

Snake River Kelt Management Plan Update 2011-2018
Supplement to the Draft Kelt Management Plan
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Executive Summary

The 2011 Kelt Management Plan lays out current and planned actions to improve Snake River B-run kelt survival. Actions are organized within three target areas: 1. Reconditioning (including both short term and long term), 2. Transportation and 3. In-River Enhanced Migration.

Reconditioning for Snake River B-run kelts has continued at Dworshak National Fish Hatchery. Experiments began in 2010 and included specimens collected at the juvenile bypass at Lower Granite Dam and, to supplement numbers, as surplus broodstock at DNFH. A greater number of kelts were available and collected at Lower Granite Dam in 2011, however, water quality issues at DNFH resulted in the loss of many of the fish. Despite losses of fish, findings from 2011 support that steelhead kelts collected at Lower Granite Dam can survive and recondition, i.e. once the water quality issue was corrected, survival increased to 30-50%. Additionally, procedures for collecting kelts at Lower Granite Dam and transporting to Dworshak Hatchery were improved upon. However, adult fish injuries occurring in the Lower Granite Bypass continue to be a problem. Future efforts relating to reconditioning include completion of the Nez Perce Tribe Kelt Master Plan, continued diet studies and reproductive success evaluations.

As a result of the marginal benefit from transport strategies, including both short-term reconditioned and unfed strategies, research efforts will instead be directed at evaluating other strategies. This recommendation is based on 5 years of data from LWG, transported kelts return rate to Bonneville Dam averaged 1.17% versus return rates of fish left in the river (5 year average return rate of 0.68%).

In-river enhanced migration research continues to inform best practices and strategies. A study on distribution of adult steelhead in fall back through the powerhouse at McNary Dam during winter months is in its first year. Study results have implications for best location of any surface bypass improvements and their operational dates at the McNary project. Current hydroacoustic monitoring at The Dalles Dam suggests that steelhead-sized fish actively used the ITS to pass the dam in December and March, outside the normal operation schedule for the sluiceway resulting in implementation of an extended operation schedule per RPA 54. Although direct injury and survival testing completed in March 2011 indicated that both the B1 ITS and the B2CC were relatively benign passage routes for out-migrating steelhead kelts, additional research is needed to assess the relative utility of these alternative passage routes for safely passing kelts. A multiyear research study titled, "Steelhead kelt passage efficiencies and survival through lower Snake and Columbia river dams" is in planning for 2012 implementation which will be used to inform operational decisions relating to improved survival of Snake River B-run kelts. Study objectives include estimating passage efficiencies (DIDSON/Hydroacoustics) and dam passage survival (JSATS) by passage route for early migrating steelhead kelts at Bonneville Dam.

Chapter 1. Introduction

Context and Background

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).

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. This document represents the annual progress report for 2011. Progress toward achieving the objectives of the Kelt Management Plan will be further 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. In addition to implementing BiOp Actions (#33 and #42) this Plan will also coordinate approaches 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).

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 are responsible for implementing 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). The Action Agencies interpret this 6% increase to be a 6% increase to the average B-run steelhead run abundance. NOAA estimates an increase in B-run returns 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 concludes that it is reasonable that an estimated average increase of 6% in B-run Snake River steelhead returns to Lower Granite Dam is possible to achieve.

Increasing the survival of kelts and their eventual return as repeat spawners can be considered one component of improving the abundance and productivity of ESA listed steelhead populations in the Snake River and Upper and Middle Columbia River. The value 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 that is relative to that found in the natural spawning population 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.

An integrated Kelt Management Plan that includes both the Snake River and the upper and middle Columbia River DPS is practical 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 presented in the plan are considered “Operational” (i.e. 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. 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 with transport*, and *Long-Term Reconditioning*. These categorical strategies are described fully in the 2010-2011 Draft Kelt Management Plan. It is important to note that there is some overlap between Operation Strategies and Kelt Reconditioning Strategies.

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. Please also refer to the 2010-2011 Draft Kelt Management Plan for a detailed literature review of current knowledge regarding steelhead iteroparity (repeat spawning).

