004-4 to the U.S. Artmy Corps of Engineers, Portland and Walla Walla Districts. 49 p.

Boggs, C. T., M. L. Keefer, C. A. Peery, J. T. Dalen, P. L. Madson, R. H. Wertheimer, K. Collis, and A. F. Evans. 2008. A multi-year summary of steelhead kelt studies in the Columbia and Snake rivers. Idaho Cooperative Fish and Wildlife Research Unit, Technical Report 2008-13, December 2008. 49p.

Branstetter, R., J. Whiteaker, D.R. Hatch, S-Y Hyun, J. Blodgett, B. Bosch, D. Fast, and T. Newsome. 2006. Kelt reconditioning: a research project to enhance iteroparity in Columbia Basin steelhead (*Oncorhynchus mykiss*). 2006 Annual Report. Columbia River Inter-Tribal Fish Commission, Technical Report 06-06, Portland, Oregon.2008-13, December 2008. 49p.

Branstetter, R., J. Stephenson, D. Hatch, J. Whiteaker, and S. Yoon Hyun. 2008. Steelhead kelt reconditioning and reproductive success. Annual Report. U. S. Department of Energy, Bonneville Power Administration. Project No. 2007-401-00, Contract No. 0030769.

Branstetter, R., J. Stephenson, D. Hatch, J. Whiteaker, and S. Yoon Hyun. 2007. Steelhead kelt reconditioning and reproductive success. Annual Report. U. S. Department of Energy, Bonneville Power Administration. Project No. 2007-401-00, Contract No. 0030769.

Brown, Larry. Regional Fisheries Manager (Retired), Washington Department of Fish & Wildlife. Personal Communication.

Busby, P. J., T. C. Wainwright, E. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I.A. Lagomarsino. V. Lagomarisino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-27.

Clabough, T. and C. Peery. 2004. Letter report to Marvin Shutters and David Clugston (USACE) Re: Removable Spillway Weir (RSW) fallback evaluation 2002 and 2003. University of Idaho Cooperative Fish and Wildlife Research Unit. Moscow, ID. http://www.cnr.uidaho.edu/uiferl/Reports.htm

Confederated Tribes of the Colville Reservation. 2008. Cassimer Bar Hatchery Master Plan, Volume I. November 2008.

Confederated Tribes of the Colville Reservation. 2008. Cassimer Bar Hatchery Master Plan, Volume II. November 2008.

Costello, R. J. 1977. The food and feeding habits of post-juvenile and adult steelhead trout, Salmo gairdneri, in the marine, estuarine, and freshwater environments. Unpublished M.S Thesis, College of Fisheries, University of Washington.

Crespi, B. J., and R. Teo. 2002. Comparative phylogenetic analysis of the evolution of semelparity and life history in salmonid fishes. Evolution 56: 1008-1020.

Dygert, P. 2007. Preliminary analysis of the survival benefits associated with a kelt reconditioning program directed a B-run steelhead. Memorandum to U.S vs Oregon Parties. Northwest Fisheries Science Center. Seattle, Washington.

Evans, A. F., R. H. Wertheimer, M. L. Keefer, C. T. Boggs, C. A. Peery, and K. Collis. 2008. Transportation of steelhead kelts to increase iteroparity in the Columbia and Snake rivers. North American Journal of Fisheries Management 28: 1818-1827.

Ferguson, J.W., G. Matthews, L. McComas, R. Absolon, D. Brege, M. Gessel, and L. Gilbreath. 2005. Passage of adult and juvenile salmonids through the federal Columbia River Power System dams. NOAA Technical Memorandum NMFS-NWFSC-64.

Fleming, I. A. 1998. Pattern and variability in the breeding system of Atlantic salmon (Salmo salar), with comparisons to other salmonids. Canadian Journal of Fisheries and Aquatic Sciences 55 (Supplement 1): 59-76.

Fleming, I. A., and J. D. Reynolds. 2004. Salmon breeding systems. Pages 264-294 in A. P. Hendry and S. C. Sterns, editors. Evolution illuminated: salmon and their relatives. Oxford University Press, New York.

Germond, J. Regional Fisheries Biologist, Oregon Department of Fish & Wildlife. Personal Communication.

Gilbertson, L. Fisheries and Natural Resources Department, Quinault Nation. Personal Communication, 06 October 2009.

Hatch, D., J. Stephenson, J. Whiteaker, S. Narum, R.D. Branstetter, J. Whiteaker, J. Blodgett, D. Fast, J. Blodgett, B. Bosch, T. Newsome, D. Lind, B. Rogers, M. Johnston, C. Fisher, R. Dasher, D. Best, J. Lovtang, M. Powell. 2006. An evaluation of the reproductive success of natural-origin, hatchery-origin and kelt steelhead in the Columbia basin. 2005 annual report. Columbia River Inter-Tribal Fish Commission, Technical Report 06-07, Portland, Oregon.

High, B., C.A. Peery, and D.H. Bennett. 2006. Temporary staging of Columbia River summer steelhead in coolwater areas and its effect on migration rates. Trans Am Fish Soc 135: 519-528.

Hockersmith, E., J. Vella, L. Stuehrenberg, R. N. Iwamoto, and G. Swan. 1995. Yakima River radiotelemetry study: Steelhead, 1989-93. Report to US Depart. Energy, Bonneville Power Administration, Project No. 89-089, Contract No. DE-AI79-89BP00276, NW Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.

Howell, P., K. Jones, D. Scarnecchia, L. Lavoy, W. Kendra, and D. Ortman. 1985. Stock assessment of Columbia River anadromous salmonids. Volume II: Steelhead stock summaries stock transfers guidelines- information needs. Report to U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Contract No. DE-AI79-84BP12737, Project N. 83-335.

Johnson, G. E., N. S. Adams, R. L. Johnson, D. W. Rondorf, D. D. Dauble, and T. Y. Barilla. 2000. Evaluation of the prototype surface bypass for salmonid smolts in spring 1996 and 1997 at Lower Granite Dam on the Snake River, Washington. Transactions of the American Fisheries Society 129: 381-397.

Keefer, M. L., R. H. Wertheimer, A. F. Evans, C. T. Boggs, and C. A. Peery. 2008. Iteroparity in Columbia river summer-run steelhead (Oncorhynchus mykiss): implications for conservation. Canadian Journal of Fisheries and Aquatic Sciences 65: 2592-2605.

Keefer, M.L., C.T. Boggs, C.A. Peery, and C.C. Caudill. 2008. Overwintering distribution, behavior, and survival of adult summer steelhead: variability among Columbia River populations. N.A. Journal Fish. Manage. 28:81-96.

Khan, F., M. Weiland, and G. Johnson. 2009. Evaluation of adult salmonid downstream passage through the sluiceway and turbines at The Dalles Dam during late fall, winter and early spring. Powerpoint presentation to the Corps' Portland District Fish Facility Design Review Work Group.

Lohr, S. C., and M. D. Bryant. 1999. Biological characteristics and population status of steelhead (Oncorhynchus mykiss) in Southeast Alaska. General Technical Report PNW-GTR-407. U. S Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Long, J. B., and L. E. Griffen. 1937. Spawning and migratory habits of the Columbia River steelhead trout as determined by scale studies. Copeia 1937; 62.

Moffitt, C. J., Buelow, Z. Penny, A. Pape, K. Hamilton, and B. Sun. 2009. Developing strategies to improve survival and return recruitment of steelhead kelts and Snake river stocks. Review draft study design for 2010 field season. Project funded by Columbia River Intertribal Indian Fisheries Commission. Revised October 7, 2009.

Newton, J. Regional Fisheries Biologist, Oregon Department of Fish & Wildlife. Personal Communication.

NOAA (National Oceanic and Atmospheric Administration). 2001. Status review of west coast steelhead. NOAA, Northwest Fisheries Science Center Technical Memo 27. Available: http://www.nwfsc.noaa.gov/pubs/tm/tm27/intro.htm#abb. (December 2001.).

NOAA (National Oceanic and Atmospheric Administration). 2008. Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program [Revised and reissued pursuant to court order,*NWF v. NMFS,* Civ. No. CV 01-640-RE (D. Oregon)]. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. May 5, 2008.

National Research Council. 1996. National Academy Press, Washington, D.C.

Scribner, Tom. Yakama Nation Fisheries Resource Management. Personal Communication, October 2009.

Stephenson, J., D. Hatch, R. Branstetter, J. Whiteaker, S. Narum, D. Fast, J. Blodgett, B. Bosch, M. Johnston, T. Newsome, D. Lind, B. Rogers, C. Fisher, R. Dasher, D. Best, J., and M. Gauvin. 2007. An evaluation of the reproductive success of natural origin, hatchery-origin, and kelt steelhead in the Columbia Basin. 2006 annual report prepared for the Bonneville Power Administration by the Columbia River Inter-Tribal Fish Commission, Portland, Oregon

Shapovalov, L, and Taft, A. C. 1954. The life histories of the steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Oncorhynchus kisutch) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin 98: 1-375.

