UPPER-COLUMBIA RIVER STEELHEAD KELT RECONDITIONING PROJECT:

2014 ANNUAL REPORT
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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 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 2011).

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 2014. 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.

2.1 Live-spawning

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 (natural or hatchery). The UCKRP proposed that the application of live-spawning techniques for NOR steelhead females would allow their inclusion into a reconditioning program and subsequently provide an opportunity to repeat spawn in the natural environment.

Before hatchery programs would agree to alter their methodologies, the efficacy of live-spawning needed to be evaluated. The lack of published studies comparing live and lethal spawning methods raised concerns that live-spawning could result in a reduction in the number of eggs collected. Since UCR steelhead are listed as "Threatened" and the number of NOR steelhead available for broodstock is limited, it could be difficult for hatcheries to take additional broodstock if egg take was reduced. The UCKRP proposed a study to address those concerns.

Under the 2011 contract, the UCKRP explored potential of live-spawning steelhead broodstock females collected for hatchery conservation programs in the Methow River. The results the 2011 study demonstrated that live-spawning did not negatively impact the number of eyed eggs collected. As a result, an agreement was reached with US Fish and Wildlife Service (USFWS) hatchery managers to begin live-spawning the NOR female steelhead broodstock and allow for their inclusion into the UCKRP starting in the spring 2012 . Live-spawning continued at Winthrop National Fish Hatchery (WNHF) in 2014. So far, NOR females spawned at WNFH have provided most of the kelts for reconditioning under this program.

The successful live-spawning of broodstock at WNFH was also 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.

2.1.1 Methods

Steelhead live-spawned at WNFH and Methow Salmon Hatchery (MSH; for the Twisp River program) 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 a 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, the fish was taken to a tank filled with water. The fish was 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 we recorded the tag number. If no tag was present, we inserted a tag into the fish's pelvic girdle.

Once data had been collected, the kelts were transferred to the MSKF for reconditioning.

2.1.2 Results

Spawning activities began at Winthrop NFH on April 15, 2014 and concluded May 20, 2014. A total of 33 NOR females were live-spawned in 2014. No HOR females were live-spawned in 2014. There were 3 post-spawn mortalities.

Spawning activities began at MSH on April 14, 2014. A total of 14 NOR females were live-spawned in 2014. There was one post-spawn mortality.

Table 2.1 - Females live-spawned at WNFH and MSH in 2014.

	NOR	HOR
WNFH	33	0
MORT	3	0
TOTAL	30	0
MSH	14	0
MORT	1	0
TOTAL	13	0

2.1.3 Discussion

The NOR female broodstock live spawned at WNFH in 2012-2014 and MSH will continue to be a consistent and reliable 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 is expected to increase in the near future. Winthrop NFH expects to increase their production of steelhead to 200,000 as soon as rearing space becomes available, with the result that up to 48 NOR females could be available for reconditioning from this source. With the annual contribution of 13 NOR females from the Methow FH, the project could consistently have up to 61 NOR females collected through live-spawning every year.

Although the number of post-spawn mortalities has been relatively small, it is hoped that they can be reduced or eliminated. Each year the project and its cooperators gain experience in live-spawning techniques. This experience increases the efficiency in which the females are spawned, decreases the amount of time each fish is handled, and allows for an overall reduction in handling stress. It is important to note that without the project's intervention, all broodstock would be lethally spawned. Improvement in post-spawn survival increases the number of kelts available for assessments of reconditioning as a potential tool for steelhead recovery in the Upper Columbia River Basin.

2.2 Kelt Trapping

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. Until 2014 UCKRP did not have ready access to such traps.

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.

2.2.1 Methods

Trapping Sites

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 operated in Little Bridge Creek, Hancock Springs, and South Fork Gold Creek in 2014. 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 Hancock Springs was located 0.17 river miles from the confluence with the Methow River. The trap was placed in a deep pool downstream of the culvert on Wolf Creek Road. The weir on South Fork Gold Creek was located 0.59 river miles from the confluence of South Fork Creek and Gold Creek and 1.77 river miles from the confluence of Gold Creek and the Methow River.