Goals of the Program

The potential benefits of a kelt reconditioning program in the Snake Basin may be critical to contributing to run improvements, particularly if operational measures alone will not increase the returns of Snake B-run steelhead by an average of 6% (Bellerud et al. 2007). In practice, this means improve adult (female) returns of Snake River B-run steelhead to Lower Granite Dam by 6% (180 total increase in adult females above the baseline 3000 adult females estimated in Bellerud et al. 2007).

Tackley and Clugston (2011) calculated the estimated survival improvement for Snake River B-run wild female steelhead attributable to the operation of the Ice and Trash Sluiceway (ITS) at The Dalles Dam (TDA) from December 1-15 and March 1-April 10. The total estimated benefit was approximately 0.9% and was acceptable by NOAA Fisheries as a partial credit for the 6% survival improvement required for Snake River B-run steelhead spawners over the life of the BiOp as defined in Section 8.5.5.8. of the 2008/2010 BiOp and Appendix J of the 2008/2010 BiOp Supplemental Comprehensive Analysis. During the overwintering period, steelhead milling in mainstem reservoirs are known to pass The Dalles Dam and other projects, via turbines or (if provided) surface routes, such as the Ice and Trash Sluiceway (Keefer et al. 2008 a,b; Khan et al. 2010 a,b). Radiotelemetry studies completed from 1993-2004 suggested that up to 40% of overwintering steelhead that fallback past The Dalles Dam were unaccounted for and presumed dead (Matt Keefer, personal comm.). Concerns about the impacts of overwintering steelhead fallback and downstream passage of steelhead kelts via turbines prompted the Corps to evaluate the benefits of extending the ITS operation season (April 1 – November 30) to include December 1-15 and March 1-31. The benefits analysis included April 1-10 to include the current pre-spill period ITS operation. A hydroacoustic evaluation of steelhead-sized target passage during these periods in 2008/09 and 2009/10 indicated that several thousand fish passed via the ITS when it was left open (Khan et al. 2010). Nearly all (96%) of the steelhead-sized targets passed via the surface-oriented ITS, and DIDSON acoustic video work completed in 2008/09 indicated that steelhead could readily move in and out of the ITS sluice gates, suggesting that ITS passage was fully volitional.

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).

Independent Scientific Review Panel (ISRP) 2011 Retrospective Report – Summary of findings relevant to kelt reconditioning

Kelt Reconditioning – Research and Development Pilot Investigations

The ISRP 2011 Retrospective Report stated that there are currently ongoing investigations to increase kelt survival in the Columbia Basin using 1) operational modifications at dams, and 2) active collection, transport, and/or short- and long-term reconditioning of kelts. These investigations continue with the assumption is that kelts in an improved condition would likely have higher rates of repeat spawning, and that intervention (reconditioning) could improve their condition. Projects reviewed by ISRP in 2010 primarily address kelt reconditioning.

Findings:

Summaries of study results for various kelt reconditioning treatments in mid-Columbia (Yakima River and Deschutes River (Shitike Creek) and the upper-Columbia (Okanogan River (Omak Creek) subbasins using data from proposals and recent annual reports indicate there can be considerable variation in the success rates of these strategies between locations and also between years at the same location. In general, little advantage has been observed between in-river migrants and individuals transported below Bonneville Dam and then released, or individuals that have short-term reconditioning (feed for short period and then transport and release below Bonneville Dam). Additionally, kelt gamete and progeny viability evaluated at Parkdale Fish facility on the Hood River demonstrated that egg quantity/quality were similar when comparing maiden spawning Skamania summer steelhead with their subsequent performance as reconditioned kelts.

ISRP Conclusions and Recommendations:

Kelt reconditioning (either transportation, short-term, or long-term) as a recovery tool is in an early stage of development. It remains to be seen whether reconditioning can contribute meaningfully as a recovery strategy. Efforts from transportation and short-term reconditioning have not yielded substantial gains compared with in-river migration. Long-term reconditioning has demonstrated some promise. An adequate comparison of reproductive performance between natural and reconditioned kelts has not yet been accomplished. It remains uncertain whether nutrition and gametogenesis in reconditioned kelts is sufficient. In any case, it should be recognized that successful reconditioning – survival and subsequent reproduction – is a necessary, but not sufficient condition, for kelt reconditioning to provide benefits for recovery.

