UPPER-COLUMBIA RIVER STEELHEAD KELT RECONDITIONING PROJECT:

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1 Introduction

Steelhead *Oncorhynchus mykiss* display a variety of life history strategies that may allow the preservation of population genetics in the face of potential environmental changes (Behnke 1992). Iteroparity, the ability to repeat spawn, is one such life history. Iteroparity in steelhead is unique among anadromous Pacific salmonids. It is thought that iteroparity may allow steelhead populations to retain genetic diversity and increase lifetime reproductive success (Seamons and Quinn 2010).

Upper Columbia River (UCR) steelhead are listed as "Threatened" under the ESA, and naturally-spawning populations currently exist at threshold levels. The incidence of iteroparity in the Columbia Basin appears to be negatively correlated with distance from the ocean and rates of iteroparity for UCR steelhead populations are extremely low. Low rates of repeat spawning are likely due to high mortality imposed by such factors as extreme energetic demand, degraded habitat quality, and post-spawning migration through the Columbia River hydropower system.

The artificial reconditioning of post-spawn steelhead, known as kelts, holds special promise for UCR populations subject to high mortality rates that depress productivity and iteroparity. Artificial reconditioning is defined as culturing kelts for 6-10 months in a captive environment where they reinitiate feeding, grow, and redevelop mature gonads. It is believed that kelt reconditioning may help counter the selective forces against iteroparity imposed by the hydroelectric power systems and provide benefits in addressing the population demographic and genetic issues in steelhead recovery (Hatch et al. 2002, 2003, and 2012).

The Yakama Nation (YN) is currently implementing a kelt reconditioning project within the Upper Columbia consistent with FCRPS BiOp requirements and the Columbia Basin Anadromous Fish Accords. Early work for the project has focused primarily in the Methow River Basin. The general objective of the Upper Columbia River Steelhead Kelt Reconditioning Project (UCKRP) is to test whether the abundance of naturally-produced UCR steelhead on natural spawning grounds can be increased through the use of long-term kelt reconditioning methods. The program has three objectives:

Objective 1: *Recondition UCR steelhead kelts using long-term methods at existing facilities.*

Objective 2: *Evaluate kelt survival and effectiveness of reconditioning methods.*

Objective 3: *Collaborate with ongoing M&E studies to document the reproductive success of kelts released from the reconditioning program.*

This report will provide a summary of the steelhead kelt reconditioning efforts undertaken by this project in 2016. Topics address will include: kelt collection efforts, kelt reconditioning efforts, monitoring and evaluation efforts, and future project direction.

2 Kelt Collection

Determining reliable sources of natural origin (NOR) steelhead kelts has been critically important to the success of the UCKRP. Unlike kelt reconditioning projects in the Yakama River in Washington and Clearwater River in Idaho, the Methow River does not have a collection or trapping location providing large numbers of kelts. Instead of pursing a large scale collection effort at a single location, the UCKRP chose to pursue smaller kelt collection opportunities at a variety of locations. The three collection methods chosen were live-spawning of NOR steelhead broodstock collected for Methow Basin conservation hatchery programs, the application of temporary tributary traps, and collection at Rock Island Dam.

The spawning of anadromous salmonids in a hatchery setting has almost exclusively applied lethal spawning techniques, with the exception of a small number coastal steelhead programs. Lethal spawning practices insured that all available gametes could be harvested and fish carcasses could be sampled for pathogens. Prior to the spring of 2012 all Upper Columbia steelhead hatchery programs lethally spawned all broodstock regardless of fish origin. The UCKRP conducted a study in 2011 in which demonstrated that live-spawning did not negatively impact the number of eyed eggs collected (Abrahamse and Murdoch 2012). Following this study, an agreement was reached with US Fish and Wildlife Service (USFWS) to begin live-spawning the NOR female steelhead broodstock at Winthrop National Fish Hatchery (WNFH) and allow for their inclusion into the UCKRP starting in the spring 2012. The successful live-spawning of broodstock at WNFH was instrumental in reopening discussions with Washington Department of Fish and Wildlife (WDFW and Douglas County Public Utility District (DCPUD) regarding live-spawning NOR female broodstock from their Twisp River conservation program. Fish from this program were of particular interest due to the ongoing reproductive success study in the Twisp River and the potential to get reconditioned kelts included in that study. YN felt that this represented the best opportunity to address the project's Objective 3: Collaborate with ongoing M&E studies to document the reproductive success of kelts released from the reconditioning program. An agreement was reached with WDFW and DCPUD in November of 2013 and live-spawning at Methow Salmon Hatchery (MSH) began in the spring of 2014. Live-spawning continued at WNFH and MSH in 2016.

The collection of NOR kelts that have spawned in the natural environment has been a priority for the UCKRP. It is unclear if genetics, fish condition, or some combination of the two drives a fish to iteroparity. Whatever cause, these fish attempting to out migrate have the necessary drive. The most successful reconditioning programs to date have been able to collect large numbers of kelts that appear as by-catch in juvenile bypass traps at diversion and hydropower dams. The UCKRP has chosen to attempt to collect kelts in the natural environment using multiple traps in small tributaries in the Methow Basin. The application of small temporary traps would allow the project to test its ability to collect and recondition NOR kelts with lower costs and permitting requirements than would a single, large scale method of collection. The project

chose to implement temporary picket weirs based on their versatility, low impact, and relative low cost.

Rock Island Dam is the only main stem facility in the UCR suitable for capturing downstream migrating kelts. The dam is located on the Columbia River about 12 miles downstream from the city of Wenatchee. Kelts captured at this facility likely would have spawned in the Methow, Okanogan, Entiat, or Wenatchee Rivers. Kelts have historically been encountered as bycatch during Chelan County Public Utility District (CPUD) juvenile sampling at Rock Island. An arrangement was reached in 2014 with CPUD to allow kelts trapped by them to be included in the UCKRP.

This section will provide a summary of kelt collection activities in 2016.

2.1 Methods

2.1.1 Live-Spawning

Steelhead live-spawned at WNFH and MSH were collected by hatchery staff. USFWS staff collected fish through the use of hook-and-line, assisted by YN when requested. Steelhead live spawned at MSH were collected by WDFW at the Twisp Weir were transported to the MSH. Pre-spawn fish care, preparation, and assessment of female gravidity were conducted by hatchery personnel.

Air spawning was chosen as the method for live-spawning based on literature review (Shrable et al 1999; Orr et al 1999) and personal communications with fish culture professionals identifying it as the most effective live-spawning method. Fish were anesthetized using Tricaine methanesulfonate (MS 222) prior to air spawning. Female steelhead were held by one person with one hand near the head and the other just anterior to the tail. A16-gauge hypodermic needle with a 1 inch tip, attached to a small air compressor via a rubber hose was then inserted ½ inch into the body cavity just posterior to the pelvic girdle by a second person. Then 5-7 psi of compressed air was injected into the body cavity to expel the eggs.

Once all the eggs were collected, each fish was taken to a water filled tank to expel remaining air in the body cavity. The fish were held vertically in the water with the head at the bottom of the tank. Gentle hand pressure was applied to the fish's abdomen just posterior of the operculum and drawn towards the tail to expel any air remaining in the body cavity.

Data was collected from all steelhead kelts following the expulsion of air. The data recorded included: length (fork and mid-orbital post-hypural) in millimeters, weight in grams, origin (natural or hatchery), sex, fish condition (good- lack of any wounds or descaling, fair- lack of any major wounds and/or descaling, poor- major wounds and/or descaling), and color (bright, medium, and dark). All fish were scanned for the presence of PIT tags. If a tag was present, the tag number was recorded. If no tag was present, a tag was inserted into pelvic girdle.

Kelts were transferred to the MSKF for reconditioning following data collection.