Weiland**,** M.A., J. Kim**,** W.T. Nagy**,** and G.E. Johnson. 2009. Evaluation of Steelhead Kelt Passage into the Bonneville Dam Second2nd Powerhouse Corner Collector Prior to the Juvenile Migration Seasons, 2007 and 2008. DRAFT FINAL REPORT**.** Prepared for the U.S. Army Corps of Engineers, Portland District**.** Under an Interagency Agreement with the U.S. Department of Energy**,** Contract DE-AC05-76RLO 1830

Wertheimer, R. H. 2007. Evaluation of a surface flow bypass system for steelhead kelt passage at Bonneville Dam, Washington. North American Journal of Fisheries Management 27: 21-29.

Wertheimer, R. H., and A.F. Evans. 2005. Downstream passage of steelhead kelts through hydroelectric dams on the lower Snake and Columbia rivers. Transactions of the American Fisheries Society, 134:853-865.

Whitt, C. R. 1954. The age, growth, and migration of steelhead trout in the Clearwater River, Idaho. Master Thesis, University of Idaho, Moscow.

Table 1. Percent Iteroparity for Various Steelhead Populations in the Columbia Basin and Washington Coastal Basins

River/Sub-Basin	Repeat Spawner Rate	Mainstem Dams Passed During Emigration	Reference Source
Columbia River (Pre-Bonneville	2-12%	0	Long and Griffin 1937
Quinault River/Washington Coast	11.6% (3.2-32.5%)	0	L. Gilbertson (Quinault Tribe) Personal Com.
Queets River/Washington Coast	22.9% (13.5-35.0%)	0	L. Gilbertson (Quinault Tribe) Personal Com.
Lower Columbia Tributaries	Exceeding 17%	0	NMFS (1996)
Hood River/Hood	4.6%	1	J.Newton (ODFW) Personal Com.
Klickitat River/Klickitat	3.3%	2	Howell et al. (1985)
Clearwater River/Snake	2-4% (Estimated)	2	Whitt (1954)
Yakima River/Yakima	1.6% (Average)	4	Hockersmith et al. 1995
SF Walla Walla/Walla Walla	2-9%	4	J. Germond (ODFW) Personal Com.
Mid/Upper Columbia	1.6% (Average)	7-9	L. Brown (WDFW) Personal Com.
Snake Basin	3.1% [1]	8	Costello (1977)

1/ Per August/September 1971 sampling of steelhead trout (293 fish) caught in Zone 1 and 2 commercial fisheries. Steelhead assumed to be predominantly Type B steelhead, based on personal communications with fish buyers and fisherman, time of catch, weight/length and ages of fish.

Table 2. Results For Yakama Nation Reconditioning Project Treatments (Yakima River), 2000-2008 [1]

Long term Reconditioning					**Short term reconditioning**				**No-term (immediately transported and released just below Bonneville Dam)**				**In River (immediately released back into the Yakima River)**			
Collection Year	In	Survive d to Release	Mature @ Release	% Survived and Mature @ Release	In	Survived to Release	Returned to Bonneville	% Detected Returning to Bonneville	In	Survived to Release	Returned to Bonneville	% Detected Returning to Bonneville	In	Survived to Release	Returned to Bonneville	% Detected Returning to Bonneville
2000	512	91	42	8%	--	--	--	--	--	--	--	--	--	--	--	--
2001	551	197	108	20%	--	--	--	--	--	--	--	--	--	--	--	--
2002	420	140	76	18%	479	334	43	9%	--	--	--	--	--	--	--	--
2003	482	298	254	53%	208	187	8	4%	--	--	--	--	--	--	--	--
2004	662	253	216	33%	105	83	5	5%	75	63	5	7%	--	--	--	--
2005	386	86	75	19%	106	99	1	1%	98	96	2	1%	67	67	3	4%
2006	279	85	79	28%	56	52	0	0%	55	49	2	4%	52	52	1	2%
2007	422	221	202	48%	40	38	1	3%	43	38	0	0%	53	53	3	6%
2008	472	269	266	56%	108	100	6	6%	100	100	2	2%	88	88	3	3%
Total	418 6	1640	1318		1102	893	64		371	346	11		260	260	10	
2005-2008 Average				*38%*	*2005-2008 Average*			2.5%	*2005-2008 Average*			1.75%	*2005-08 Average*			3.75%
2003-08 average				*40%*	*2003-08 average*			3%	*2004-08 average*			3%				
2000-08 average				*31%*	*2002-08 average*			4%								

1/ Data for Table derived from Page 29 of Branstetter et al. 2008

Table 3. Results and Comparisons of Kelt Long-term Reconditioning Treatment by Release Site in the Yakima, Deschutes, and Okanogan Subbasins, 2000-2008 [1]

Yakima River (Yakima Subbasin)					**Shitike Creek (Deschutes Subbasin)**				**Omak Creek (Okanogan Subbasin)**			
Collection Year	In	Survived to Release	Mature at Release	% Mature @ Release	In	Survived to Release	Mature at release	% Mature at Release	In	Survived to Release	Mature at release	% Mature at Release
2000	512	91	42	8%	-	-	-	-	-	-	-	-
2001	551	197	108	20%	-	-	-	-	-	-	-	-
2002	420	140	76	18%	-	-	-	-	-	-	-	-
2003	482	298	254	53%	-	-	-	-	-	-	-	-
2004	662	253	216	33%	-	-	-	-	-	-	-	-
2005	386	86	75	19%	9	1	1	11%	51	3	3	6%
2006	279	85	79	28%	4	0	0	0	27	2	2	7%
2007	422	221	202	48%	14	1	1	7%	43	8	8	19%
2008	472	269	266	56%	11	0	0	0	32	9	9	28%
Total	4186	1640	1318		38	2	2		153	22	22	
2003-08 average				*40%*								
2000-08 average				*31%*								
2000-08 average				*38%*	2005-2008 average			*5%*	2005-2008 average			*14%*

1/ Table contents extracted from Page 31 of Branstetter et al. 2008

Table 4. Project Funding by the Action Agencies for Resolution of Critical Uncertainties and Data Gaps Relative to Operational and Reconditioning Measures to Increase the Survival Rates of Kelts and Productivity of Steelhead Populations in the Snake and Columbia Rivers

Funding Agency	Project Number	Project Title	Contractor	Start Date (FY)	End Date (FY)
Bonneville Power	2000-017-00	Recondition Wild Steelhead Kelts	CRITFC	2000	2006
Bonneville Power	2003-062-00	Evaluate Reproductive Success Steelhead Kelts	CRITFC	2003	2007
Bonneville Power	2007-401-00	Kelt Reconditioning and Reproductive Success Evaluation Research	CRITFC	2007	2017
Bonneville Power	2008-458-00	Steelhead Kelt Reconditioning (Upper Columbia)	Yakama Nation	2009	2017

Table 5. RM&E related projects to address RPAs Issues [1]

RPA Number	**RPA Description**	**Project Number**	**Project Title**	**Primary Workgroup**
50.5	Provide additional status monitoring to ensure a majority of Snake River B-Run Steelhead populations are being monitored for population productivity and abundance. (Initiate by FY 2009, then annually)	1982-013-01	Coded Wire Tag - PSMFC	Fish Populations / Habitat
		1989-098-00	Hood River Production M&E - Warm Springs	Hydrosystem / Predation
		1990-055-00	Salmon Studies ID Rivers IDFC	Fish Populations / Habitat
		1991-073-00	Idaho Natural Production Monitoring	Fish Populations / Habitat
		1992-062-00	ID Steelhead M&E Studies	Fish Populations / Habitat
		1992-068-00	ID Steelhead M&E Studies	Fish Populations / Habitat
		1993-029-00	ID Steelhead M&E Studies	Fish Populations / Habitat
		1993-037-01	ID Steelhead M&E Studies	Fish Populations / Habitat
		1993-040-00	ID Steelhead M&E Studies	Fish Populations / Habitat
		1993-056-00	ID Steelhead M&E Studies	Fish Populations / Habitat
		1993-060-00	ID Steelhead M&E Studies	Fish Populations / Habitat
		1994-050-00	Idaho Natural Production Monitoring	Fish Populations / Habitat
		1996-020-00	PIT Tagging Spring / Summer Chinook	Fish Populations / Habitat
		1996-046-01	PIT Tagging Spring / Summer Chinook	Fish Populations / Habitat
		2003-017-00	Integrated Status / Effect Program	Fish Populations / Habitat
		2005-002-00	Lower Granite Dam Adult Trap Operations	Fish Populations / Habitat

RPA Number	RPA Description	Project Number	Project Title	Primary Workgroup
		2008-748-00	Additional B-Run Steelhead Work	Fish Populations / Habitat
53.5	In addition to current operations (generally April 10 - August 31), evaluate operation of the Bonneville Dam PH2 corner collector from March 1 – start of spill as a potential means to provide a safer downstream passage route for steelhead kelts, and implement if warranted.	1983-319-00	New Marking & Monitoring Technology	Hydrosystem / Predation
		ADS-P-00-6	Evaluation of Steelhead Kelt and Overwintering Summer Steelhead Downstream Passage Through Columbia and Snake River dams.	Hydrosystem / Predation
64.1	Continue to estimate the relative reproductive success (RSS) of hatchery-origin salmon and steelhead compared to reproductive success of their natural-origin counterparts for ESA-listed spring/summer Chinook population in the Upper Grande Ronde, Lostine River, and Catherine Creek; listed spring Chinook in the Wenatchee River; and *listed steelhead in the Hood River*. (Initiate in FY 2007-2009 Projects.)	1988-053-03	Hood River Production M&E - Warm Springs	Hatcheries / Harvest
		1988-053-07	Hood River Production O&M - WS / ODFW	Hatcheries / Harvest
64.2	Determine if properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations. (Initiate in FY 2007-2009)	2007-401-00	Kelt Recondition / Reproductive Success	Hatcheries / Harvest
		2008-458-00	Steelhead Kelt Reconditioning	Hatcheries / Harvest

1/ Appendix in document "Recommendations for implementing research, monitoring and evaluation for the 2008 NOAA Fisheries FCRPA BiOp, Based on AA/NOAA/NPCC RM&E workgroup assessment of actions called for under the BiOp reasonable and prudent alternative, Final draft- June 1, 2009."