Evaluation of the demographic effects of kelt reconditioning on viability assessments at the population and ESU are necessary. Even if successful, in many cases habitat may already have been filled to its smolt capacity so steelhead populations may not effectively respond since the limiting life stage remains in survival from smolt to adult. The scale of implementation to affect steelhead population viability and to contribute to recovery and delisting is needed before the

strategy can be judged as providing benefits to fish. Fish managers need to recognize that there appears no end point to implementation if it is judged effective, since the reconditioned kelt strategy is incapable of redressing the actual cause of depressed abundance and productivity.

Chapter 2. Progress update and future work identified

Progress Update

Common to All Four Strategies

Designs for a remodeled and upgraded Juvenile Fish Facility (JFF) at Lower Granite Dam were developed by the Corps of Engineers in 2010. Scope and costs for the new system in its total configuration became a concern of regional FCRPS managers, so in 2011 the project was developed into two phases. Phase 1 addresses the total system constraints and replacement priorities for salmon and steelhead passage via the bypass system; principally water supply to the bypass system and meeting most recent hydraulic criteria for fish passage with replacement of existing collection channel orifices with overflow weirs and larger diameter orifices, elimination of downwell and upwell including replacement of pressurized pipes with non-pressurized pipes or open flumes, improved dewatering, elimination of the hydraulic upwell lift required to get fish onto the separator, and new primary and emergency outfall pipes. Phase 1 is scheduled for design completion with plans and specs development in 2012, with construction likely in 2014 if regionally accepted. Phase 2 includes replacement of the existing separator with a new juvenile fish separator after adult fish and debris are diverted through a new adult separator to a debris removal location and a new kelt collection and holding system (addressed in the 2009 KMP as developed by the US Army Corps of Engineers, the University of Idaho, and CRITFC). Phase 2 facilities require completion of Phase 1 construction to be implementable. Preliminary designs were completed in 2010. Final designs with plans and specs would be scheduled for 2013 and 2014 pending regional prioritization in 2012, with construction not occurring until at least 2015. 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.

Reconditioning

1. In-river migration
 - a. 2008-2011
 - i. To support ongoing research to evaluate reconditioning treatment strategies a number of kelts were PIT tagged and released at LWG on the Snake River and at Prosser Dam on the Yakima River.
 - ii. Expanded LWG collection and handling facilities to aid research
 - iii. Return rates to Bonneville Dam ranged from 0 to 5.17% for steelhead in the Yakima River and 0 to 1.12% for steelhead in the Snake River.
 - b. 2012-2018
 - i. Steelhead will be systematically PIT tagged and released at LWG and Prosser Dam to provide control groups to compare treatments and strategies.

2. Transport (unfed)

a. 2008-2011

- i. Groups of kelt steelhead were collected and transported from LWG and Prosser dams to below Bonneville Dam and released. Most releases were near Bonneville Dam but some releases were in the upper estuary. Evaluations were made by measuring survival through the river and estuary using acoustic telemetry and by return rate to Bonneville Dam using PIT tag detections.
- ii. For the Snake River groups survival to the ocean was 12% and 7% for the near Bonneville Dam releases and 40% and 32% for the upper estuary releases. To date no PIT tag detections have been at Bonneville Dam from these groups.
- iii. For the Yakima River groups survival to the ocean ranged from 34% to 53% for the near Bonneville Dam releases and 22% to 37% for the upper estuary releases. Return rates to Bonneville Dam have ranged from 0.8% to 3.0%.

b. 2012-2013

- i. Currently there are no plans to continue testing this strategy at LWG or Prosser dams. Based on 5 years of data from LWG, transported kelts return rate to Bonneville Dam averaged 1.17%. This return is better than return rates of fish left in the river (5 year average return rate of 0.68%) but research efforts will be directed at evaluating other strategies. Based on 7 years of data from Prosser Dam, transported kelts return rate to Bonneville Dam averaged 2.42%. The in-river groups averaged 2.96% over 6 years so this strategy will no longer be evaluated at Prosser Dam.