2.1.2 Weir Trapping

Site Selection

Trapping locations were selected based on four criteria: a low spring stream discharge, site morphology that includes pools or slow water, site access, and steelhead spawning activity. Streams that have a relatively low discharge at their peak do not move large amounts of debris which can cause of weir failures. Weir trap boxes must be placed in slow water or pools so kelts are not subject to the stress of having to continually maintaining themselves in the current. Reasonable access to the site by truck is important so kelts can be transported to the MSKF in a timely fashion. Only streams in which five or more redds had be observed within the last five years were considered for trapping so that resources were being spent in streams with a higher likelihood of encounter kelts.

Weirs were to be operated in Little Bridge Creek (Figure 2.1) and Beaver Creek (Figure 2.2) in 2016. The weir on Little Bridge Creek was located 0.15 river miles from the confluence with the Twisp River. At this point, reduced gradient creates a wide pool area where water velocity is diminished. The site was accessed from a small two-track road off of National Forest Development Road 4415. The weir on Beaver Creek was located 0.15 river miles from the confluence with the Methow River.

Figure 2.1 - Little Bridge Creek weir trap.

Figure 2.2 - Beaver Creek weir trap.

Weir Design

The traps consisted of weir panels, pickets, a downstream trap box, and an upstream passage chute. The weir panels were constructed of angle iron 4.5 feet tall and 6 feet long with 0.875 inch holes spaced 1.5 inches apart. Two adjustable legs were attached to each frame for support and to allow the angle of the panel to be modified to best suit their placement location and stream flow. Steel electrical conduit pickets, 5 ft tall and 0.75 inch diameter, were inserted into the holes in the cross pieces of the weir panels. The pickets were not attached to the panel frame to allow their removal during cleaning and times of high flow.

The trap boxes were constructed of an angle iron frame with 1-inch aluminum pipe installed horizontally at a spacing of 1.5 inches for the sides and top to allow small, non-target fish to swim through the trap box. The floor of the trap box consisted of Vexar mesh fastened to the frame with zip ties. The downstream end of the box was removable. The upstream end of the trap was configured into a downstream-facing V with a gap of 4 inches to which a cod trigger was attached to prevent fish from swimming out. The trap boxes at were 2 feet wide by 4 feet long by 3 feet deep. The passage chutes at were attached to the trap box to form a single unit. The passage chute in these streams was 1 foot wide by 4 feet long by 3 feet deep.

Weir Operation

The traps were to be installed in late March to early April wherever conditions allowed. The traps were to be operated until mid-June unless conditions required early removal. The traps were checked a minimum of twice a day, seven days a week. If the trap could not be checked regularly, the downstream panel of the trap box was removed so fish could move past the weir without obstruction.

Only female natural origin (NOR) kelts were retained for the reconditioned project and all males were released regardless of origin. It is difficult to determine if males have truly completed

spawning and are attempting to out-migrate or if they are still actively spawning and searching for mates. All males, hatchery-origin kelts, pre-spawn steelhead, or other non-target fish were released downstream of the weir.

A PIT tag detection antenna was also installed and operated upstream of the weir. This array was used to collect data regarding the potential impact of weir operation on upstream migration of steelhead. .

2.1.3 Rock Island Dam

Kelts were encountered by CPUD during their operation of the Rock Island Dam juvenile bypass trap. Kelts suitable for reconditioning were retained in an aerated tank onsite to until UCKRP staff was able to transport kelt back to the MSKF for reconditioning. CPUD fisheries personnel were given a list of criteria by YN outlining which kelts were to be retained for transport and which kelts were to be released back into the fish ladder. Kelts that were retained possessed no hatchery marks, had little to no fungus on the body, and had no major wounds or descaling. If a suitable kelt was collected by CPUD they contact the UCKRP and the kelt was transported to the MSKF within 24hrs.

2.2 Results

2.2.1 Live Spawning

Spawning activities began at Winthrop NFH on April 13, 2016 and concluded May 18, 2016. A total of 31 NOR females were live-spawned in 2016. No HOR females were live-spawned in 2016. There were 2 post-spawn mortalities.

Spawning activities began at MSH on April 11, 2016 and concluded May 16, 2016. A total of 6 NOR females were live-spawned in 2016. There was one post-spawn mortality.

Table 1 - Females live-spawned at WNFH and MSH in 2016.

	NOR	HOR
WNFH	31	0
MORT	2	0
TOTAL	29	0
MSH	6	0
MORT	1	0
TOTAL	5	0

2.2.2 Weir Trapping

We were unable to operate weirs during 2016 due to high water conditions. Stream discharge was greater than the historical mean during the 2016 trapping season which prevented safe and effective operation of the traps.

2.2.3 Rock Island

Thirty-two NOR kelts were collected from the Rock Island Dam juvenile bypass facility in 2016.

Table 2 - Summary of NOR kelt collection numbers 2016.

Collection Location	# Collected
Winthrop NFH (Live-Spawn)	31
Methow Salmon Hatchery (Twisp Stock Live Spawn)	6
Rock Island Dam Juvenile Bypass	32
Total	**69**

2.3 Discussion

In 2016 we collected a total of 69 NOR kelts through a combination of live-spawning, and Rock Island Dam (Table 2). The NOR female broodstock live spawned at WNFH and MSH have continued to be a consistent source of kelts. The fish come to the reconditioning project in good condition because they have not sustained injuries spawning in the natural environment, and they are treated with formalin while being held prior to spawning at the hatchery which reduces the spread of external fungal infections. The number of kelts obtained for reconditioning through the use of live-spawning may to increase in future seasons. WNFH increased their production of steelhead to 200,000 in 2016. Up to 48 NOR females could be available for reconditioning from this WNFH if broodstock goals are met. With the annual contribution of 14 NOR females from the Methow FH, the project could consistently have up to 62 NOR females collected through live-spawning every year.

Although the project was unable to operate temporary weirs in 2016 due to above average stream discharge, we will continue to pursue them when conditions warrant their use. Due to the low proportion of NOR spawners in the Methow basin and the difficulty in maintaining traps during spring runoff, it is likely that temporary weir traps will contribute a relatively small proportion of kelts for the Upper Columbia Steelhead Kelt Reconditioning Project. However, because NOR females are scarce in the Methow and Twisp basins, reconditioning these fish so that they can repeat spawn could be important. Successful reconditioning of the few NOR females collected at these weirs will increase the number of NOR females available to spawn in areas where they appear to be uncommon.

The UCKRP collected 11 more NOR kelts in 2016 than the previous year. This is largely due to an increased number of kelts collected at Rock Island Dam. The 32 kelts collected at Rock Island in 2016 was the most collected from this location to date. We expect that the number of kelts collected at Rock Island Dam will continue to vary year to year.

3 Kelt Reconditioning

The UCKRP implements long-term kelt reconditioning techniques in pursuit of its project objectives. Long-term recondition has been determined to be the more effective at improving kelt survival than either short-term reconditioning or transporting unfed kelts (Hatch et al. 2012). Long-term reconditioning is the process where steelhead kelts are collected through live-spawning or during their seaward migration, held and cultured in large tanks, and released in fall to coincide with the return of maiden spawners from the ocean. Prior to 2016, all kelts were released after approximately six months of reconditioning, regardless of their maturation status. In 2016, the UCKRP modified of its reconditioning practices to better address the different life history strategies observed in naturally occurring kelts, consecutive repeat spawners and skip repeat spawners.

Consecutive repeat spawners are those that return to spawn in the same calendar year as their outmigration. Skip repeat spawners are those that return the calendar year after their outmigration. It has been observed that steelhead populations that travel further upstream to spawn (i.e. Upper Columbia and Snake rivers and their tributaries) have a higher prevalence of skip repeat spawners (Keefer et al 2008). In 2016, the UCKRP began retaining non-maturing kelts for additional reconditioning to allow expression of the skip repeat spawning life history.

The section describes the reconditioning efforts that the UCKRP conducted during 2016.

3.1 Methods

Methow Steelhead Kelt Facility

The MSKF was constructed on Winthrop National Fish Hatchery grounds in 2011. The facility was constructed by YN specifically for the UCKRP. The building is a pre-engineered, all-steel building, 70 ft. long and 27 ft. wide. The facility contains four circular, fiberglass tanks. The tanks are 12 ft. in diameter and 4 ft. in depth. Each tank has 340 ft^3 of rearing volume and has a maximum rearing capacity of 34 adult steelhead. The facility has a total adult capacity of 136 adults.