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 box at Little Bridge Creek was constructed of an angle iron frame 3 feet wide by 4 feet long by 3 feet deep (Figure 2-1). The trap boxes at Hancock and South Fork Gold Creek were 2 feet wide by 4 feet long by 3 feet deep.

The passage chutes were constructed of the same materials used on the trap box. The upstream end of the chute was configured into an upstream-facing V with a gap of 4 inches. The passage chute in Little Bridge Creek was 2 feet wide by 4 feet long by 2 feet deep (Figure 3-6). The passage chutes at Hancock Springs (Figure 3-7) and South Fork Gold Creek (Figure 3-8) 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.

Figure 2.1 - Little Bridge Creek weir trap layout and trapbox from downstream

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Figure 2.2 - Little Bridge Creek weir trap layout, upstream view

Figure 2.3 - Hancock Springs weir

Figure 2.4 - South Fork Gold Creek weir

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.

2.2.2 Results

Little Bridge Creek

The weir in Little Bridge Creek was installed on April 11, 2014. A total of 23 steelhead were trapped in this weir: 19 males and 4 females (Table 3.8). Of the females trapped, one female was NOR. The NOR female kelt was transported to the MSKF for reconditioning. The weir was removed on June 9, 2014.

Hancock Springs

The weir in Hancock Springs was installed on April 10, 2014. A total of 20 steelhead were trapped in this weir, 14 males and 8 females. One of the females was a NOR kelt that was brought to the MSKF for reconditioning. Four of the females were HOR and released downstream. Three of the NOR females were determined to be in pre-spawn condition and were released downstream of the weir. The weir was removed on June 9, 2014.

South Fork Gold Creek

The weir in South Fork Gold Creek was installed on April 16, 2014. A total of 14 steelhead were trapped in this weir, 12 males and 2 females. One female was a NOR kelt that was brought to the MSKF for reconditioning. The other female was determined to be in pre-spawn condition and was released downstream of the weir. There were also 4 resident rainbow trout that were trapped and released downstream of the weir. The trap was removed on May 15, 2014 due to increased stream discharge.

Table 2.2 - Summary data for fish encountered at the tributary weir traps in 2014

	MALE		FEMALE - KELT		FEMALE - PRESPAWN		
SITE	HOR	NOR	HOR	NOR	HOR	NOR	TOTAL
Little Bridge	5	14	3	1	0	0	23
Hancock	10	4	4	1	0	3	22
South Fork Gold	0	12	0	1	0	1	14
TOTAL	15	30	7	3	0	4	59

Discussion

A total of three NOR kelts were collected for the project through the application of these temporary weir traps in 2014.

The temporary picket weirs appear to be effective at trapping downstream migrants while passing upstream migrants. However due to the low proportion of NOR spawners in the Methow basin, it is likely that temporary weir traps will contribute a relatively small proportion of kelts for the Upper Columbia Steelhead Kelt Reconditioning Program. 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 project will continue to explore the use of temporary tributary weirs as a means for kelt collection. Two weirs will be added in 2015 in Beaver Creek and Libby Creek, both tributaries to the Methow River, in addition to the three weirs operated in 2014.

2.3 Rock Island Dam

In 2014, YN also began kelt collections at Chelan PUD's Rock Island bypass facility. Rock Island Dam, located on the Columbia River about 12 miles downstream from the city of Wenatchee, is the only main stem facility in the UCR suitable for capturing downstream migrating kelts. Kelts captured at this facility likely would have spawned in the Methow, Okanogan, Entiat, or Wenatchee Rivers.

The collection of kelts at Rock Island Dam has proven to have some significant advantages. It has given the project the potential to expand reconditioning to additional river basins in the Upper Columbia. Kelts from the Wenatchee, the Entiat, and the Okanogan Rivers could be collected at this site. There is also the potential to collect fish from the Methow Basin not encountered through other collection methods. One of the biggest benefits of this collection method is that it allows the project to increase the number of kelts with little resource investment.