3. Short Term Reconditioning

a. 2008-2011

- i. All short term reconditioning and transport research has been done at Prosser Dam, to date. This strategy is also known as “transport fed”.
- ii. In 2008, the last test was conducted. Survival through the lower Columbia River to the Ocean was measured at 56%, compared to the unfed group of 53%. Return to Bonneville Dam was 6.5% for the 2008 group, however the 7 year average return rate to Bonneville Dam was 5.8%. Returns to Bonneville Dam rates were not significantly different than unfed groups.

b. 2012-2013

- i. As a result of the marginal benefit from this strategy, research efforts will be directed at evaluating other strategies.

4. Long Term Reconditioning

a. 2008-2011

i. Snake River

1. Beginning in 2010, experiments were conducted at Dworshak National Fish Hatchery (DNFH) on the Clearwater River to recondition kelt steelhead. Specimens were collected from surplus broodstock at DNFH and at the juvenile bypass at Lower Granite Dam. In 2010, we encountered difficulties obtaining fish for reconditioning. Our plans were to collect B-run hatchery kelts at Lower Granite Dam, however, the supply of these fish in good condition was low. Therefore, we opted to collect A-run fish as well.
2. In 2011, a greater number of kelts were available and collected at Lower Granite Dam, however, water quality issues at DNFH resulted in the loss of many of the fish. Hatchery personnel discovered that municipal water was being mixed with the line connected to the kelt tanks. This municipal water was chlorinated and fish mortalities were consistent with chlorine toxicity. After the municipal line was shut off, no additional kelt mortalities were observed.
3. Steelhead kelts collected at Lower Granite Dam can survive and recondition. Equipment and procedures for collecting kelts at Lower Granite Dam and transporting to Dworshak Hatchery were developed and tested. Initial survival of fish at Dworshak Hatchery was low, due to an error on the part of the hatchery which introduced chlorinated domestic water into our water supply. Once this was corrected, survival increased to 30-50%.
4. Fish injuries occurring in the Lower Granite Bypass continue to be a problem.

ii. Yakima River, Hood River, and Omak Creek

1. Kelt steelhead reconditioned for about 6 months (“long-term”) at Prosser Hatchery on the Yakima River had a survival rate of 33% in 2011. The long-term survival benefit is approximately 12.5 times higher than return rates to Bonneville Dam of kelts left in the river.
2. Long-term reconditioned steelhead kelts that are released below Prosser Dam have PIT tag detection histories that suggest that steelhead kelts are migrating upriver with ocean returning steelhead to spawning grounds.
3. Survival of long-term reconditioned kelt steelhead from Omak Creek, Washington was 20% in 2011. The long-term survival benefit is approximately 12 times higher than repeat spawner rates calculated from the literature (Hockersmith et al. 1995).
4. At Prosser Dam on the Yakima River between 2008 and 2011 kelt steelhead collections for long term reconditioning ranged from 472

to 1,157 fish annually. Survival to release in October has ranged from 28% to 57%. On average, there is a 12 times survival benefit to long term reconditioned kelts relative to fish that remain in the river.