To prevent the spread of pathogens from the NOR steelhead held at the MSKF to the surrounding watershed, all effluent was sterilized. The MSKF has a UV sterilization system capable of treating a maximum of 200 gallons/minute. The system consists of a concrete settling basin to separate solids and three UV units. The three units allow for two units to be operated in concert and one available as a backup in case maintenance is required on one unit. Additional bio-security measures were taken to ensure that pathogens are not carried out of the MSKF by humans. Foot baths at facility exits were maintained to contain pathogens. Vehicle and foot traffic access was limited through the parking lot outside the fenced hatchery rearing area.

Treatment

Emamectin Benzoate

Kelts held for an extended period time in a captive environment are susceptible to severe infestation of parasitic copepods of the genus *Salmonicola*. These copepods attach to the gill lamellae and can inhibit oxygen uptake and gas exchange at the gill lamelle/water surface interface. All kelts coming into the reconditioning program received an injection of emamectin benzoate for the treatment of parasites. The emamectin was administered at a dosage of 200 micrograms per kilogram of body weight which was injected into the body cavity.

Based on a half-life of 10.5 days and a theoretical minimum effective concentration of 15 ug kg in muscle tissue, our emamectin dose is projected to protect fish from copepods for 41 days (Glover et al. 2010).

Formalin

Kelts are particularly susceptible to fungal infections due to the presence of dermal abrasions, lesions, or lacerations. Kelts have a weakened immune system and untreated fungal infections can be lethal. Fungal infections can be difficult to treat once established. To prevent the establishment of fungus the kelt tanks were drip treated with formalin at 167 ppm for one hour. Treatments were administered every other day for the duration of the reconditioning process. If fungus became established the concentration of formalin was increased to 200 ppm and tanks were treated every day until the infection resolved.

Feeding

The kelts were initially offered parboiled, flash frozen Antarctic krill in 6 to 8 small feedings per day. Krill was fed to satiation for approximately six weeks. After six weeks the kelts were slowly transitioned to a modified Moore-Clark pellet feed designed to have a sink rate comparable to the krill. Each tank was fed a minimum of 2% of the total pre-reconditioning fish weight. The percent body weight fed was increased to 2.5% of the total pre-reconditioning fish weight as fish demonstrate increased feeding response and to approximate weight gain. Initially a mixture of 75% krill and 25% pellets are fed for one to two weeks. The ratio was then shifted to include 50% krill and 50% pellets for another one to two weeks, 25% krill and 75% pellets for one to two weeks, and 10% kill and 90% pellets which was fed for the remainder of the reconditioning period.

Mortalities

Any kelt mortalities were immediately removed from the tank. Date collected from mortalities included fork length in millimeters, POH length in millimeters, weight in grams, origin (natural or hatchery), sex, fish condition (good- lack of any wounds or descaling; fair- lack of any major wounds and/or descaling; poor- major wounds and/or descaling), color (bright, medium, and dark), percent fungus coverage, presence of parasites, and maturation status. All fish were scanned for the presence of PIT tags and the data was included in the database.

Pre-Release Sampling

All kelts surviving to September were sampled to assess reconditioning effectiveness and maturation status. Data collected included: blood samples, fork and POH lengths, weight, body fat percentages, and any notable physical characteristics. Descriptions of methods used to collect body fat readings and blood samples can be found in Section 4.3 of this report.

Blood samples were sent to the University of Idaho where CRITFC physiologists measured concentrations of plasma estradiol to assess the maturation status of reconditioned kelts. Blood plasma analysis was done according to methods described in Pierce et al. (2016). Female kelts were divided into three categories based on the concentration of estradiol concentration: maturing (>3,162 pg/ml), borderline (<3,162 pg/ml but >1,000 pg/ml), and not maturing (<1,000 pg/ml). These categories were used to determine if kelts would be released or retained for additional reconditioning.

Length and weight data was used to calculate Fulton Condition Factor (K). K and body fat percentage were used as indices of available energy. One-way ANOVA was applied to compare K values and body fat percentage among kelts released in 2016 (release group), kelts retained in 2016 (retained group), and kelts released in previous years that had spring PIT tag detections in the UCR (detected group), and those that were released in the previous years that did not have spring PIT tag detections in the UCR (undetected group). If differences between groups were found with ANOVA, Tukey's test was used to identify where differences originated. All tests were done using an alpha level of 0.05.

Release and Tracking

Female kelts determined to be maturing and borderline through blood plasma estradiol analysis were released into the river basins from which they were collected. Male kelts were not tested and all surviving males were released. Kelts collected from Winthrop NFH and Methow Salmon Hatchery were released into the Methow River. Kelts collected at Rock Island Juvenile Bypass were released in to the Columbia River upstream of Rock Island Dam at river kilometer 742 (near Wenatchee, WA). Kelts determined not to be maturing were retained for additional reconditioning.

All kelts were scanned for existing PIT tags prior to release. If scanning revealed a kelt had lost its existing tag, a new tag was inserted into the pelvic girdle. Movements of the kelts post release were monitored using the existing PIT tag antenna arrays operating through the Methow and Columbia River basins.

3.2 Results and Discussion

The UCKRP completed its 2016 reconditioning activities in September. The project began the reconditioning process with a total of 69 NOR steelhead kelts and 53 of those fish survived through October. Total survival rate for 2016 kelts was 76.8%.

Blood plasma estradiol analysis revealed that 30 of the 51 surviving female kelts were maturing or borderline. These fish were released, along with 2 male kelts that were not tested for plasma estradiol concentration. A total of 32 NOR kelts, 60% of those surviving to October, were released into the Methow and Columbia rivers.

Kelts collected from Winthrop NFH and Methow Salmon Hatchery were released into the Methow River on November 2, 2016. Kelts were released Methow River at two locations. Ten randomly selected kelts were released at river kilometer 1 (near the mouth) and 10 randomly selected kelts were released at river kilometer 44 (near Carlton, WA). Kelts collected at Rock Island Juvenile Bypass were released in to the Columbia River upstream of Rock Island Dam on November 16, 20016 at river kilometer 742 (near Wenatchee, WA).

The remaining 21 kelts, 40% of those surviving to October, were determined to be not maturing. These fish were considered skip spawners and were retained at the MSKF to undergo an additional year of reconditioning (Table 3).

Table 3 – Number of kelts collected, released, and retained by the UCKRP in 2016.

Collection Location	Collected	Released	Retained
Winthrop NFH	31	15	11
Methow Salmon Hatchery	6	5	0
Rock Island Dam Juv. Bypass	32	12	10
Total	**69**	**32**	**21**

One-way ANOVA analysis indicated that mean K value differed among the four groups defined in the Pre-Release Sampling section: released, retained, detected, and undetected. Tukey's test identified that the released group kelts had a mean K value similar to kelts in the detected group. Kelt in the retained group had a mean K value similar to kelts in the undetected group.

One-way ANOVA analysis indicated that there were no differences in mean body fat percentage among the four groups.

A summary of the mean values and 95% confidence intervals can be found in Table 4.

Table 4 - Summary of mean condition factor (K) and percent body fat from kelts released in 2016 (Released), kelts retained in 2016 (Retained), kelt released in previous year that had spring PIT tag detections in the UCR (Detected) and those that did not have spring PIT tag detections in the UCR (Undetected).

		K		Fat %	
Project Year	Group	Mean	95% CI	Mean	95% CI
2016	Released	1.22	(1.19, 1.27)	5.1	(4.5, 5.6)
	Retained	1.12	(1.03, 1.18)	4.5	(3.7, 5.3)
2013 to 2015	Detected	1.21	(1.17, 1.25)	5.8	(5.2, 6.3)
	Undetected	1.13	(1.01, 1.17)	5.1	(4.6, 5.7)

We recognize that indices of fish condition are not predictive of the success of the 2016 kelt release. However, we are encouraged that the kelts in the released group had K values and body fat % levels consistent with the detected group, as those kelts have demonstrated movement patterns consistent with multiple spawning events. We also believe that the similarities in condition factors between kelts in the retained group and the undetected group provides support for the rationale that non-maturing kelts should be retained for additional reconditioning. It is suspected that undetected kelts are those that have not survived the post-release and may have benefitted from additional reconditioning.