Kelts have historically been encountered as bycatch during Chelan County Public Utility District (CPUD) juvenile sampling. In 2014, instead of CPUD releasing these kelts back into the fish ladder they placed the kelts in a holding tank and contact the UCKRP to transport them to the MSKF. This arrangement allows the UCKRP to focus on kelt collection efforts in the Methow Basin and only commit resources to transporting kelts from Rock Island Dam when it is known that kelts are available.

Twenty-six NOR kelts were collected from the Rock Island Dam bypass facility in 2014.

2.4 Conclusion

The UCKRP collected substantially more NOR kelts in 2014 than any previous years. We began the reconditioning process with a total of 76 NOR kelts were collected through live-spawning, weirs, and main stem dams (Table 2-3).

Table 2.3 - Summary of NOR kelt collection numbers in 2014.

Collection Location	# Collected
Winthrop NFH (Live-Spawn)	33
Methow Salmon Hatchery (Twisp Stock Live Spawn)	14
Little Bridge Creek Weir	1
S. Fork Gold Creek Weir	1
Hancock Springs Weir	1
Rock Island Dam Juvenile Bypass	26
Total	**76**

3 Kelt Reconditioning

The UCKRP implements long-term kelt reconditioning techniques in pursuit of its project objectives. 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 of the same year as maiden steelhead spawners are returning from the ocean. 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).

The section describes the reconditioning efforts that the UCKRP conducted during 2014.

3.1 Methods

Methow Steelhead Kelt Facility

The MSKF was constructed on Winthrop National Fish Hatchery grounds in 2011. The facility was constructed by the Yakama Nation 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 2014, feeding frequency was increase from 2 to 3 large feedings per day to 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 the shifted to include 50% krill and 50% pellets for another one to two weeks and then 25% krill and 75% pellets.

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.

Release and Tracking

Kelt surviving to the September, at which time maiden spawners are returning to the Methow River, were considered to be successfully reconditioned. Successfully reconditioned kelts were then evaluated during a pre-release workup to determine their maturation status. Pre-release sampling was conducted on October 1st to assess reconditioning effectiveness and maturation status of the remaining kelts. Data

collected included fork and POH lengths, weight, fat meter readings, the presence/absence of copepods, and any notable physical characteristics. Blood samples were taken and evaluated by Columbia River Intertribal Fish Commission (CRITFC) researches for plasma levels of vitellogenin and estradiol, indicators of maturation status. Fish were then released into the river to coincide with the fall migration of maiden spawners. Movement of the kelts was monitored using PIT tag antenna arrays throughout the Methow and Columbia River basins.

3.2 Results and Discussion

The Upper Columbia Steelhead Kelt Reconditioning Project completed its 2014 reconditioning activities in October. The project began the reconditioning process with a total of 76 NOR steelhead kelts and 58 of those fish survived until their release in mid-October (Table 3-1). This survival rate (76%) is one of the highest observed in a Columbia Basin steelhead reconditioning project to date (Hatch et al. 2015).

Examinations of reconditioned kelts revealed greatly improved physical condition in nearly all fish (Figures 3-1). Data analysis has focused primarily on weight gain and fat meter readings, as large increases in body weight and high body fat percentage are often indicators of successful reconditioning. A summary of the weight gain and fat meter data can be found in Table 3-2.

Table 3.1 - 2014 MSKF kelt collection and release numbers

Collection Location	**# Collected**	**# Released**
Winthrop NFH (Live-Spawn)	33	25
Methow Salmon Hatchery (Twisp Stock Live Spawn)	14	11
Little Bridge Creek Weir	1	1
S. Fork Gold Creek Weir	1	1
Hancock Springs Weir	1	1
Rock Island Dam Juvenile Bypass	26	19
Total	**76**	**58**

Figure 3.1 - Examples of kelts pre-reconditioning (left) and post-reconditioning (right) collected at Rock Island Dam (top), via live-spawning (middle), and at a weir trap (bottom).

Table 3.2 - Summary of weight gain and fat meter readings from 2014 pre-release workup.