5. In Hood River and Omak Creek from 2008 through 2010, long term reconditioning survival ranged from 12% to 50%. The average survival benefit to long term reconditioned kelts relative to fish left in the river was 20 times for Hood River and 12 times Omak Creek.
6. The mean proportion of Prosser steelhead relative to the aggregate steelhead count at Bonneville has increased significantly ($P < 0.001$) from the 1983-1999 ($n=17$ years; Prosser mean 0.54% of Bonneville aggregate) period to the 2000-2011 years ($n=12$ years; Prosser mean 0.94% of Bonneville aggregate). Assuming freshwater environmental variables were similar between Yakima and other upriver Columbia stocks during these periods, potential explanations are:
 - a. Yakima steelhead have somehow responded more positively to improved marine conditions than other upriver Columbia Basin stocks -- more optimal arrival timing at estuary?
 - b. 1) Habitat enhancement in the Satus, Toppenish, and other Yakima Basin watersheds have resulted in a population response 2) And/or Steelhead reconditioning in the Yakima Basin has resulted in a population response
 - c. Treatment with emamectin reduces mortality and is more effective for control of copepods than treatment with ivermectin. Administration of ivermectin into the stomach to control parasitic gill copepods has been used for over 10 years in Chinook and sockeye salmon captive broodstock programs, and we have used ivermectin in our project at Prosser. We tested injection with emamectin, a replacement for ivermectin developed for the Atlantic salmon aquaculture industry. We found that emamectin was more effective than ivermectin for copepod control, and that emamectin treated fish had substantially lower mortality than ivermectin treated fish.
 - d. Feeding with fish oil and cyclopeeze supplemented diets increases growth and lipid stores. Based on our results from previous years showing that fish with high muscle lipid levels matured and migrated at higher rates than fish with lower muscle lipid levels, we tested feeding a diet supplemented with fish oil and cyclopeeze, an appetite

stimulant, to kelts in the reconditioning program at Prosser. Our results suggest that fish fed the supplemented diet have increased growth and higher muscle lipid levels.

- e. Blood levels of vitellogenin and estradiol indicate reproductive development in female kelt steelhead. We continued our studies on reproductive development in kelt steelhead in the reconditioning program at Prosser. Our results confirm that female fish with vitellogenin levels greater than 0.1 mg/ml after Sept 1st are maturing. Initial results suggest that estradiol may indicate maturation status earlier than vitellogenin. Initial results give a maturation rate of 46% for 2011, but many samples remain to be run.
- f. Steelhead of the Yakima River sub-basin are comprised of at least five genetically distinct populations (Satus Cr., Toppenish Cr., Ahtanum Cr., Naches R., Teanaway Cr.). Genetic Stock Identification shows that each group may have differential migration timing as both upstream first time spawners and downstream kelts. Additional variation in kelt composition was seen using gender and final known status (mortalities, survivors, pit tag detections). Proximity of the tributaries to the collection facilities may partially explain these results, but a genetic component to iteroparity cannot be ruled out.
- g. Age-0 juveniles are easily collected by electrofishing in the fall following spring migration. At this time, field identification appears to be reliable for use in discriminating from Age-0 juveniles that would represent the first time spawning event rather than spawning following reconditioning efforts.

b. 2012-2013

- i. The Nez Perce Tribe will continue to develop a steelhead kelt master management plan for the Snake River Basin
- ii. We will continue to conduct and evaluate long-term reconditioning on the Yakima River, Omak Creek, and Snake River.
- iii. Diet tests using fish oil and cyclopeeze top dressings on pelleted feed will be continued. Fish with high muscle lipid levels matured and migrated at higher rates than fish with lower muscle lipid levels, preliminary tests support the notion that the supplemented diet increases growth and muscle lipid levels.