We will continue monitoring whether these or other indices may influence the potential success of kelts released from the UCKRP.

4 Monitoring and Evaluation

Ongoing monitoring and evaluation (M&E) efforts are being conducted to determine the potential for the application of long-term reconditioning to aide in the recovery of NOR steelhead in the UCR. The focus of these M&E efforts to date has been on addressing three questions:

(1) Are reconditioned kelts surviving to a second spawn at a rate lesser than, equal to, or greater than non-reconditioned kelts?
(2) Are reconditioned kelts reproductively successful?
(3) Are the phenotypic characteristics of reconditioned kelts similar to the phenotypic characteristics of maiden spawning steelhead?

In 2016, the UCKRP continued answering these questions by examining post-release movement and survival of reconditioned kelts, reproductive success of reconditioned kelts, and comparing maturation status and available energy between reconditioned kelts and maiden spawning steelhead.

4.1 Movement and Survival

The demonstration of improved survival of iteroparous steelhead in the Upper Columbia is important if the UCKRP is to be considered a viable contributor to steelhead recovery. True comparisons of the survival rates of reconditioned kelts and non-reconditioned kelts calculated on a year to year basis are likely beyond the budget and scope of the UCKRP. However, standardized indices may be developed and used to assess temporal trends in the survival rates of reconditioned and non-reconditioned kelts. These indices may be applied to assess the potential for reconditioning to increase the survival of steelhead kelts over a no-action alternative.

4.1.1 Methods

An in-river reference group was developed to evaluate the extent of benefits of reconditioning to survival and repeat spawning rates. This reference group was made up of non-reconditioned kelts identified through the use of PIT tag data. The PTAGIS database was used to identify known UCR steelhead demonstrating downstream migration consistent with iteroparous life history. Two criteria were used in choosing steelhead for the reference group: (1) tagged or recapture as adults in the Upper Columbia and (2) demonstrated downstream movement in the Columbia River following spawning.

The advance reporting tool in the PTAGIS database was used to identify PIT tag codes of all steelhead tagged or recaptured as adults at two sites in the Upper Columbia. These sites were chosen because the primary focus of projects operating during the designated time frames is to identify and enumerate adult steelhead. The two sites and time periods queried in PTAGIS were:

(1) Twisp River weir (TWISPW) – March 1- June 30 of the maiden spawn year (MY),
(2) Wells Dam fish ladders (WEL) – July 1- October 31 of the year previous to the MY, and

These queries were used to create a list tag codes from the known adult steelhead spawning in the Upper Columbia in a given year. The list of known steelhead spawners was then cross referenced with the list of tag codes of steelhead detected moving downstream through the Rocky Reach Dam juvenile bypass system (RRJ) between March 1 and July 31 of the MY. Steelhead appearing in both the known steelhead spawner and kelts at RRJ lists were included in the in-river reference group for a given year.

The in-river reference group PIT tag codes are queried in PTAGIS for two years following their MY to account for the two distinct iteroparous life histories, consecutive spawning and skip spawning. Consecutive spawning kelts are kelts that return to spawn the year following their maiden spawn. Skip spawning kelts are kelts that return to spawn the second year following their maiden spawn. Both types of kelts will be enumerated and the data will be used to calculate the rate of survival to return index and rate of survival to repeat spawning index. Rate of survival to return index (S_r) will be calculated as:

$$S_r = \frac{Q_r + P_r}{C_r} * 100$$

whereas Q_r is defined as the number of consecutive spawners kelts detected at a Upper Columbia site the summer/fall following their maiden spawn year, P_r is defined as the number of skip spawners kelts detected at a Upper Columbia site summer/fall two years following their MY, and C_r is the number of kelts in the in-river reference group. The rate of survival to repeat spawn index (S_s) will be calculated as:

$$S_s = \frac{Q_s + P_s}{C_s} * 100$$

where $Q_s$is defined as the number of kelts detected in the Methow Basin the spring following their MY, P_s is defined as the number of kelts detected in the Methow Basin the spring two years following their MY, and C_s is the number of kelts in the in-river reference group.

The rate of survival to return index will be compared against the rate of survival to release for reconditioned kelts from the UCKRP. The rate of survival to repeat spawn index will be compared against the survival to repeat spawn for reconditioned kelts from the UCKRP.

4.1.2 Results

The in-river reference group for MY 2013 was made up of 40 steelhead kelts from the UCR and was compared against the 9 reconditioned kelts released in 2013. The in-river reference group for MY 2014 was made up of 103 from the UCR and was compared against 58 reconditioned kelts released in 2014. The in-river reference group for MY 2015 was made up of 48 from the UCR and was compared against 30 reconditioned kelts released in 2015. The in-river reference group for MY 2016 was made up of 53 steelhead kelts from the UCR. The MY 2016 reference group will be compared to the 53 kelts surviving to the time of release. Non-maturing kelts were retained by UCKRP for the first time in 2016 and will be released in 2017. These will be treated as skip spawners (P) and included in all project group calculations for MY 2016.

S_r calculations have been completed for the MY 2013 reference group (Table 5). None of the reference group kelts were detected returning in the fall of 2013 or 2014 (S_r = 0.0). In comparison, 6 of the 9 kelts in the UCKRP survived to release (66.7%). One of the surviving kelts was a HOR female that was not released.

S_r calculations have been completed for MY 2014 reference group (Table 5). Three of the reference group kelts were detected returning in 2014 and no kelts were detected in 2015 (S_r = 2.9). In comparison, 58 of the 76 kelts in the UCKRP survived to release (76.3%).

S_r calculations have been completed for MY 2015 reference group (Table 5). None of the reference group kelts were detected returning in 2015 or 2016. In comparison, 30 of the 58 kelts in the UCKRP survived to release (51.7%).

S_r calculations have not been completed for MY 2016 reference group (Table 5). None of the reference group kelts were detected returning in 2016. The S_r calculations will be completed in fall of 2017. Once completed, the S_r values for MY 2016 reference group will be compared to 53 of 69 kelts in the UCKRP that survived to release (76.8%).

Table 5 - Summary of rate of survival to return index (S_r) data for in-river reference groups and comparisons with survival to release rates for kelts reconditioned by UCKRP.

Maiden Year	In-River Reference Group				Project Group		
	Q_r	P_r	C_r	S_r	Collected (C_r)	Remaining (Q_r+P_r)	Survival % (S_r)
2013	0	0	40	0.0	9	6	66.7
2014	3	0	103	2.9	76	58	76.3
2015	0	0	48	0.0	58	30	51.7
2016	0	-	53	-	69	53	76.8

S_s calculations have been completed for the MY 2013 reference group (Table 6). None of the reference group kelts were detected returning in the spring of 2014 or 2015 (S_r = 0.0). In comparison, 1 of the 5 (20.0%) kelts released by the UCKRP were detected in the UCR in spring of 2014.

S_s calculations have been completed for the MY 2014 reference group (Table 6). One of the reference group kelts was detected returning in the spring of 2015. No reference group kelts were detected returning in spring of 2016 (S_r = 0.9). In comparison, 31 of the 58 kelts released by the UCKRP were detected in the UCR in spring of 2015.

S_s calculations have not been completed for the MY 2015 reference group (Table 6). No reference group kelts were detected returning in spring 2016. Calculations will be completed in 2017 and will be compared to the 13 kelts that were detected from the 30 released in 2015 (43.3%).

S_s calculations for the reference group will be completed in 2018. To date, 32 of the 53 kelts reconditioned in 2016 have been released. The kelts held for additional reconditioning will be included in the analysis once they are released in 2017 and after any detections are made in the spring of 2018.

Table 6 - Summary of rate of survival to spawn index (S_s) data for in-river reference groups and comparisons with survival to spawn rates for kelts reconditioned by UCKRP.