Metric	Weight Gain (kg)	Weight Gain (%)	Fat %
Mean	1.37	79	5.2
Maximum	3.02	137	10.5
Minimum	0.24	16	1.3

Results of the blood analysis demonstrated that 53% of the reconditioned kelts appeared to be re-maturing. This was the highest re-maturation rate observed by a kelt reconditioning project in 2014 (Hatch et al. 2015). Kelts collected at the weirs and via live-spawning had a 66.6% re-maturation rate. Kelts collected at Rock Island Dam had a 26.3% re-maturation rate (Table 3-3). Potential factors contributing to the lower re-maturation rates for Rock Island kelts may include: greater energy expenditure due to longer downstream migrations, transportation related stress,

travel through the hydropower system, or tank effect. Further study may be needed to identify causes for lower re-maturation in Rock Island kelts.

Table 3.3 - Re-maturation rate by kelt collection method.

		Non Re-maturing		Re-maturing	
Collection Type	Total	#	%	#	%
Weirs	3	1	33.3	2	66.7
Live-spawning	36	12	33.3	24	66.7
Mainstem Dam	19	14	73.7	5	26.3
Total	*58*	*27*	*46.6*	*31*	*53.4*

All 58 kelts on station were released. Kelts originating in the Methow basin were released at river km 64 of the Methow River on October 15th and 16th. Kelts originating from Rock Island Dam were released into the Columbia River at river km 742 on October 21st.

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) Do kelt collection efforts have an impact on the migration timing or behavior of maiden spawning steelhead?

In 2014, the UCKRP began answering these questions by examining post-release movement and survival of reconditioned kelts, reproductive success of reconditioned kelts, and the potential impact of kelt collection weirs on migration timing of maiden spawning steelhead.

4.1 Movement and Survival

The demonstration of improved survival of iteroparious 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 made 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.

4.1.1 Methods

An in-river reference group was developed to evaluate the extent of benefits to survival and repeat spawning rates. This reference group was made up of non-reconditioned kelts identified through the use of PIT tag data retrieved from the PTAGIS database. PTAGIS was used to identify UC steelhead

demonstrating downstream migration consistent with iteroparous life history. Two criteria were used in choosing steelhead for the control group: (1) tagged or recapture as adults in the Upper Columbia and (2) demonstrated downstream movement in the Columbia River following spawning, both criteria must be met to be considered in the in-river reference group

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. The 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 Rock Reach Dam juvenile bypass system (RRJ) between March 1 and July 31 of the brood year. Steelhead appearing in both the known steelhead spawner and kelts at RRJ lists were included in the in-river reference group.

The in-river reference group PIT tag codes will be queried in PTAGIS for two years following their MY to account for the two distinct iteroparous life histories, sequential spawning and skip spawning. Sequential 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 survival to return index and rate of 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 sequential 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 spring 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 kelts being reconditioned by the UCKRP in 2013. The in-river reference group for MY 2014 was made up of 103 from the UCR. Only S_r calculations have been completed for MY 2013 (Table 4-1). None of the reference group kelts were detected returning in 2013 or 2014 (S_r = 0.0). Six of the 9 kelts in the reconditioning project survived to release (66.7%). One of the surviving kelts was a HOR female that was not released.

Table 4-1. 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	Remaining	Survival %
2013	0	0	40	0	9	6	66.7
2014	3	-	103	-	76	58	76.3

Calculations of S_s for MY 2013 will be completed after data from the 2015 spawning period is analyzed (Table 4-2). One of the brood year 2013 reconditioned kelts was detected moving up the Chewuch River on April 11, 2014. This fish was also detected moving downstream in the Chewuch River on April 23rd. The timing and pattern of movement is indicative of a spawning event.

Table 4-2. 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.

Maiden Year	In-River Reference Group				Project Group		
	Q_s	P_s	C_s	S_s	Released	Detected	Survival %
2013	0	-	40	-	5	1	20.0
2014	-	-	103	-	58	-	-

Data collection and calculation for MY 2014 and beyond will continue in subsequent years.

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).

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. YN acknowledges that simply tracking the kelts to the spawning ground indicates a spawning event, but will not confirm that the reconditioned kelts successfully spawned. 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.