APPENDIX A: Excerpt from Regional RM&E Workgroup Gap Analysis

The current federally funded kelt projects in the Columbia River Basin incorporate a monitoring & evaluation (M&E) element. The monitoring and evaluation component of these projects is meant to measure progress toward achieving the stated objectives, and serves as mechanism to adapt/adjust the projects accordingly.

The Action Agencies (USACE, BPA, and USBR), NOAA Fisheries and the Northwest Power and Conservation Council generated a final draft document (Anonymous 2009) recommending the implementation research, monitoring and evaluation activities to address Reasonable and Prudent Alternatives (RPAs) mandated in the 2008 NOAA Fisheries FCRPS Biological Opinion. Within this plan, M&E elements are set forth to address particular project specific issues related to operational measures for increasing steelhead kelt survival. Descriptions of specific RPA actions (M&E elements) are:

1. **RPA 50.5**- Provide additional status monitoring to ensure a majority of Snake River B-Run steelhead populations are being monitored for population productivity and abundance (Initiate by FY 2009, then annually)

   RM&E projects - coverage assessment: The Workgroup conducted an inventory on the current level of status monitoring of B-Run steelhead (see Bruce's tables; Rishi 2009). The Workgroup identified significant gaps in monitoring B-Run steelhead. Because the watersheds of the Clearwater and Salmon River are remote and snow filled in early spring when adult steelhead spawn, the state and tribes have not been able to make meaningful spawner surveys. This is because of access problems and the effects of spring runoff and turbidity on redd and spawner visibility. Likewise the use of weirs and smolt traps has been problematic due to the same high-runoff conditions. Therefore, adult spawner abundance has been extrapolated by determining summer low-flow parr densities and then back calculating the densities to estimate the number of spawners needed to produce those densities. The accuracy of such back calculations is highly questionable. The second strategy has been to use dam counts at Lower Granite Dam as a firm known count for the entire upper Salmon and Clearwater Rivers and to manage at a multi-MPG scale for spawner escapement. The present strategy for juvenile migrants has been to place smolt traps in accessible smaller tributaries where water conditions are more manageable and then extrapolate such index sites to the entire population. Juvenile density monitoring until recently was at fixed sites so that their utility for determining changes in distribution have been limited. In addition, diversity measures associated with cohorts, sex ratio, size, etc. have suffered from the same difficulties in obtaining adult fish for sampling. Limited sampling has occurred through creek surveys and some limited trap sites at hatcheries.

   The following are being pursued as possible solutions. They may or may not provide the expected outcome in its entirety, but appear to be on a reasonable and prudent course.

   - Use a series of PIT-tagging programs coupled with strategically placed detection arrays in order to determine adult migration timing, distribution, and survival of tagged fish. It is likely that PIT tags would be able to detect behavioral and distributional differences in A Run and B Run, if they exist, or it may confirm that the two runs are an artificial demarcation.

- Obtain detailed DNA SNP information about each population within the steelhead MPGs in Idaho in order to be able to obtain a genetic fingerprint of each population that can be detected at Lower Granite Dam. DNA SNP sampling should also contribute to the A-Run/B Run question as they move through Lower Granite.

- Obtain DNA fingerprint of each hatchery stock so that they can be detected passing through the fisheries and into the spawning grounds. This fingerprint would be done each year based upon known DNA sequences for each female spawned.

- Continue to use tributary traps and weirs where feasible.

- Move toward probabilistic juvenile sampling where feasible to improve distribution information and to make better unbiased estimates of juvenile parr densities.

Recommendation (Implement as soon as possible): The Workgroup recommends that following:

1. Maintain current contracts ISMES 19905500, and INPMEP 199107300. ISS 198909800 is scheduled to end in 2014. However, the location and information derived from the weirs and traps associated with this project are extremely valuable for evaluating status of B-Run steelhead in many tributary streams. This project should be re-configured in 2014 based on results of FPG 200732300 to continue to collect adult and juvenile data for strategic locations in the basin or combined with ISMES 199005500.

2. Fund FPG 200732300 through at least one more funding cycle to ascertain results of project DNA objectives.

3. If the above strategy is successful, reconfiguring of adult and juvenile monitoring may be appropriate in 2013.

4. Systematically sample returning adult steelhead at Lower Granite Dam for genetics (tissue samples) and age structure (scale samples), and mark the fish with PIT tags (tagging will be consistent with the PIT-tagging approach recommended for RPA 50.1). Establish remote PIT-tag interrogation systems near the mouths of the Selway, Lochsa, South Fork, and Lolo Creek populations (part of the Clearwater MPG). As part of RPA 56.2, an

interrogation system already exists near the mouth of the South Fork Salmon River population. Finally, place another interrogation system in the Salmon River upstream from the confluence of the Middle Fork Salmon River. The latter system can be used to determine if B-Run steelhead occur in areas upstream from the Middle Fork population (the assumed most-upstream population of B-Run steelhead). These systems can be used to assess the distribution, abundance, and productivity of steelhead within a majority of the B-Run populations.

Provide hand-held PIT-tag detectors to harvest managers to determine the harvest of steelhead in fisheries upstream from Lower Granite Dam

2. **RPA 53.5 -** Evaluate operation of the Bonneville PH2 corner collector from March 1 through start of spill as a potential means to provide a safer downstream passage route for steelhead kelts, and implement if warranted.

   RM&E projects - coverage assessment: No gap exists. The Corps has funded two years of research on this issue. Management is now digesting that information and will prescribe operating guidelines. Even so, NOAA & BPA are suggesting there may be a need to obtain more population-specific information.

   Recommendations: A formal plan for B2CC operation needs to be developed. This matter can be addressed within the upcoming Kelt Management Plan. (Anonymous, 2009)

3. **RPA 54.13 -** Evaluate operation of The Dalles Dam sluiceway from March 1 – March 31 and from December 1 – December 15 as a potential means to provide a safer fallback passage route for overwintering steelhead and kelts, and implement if warranted.

   RM&E projects - coverage assessment: No gap exists. In AFEP, project ADS-P-00-6 addresses this issue.

   Recommendations: None.

4. **RPA 64.1**- Continue to estimate the relative reproductive success (RSS) of hatchery – origin salmon and steelhead compared to reproductive success of their natural-origin counterparts for ESA-listed spring/summer Chinook population in the Upper Grande Ronde, Lostine River, and Catherine Creek; listed spring Chinook in the Wenatchee River; and *listed steelhead in the Hood River*. Continue to fund the ongoing RRS feasibility study for Snake River fall Chinook to completion in 2009 (Initiate in FY 2007-2009 Projects).

   RM&E projects - coverage assessment: The Workgroup identified no gaps associated with this RPA.

Recommendation: The Workgroup offers no recommends for this RPA.

5. **RPA 64.2 -** Determine if properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations (Initiate in FY 2007-2009 Projects**).**

   RM&E projects - coverage assessment: There are no gaps associated with this RPA, unless additional information is needed to assess whether all threats are being monitored.

   Recommendation*:* The Workgroup offers no recommends for this RPA.

Table 5 provides additional information about these RPAs in terms of RM&E-related projects to close steelhead kelt and productivity data gaps. RM&E Workgroup discussed kelt reconditioning in the Upper Columbia as specific gap in coverage since there are currently no work elements that address this RPA.

APPENDIX B: Detail of Potential Kelt Handling and Collection Facilities

The following information is excerpted from Corps Engineer Design Report (EDR) Section 4-Hydraulic Design for new proposed Lower Granite Juvenile Fish Facility (JFF) which includes a new independent raised elevation kelt diversion and collection facility. The most recent proposed construction start date is 2014. Between 2011 and 2013, the temporary kelt diversion and holding tanks constructed in 2009-2010 for University of Idaho study (BPA funded through subcontract of Yakama Tribe) would be operated:

4.04 LOWER FACILITIES (at Lower Granite Dam)

4.04.01 General

(1) Lower Facilities consist of the kelt handling facilities, adult fish and juvenile fish separators, and the holding and loading facilities.