	In-River Reference Group				Project Group		
Maiden Year	Q_s	P_s	C_s	S_s	Released (C_s)	Detected ($Q_s + P_s$)	Survival % (S_s)
2013	0	0	40	0.0	5	1	20.0
2014	1	0	103	0.9	58	31	54.4
2015	0	-	48	-	30	13	43.3
2016	-	-	53	-	32	-	-

To date, 51% of reconditioned kelts released from the UCKRP have been detected at least once in the UCR during the spring spawning period. Many of these kelts have upstream and downstream detections whose timing and pattern are indicative of spawning events (Appendix A).

4.1.3 Discussion

Preliminary data suggests that long-term reconditioning efforts improve survival to return. While initial results are promising, meaningful analysis of these indices of survival cannot be done with so little data. Further data collection and analysis will be needed before any assumptions regarding the UCKRP's ability to contribute additional NOR steelhead to natural spawning grounds.

4.2 Reproductive Success

The documentation of the reproductive success of reconditioning kelts has been a primary focus of the project since its inception, as is demonstrated by the project's Objective 3. To date, efforts to address reproductive success have centered on obtaining, successfully reconditioning, and releasing kelts from the Twisp River. WDFW is currently operating a multi-generational relative reproductive success study (RRS) on steelhead in the Twisp River. This study will be operational from 2009-2025 and will quantify the relative reproductive success of natural and hatchery-produced fish at three life stages (parr, smolt, and adult).

YN acknowledges that tracking the kelts to the spawning ground may indicate a spawning event, but will not confirm that the reconditioned kelts successfully spawned. The reconditioning and release of Twisp River-origin kelts will allow their inclusion in the Twisp RRS study when they return to the Twisp to spawn, thus providing a direct means to document the reproductive viability of reconditioned kelts. The Twisp RRS study would document living offspring. It uses

genetic testing to assign parents to juvenile steelhead collected in the Twisp. If the results show that one of the reconditioned females is the parent of a certain number of juvenile steelhead, it will demonstrate that reconditioned kelts can be reproductively viable. It is the only current study in the UCR Basin that may have reconditioned kelts to contribute to the analysis of relative reproductive success of steelhead in the natural environment.

Between 2014 and 2016, 27 successfully reconditioned, Twisp origin kelts have been released. Most of these fish were lived spawned broodstock from the Douglas County PUD Twisp River Steelhead Program operated by WDFW at MSH. There have also been fish released that were collected at the Little Bridge Creek weir and Rocks Island Dam.

The sampling of age-1 steelhead by WDFW in 2016 marks the first time the progeny of kelts released in 2014 could be sampled to assign maternal and paternal DNA signatures. Parental analysis is currently being conducted. Progeny of kelts released in 2015 and 2016 will have the potential to be sampled in 2017 and 2018, respectively.

Live-spawning of NOR females from the Twisp River Steelhead Program and efforts to trap Twisp River kelts will continue into the foreseeable future. The RRS study will sample parental generations through 2018 and continue sampling progeny until 2025.

As data and results become available they will be present in future reports.

4.3 Phenotypic Characteristics of Reconditioned Kelts and First-time Steelhead Spawners

The UCKRP underwent NPCC/ISRP review in 2014. Their recommendation was that the project continue operations with the understanding the certain qualifications be addressed in subsequent proposals and reports. One qualification was that the project develops methods for comparing maturation timing and available energy stores between reconditioned kelts and maiden spawners.

The project has been collecting data from its reconditioned fish prior to their fall release for several years, and began collecting data from maiden spawners in 2015. To accomplish this, the UCKRP coordinated with WDFW to collect blood samples and Fatmeter readings concurrently with existing data collection efforts at Wells Dam.

4.3.1 Methods

Sampling was conducted during the late-summer/early-fall at the MSKF and Wells Dam to coincide with the UCKRP's pre-release sampling and the WDFW's annual steelhead run composition monitoring efforts at Wells Dam. Sampling was conducted between September 1st and October 31st. Reconditioned kelts were sampled over a period of one to two days in late-September or early-October. An effort was made to collect samples at Wells Dam two weeks before and/or after sampling a MSKF. Trapping by WDFW occurred 3 days a week and sampling was conducted the day after trapping.

Sampling will continue for up to 4 years.

Data Collection

Sampling at both locations consisted of collecting fork length (mm), weight (g), body fat percentage, and blood samples. All recondition kelts were sampled at the MSKF. Beginning in 2015, sample were collected from up to 25 HOR and 25 NOR maiden spawners at Wells Dam, per year.

Muscle lipid levels were measured using a Distell Fish Fatmeter model 692. Two readings were taken (locations 1 and 2; Figure 4.1) and the results averaged.

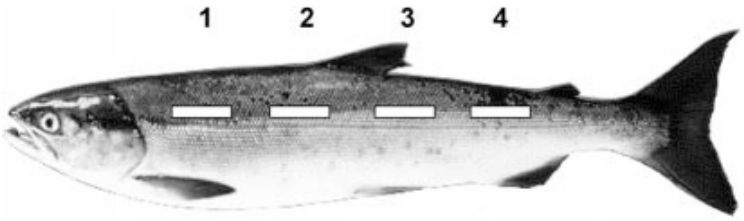

Figure 4.1 - Fatmeter reading locations. Readings are taken at locations 1 and 2

.

Blood sampling occurred while the fish were anesthetized. The fish were held on a board with their head in the water. A heparinized syringe was inserted along the ventral midline between the anal fin and the tail (Figure 4.2) and approximately 2 ml of blood was drawn. The syringe was then removed and gentle pressure applied to the puncture site to stop blood flow. Blood was dispensed from the syringe into microcentrifuge tubes and stored on ice. The samples were then placed into a centrifuge and spun for 5 minutes at 1000g to separate the plasma. The plasma was then collected and frozen until it could be sent to the University of Idaho to be analyzed for the concentration of estradiol to determine the fishes' maturation status. Blood plasma analysis was done according to methods described in Pierce et al. (2016).

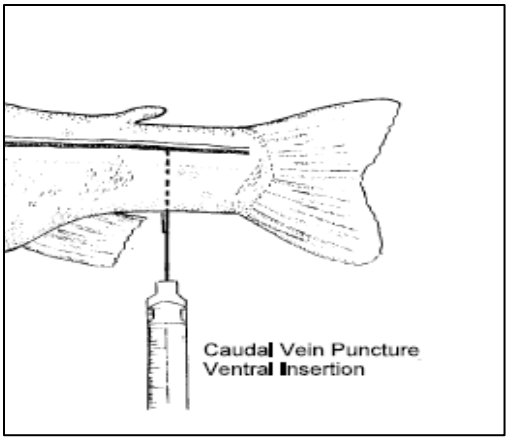

Figure 4.2 - Blood sampling location.

Data Analysis

Length and weight data was used to calculate Fulton Condition Factor (K). K and percent body fat were used as indices of available energy. One-way ANOVA was used to compare K and body fat among NOR maiden spawners, HOR maiden spawners, and kelts. If differences between groups were found with ANOVA, Tukey's test was used to identify where differences originated. If insufficient numbers of NOR or HOR maiden spawners were collected for robust statistical analysis, maiden spawners were pooled and t-tests were used compare kelts and maiden spawners.

Concentrations of estradiol in the blood plasma were compared among groups using non-parametric statistics, as the data does not have normal distribution. Kruskal-Wallis test was to compare estradiol concentrations among NOR maiden spawners, HOR maiden spawners, and kelts. If differences between groups were found with Kruskal-Wallis, Dunn's test was used to identify where differences originated. If insufficient numbers of NOR or HOR maiden spawners were collected for robust statistical analysis, maiden spawners were pooled and Mann-Whitney U test was used compare kelts and maiden spawners. Non-maturing kelts were retained for additional reconditioning in 2016. These 21 kelts were not included in the comparisons of estradiol concentration.

All tests were done using an alpha level of 0.05.