The Wells Habitat Conservation Plan Hatchery Committee agreed to begin live-spawning broodstock in 2014 for the Douglas County PUD Twisp River Steelhead Program operated by WDFW at MSH. The 14 NOR females from the Twisp program were live spawned in 2014 and 11 were successfully reconditioned and released. There was also one kelt trapped in Little Bridge Creek and one Twisp-origin kelt trapped at Rock Island dam that were successfully reconditioned and released. A total of 13 reconditioned female kelts of Twisp River origin are expected to return to the Twisp River in 2015 and included in the steelhead RRS study. All age-1 steelhead sampled by WDFW in 2016 will be genetically tested in an effort to assign maternal and paternal DNA signatures. The list of potential maternal genetic donors would include reconditioned fish and any first-time spawners sampled at Twisp Weir.

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 Steelhead Migration Timing Study

YN's Upper Columbia Steelhead Kelt Reconditioning Project kelt collection weir in Little Bridge Creek was subject to a Biological Assessment with the NOAA Fisheries in the winter of 2013. During this consultation questions arose regarding the possibility of the temporary weir delaying migration of steelhead, particularly adults. When the literature was reviewed, the project was unable to identify existing studies on the potential impact of similar traps on fish behavior. It was agreed that the project proceed in 2014 with condition that the project gather information on steelhead movement in relation to weir operation

4.3.1 Methods

The project used PIT tags to assess fish movement in relation to the weir. An ongoing WDFW project operates a channel spawning weir in the Twisp River downstream of the confluence with Little Bridge Creek. WDFW personnel PIT tag all adult steelhead encountered at the weir. As a result, nearly every adult steelhead in the upper Twisp River have PIT tags.

Two PIT antenna arrays were employed, one downstream of the weir and one upstream of the weir (Figure 6). This configuration allowed us to calculate the time it would take a fish to travel upstream through the weir's passage chute. The downstream array was located approximately 50 m downstream of the weir. This array was originally operated by the USGS and was designed as a permanent antenna array. YN staff took over operation and maintenance of the array for the duration of the study. The array was removed by USGS upon completion of the study in June of 2014. The upstream array was located directly upstream of the weir's passage chute. This array was a temporary structure designed to detect fish upon their exit from the weir's upstream passage chute. The array was operational from April 12 to June 9, 2014.

Travel time for an individual fish from the downstream array through the weir was estimated by calculating the difference in hours between the first detection at the downstream array and the first detection at the upstream array. Detections of known juvenile, resident, or residual sized fish were removed from the data set. There is little concern that the weir would negatively impact the movement of such fish as the weir components were designed to allow small size classes of fish pass above and below the weir freely. Single detections were also removed from the data set. Single detections at either the downstream or upstream arrays do not allow determination of directional movement.

The typical time for fish to travel through that section of stream was unknown prior to the study, as the array configuration was not present in previous years. Therefore, Therefore, we collaborated with co-managing agencies to established expectations for what would we consider "normal migration" and "disturbed migration". These standards were based on movement patterns observed by examining PIT tag data in the Methow River and its tributaries in years prior to this study.

A fish exhibiting normal migration would be expected to be detected at the downstream array between March 15 – and June 15 and detected at the upstream array no more than 48 hours following its first detection. Once upstream of the weir there are three possible movement patterns we would consider consistent with normal migration. The first would be that the fish would not be detected again due to predation or post-spawn mortality. The second would be that would be detected at the upstream area and/or found in the weirs trap box one to five days following its upstream detection. This behavior has been observed by the project in previous years. This behavior is consistent with fish, typically males, which are still actively spawning and searching for mates. The third would be that would be detected at the upstream array and/or found in the weirs trap box approximately 2 weeks following its upstream detections. The kelt reconditioning project for the Colville Tribe observed that steelhead typically spend approximately 2 weeks upstream of their weir before returning downstream as kelts (Rhonda Dasher pers. comm.).

A fish exhibiting a disturbed migration would be expected to be detected at the downstream array between March 15 – and June 15 and detected at the upstream array more than 48 hours following its first detection, if at all. Multiple detections at the downstream array with no detections at the upstream array

would be indicative of a fish trying to pass upstream of the weir but is unable or unwilling to pass the weir.