(2) For fish and flow routed to the lower facilities, the 3-foot wide rectangular flume will gradually transition to a 4-foot flume upstream of the adult fish and debris separator. From here, adult fish and debris will be routed to either the kelt facility, or returned to the river. Juvenile fish would continue on to the holding and loading facilities. A general site plan is shown on sheets M-101, M-104 and M-105.

(3) Adult fish routed to the kelt facility will be sorted and held until released for trucking, barging, or return to the river.

(4) Once juvenile fish are separated by size at the juvenile fish separator, they will be routed to sample tanks, direct barge loading, raceways, river release, or PIT-tag facilities. From the sample tanks, fish will be routed to holding tanks near the laboratory for study. From the raceways fish will be routed to barge or truck loading for transportation, or to the river release site. A research building will be built to support juvenile fish research, currently operated by NMFS. See separate sections for sheet references.

4.04.02 Kelt Handling Facilities

Note: Most features of the kelt handling facilities are not completely designed. The following information provides a general idea of facility function.

(1) General

a. Kelt facilities will be designed to collect, sort, evaluate, and transport diverted adult fish in support of the kelt management plan. These facilities will be located just downstream of the existing lab building. The main components of the kelt facilities will include the following:

1. A PIT tag diversion system to route PIT tagged fish to a holding tank.

2. A holding tank to hold fish before sorting and/or evaluating them.

3. An anesthesia tank and sorting trough for sorting and/or evaluating fish before sending them onto recovery tanks or river release.

4. A work area to evaluate fish and record data.

5. Truck loading, barge loading, and river release capability from all tanks.

b. See sheets M-105 and M-119 through M-121 for more information on flume routings, facility layout, and tank locations.

(2) Fish Distribution Flumes

a. A network of 15-inch wide by 24-inch high flumes and 16-inch diameter pipes (15-inches inside diameter), will be used to transport fish and transportation water from the adult fish and debris separator to the kelt facility. Rectangular and U-shaped flumes along with related components (such as switch gates and drop gates) will be used throughout the facility. See sheet M-119 for information on related flume components.

b. After leaving the adult fish and debris separator, fish and about **XX** cfs of transportation water will either be diverted back to the river, or into the kelt facility in 15-inch wide by 24-inch high U-shaped flumes. After passing through a PIT tag detector, the flume will transition to a 15-inch wide rectangular flume and switch gates will divert fish and flows to a PIT tag holding tank, holding tank, sorting trough, or onto the river release. See sheet M-119 for flume layouts. Flush lines will be located at all gate locations to move fish through after gates have been switched.

c. Normal pipe and flume slopes will range from about 0.02 feet per foot to 0.07 feet per foot. Flume curves (to the flume center lines) will typically be 7 foot radius or larger. All flume curves will be simple curves in U-shaped flumes. Curves on pipes will typically equal or exceed 7 foot radiuses. Pipe curves will be simple curves.

d. Assuming a flow of 6 cfs, a flume width of 15 inches, and a Manning's n of 0.01 the following conditions apply. For a slope of 0.02 feet per foot, the normal flow depth and velocity will equal about 6.5 inches and 9.2 fps, respectively. increasing the flume slope to 0.07 feet per foot will decrease normal depths and increase normal velocities to approximately 4 inches and 14.2 fps, respectively. Flow in fish distribution flumes will be supercritical.

(3) Holding Tank

a. A 15-foot wide by 30-foot long holding tank will be provided to hold fish until they are sorted and sent to recovery tanks, or on to the river release. The tank will have a minimum depth of 4.0 feet with two feet of freeboard above. The tank will have a floor crowder to move fish up into an exit flume. This flume contains a sorting trough and anesthetic tank for sorting fish into recovery tanks, evaluating fish condition, or returning them to the river. The tank will be covered with a net to prevent fish jumping. Approximately 0.5 cfs of flow will be provided to the tank.

b. In addition to the floor crowder, fish and transportation water can exit the tank through a 16-inch-diameter outlet pipe fitted with a knife gate valve. This outlet pipe will be located just above the floor crowder when lowered. Dewatering of excess flow will take place downstream of the knife gate valve, before entering the 16-in-diameter outlet pipe. From here, fish can be diverted to truck loading, barge loading, or river release.

(4) PIT Tag Holding Tank

a. A 12-foot-wide by 25-foot-long PIT tag holding tank will be included in the facility. Selected fish will be automatically diverted to this tank by a switch gate after passing through the upstream PIT tag detector. Fish will be held until they are sorted and sent to recovery tanks, or on to the river release. The tank will have a minimum depth of 4.0 feet of water with two feet of freeboard above. The tank will have a floor crowder to move fish up into an exit flume. This flume contains a sorting trough and anesthetic tank for sorting fish into recovery tanks, evaluating fish condition, or returning them to the river. The tank will be covered with a net to prevent fish jumping. Approximately 0.3 cfs of flow will be provided to the tank.

b. In addition to the floor crowder, fish and transportation water can exit the tank through a 16-inch-diameter outlet pipe fitted with a knife gate valve. This outlet pipe will be located just above the floor crowder when lowered. Dewatering of excess flow will take place downstream of the knife gate valve, before entering the 16-in-diameter outlet pipe. From here, fish can be diverted to truck loading, barge loading, or river release.

(5) Recovery Tanks

a. The facility will be designed to operate up to four 12-foot-wide by 25-foot-long recovery tanks. Two are planned for initial installation, with the option to add two more at a later date. After sorting, fish will be routed to these tanks for holding until being released to truck loading, barge loading, or back to the river. The tanks will have a minimum depth of 4.0 feet of water with two feet of freeboard above. The tanks will be covered with nets to prevent fish jumping. Approximately 0.3 cfs of flow will be provided to each tank.

b. Fish and transportation water will exit the tanks through 16-inch-diameter outlet pipes fitted with knife gate valves. Dewatering of excess flow will take place downstream of the knife gate valve, before entering the 16-in-diameter outlet pipe. From here, fish can be diverted to truck loading, barge loading, or river release.

(6) Sorting Trough

a. Fish and transportation water can be routed to the sorting trough from the holding tank, PIT-tag holding tank, or directly from the adult fish separator. This trough will be 15-inches wide and located in the flume system. A gate will be located at the downstream end of the trough to briefly hold fish until drop gates can be adjusted to move the fish into the desired recovery tank, or return them to the river. Once gates are adjusted, fish and transportation flow will continue down the flume to the desired location. See sheet M-404 for drop gate design and sheet M-119 for the sorting trough and anesthetic tank arrangement.

b. An anesthetic tank will be located directly downstream of the sorting trough in the flume system to anesthetize selected fish for biological evaluation. After evaluation, fish will then be moved by hand, or routed through the flume system to a recovery tank. The anesthetic tank will be covered when not in use to allow fish to pass directly to the recovery tanks or river release.

(7) Work Area

a. A work area will be located near the sorting trough and anesthetic tank. The work area will contain two work stations with troughs supplied with running water similar to lab marking stations. In addition, a small work desk area will be available for data sheets, tags, etc..

b. There will be a cabinet for storing supplies and equipment, as well as lighting for night time operations. Electricity will be supplied to the work area to support computer and miscellaneous equipment. The work area and all tanks will be covered for shading.

(8) Barge and Truck Loading

a. A series of 15-inch-wide by 24-inch-high flumes, 16-inch-diameter pipes, and switch gates will be used to route kelt to barge and truck loading. See sheet M-121 for pipe/flume configuration.

b. Kelt will be loaded on to barges at the new barge dock (see Section 4.04.05.c). The final barge loading configuration has not been finalized, but loading should be through a large diameter pipe or flume.

c. Truck loading will be located just south of the kelt recovery tanks. The outlet to the truck loading flume will be at 662.0 fmsl (about 10 feet above the grade elevation). A flex hose or pivoting chute will direct fish into the truck hold.

(9) River Release

For river release from kelt tanks, 16-inch-diameter pipes will be used for most of the distance. Short sections of 15-inch rectangular flume and one switch gate will also be used to route fish to the CMF river release flume. Kelt and water will be transported through the CMF and discharged into the river. See sheet M-120 for pipe routing and connection to the CMF, and sheet M-104 for CMF routing. Paragraph 4.04.06 describes the CMF river release conditions.