- iv. Reproductive success evaluations will continue in three settings. The first being the most controlled at Parkdale Hatchery, we will continue to evaluate progeny and gamete viability from maiden and kelt steelhead. Next, we will evaluate long-term reconditioned steelhead in a spawning channel at Prosser Hatchery. Lastly, we will evaluate reproductive success using parentage analysis in Omak Creek. Additionally, we will continue our studies on reproductive development in kelt steelhead using blood levels of vitellogenin and estradiol to indicate reproductive development in female kelt steelhead. This will help address ISRP questions regarding long-term reconditioning.
 - v. We have begun to develop a simulation model using bioenergetics of two sizes of steelhead migrating upstream during average river conditions, and travel rates. The model has been developed to estimate energy expenditures of steelhead under conditions of no feeding. We have developed a preliminary assessment of the costs of upstream migration and plan to add compartments to consider energy use during freshwater residence during the winter and reproductive costs of spawning. These simulations will be compared with empirical estimates of energy content in tissues from steelhead collected at several stages of migration, at the Celilo fishing area, samples from Idaho tributaries in the late fall, and samples collected from hatchery origin Clearwater River steelhead over several months at Dworshak National Fish Hatchery. Using these energy relations, we will also develop correlations of total body energy with non-lethal physiological assessment from analysis of nutritional factors in the plasma of steelhead sampled at intervals including samples from migrating steelhead at Bonneville Dam and Lower Granite Dam in the fall, and any paired samples of blood taken at the time of tissue samples.
- c. 2013-2018
- i. We, as well as the ISRP, have develop a variety of questions to address over this time period that will inform policy makers on the utility and value of utilizing the kelt steelhead stage as a platform for restoration measures. Evaluating survival, re-maturation, and reproductive success will continue, additionally we will address the following:
 - 1. What percentage of skip spawners, fish which do not mature after the first summer of reconditioning, will mature the following year? What is the best management strategy for allowing these fish to contribute to the population?
 - 2. What is the energy budget of kelt steelhead? How do the energy stores of reconditioned fish at release compare to those of maiden spawners?

3. What determines survival of kelts in reconditioning programs? Are all fish capable of survival?
 4. What determines whether kelts in reconditioning programs remature? How early can we determine maturation status?
 5. Are there negative genetic effects from reconditioning?
 6. Do kelts need saltwater for proper reconditioning?
 7. Where is the best location to site a reconditioning facility for SR B-run and mid-/upper-Columbia River DPSs? For example, SR B-run: Dworshak NFH vs alternate Clearwater River acclimation sites vs Lower Granite Dam vs Lyon's Ferry Hatchery vs Little Goose Dam, etc...
 8. Can we screen fish to select individuals for optimal placement in reconditioning programs?
 9. What is the optimum amount of time to recondition kelts?
- d. 2013-2018
- i. What is the reproductive success of long-term reconditioned fish? Investigating this in more detail will address ISRP concerns as well as validate Bellerud et al.'s (2007) assumption that LT reconditioning spawning success can be equal to 1.
 - ii. How does the egg quality and fecundity of reconditioned kelts compare to maiden spawners?

Transportation

1. 2008-2011
 - a. PIT tag kelts at LWG to monitor returns from Transportation
 - b. Expand LWG collection and handling facilities to aid research
2. 2012-2013
 - a. No proposed transportation study until comparable reconditioning and in-river survival results available in 2013.
3. 2012-2018
 - a. Is transporting kelts to the lower river beneficial?

Enhanced In-river Migration

1. 2008-2011
 - a. Surface Passage through spillbays and/or ice-and-trash sluiceway/corner collectors available at all 8 FCRPS projects
 - b. Expanded late-fall and early-spring operations to protect overwintering fallbacks and re-ascending spawners passage and survival at TDA and BONN.