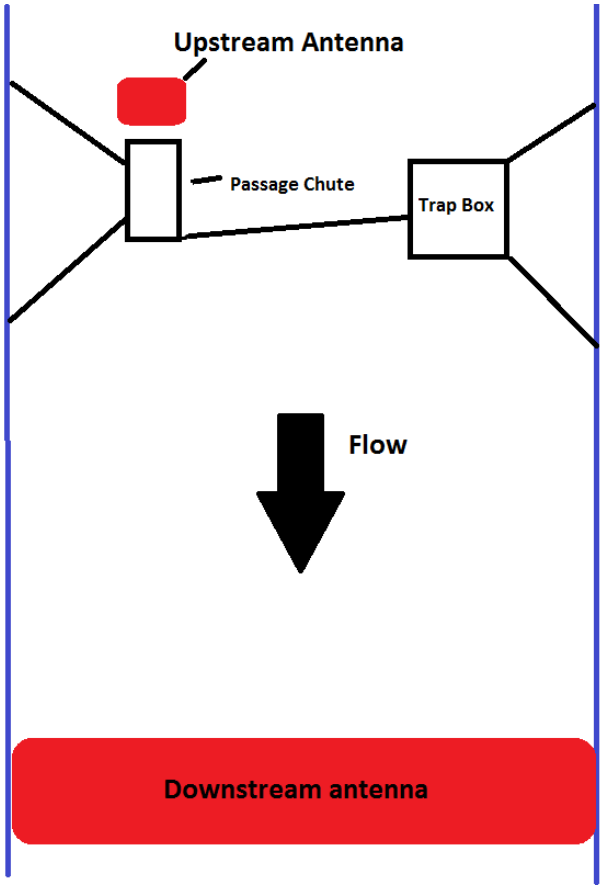

Figure 4.1 - Diagram of PIT antenna array configuration in Little Bridge Creek.

The project understood that the efficiency of the PIT tag detection arrays is always less than 100%. Without knowing the detection probability for the Little Bridge Creek Arrays we were unsure how many steelhead would have an accurate measure of travel time, and there was not estimated detection probability for the Little Bridge Creek Arrays. High stream flows experienced during the study would also be likely to decrease the detection efficiency. A study in another tributary to the Methow River found that a similar antenna array configuration, operated during similarly high stream flows, experienced detection efficiency as low as 55% (Connolly et al. 2008). The lack of antenna redundancy and low efficiency would also prevent the determination of directional movement and travel time should a tag be missed at either array.

4.3.2 Results and Discussion

Analysis of PIT tag data collected between April 11th and June 9th revealed there were 50 unique tag codes detected and a total of 428 detections were made. Low detection efficiency and multiple power

outages at the arrays resulted in a relatively incomplete dataset. Once non-adults and single detections were removed from the dataset 20 unique tag codes from adult steelhead remained.

We were only able to accurately calculate upstream travel time for 4 out of the 20 unique tag codes. Travel times for these 4 fish were indicative of normal migration and showed no apparent trap affect (Table 41). The downstream migration detections, while only complete for one fish, provided an example of the time between upstream and downstream migrations. This data helped us identify the possibility of missing data in some of the records.

It appears 11 of the 20 unique tag codes have missed detections during the upstream migration at one or both of the antenna arrays. This assumption is based on the amount of time between upstream and downstream migrations as described above, as well as observations/detections made at other sites downstream of Little Bridge Creek (Table 2).

The remaining 5 unique tag codes in the data set were not useful in assessing the potential impact of the weir. The first detections recorded for these fish in Little Bridge Creek all occurred at the upstream array. There are two likely explanations for these detection patterns. The first possibility is that the fish were upstream of the weir site prior to the installation of the upstream array and the first detection was the fishes' downstream migration. The other possibility is that the fish were not detected at the downstream array due incomplete array efficiency and the first detection was made at the upstream array as they were passing through the weir chute.