4.3.2 Results

Sampling of kelts at the MSKF occurred on October 8th in 2015 and on September 28th in 2016. Sampling of maiden spawners at Wells Dam occurred on September 28th and October 5th in 2015 and on September 13th, 20th, and 21st in 2016.

Data was collected from 30 reconditioned kelts, one NOR, and 12 HOR in 2015. T-tests were used to compare K values and body fat percentage between kelts and maiden spawners in 2015

due to the small sample size of NOR maiden spawners. K values were found to be significantly greater for reconditioned kelts, $p<0.001$. Mean K values were 1.17 for reconditioned kelts and 0.94 for maiden spawners. Body fat percentages were found to be significantly greater in reconditioned kelts, $p=0.017$. Mean body fat percentages were 5.7% for reconditioned kelts and 4.5% for maiden spawners. Estradiol concentrations were found to be significantly greater in reconditioned kelts, Mann-Whitney $U=109$, $p=0.023$.

Data was collected from 51 reconditioned kelts, six NOR maiden spawners, and 25 HOR maiden spawners in 2016. T-tests were used to compare K values and body fat % between kelts and maiden spawners in 2016 due to the small sample size of NOR maiden spawners. K values were found to be significantly greater for reconditioned kelts, $p<0.001$. Mean K values were 1.19 for reconditioned kelts and 0.97 for maiden spawners. Body fat percentages were found to be significantly greater in reconditioned kelts, $p=0.002$. Mean body fat percentages were 4.9% for reconditioned kelts and 3.9% for maiden spawners. Estradiol concentrations were found to be significantly greater in reconditioned kelts, Mann-Whitney $U=170$, $p<0.001$.

4.3.3 Discussion

Analysis of 2015 and 2016 data suggests that reconditioned kelts have significantly greater available energy stores to utilize during the overwinter, pre-spawning, and spawning periods. We will continue collected data for the next two to three years to determine if this trend continues. If it does, it would suggest that reconditioned kelts will be able to have sufficient energy stores to survive to and participate in spawning.

Analysis also suggests that reconditioned kelts have significantly higher concentrations of estradiol in their blood plasma. This is likely due to the difference in activity levels between the two groups. Maiden spawners were sampled during active migration periods in which much their energy reserves are being used for swimming and less on ovary development. High estradiol concentrations in reconditioned kelts indicate they are able to put much of their energy to ovary development, i.e. creating more and/or larger eggs. While it is known that there is a lower threshold of estradiol concentration level at which steelhead are unlikely to spawn the following spring it is unknown whether there is a higher threshold at which an concentration is likely to cause a biologically significant event, such as earlier spawn timing.

5 Addressing ISRP Qualifications

In 2014, the UCKRP had a check in with the Independent Scientific Review Panel (ISRP). At this time the project was given a list of qualifications that need to be addressed in subsequent proposals and reports. These qualifications include:

1) The prior recommendation, by the ISRP, to establish methods to assess how kelt reconditioning may benefit population growth, abundance, spatial structure, and diversity still needs to be addressed.

2) Some modeling and a power analysis need to be conducted to clarify how many juvenile and F_1 adults should be sampled to detect meaningful differences in the breeding and reproductive success of HOR, NOR, and reconditioned NOR females.
3) Methods to assess the fat levels, maturation timing, fecundity, egg size, and gamete viability of the project's reconditioned kelts need to be developed and implemented. The fate of non-maturing or skip-repeat reconditioned fish also should be disclosed.
4) Viable plans are needed to monitor the homing and straying rates of reconditioned kelts released by the project.
5) Experiments are needed to discover the best geographic locations and times of year for release of the project's reconditioned fish.

The UCKRP has begun to address these qualifications within the scope of its project objectives. This section will summarize the steps the project has taken to date towards addressing these qualifications and its plans for future action.

5.1 Qualification #1

The prior recommendation, by the ISRP, to establish methods to assess how kelt reconditioning may benefit population growth, abundance, spatial structure, and diversity still needs to be addressed.

In this qualification, the ISRP is asking the UCKRP to track changes in Viable Salmonid Population (VSP) parameters. There is a combined effort to collect data for all VSP parameters in the Methow Basin involving multiple projects and agencies. The difficult task of attributing population level change to any one project is outside the scope of this project.

A combination of analyses is being applied to assess the potential contribution of kelt reconditioning to UCR steelhead populations. The project is applying standardized indices of survival rate for both reconditioned and non-reconditioned kelts to determine if reconditioning results in an increase of repeat spawners on the spawning grounds when compared to the no action alternative. Details of the project's progress in this area can be found in Section 4.1 of this report. The project is also attempting to document the reproductive success of reconditioned kelts and, if sufficient sample size is obtained, compare the relative reproductive success of reconditioned kelts with NOR and HOR maiden spawners. Details of the project's progress in this area can be found in Section 4.2 of this report.

5.2 Qualification #2

Some modeling and a power analysis need to be conducted to clarify how many juvenile and F_1 adults should be sampled to detect meaningful differences in the breeding and reproductive success of HOR, NOR, and reconditioned NOR females.

These analyses are being conducted as part of the WDFW's Twisp RRS study and will be included in Section 4.2 of our report when the analysis is complete. There are varying degrees of reproductive success information that may be collected through the Twisp RRS study. The

minimum level of data hoped for would be to document the offspring produced by a reconditioned kelt. The next level would be documentation of the average number of offspring produced by reconditioned kelts and quantification of life-time reproductive success. The best level of data that can be hoped for would be a comparison of relative reproductive success between reconditioned kelts and both NOR and HOR maiden spawners. Results will largely depend on the WDFW's ability to capture and detect offspring as well as the natural variability in the data.

5.3 Qualification #3

Methods to assess the fat levels, maturation timing, fecundity, egg size, and gamete viability of the project's reconditioned kelts need to be developed and implemented. The fate of non-maturing or skip-repeat reconditioned fish also should be disclosed.

The UCKRP has begun to address many aspects of this qualification either directly or indirectly. A study designed to assess the maturation timing and available energy stores of reconditioned kelts and compare them to NOR and HOR maiden spawners was initiated in 2015. A detailed description of this study can be found in Section 4.3. Gamete viability will be indirectly assessed through the Twisp RRS study described in Section 4.2

Assessments of fecundity and egg size have been determined not to be feasible. These measures would require holding reconditioned kelts overwinter on well water that has a higher mean temperature than river water. This rearing temperature difference would have a high likelihood of altering the maturation timing and create bias in any comparisons to maiden spawners.

Prior to 2016, non-maturing fish have been released at the same time as maturing fish. Of the non-maturing fish released in the fall of 2014, 10 were detected the following spring. Many of these fish were detected moving downstream through the Columbia River hydropower system (Appendix A). This indicates that these non-maturing fish overwintered in the Methow River or UCR and continued downstream during high water conditions in the spring.

Retaining non-maturing kelts has become standard practice in recondition programs in recent years (Hatch et al 2016). In 2016, the UCKRP kept 21 non-maturing kelts for additional reconditioning. Kelts that survive through a second reconditioning cycle will have their maturation status evaluated in the fall of 2017 and will be released. This practice will continue to be evaluated by this project and other kelt reconditioning programs throughout the Columbia River basin for the next several years.

5.4 Qualification #4

Viable plans are needed to monitor the homing and straying rates of reconditioned kelts released by the project.

All reconditioned kelts released from the project are marked with a PIT tag with a unique code. There is an intensive system of PIT tag detection arrays in Methow River and other basins in the Upper Columbia. Many of these antennas, particularly in the smaller tributaries, were installed as one of the primary means of determining adult steelhead spawning distribution and abundance. PIT tag detections will be the primary means for tracking kelt movement.

Information on where kelts originally spawned often completely unknown and, if known, only in a general location. It is unlikely that homing and straying rates can be quantified in any significant way. However, any unusual detection data suggesting that a kelt may be straying outside its natal basin will be noted in this report.

The WDFW began a two year steelhead radio telemetry study in 2015 to verify the accuracy of the PIT arrays for steelhead abundance and distribution data. Nine reconditioned kelts from the Twisp River were radio tagged prior to release in collaboration with that study. None of these fish were observed straying outside the Methow Basin during the spawning period.