- c. Year 1 study investigating enumeration, horizontal, and vertical distribution of adult steelhead fish falling back through the powerhouse at McNary Dam during winter months. Study results have implications for best location of any surface bypass improvements and their operational dates at the McNary project. The high costs associated with winter time operation will need to be considered and weighed against any benefits associated with improving numbers of Snake River B-run steelhead.
 - d. Bonneville Dam trigger (2009) get out of 2009 or other FPP/FOP...
2. 2012-2013
- a. A multiyear research study titled, “Steelhead kelt passage efficiencies and survival through lower Snake and Columbia river dams” will inform operational decisions of the RPAs through evaluation of passage behavior and dam, reach, and system survival estimates by passage route of adult steelhead that is a mixed population comprised of both kelts moving downriver and overwintering pre-spawners moving upriver between Lower Granite and Bonneville dams. Study objectives include estimating passage efficiencies (DIDSON/Hydroacoustics) and dam passage survival (JSATS) by passage route for early migrating steelhead kelts at Bonneville Dam. Passage routes evaluated include the B1 ITS, the B2CC, and the Juvenile Bypass System, and estimating composition (origin) of steelhead kelts and overwintering steelhead passing the Smolt Monitoring Facility at Bonneville Dam in early spring to compare with known out-migration timing of Snake River B-run steelhead kelts. Overwintering adult steelhead and steelhead kelts actively use surface-flow outlets, such as ice-and-trash sluiceways (ITS) and the Bonneville B2 Corner Collector (B2CC), to pass dams. Hydroacoustic monitoring of turbine intakes and open sluice gates at The Dalles Dam (2008-2010) suggested that steelhead-sized fish actively used the ITS to pass the dam in December and March, outside the normal operation schedule for the sluiceway resulting in implementation of an extended operation schedule per RPA 54. Although direct injury and survival testing completed in March 2011 indicated that both the B1 ITS and the B2CC were relatively benign passage routes for out-migrating steelhead kelts, additional research is needed to assess the relative utility of these alternative passage routes for safely passing kelts.
 - b. A multiple year research study titled, “Steelhead kelt passage distributions and FCRPS survival and return rates for fish tagged above and at Lower Granite Dam” will measure and compare downriver survival and repeat spawner return rates for kelt releases from Snake River subbasin weirs, including Clearwater and Salmon river and Asotin Creek sources, and the Lower Granite Dam separator. Passage route efficiencies would be possible for all routes at Little Goose and Lower Monumental dams and the RSW, turbines, and bypass at Lower Granite,

but survival may be restricted to preference for attraction to specific dam passage routes, such as the spillway weirs. Systematic evaluation of dam route passage success and terminal point of mortality estimates for Snake River B-run kelts would determine where survival and passage bottlenecks may exist, as well as set up a baseline post-spillway weir in-river survival database for a more resolute benefits comparison to efficacy of short- vs long-term reconditioning programs identified in the FCRPS BiOps.

- c. Genetics studies on steelhead a and b run (IDFG)
- 3. 2013-2018
 - a. Why is the stock composition at Lower Granite Dam different on the downstream migration compared to the upstream migration?
 - b. What is the survival of kelts migrating through the lower Columbia River?
 - c. What is the travel time and behavior of kelts migrating through the lower Columbia River?

Identified Future Needs

Research Needs

- 1. 2012-2013
 - a. Reconditioning
 - i. How to handle skip spawner in reconditioning program
 - ii. Can we screen fish to select individuals for optimal placement in reconditioning programs?
 - b. In-River Migration
 - i. Measure in-river survival (and associated return rates)and compare to assumptions in SCA. Specifically, efficacy of surface spill weir passage for kelt with direct survival estimates of TSW/RSW and turbine passage, currently being coordinated for 2013.
 - 1. Determine optimal operation points, configuration, and operations to facilitate life history expression for overwintering steelhead and kelts.
 - 2. Determine Spring Powerhouse priorities at BON.
 - a. 1. Follow-on to FY 12 JSATS test (if necessary).
 - 3. Determine direct injury and route survival of adults passing turbines.
 - 4. Determine direct injury and route survival of kelts passing spill weirs.
 - 1. Effects of impact with spillway ogee, chute, and/or deflectors
 - ii. Consider additional projects to provide overwintering protection

- iii. Differentiation of A-run steelhead from B-run, and are there phenotypic characteristics or run designation inference upon skip vs non-skip re-spawners?
- iv. What is the preferred migration path through hydro-projects? How has migration through hydro projects changed with the new spill regime and the full implementation of surface spill passage for juvenile salmon and steelhead at all 8 FCRPS dams? How does this affect the survival of kelts?
- v. What is the survival of kelts migrating through the lower Columbia River?
- vi. What is the travel time and behavior of kelts migrating through the lower Columbia River?
- vii. What is the PIT tag detection probability at mainstem dams

2. 2013-2018

- a. What role does ocean conditions play in kelt survival?
- b. What are natural repeat spawner rates, does it differ between A-run and B-run groups?
- c. When do steelhead decide to spawn?
- d. What factors affect kelt re-maturation? When can these factors be detected in a kelt?
- e. Do all re-matured kelts migrate upstream and spawn?
- f. Do any non-mature kelts migrate upstream? If so, what are the mechanisms causing migration?