From designing engineer's FFDRWG coordination package:

1. Lower Granite

a. Current configuration for collection

Collection by hand from juvenile/smolt separator within the existing juvenile fish facility (JFF). Operation totally dependent upon configuration and operation of smolt facility. Installation of research routing flumes and tanks for University of Idaho studies in 2009 and 2010.

b. Gap between current configuration and optimal configuration

Current configuration restricted to existing configuration and operation of the JFF for smolts where adults are incidentals. Research facilities used at LGR are adapted around existing smolt routing configuration and operations. Optimal will be fully independent facility separated from smolt facility designed specifically for kelt routing, handling, and monitoring.
Current requires physical handling, optimal would be water-to-water routing and holding capabilities.
Propose that transport option either by designated barge hold within existing amolt barges or by truck would be determined by daily kelt numbers collected and seasonal smolt transport schedule and release scenarios and locations. Except for specific RM&E study, barged kelts would be released when smolts released, whereas trucked kelts would be transfered to Bonneville Dam outfall flume for release.

c. Future plans for modifications including timelines

Design completed by March 2011...Construction not likely until 2014...

Kelt collection would occur to adult fallback or downstream emigrating kelts routed and passed through the Juvenile Fish Facilities at each dam immediately downriver from primary confluences and primary hatchery operations, minimally Lower Granite, Little Goose, McNary, and possibly John Day dams. Collection would only be required at the dams where monitoring has determined that those location-specific or distance-specific subbasin kelt populations demonstrate higher kelt-to-return spawner return survival (KSR) correlated to transportation and reconditioning. For transport to the Columbia River estuary or an accessible reconditioning facility, collected and sorted kelts would be routed to existing smolt transportation barges fitted with net pens when a barge is available and staged for smolt loading. When barges are not available for 4 hours or more, kelts would be diverted to the river.

Collection at all hydroelectric project facilities would be designed independent of the existing juvenile fish facilities as connected down-flume from the juvenile/adult/trash separator, designed similar to the recently designed Kelt Facility for the Lower Granite Juvenile Fish Facility. Information used for the design for the 2009 Kelt Facility at LGR pictured below has been regionally coordinated.

Since condition and fitness of individual post-spawn kelts has been correlated to survival to repeat spawning success, it would be prudent to collect both undetermined consecutive or skip repeat spawning kelts that emigrate from most primary and all secondary and smaller tributaries from within their specific tributary of use via utilization of the existing wiers, traps, and ponds, supported by truck and/or trailer transport, that have been used since at least year 2000 during the development of the Kelt Program. This probable reduction in the potential accumulation of stressing factors leading to direct and latent mortality due to the elimination of reservoir and dam passage of the next downriver dam capable of kelt collection could be substantial enough for meaningful contribution to recovery of certain drainage population, such as the Tucannon River.

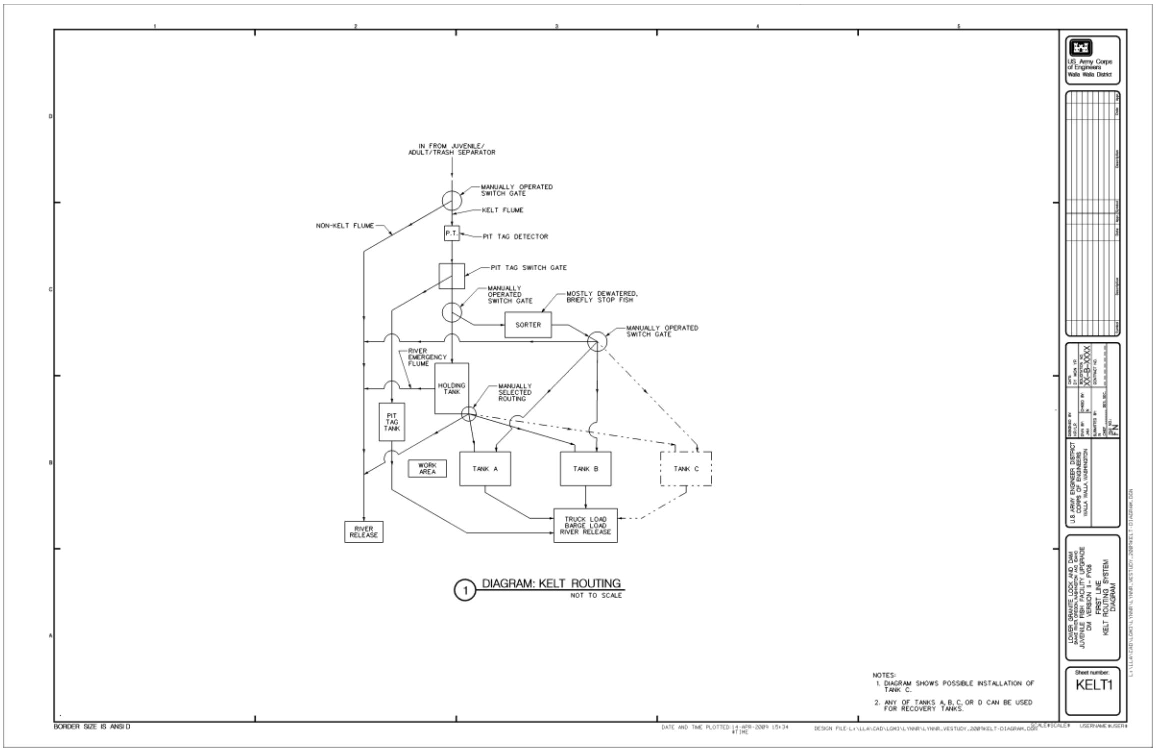
The Kelt routings designed for Lower Granite listed below and illustrated in Figure 4 should be designed into all kelt facilities funded for construction.

<u>ADULT RIVER RELEASE LINE ***to the following***</u>:
Adult river release flume.
Kelt facility flume (*see below*).

<u>KELT FACILITY FLUME ***to the following***</u>:
PIT tag tank (*see below*).
Sorting tank ***to…***
Holding tanks (*see below*).
River release.
Flume sorter ***to…***
Holding tanks (*see below*).
River release.

<u>PIT TAG TANK AND HOLDING TANKS ***to the following***</u>.
Truck loading.
Barge loading.
River release.

Figure 4. Lower Granite Kelt Facility design schematic, 2009.



The following linked .tif files are design drawing plates for the Lower Granite kelt facility design, 2009.

GENERAL TANK INFORMATION:

Minimum 5 tanks total: 1 sorting, 1 PIT tag, 1 holding, at least 2 anesthesia.
No concrete walls (fiberglass likely).
Advantage to modular tanks.
Water spray system and netting cover to minimize jumping.
Tanks should be shaded with about 2 feet of freeboard below top of tank.
Need about 4 to 5 feet above WSE to allow for fish jumping and to help keep fish quiet.
All tanks require crowding ability via sloped floor or mechanical crowder. Only the sorting tank requires a floor crowder.
Standpipe drains with varying standpipe heights to allow dropping water surface elevation (WSE) for crowding, netting, etc.
Barge loading capability required.
If elevations allow, it should work to load the adult fish through the 10” diameter barge loading boom. ***Verify that 10” diameter pipe will work for loading adults, if used. Check on this, because design engineer would say no...Lower Monumental biologist requesting a larger diameter pipe in existing kelt transfer pipe...***

SORTING TANK.

Used for holding fish prior to sorting in shallow water sorting flume.

Should be adequate to hold 75 to 100 fish (provided there is adequate flow), minimal dimensions 15 by 30 feet with 4 feet of water depth.
Need for at least one tank at least 10 feet deep (assuming that McNary and JDA may have an expanded system designed for handling additional volume and numbers of kelts) for diversion of kelts into compensation-depth holding water to acclimate if elevated pre-exposure with gas bubble disease.
Floor crowder to move fish out of the tank.
Provide a flume counter to keep track of number of fish in tank.
Provide access to anesthesia tank, work area, and flume sorter.

HOLDING TANKS.

Provide 3 large tanks with option for 4.
Provide sloping "V" shaped floor to move fish out of tanks – no crowder in tanks.
Tanks could be circular if "V" shaped floor, but if no crowder, tanks should be rectangular for traveling crowder.
Tank dimensions should be 12-15 feet wide by 25-30 feet long.
Water depth should be at least 4 feet with walls about the same height above that or taller or surface cover netting.

PIT TAG TANK.

Locate near work area so fish can be anesthetized and worked up.
Provide access to anesthesia tank, work area, and flume sorter.
Does not require flume counter due to upstream detection.
Dimensions same as holding tanks except wall height.
Floor crowder for ability to do additional sorting with sorting flume.

ANESTHESIA TANKS.

Dimensions same as holding tanks.
Although all tanks will be water-to-water transfer capable, anesthesia tanks will also be served by at least two (2) 200 liter totes on wheels that are easy to move where needed and for transfer of fish for surgery as needed.

FISH INFORMATION:

Although current monitoring indicate that kelt do not generate a large oxygen demand at the time of collection because they are not eating and should have lower demands per kg than juvenile fish, the prime objective of reconditioning is re-establishment of feeding as rapidly as feasible. An adequate oxygen supply supplied to the smolt facility should be the minimal requirement for the kelt facility.

WATER REQUIREMENTS:

For 12x25 ft. long tank with 4 feet of water – need 150 gpm.
0.33 cfs for 1200 sf = 1 turnover per hour.