5.5 Qualification #5

Experiments are needed to discover the best geographic locations and times of year for release of the project's reconditioned fish.

Uncertainty over the best release locations and times is primarily linked to attempts to avoid an active steelhead fishery in the UCR and Methow River. There was not an active sport fishery at the time of release in 2016. A study to determine if release location influences survival to spawn was initiated in the fall of 2016. The results of this study will be included in the 2017 annual report for UCKRP.

6 Future Activities

6.1 Kelt Collection

6.1.1 Live-spawning

All NOR females used as broodstock by WNFH continue to be live-spawned in a combined effort by the YN and USFWS staff. WNFH is planning on spawning 48 pairs of steelhead in 2017. Steelhead pairs can be either both NOR or NOR by HOR crosses. Up to 48 NOR females could be available for live spawning and reconditioning.

In 2014, all NOR females from the Douglas County PUD Twisp River conservation hatchery program operated by WDFW at the MSH were live-spawned in a combined effort by the YN and WDFW staff. This activity continued in 2016 and is expected to continue into the future. Live-spawning of kelts from MSH not only increases the number of kelts for reconditioning but also increases the number of kelts expected to return to the Twisp River for inclusion in the ongoing steelhead reproductive success study described above. Up to 14 NOR females could be available for live spawning and reconditioning.

6.1.2 Temporary tributary weirs

The project has decided to give lower priority to the use of weirs as a collection method due to the low number of kelts collected compared to other collection methods. Weirs will still be employed in areas of special interest, such as those with ongoing reproductive success studies or

populations not represented through other means of collection. Weirs will be operated in Little Bridge Creek and Beaver Creek in 2017. Traps will be installed as early as possible in the spring relative to run timing for a specific year.

6.1.3 Rock Island Dam

The collaboration with CPUD is expected to continue in 2017. The number of kelts collected at Rock Island Dam has varied during the three years the project has used it as a collection site. The number of kelts collected at Rock Island Dam is likely linked to stream discharge in the tributaries upstream. More years of data are needed to establish if there is a relationship between peak discharge or some variables. Regardless of the cause, the number of kelts collected at Rock Island Dam will likely vary year to year.

6.2 Kelt Reconditioning and Release

This activity will continue in 2017 as it had the past 3 years. It is expected that the UCKRP will begin reconditioning with 60 to 100 in 2017. Based on survival rates at the reconditioning facility seen to date, YN could expect to see 30 and 75 reconditioned kelts released.

Retaining skip spawning kelts has become standard practice in recondition programs in recent years (Hatch et al 2016). The UCKRP began retaining non-maturing kelts for additional reconditioning for the first time in 2016. Twenty-one kelts were retained in 2016 and will be released in 2017. This practice will continue to be evaluated by this project and other kelt reconditioning programs throughout the Columbia River basin for the next several years.

6.3 Monitoring and Evaluation

All reconditioned kelts will continue to be PIT tagged. The existing PIT-tag arrays will continue to be used to track the movements and survival of the reconditioned kelts. YN will continue to monitor indices of survival of an in-river reference groups

The YN will continue to live-spawn and trap, reconditioning, and release Twisp River-origin steelhead in an effort to get reconditioning kelts included in the Twisp River RRS study. The YN will collaborate with WDFW in documenting any progeny of reconditioning kelts in the RRS study.

The YN will continue data collection from NOR and HOR maiden spawners at Wells Dam and comparisons of maturation timing and available energy stores to those observed in reconditioned kelts will be ongoing.

The study examining the effect of release location on survival to spawn initiated in the fall of 2016 will continue in 2017.

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Appendix A

Summary of spring PIT detections for reconditioned kelts released in the fall of 2013.

Tag Code	Origin	Detection Site	Event Date	Remature
384.3B239AA629	WNFH	CRW - Chewuch River above Winthrop CRW - Chewuch River above Winthrop	04/11/14 04/23/14	YES
384.3B239A393F	WNFH	No detections		YES
384.3B2399F131	WNFH	No detections		YES
3D9.1C2D73DFAF	WNFH	No detections		NO
384.3B2399AA58	WNFH	No detections		NO

Summary of spring PIT tag detections for reconditioned kelts released in the fall of 2014.

Tag Code	Origin	Detection Site	Event Date	Remature
3D9.1C2D734B1F	WNFH	CRW - Chewuch River above Winthrop	03/22/15	YES
		CRW - Chewuch River above Winthrop	04/17/15	
3D9.1C2D73BE5A	WNFH	CRW - Chewuch River above Winthrop	03/11/15	YES
		CRW - Chewuch River above Winthrop	04/02/15	
3D9.1C2D743279	WNFH	CRW - Chewuch River above Winthrop	03/23/15	YES
		CRW - Chewuch River above Winthrop	04/24/15	
3D9.1C2D7442F9	WNFH	CRW - Chewuch River above Winthrop	03/14/15	YES
		CRU - Upper Chewuch Instream Array	04/05/15	
		RRJ - Rocky Reach Dam Juvenile	04/11/15	
3D9.1C2E0A38F1	WNFH	CRW - Chewuch River above Winthrop	03/08/15	YES
		BCC - BON PH2 Corner Collector	06/07/15	
384.36F2B4A078	WNFH	RRJ - Rocky Reach Dam Juvenile	04/22/15	YES
384.3B23ADF01C	WNFH	RRJ - Rocky Reach Dam Juvenile	05/06/15	YES
3D9.1C2D732EDE	WNFH	MRW - Methow River at Winthrop	03/18/15	YES
3D9.1C2D739A01	WNFH	CRW - Chewuch River above Winthrop	03/12/15	YES
3D9.1C2D73EB2A	WNFH	RRJ - Rocky Reach Dam Juvenile	04/29/15	YES
3D9.1C2D74376F	WNFH	CRW - Chewuch River above Winthrop	04/08/15	YES
3D9.1C2DF7C1E9	WNFH	CRW - Chewuch River above Winthrop	02/21/15	YES
3DD.003BC49E7B	WNFH	RRJ - Rocky Reach Dam Juvenile	04/03/15	NO
		BCC - BON PH2 Corner Collector	04/29/15	
3D9.1C2DF64BDE	WNFH	RRJ - Rocky Reach Dam Juvenile	04/21/15	NO
		RRJ - Rocky Reach Dam Juvenile	04/22/15	
3D9.1C2DF75115	WNFH	BCC - BON PH2 Corner Collector	05/04/15	NO
3DD.003BC49E73	WNFH	BCC - BON PH2 Corner Collector	05/18/15	NO
3DD.003BC49E6A	WNFH	PRA - Priest Rapids Adult	09/05/15	NO
		RIA - Rock Island Adult	09/17/15	
		RRF - Rocky Reach Fishway	10/23/15	
		WEA - Wells Dam, DCPUD Adult Ladders	10/26/15	
		WEA - Wells Dam, DCPUD Adult Ladders	10/27/15	
		WELLD2 - WEL - Release into the West Adult Fish Ladder	10/27/15	
3DD.003BC49E35	WNFH	Not Detected		YES
3D9.1C2F6D35E	WNFH	Not Detected		YES
3D9.1C2E0A88EA	WNFH	Not Detected		YES
3D9.1C2D743711	WNFH	Not Detected		NO
3D9.1C2D73EE8A	WNFH	Not Detected		NO
3D9.1C2D73EB54	WNFH	Not Detected		NO
3D9.1C2D73D807	WNFH	Not Detected		NO
3D9.1C2D73D1C8	WNFH	Not Detected		YES
3D9.1C2D73EBB3	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	03/20/15	YES
		TWISPW - Twisp River Weir (WDFW)	04/22/15	
3D9.1C2DF5CDB3	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	03/25/15	YES
		TWISPW - Twisp River Weir (WDFW)	04/20/15	
		RRJ - Rocky Reach Dam Juvenile	05/30/15	