Infrastructure Needs

1. 2012-2013

- a. Reconditioning
 - i. Complete plans and specs for Lower Granite Dam JFF Upgrade Phase 1 with collection gallery overflow weirs and removal of upwells and downwells.
 - ii. Holding facility or facilities for Snake River B-run with adequate capacity and designated water source/supply. Currently relying upon temporary ad hoc holding facility at Dworshak NFH that has had previous water source concerns that have resulted in negative performance of implementation of the program. Continuation of use of Dworshak NFH for development of a permanent facility will be contingent upon continued coordination for modification of Dworshak NFH rehabilitation and upgrade project currently facilitated by the Corps. Other alternatives for SR B-run include alternate Clearwater River acclimation sites vs Lower Granite Dam vs Lyon's Ferry Hatchery vs Little Goose Dam vs conversion of juvenile fish transport barges moored at collection dams.

- iii. If warranted for survival benefit and kelt collection to adequately compare program and RPA success with Bellerud et al. (2007) or subsequent 2014 FCRPS BiOp RPA, a specific kelt separating/diversion, handling, holding, and bypass facility at Little Goose Dam should be designed into the existing JFF.
 - b. Transportation, not warranted for implementation based upon study results to date.
 - i. Complete plans and specs for Lower Granite Dam JFF Upgrade Phase 1 with collection gallery overflow weirs and removal of upwells and downwells.
 - c. In-River Migration
 - i. Complete plans and specs for Lower Granite Dam JFF Upgrade Phase 1 with collection gallery overflow weirs and removal of upwells and downwells.
- 2. 2013-2018
 - a. Reconditioning
 - i. additional holding tanks at Dworshak
 - 1. Address water supply issues at Dworshak. The kelt reconditioning tanks currently rely on water from a fire hydrant. This is not an acceptable water source for work beyond the proof of principle stage.
 - ii. additional holding tanks at Prosser
 - iii. modified facilities at Bonneville hatchery to facilitate reconditioning.
 - iv. modified facilities at XYZ hatchery to facilitate reconditioning
 - v. Lower Granite Dam JFF Upgrade Phase 1 and Phase 2 with kelt facility.
 - vi. If warranted for survival benefit and kelt collection to adequately compare program and RPA success with Bellerud et al. (2007) or subsequent 2014 FCRPS BiOp RPA, a specific kelt separating/diversion, handling, holding, and bypass facility at Little Goose Dam should be constructed into the existing JFF.
 - b. Transportation
 - i. additional barges
 - 1. Can current fleet support additional barging of kelts if warranted?
 - ii. modified barges
 - 1. Does the existing fleet need to be modified to support kelt transport if warranted?
 - iii. Use of a barge as a reconditioning facility at Lower Granite
 - iv. Lower Granite Dam JFF Upgrade Phase 1 and Phase 2 with kelt facility
 - c. In-River Migration

- i. Determine optimal operation points, configuration, and operations to facilitate life history expression for overwintering steelhead and kelts.
- ii. Determine Spring Powerhouse priorities at BON.
 - 1. Follow-on to FY 12 JSATS test (if necessary).
- iii. Determine direct injury and route survival of adults passing turbines.
- iv. Determine direct injury and route survival of kelts passing spill weirs.
 - 1. Affects of impact with spillway ogee, chute, and/or deflectors
- v. Lower Granite Dam JFF Upgrade Phase 1 and Phase 2 with kelt facility.
- vi. If warranted for survival benefit following in-river kelt passage and survival studies, the Corps Configuration and Operation Plans (COPs) could prioritize surface passage structures such as additional HI/LO crest TSWs for operation for kelt passage during off-season smolt passage time periods.
- vii. If warranted for survival benefit and kelt collection to adequately compare program and RPA success with Bellerud et al. (2007) or subsequent 2014 FCRPS BiOp RPA, a specific kelt separating/diversion, handling, holding, and bypass facility at Little Goose Dam should be constructed into the existing JFF.

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