GENERAL INFORMATION:

Design for adequate fish transport truck access.
CRITFC will have a major leadership role in operation and modification, although it has not yet been decided who will operate each proposed facility.
Lower Granite will likely be the primary collection point for kelts.
Lower Granite, Little Goose, and McNary facilities will accommodate fish transport by truck and barges with netpen holding areas. Truck loading would principally be dependent upon 3 criteria: 1) availability of a barge at the site, 2) daily collection numbers below density capacity of the truck, and 3) program criteria determination for transport to reconditioning facilities versus transport to estuary release.

FACILITY OPERATION.

Based on previous monitoring, kelt collection would start around March 10-15, but could begin when the juvenile bypass systems are operational for the season (around March 1 at LGR).
Juvenile fish facility operation usually starts up around the end of March at LGR, so an early start would be required for kelt collected since the juvenile fish separator would need to be up and running for the kelt facility to be receiving fish.
These proposed operations would annually be coordinated and scheduled by TMT coordination.
These proposed operations would benefit survival and SAR of the reservoir-type life history of SR fall chinook salmon smolts.
Required ability to isolate kelt facility to shut down and perform maintenance.
Required ability for Kelt facility to operate independently of Juvenile Fish Facility operation and hydraulics.

RESEARCH / WORK AREA.

General:
Provide an anesthesia tank and work area just out of the sorting tank.
Also need access from the PIT tag tank area.
Cover the anesthesia tank if not in use and route the fish directly to the sorter.
Ability to route fish from the work area to the holding tanks for recovery.
Provide lighting for night time operations.
Need to keep shadows down to avoid spooking fish and optimize work area.
Provide vehicle access near work area to transfer equipment, etc.
Anesthesia tank:
Provide a similar set-up to the Lower Granite adult fish trap for getting fish out of the sorting tank and into the anesthesia chamber.
Work area:
Provide 2 workstations similar to lab stations.

Provide small desk area for data sheets, tags, scale cards, tissue samples, etc.
Provide shallow trough with running water to keep fish wet.
Two people working and one recording information.

FLUMES.

PIT tag diversion system:
A switchgate for the adult PIT tag diversion gate similar to Bonneville Dam.
PSMFC will set criteria for information on spacing, timing, flume velocities, etc.
Provide a sort by code gate in flume to route some PIT tagged fish directly to holding tanks.
Provide all gates anticipated in the flumes (even though all tanks may not be installed) to ease expansion of system in the future, if needed.
Prefer shallow water in most flumes, especially flumes used for sorting and PIT-tag interrogation.
If fallback adult fish that are not kelts get turned around, it prevents them from trying to swim upstream.
Cover flumes with net to keep fish in.
Provide one flume sorter for routing fish.
Use for main kelt flume, sorting tank, and PIT tag tank.
May want PIT tag detector (or ability to check tags) to aide in routing fish at the flume sorter.

2. Little Goose - None at current time.
    a. Current configuration for alternate collection point

From LGO project biologist George Melanson:

At Little Goose, adult fallbacks that get trapped into the juvenile system are removed from the separator and released back to the river via the outfall flume. Fallbacks are identified by species, stock (clipped, unclipped) and jack/mini-jack (Chinook and Coho). Fish are also classified with condition (Good, Fair, Poor or dead). Steelhead are also classified as Kelt or non-kelt. Please note, classification of fish condition (except for dead) and kelt, non-kelt are somewhat subjective - but we do our best to train bio-techs to be consistent.

Below is a table of recent years of Steelhead fallbacks at Little Goose. The data encompasses the entire season (April 1 - October 31) for each year. If you want seasonal specific data we can do that too. If you have any more questions, please don't hesitate to call.

Steelhead removed from the separator and returned to the river at Little Goose Dam JFF, 2003-2009.

Year	Clipped Steelhead	Unclip Steelhead	Total	Kelts
2003	3,069	2,755	5,824	3,072 (52.7%)
2004	3,948	4,346	8,294	6,244 (75.3%)
2005	1,983	2,992	4,975	3,950 (47.6%)
2006	2,712	2,410	5,122	3,910 (76.3%)
2007	1,348	839	2,187	1,107 (50.6%)
2008	2,119	1,934	4,053	2,761 (68.1%)
2009	2,971	2,114	5,085	Data incomplete.

b. Gap between current configuration and optimal configuration

Same as for Lower Granite JFF...

c. Future plans for modifications including timelines

None scheduled, but regional coordination would prefer duplicate system for diversion, collection, and transport as that designed at Lower Granite. Little Goose kelt facility could be streamlined in design and operation since open space and flume/piping configuration exists within the existing JFF (suggestion G. Moody, USACE Operations Biologist). Propose design and construct parallel to LGR Kelt facility 2011 through 2014. Propose that transport option either by designated barge hold within existing amolt barges or by truck would be determined by daily kelt numbers collected and seasonal smolt transport schedule and release scenarios and locations. Except for specific RM&E study, barged kelts would be released when smolts released, whereas trucked kelts would be transfered to Bonneville Dam outfall flume for release.

3. Lower Monumental - None at current time.
   a. Current configuration for alternate collection point

From LMO project biologist Bill Spurgeon...

Capability of sorting/collection/bypass facilities. LoMo capabilities dependent on modifications toward this end. Currently I have a small CAP project awaiting funding to increase the size of the separator adult release hopper and transit pipe with those of larger diameter. Currently, large fallbacks are carried to the flume for release while normal and less are sent through the existing adult release hopper. If we want to collect and transport adults from LoMo we'll need another raceway or well located large tank (with adequate water supply, drain, and cover), and with a flume or pipe from the separator area plumbed with flush water and another from raceway or tank to the barge loading flume also with flush water. As is the case with the other transport facilities we already record condition, group, and tag info. (tag info only if it doesn't put the fish at risk)

In the read I see that LoMo is not a likely candidate for adult transport. The additional time required for the loading of this group onto barges or trucks at LoMo if warranted would need a change to the start loading operations at Lower Granite and Little Goose or LoMo loading would occur late at night.

4. Ice Harbor Dam

No collection and transport possible. Propose spread-the-risk operation utilizing existing smolt bypass configuration with RSW for spill flow and ice-and-trash sluiceway and turbine screens with full flow bypass.
Propose the inclusion of kelts in post-construction testing of the reshaped spillbay nappe, flow deflector radius extension, and flat-plate PIT detectors being designed for the IHR RSW.

5. McNary Dam

6. John Day Dam

7. The Dalles Dam

8. Bonneville Dam

9. Tributaries:

Tributary and off-mainstem channel utilizing kelts would remain uncollected in the respective stream and/or collected according to existing programs or RM&E studies, such as:

A. CRITFC –
- i. Clearwater River by Nez Perce Tribe (NPT).
- ii. Umatilla River by Confederated Tribes of the Umatilla Indian Reservation (CTUIR).
- iii. Walla Walla River by CTUIR.
- iv. Yakima River by Yakama Tribe (YT).

B. WDFW –
- i. Tucannon River.
- ii. Touchet River.

C. ODFW-
- i. Deschutes River.
- ii. John Day River.

10. 2010 Plan

APPENDIX C: Annotated Notes From Pertinent Kelt Research

Bronson, James, Bill Duke, "Walla Walla River Fish Passage Operations Program", 2004-2005 Annual Report, Project No. 200003300, 36 electronic pages, (BPA Report DOE/BP-00012779-4):

During the 2004-2005 project year, there were 590 adult summer steelhead and 31 summer steelhead kelts (*Oncorhynchus mykiss*) enumerated at the Nursery Bridge Dam fishway video counting window between December 13, 2004, and June 16, 2005. In addition, the old ladder trap was operated by ODFW in order to enumerate fish passage. Of the total, 143 adult summer steelhead and 15 summer steelhead kelts were enumerated at the west ladder at Nursery Bridge Dam during the video efforts between February 4 and May 23, 2005.

Any steelhead or chinook smolts, and all summer steelhead kelts trapped was hauled to the lower mainstem Walla Walla for release. Fish are hauled as needed to prevent accumulation of juveniles or kelts at the facility.

Trapping data collected include dates of operation, species composition of juveniles trapped at the Little Walla Walla facility, estimates of mortality, and disposition of fish trapped. Data collected from kelts trapped at the Little Walla Walla facility include number, condition, and external marks. Hauling data include dates, pounds or number hauled, estimates of mortality, and release location.

Operation of the Little Walla Walla River juvenile trapping facility is conducted under guidelines developed by the project in conjunction with NOAA Fisheries and other affected agencies.

ODFW liberation protocols are used as the basic guideline for hauling operations.
The 3,500 and/or 3,000 gallon unit are used to haul spring chinook adults. In addition, the 750 gallon unit may be used to haul spring chinook adults. A 12 inch discharge opening is needed for releasing fish of this size. The trailers, with eight inch discharge openings, are adequate for hauling kelts. Transportation data collected includes date, transport unit, number of pounds or fish hauled, species composition, and an estimate of mortality.