Tag Code	Origin	Detection Site	Event Date	Remature
3D9.1C2DF62C18	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	03/14/15	YES
		TWISPW - Twisp River Weir (WDFW)	03/21/15	
		TWISPW - Twisp River Weir (WDFW)	04/20/15	
3DD.003BC49A4D	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	03/28/15	YES
		TWISPW - Twisp River Weir (WDFW)	04/21/15	
		BCC - BON PH2 Corner Collector	06/02/15	
		TWX - Estuary Towed Array (Exp.)	06/04/15	
3DD.003BC49A5C	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	04/19/15	YES
		TWISPW - Twisp River Weir (WDFW)	05/04/15	
		TWR - Lwr Twisp Rvr near MSRF Ponds	05/11/15	
3DD.003BC49A81	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	03/21/15	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	04/27/15	
		RRJ - Rocky Reach Dam Juvenile	05/07/15	
3DD.003BC4A0F4	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	03/28/15	YES
		TWISPW - Twisp River Weir (WDFW)	04/22/15	
		MWF - Whitefish SC in Methow River	05/11/15	
		RRJ - Rocky Reach Dam Juvenile	05/15/15	
3DD.003BC49A31	MSH	Not Detected		NO
3DD.003BC4A105	MSH	Not Detected		NO
3DD.003BC4A127	MSH	Not Detected		NO
3DD.003BC4A0E8	MSH	Not Detected		NO
3D9.1C2DF7D9E3	SFG	GLC - Gold Creek, Methow River	03/24/15	YES
		GLC - Gold Creek, Methow River	03/26/15	
3D9.1C2D73D746	HCS	RRJ - Rocky Reach Dam Juvenile	05/25/15	YES
3DD.003BC49A54	LBC	Not Detected		NO
3D9.1C2D733EA6	RI	FST - Foster Creek	03/15/15	YES
		FST - Foster Creek	03/19/15	
		FST - Foster Creek	03/24/15	
		FST - Foster Creek	03/25/15	
		TNK - Tunk Creek Instream Array	03/29/15	
		TNK - Tunk Creek Instream Array	04/01/15	
		RRJ - Rocky Reach Dam Juvenile	05/16/15	
		BCC - BON PH2 Corner Collector	06/01/15	
3D9.1C2D73BAA9	RI	PES - Peshastin Creek	03/14/15	YES
		PES - Peshastin Creek	04/04/15	
3D9.1C2D73D51E	RI	PES - Peshastin Creek	03/07/15	YES
		PES - Peshastin Creek	04/06/15	
		BCC - BON PH2 Corner Collector	05/18/15	
3D9.1C2D744057	RI	TWR - Lwr Twisp Rvr near MSRF Ponds	03/28/15	YES
		RRJ - Rocky Reach Dam Juvenile	04/30/15	
3D9.1BF1AC6840	RI	LWE - Lower Wenatchee River	03/31/15	NO
3D9.1C2D7344E2	RI	BCC - BON PH2 Corner Collector	04/30/15	NO
3D9.1C2D7398AF	RI	BCC - BON PH2 Corner Collector	05/19/15	NO
3D9.1C2D73B2DE	RI	BCC - BON PH2 Corner Collector	05/21/15	NO
3D9.1C2D743D67	RI	JDJ - John Day Dam Juvenile	05/22/15	NO
384.36F2B4A35A	RI	Not Detected		NO
3D9.1C2D73B098	RI	Not Detected		NO

Tag Code	Origin	Detection Site	Event Date	Remature
3D9.1BF1AC542B	RI	Not Detected		NO
3D9.1C2D733B2F	RI	Not Detected		NO
3D9.1C2D73CAD9	RI	Not Detected		NO
3D9.1C2D73D2C0	RI	Not Detected		NO
3D9.1C2D73D569	RI	Not Detected		NO
3D9.1C2D73E484	RI	Not Detected		NO
3DD.003BC4A0DC	RI	Not Detected		NO
3D9.1C2D744268	RI	Not Detected		NO

Summary of spring PIT tag detections for reconditioned kelts released in the fall of 2015.

Tag Code	Origin	Detection Site	Event Date	Remature
3D9.1C2D625F7C	MSH	LMR - Lower Methow River at Pateros	03/09/16	YES
		MRC - Methow River at Carlton	03/22/16	
		TWR - Lwr Twisp Rvr near MSRF Ponds	03/24/16	
		TWISPW - Twisp River Weir (WDFW)	03/31/16	
3D9.1C2D734CD7	WNFH	MRC - Methow River at Carlton	03/05/16	YES
3D9.1C2D736B89	WNFH	LMR - Lower Methow River at Pateros	03/07/16	YES
		MRC - Methow River at Carlton	03/21/16	
		MRC - Methow River at Carlton	03/22/16	
		LMR - Lower Methow River at Pateros	03/24/16	
		MRC - Methow River at Carlton	03/27/16	
		MRW - Methow River at Winthrop	04/01/16	
3D9.1C2D73AEC0	WNFH	TD1 - The Dalles East Fish Ladder	08/13/16	NO
		MC1 - McNary Oregon Shore Ladder	08/17/16	
3D9.1C2D73BA6A	WNFH	CRW - Chewuch River above Winthrop	04/05/16	YES
		RRJ - Rocky Reach Dam Juvenile	04/10/16	
3D9.1C2D744821	RI	ENL - Lower Entiat River	04/06/16	
		ENS - Upper Entiat River at rkm 35.7	04/15/16	
		ENF - Upper Entiat River at rkm 40.6	04/16/16	
		ENF - Upper Entiat River at rkm 40.6	05/19/16	
3D9.1C2E0A77FD	RI	TUF - Tumwater Dam Adult Fishway	03/31/16	
		TUM - Tumwater Dam, Wenatchee River	04/01/16	
3DD.003BC452B7	MSH	LMR - Lower Methow River at Pateros	03/28/16	NO
		MRC - Methow River at Carlton	04/06/16	
		TWR - Lwr Twisp Rvr near MSRF Ponds	04/08/16	
		RRJ - Rocky Reach Dam Juvenile	05/05/16	
3DD.003BC45329	WNFH	MRC - Methow River at Carlton	03/05/16	YES
		MRT - Methow River at Twisp	03/13/16	
		CRW - Chewuch River above Winthrop	03/27/16	
3DD.003BC4535D	WNFH	LMR - Lower Methow River at Pateros	02/15/16	YES
		LMR - Lower Methow River at Pateros	02/23/16	
		MRC - Methow River at Carlton	03/21/16	
		MRW - Methow River at Winthrop	04/06/16	
3DD.0077534573	RI	BCC - BON PH2 Corner Collector	05/03/16	
3DD.007754E568	MSH	RRJ - Rocky Reach Dam Juvenile	04/09/16	NO
3DD.0077552C7A	WNFH	LMR - Lower Methow River at Pateros	03/13/16	NO
3DD.0077553AD9	MSH	MRC - Methow River at Carlton	03/26/16	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	04/04/16	
3D9.1C2D734295	WNFH	Not Detected		YES
3D9.1C2D73446A	WNFH	Not Detected		NO
3D9.1C2D73C8B6	WNFH	Not Detected		YES
3D9.1C2D73CEB4	WNFH	Not Detected		NO

Tag Code	Origin	Detection Site	Event Date	Remature
3D9.1C2D743876	WNFH	Not Detected		YES
3DD.003BC45324	WNFH	Not Detected		YES
3DD.007752C04B	WNFH	Not Detected		NO
3DD.007755656F	WNFH	Not Detected		YES
3DD.003BC452DC	MSH	Not Detected		YES
3DD.003BC452F9	MSH	Not Detected		YES
3DD.003BC4537B	MSH	Not Detected		NO
3DD.00775524B0	MSH	Not Detected		NO
3DD.00775546F0	MSH	Not Detected		NO
3D9.1C2D73276A	RI	Not Detected		NO
3D9.1C2D73B1FF	RI	Not Detected		YES
3D9.1C2D733A4A	WNFH	Not Detected		YES
3D9.1C2D73F109	WNFH	Not Detected		YES