Mahoney, B.D., M.B. Lambert, P. Bronson, T.J. Olsen, and J. Schwartz (CTUIR). Walla Walla Basin Natural Production Monitoring and Evaluation Project, 2006 Annual Report. Report to Bonneville Power Administration (BPA), Portland, OR. BPA Project Number 2000-039-00, Contract Number 00033613.:

As per the Walla Walla Fish Passage Annual Operation Plan (Bronson 2007), all adults were enumerated by using Salmon-soft fish video-tracking program through the duration of the adult return season (generally early December through June). Video enumeration was initiated in November 2006 and continued through August 2007; this expanded effort was done to assist the USFWS with bull trout research. Data collected during video enumeration included date, species, jack or adult spring Chinook salmon, the number of summer steelhead kelts and migration direction for bull trout. Notations were also made of other species encountered and general fish condition.

2005-2006 Brood Year

Based on video enumeration 581 adult summer steelhead, 12 summer steelhead kelts, 119 adult bull trout and 183 adult and two jack spring Chinook were counted at the Nursery Bridge Dam fishway between 5 December 2005 and 7 July 2006. Of these, 43 adult summer steelhead, two summer steelhead kelts, one bull trout, and eight adult spring Chinook were enumerated by ODFW in the old west side fish ladder between 4 January and 24 June 2006 (see also Bronson and Duke 2007). ODFW installed the Digital Video Recorder in the west ladder on 4 January 2006, so it is likely that part of the steelhead run may have gone undetected before the video equipment was installed in the west ladder. The summer steelhead brood of 2005-06 was enumerated from 30 December 2005 to 11 June 2006 as they passed Nursery Bridge Dam. The peak return occurred during April when about 40% (234 of 581) of the total return was counted. Summer steelhead kelts were observed between 25 April and 2 June 2006. Peak kelt outmigration occurred in May when 50% (6 of 12) were enumerated.

2006-2007 Brood Year

Based on video enumeration 314 summer steelhead, six steelhead kelts, 64 bull trout, and 236 adult and 6 jack spring Chinook returned to Nursery Bridge between 1 November 2006 and 31 August 2007. Of these, 23 summer steelhead, two steelhead kelts and 63 adult spring Chinook were enumerated at the west ladder between 15 November 2006 and 29 May 2007.

The summer steelhead brood of 2006-07 was enumerated from 20 June 2006 to 12 May 2007 as they passed Nursery Bridge Dam. The peak return occurred during March when roughly 52% (162 of 314) of the total return was counted (Figure 3). Summer steelhead kelts were observed between 18 April and 28 June 2007 as they passed downstream. Peak kelt outmigration occurred in May when two of four kelts were enumerated.

Tributary use

Radio-tagged steelhead distributed upstream unequally among four stream drainages (Figure 19). Roughly, 51% of fish used the Touchet River, 39% used the upper Walla Walla, 7% used Mill, Yellowhawk and Cottonwood, and 3% used Dry Creek. Based on radio-tag detections, mean upstream migration for spawning was 88.5 rkm above the Columbia River (range 41.1-158.6 rkm). Radio-ragged steelhead reached their upstream location with a mean travel time of 117 days (n = 96; SD 30). Mean daily movement of radio-tagged steelhead was 0.7 rkm/day (n = 96; SD 0.32). About 54% of radio-tagged steelhead that entered a tributary or spawning reach eventually entered the Columbia River presumably as live kelts (Table 34).

Seasonal fish movement

A general pattern of seasonal movement was observed in radio-tagged steelhead. Based on fish capture and telemetry detections, most adult steelhead entered the lower Walla Walla River between September and November. Most fish did not move directly upstream, but held either near the mouth of the Walla Walla or nearby in Columbia River (i.e. Lake Wallula). Most fish moved upstream through the mainstem Walla Walla and Touchet Rivers between November and March, usually on the declining hydrograph of a freshet. Most steelhead entered tributaries between December and May; and similar to our video results, peak migration of radio-tagged steelhead into the headwaters past Nursery Bridge Dam (rkm 71.9) was in March and April. Radio-tagged steelhead reached the spawning grounds between January and April (Figure 20) and remained there for a few days to a few weeks. Most, steelhead kelts returned downstream to the Columbia River between April and May (Figure 21).

Table 36 and 37 show the summary statistics for number of days and distance migrated by radio-tagged steelhead that eventually migrated to the Columbia River as presumably live kelts. The mean number of days spent by radio-tagged hatchery and wild female steelhead in the Walla Walla watershed was significantly different ($t = 2.35$; $P = 0.026$, df = 28). The median time spent in-basin by radio-tagged wild and hatchery females was 152 days (range 75-197 days) and 134 days (range 112-173 days), respectively (Table 36). Most of the difference in residency time was because hatchery females tended to migrate significantly less distance upstream ($z = 3.93$; $P < 0.001$; df = 20) than wild females (Table 37). Median upstream migration for female hatchery steelhead (n = 12) (that would later escape as kelts) was 36.4 rkm above the Columbia River (SD 25.4; range 19.8-105.0 rkm). Median upstream migration for female wild kelts (n = 22) was 73.3 rkm (SD 21.7; range 32.0-126.4 rkm). Fewer (35%; n = 28) radio-tagged males escaped the

Walla Walla River as kelts. We did not investigate kelt migration through the Columbia River hydro-system.

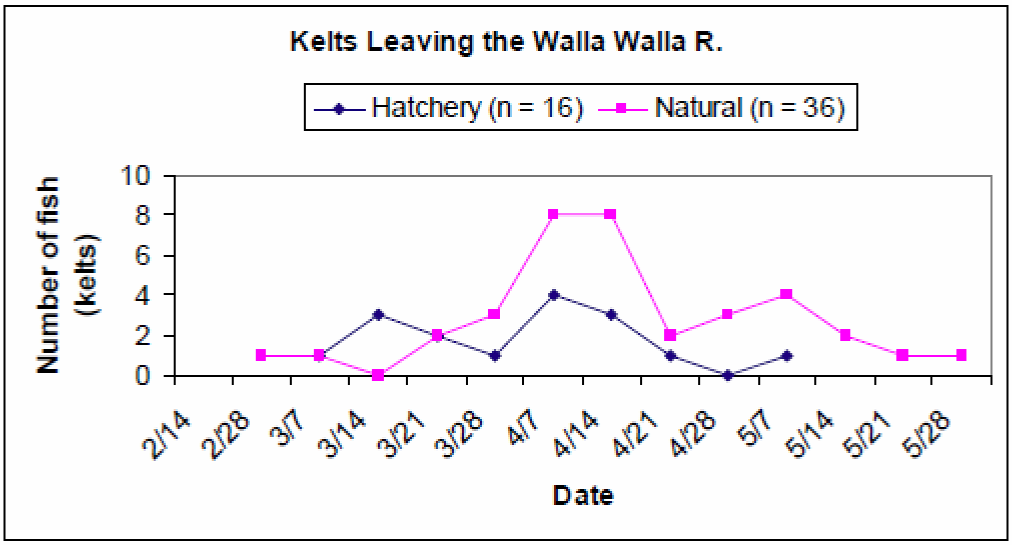


Figure 5. Telemetry detections of radio-tagged steelhead kelts by date leving the Walla Walla River (rkm 15), 2001-2006.

Table

Table 36. Summary statistics of days spent in the Walla Walla watershed for radio-tagged adult females and males that presumably returned to the Columbia River as kelts 2001-2006.

Statistic	Natural Female	Natural Male	Natural Total	Hatchery Female	Hatchery Male	Hatchery Total
N	22	14	36	12	4	16
Mean Days	149	142	146	120	154	129
Median Days	152	134	149	120	156	124
Std Dev (days)	28	21	25	26	22	29

Table 37. Summary statistics of distance migrated upstream in the Walla Walla watershed for radio-tagged adult females and males that presumably returned to the Columbia River as live kelts 2001-2006.

Statistic	Natural Female	Natural Male	Natural Total	Hatchery Female	Hatchery Male	Hatchery Total
N	22	14	36	12	4	16
Mean river km	77.9	70.4	75.0	43.8	66.5	59.2
Median river km	73.4	65.8	69.4	36.4	64.4	42.7
Std Dev (rkm)	21.7	25.3	23.2	25.4	26.7	26.9

Zimmerman, B.C. (CTUIR) and B.B. Duke (ODFW). 1993. Umatilla River Basin Trap & Haul Program, Annual Report 1993. Report to Bonneville Power Administration (BPA), Portland, OR, Project Number 88-022, Contract Number DE-BI79-89BP98636.:

The Threemile Dam west bank juvenile facility was in operation from April 7 to July 26, 1993. The facility operated in the bypass mode the entire period.

The Westland facility, located near Echo (RM 27), is the capture point for outmigrating summer steelhead kelts. The facility is designed to either bypass kelts directly back to the river or to trap them. Kelts entering the trap are separated from juveniles by a horizontal bar grader and then proceed into an adult holding pond. Kelts can then be loaded into tanks for hauling downstream.
Outmigrants (both juveniles and kelts) were to be hauled whenever flow conditions in the Umatilla River were projected to drop below 150 cfs at Echo within 10 days. Downstream migrants were to be released at the Umatilla boat ramp (RM 0.5) as long as flows remained above 50 cfs. At lower flows an alternate site (i.e. Columbia River) was to be used. ODFW liberation protocol was used as the basic guideline for juvenile hauling operations. Only one known summer steelhead kelt was hauled from Westland this year. Steelhead kelts were able to volitionally migrate during spring flow conditions.

Wertheimer, R.H. (USACE), C. T. Boggs, M. L. Keefer, C. A. Peery (ICFWRUDFWR), K. Collis, and A. F. Evans (Real Time Research, Inc.). 2008. A Multi-year Summary of Steelhead Kelt Studies in the Columbia and Snake Rivers. A Report to U.S. Army Corps of Engineers, Portland and Walla Walla Districts.

Wertheimer and Evans (2005), for example, reported downstream survival of 15.6% for kelts radio tagged at Lower Granite Dam in 2002, yet only ~1% of good condition fish returned from that sample. Clearly more research is needed to better understand the influence of abiotic factors on kelt survival and returns.

Boggs, C.T. and C.A. Peery (ICFWRU). 2004. Steelhead (Oncorhynchus mykiss) Kelt Abundance, Condition, Passage, and Survival in the Lower Snake and Columbia Rivers, 2003. Report to U.S. Army Corps of Engineers, Walla Walla District, Contract No. DACW68-02-D-0002, Task Order 0005. ICFWRU Technical Report 2004-1.:

In the Snake River, post-spawn steelhead (kelts) must pass up to eight dams during out-migration and each year thousands are observed falling back over dams via juvenile bypass systems. Between 12 April and 15 June 2003, we sampled 1,774 steelhead from the Lower Granite Dam separator and used ultrasound imagery to distinguish post-spawn kelts from spring migrating pre-spawn steelhead. Of steelhead sampled, 96.8% were determined to be kelts. Kelts were predominantly female (82.7%) and of wild origin (~50%). The majority (72.6%) of kelts were in good or fair physical condition and were best distinguished from pre-spawn steelhead by a thin, imploded abdomen (72.4%). We estimate that at least 4,026 kelts were bypassed from the Lower Granite Dam separator during this study period.

We PIT-tagged a total of 1,254 kelts and randomly assigned 701 to an in-river/transport paired release experiment. A total of 372 kelts were transported to the estuary in conjunction with the juvenile transport effort, and 329 were released in the tailrace of Lower Granite Dam. Tagged kelts from this study are expected to begin returning to the Columbia River in the fall of 2003, though the majority will probably reascend during summer and fall of 2004. Data from PIT detectors located at Bonneville, McNary, Ice Harbor, and Lower Granite dams will be used to compare return rates of the experimental groups.

We radio-tagged an additional 212 kelts, released them in the Lower Granite tailrace, and monitored their migration rates and survival through the hydrosystem. Telemetry receivers detected 142 kelts (67.0%) downstream from Ice Harbor Dam and 73 (34.4%) were recorded passing Bonneville Dam.

Radio-tagged kelts in good condition were more likely to successfully exit the hydrosystem than those in fair condition ($\chi 2$ test, P=0.003). Migration rates through Snake River inter-dam reaches (tailrace to tailrace) averaged 32.4 km/d (*range* 22.6-42.6); migration rates through Columbia River reaches were generally higher (*mean*=55.3 km/d, *range* 39.5-80.1). Regression analysis revealed pooled migration rates through all reaches were positively related to river discharge ($P < 0.0001$, r2=0.63), though when examined individually this relationship was not significant for three of the eight reaches. We calculated both inter-dam and daily survival rate estimates using Program MARK and a Cormack-Jolly-Seber ‘recaptures only’ model. Estimates of inter-dam survival in the three Snake River reaches averaged 0.885 (*range* 0.840-0.970) and estimates for the four Columbia River reaches averaged 0.846 (*range* 0.706-0.936). Daily survival estimates averaged 0.935 (*range* 0.897-0.991) for Snake River reaches and 0.883 (*range* 0.788-0.952) for Columbia River reaches. Both inter-dam and daily survival estimates showed a general downward trend as kelt migration progressed downstream, although the trend was significant only for daily estimates (Bonferroni P=0.058).

Research at Little Goose and Lower Granite dams in past years revealed that the majority of adult steelhead in juvenile separators were kelts, the majority of kelts (>75%) examined were in good or fair physical condition and the kelt run was disproportionately female (>80%) and of wild origin (~50%). In fact, it was estimated that about 23% of the 2000 wild steelhead run (2,780 wild fish) and 21% of the 2001 wild steelhead run (4,695 wild fish) passed through the Lower Granite Dam bypass facility after likely spawning (Evans and Beaty 2000; 2001) though this proportion dropped to 8.6% (Hatch et al. 2003) in 2002.

In 2001 and 2002, in an effort to obtain information on kelt outmigration survival rates, radio tags were affixed externally to 422 kelts and their migration through the hydrosystem was monitored from release at Lower Granite Dam to the tailrace of Bonneville Dam (Evans 2002; Hatch et al. 2003).

Near-record low river flows occurred in 2001, with no spill at Snake River dams and drastically reduced spill at Columbia River dams. Of the 212 radio-tagged kelts released at Lower Granite Dam that year, only 8 (3.8%) were detected in the Bonneville Dam tailrace (Evans and Beaty 2001). River flow in 2002 was about 80% of the 10 year mean with spill occurring at all Snake and Columbia river dams. Twenty-eight (13.3%) of 210 radio-tagged kelts released at Lower Granite Dam in 2002 were detected in the Bonneville tailrace (Hatch et al. 2003). Differences in river flow and dam passage conditions are generally believed to be responsible for the differences in hydrosystem survival between the two years. In both years, the physical condition of kelts at tagging was also correlated to migration success: kelts in good condition were more likely to successfully migrate out of the hydrosystem than those in fair or poor condition. As part of the 2002 study, researchers used a randomly assigned paired release experiment to estimate return rates of kelts and to evaluate the efficacy of transporting kelts collected at Lower Granite Dam through the hydrosystem in conjunction with the smolt barging effort. After ultrasound examination, kelts were PIT tagged and randomly assigned to two treatments. The 'transport' group was loaded into submerged pens within a hold on a juvenile barge and released in the Columbia River estuary with the smolts. The 'in-river' group was released in the tailrace of Lower Granite Dam and allowed to out-migrate through the hydrosystem. Return rates of these two experimental groups (transported and in-river) continue to be monitored.

Dam Passage Routes

Telemetry coverage permitted assignment of kelt passage routes at McNary (limited coverage), John Day and Bonneville dams. At McNary Dam, 8.1% of all kelts that passed the dam did so via the juvenile bypass, 2.4% were detected passing downstream through fishways and none was detected by antennas in the navigation lock. Passage by kelts at John Day Dam was primarily through the spillway (76.1%) and the navigation lock (12.0%) with 2.2% of kelts detected in the juvenile bypass.

Telemetry coverage was most complete at Bonneville Dam where 49.3% of kelts likely passed the dam via the spillway and smaller proportions used the ice and trash sluiceway (19.2%) and juvenile bypass (17.8%).

Antennas in fishways did detect fallbacks via this route at some dams. One kelt passed Little Goose Dam via the fishway as did two kelts at Lower Monumental and three kelts at Ice Harbor Dam. No kelts were detected passing The Dalles Dam fishways.

Kelt Survival

Of the 212 radio-tagged kelts released at Lower Granite Dam, 142 (67.0%) were detected by receivers downstream from Ice Harbor Dam and 70 (33.0%) were detected by receivers downstream from Bonneville Dam. Three additional kelts were detected by receivers within the juvenile bypass system of Bonneville Dam but were not detected by tailrace receivers. Radio-tagged kelts in good condition were more likely to successfully out-migrate through the hydrosystem. Of 141 kelts in good condition when radio-tagged, 62 (44.0%) were determined to have passed Bonneville Dam while 11 of 71 (15.5%) kelts in fair condition when tagged survived the same migration ($\chi 2$ test, P=0.003). There was no difference in the proportion of radio-tagged hatchery origin (35.5%) and wild origin (33.8%) kelts to survive out-migration. Twenty-one kelts were documented with headburn at the time of radiotagging, 8 (38.1%) were detected downstream of Ice Harbor Dam. Only one (4.8%) headburned kelt was detected downstream of Bonneville Dam. The distributions of radio-tagging dates for kelts that did or did not survive out-migration were not significantly different (Kolmolgorov-Smirnov two sample test).

Estimates of inter-dam survival in the three Snake River reaches averaged 0.885 (*range* 0.840-0.970) and estimates for the four Columbia River reaches averaged 0.846 (*range* 0.706-0.936). Daily survival estimates for Snake River reaches averaged 0.935 (*range* 0.897-0.991) and estimates for Columbia River reaches averaged 0.883 (*range* 0.788-0.952).

Daily survival estimates were significantly and negatively related to the progression of downstream migration through inter-dam reaches (Bonferroni P=0.058). No relationship existed between interdam survival estimates and the progression of downstream migration.