No occurrences of multiple detections at the downstream array, indicative of fish unwilling or able to bypass the weir, were observed during the study.

While we recognize that the PIT tag data from 2014 is missing detections (assumed low detection efficiency/ detection probability). We plan to continue monitoring steelhead travel time surround the weir and hope to improve the detection probabilities by install multiple antennas at each array. Antenna redundancy has been shown to improve array detection efficiency significantly (Connolly et al. 2008). If continued monitoring efforts find evidence of migrations delays associated with weir operation, operations can be modified, or suspended.

Table 4.3 - Migration summary for fish with complete upstream detection history. Travel time is calculated in hours.

PIT Code	Pre-Spawn Upstream Migration		Upstream Travel Time	Post-Spawn Downstream Detection		Downstream Travel Time	Comments
	Lower Array	Upper Array		Upper Array	Lower Array		
384.36F2B4A387	5/02/14 16:21	5/02/14 17:07	0.77	5/14/14 01:48	5/14/14 01:58	0.17	
3D6.000B40C2B6	4/21/14 12:16	4/21/14 13:14	0.97	6/04/14 05:14			
3DD.003BC4A0FF	4/22/14 12:35	4/22/14 17:40	5.08				
3D9.1C2DF64D2D	5/13/14 10:41	5/14/14 14:28	28.25		5/25/14 12:29		
	Mean		8.77				

Table 4.4 - Migration summary for fish with incomplete upstream detection history. Travel time is calculated in hours. Detections or observations listed in the comment section are what were used to justify if the detections were made during pre-spawn upstream migrations or post-spawn downstream migrations.

PIT Code	Pre-Spawn Upstream Migration		Upstream Travel Time	Post-Spawn Downstream Detection		Downstream Travel Time	Comments
	Lower Array	Upper Array		Upper Array	Lower Array		
3D9.1C2DF7EFF1	4/29/14 15:04			5/24/14 11:50	5/24/14 11:54	0.07	Detected RRJ[1] 5/25
3DD.003BC49A54	5/03/14 16:01			5/18/14 12:21			In trap box 5/18
3DD.003BC4A114	5/11/14 12:26			5/25/14 07:52	5/25/14 08:40	0.97	
3DD.003BC4A10D	5/15/14 11:33				5/21/14 14:02		Recap in BVC[2] 5/23
3DD.003BC4A0F9		4/23/14 19:28		4/24/14 08:54	4/24/14 14:31	5.62	In trap box 4/24
3DD.003BC4A100		4/23/14 22:50		4/24/14 12:58	4/24/14 14:30	1.53	Detected LTR[3] 4/25 and LMR[4] 4/30
3DD.003BC4A103		4/24/14 06:45			6/13/14 17:46		Detected RRJ[1] 6/18
3D9.1C2DEEDEF8		4/28/14 09:32		5/01/14 17:40	5/02/14 13:52		Detected LTR[3] 5/29
3DD.003BC4A0E5		4/30/14 13:49		4/30/14 16:33	5/01/14 14:32		In trap box 5/1. Detected LTR[3] 6/1
3DD.003BC4A0F0				5/28/14 19:39	5/28/14 19:51	0.20	Detected LTR[3] 5/31
3DD.003BC4A117				4/27/14 16:09	4/28/14 11:16	28.88	Detected LTR[3] 4/29

1 – Rocky Reach Juvenile Bypass, 2 – Beaver Creek, Methow Basin, 3 – Lower Twisp River, 4 – Lower Methow River

5 Future Activities

5.1 Kelt Collection

5.1.1 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. In 2014, the number of spawning pairs increased from 12 to 33. Further expansion of the steelhead program at WNFH could begin as early as 2015, which could again increase the number of spawning pairs required to meet USFWS minimum production goals, thus further increasing the number of NOR females available for 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 is expected to continue, which 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.

5.1.2 Temporary tributary weirs

In 2014, traps were installed at South Fork Gold Creek, Hancock Springs, and Little Bridge Creek. Beginning in 2015, the project also plans to add temporary weir traps on Libby Creek and Beaver Creek, which are tributaries to the Methow River. Traps are installed as early as possible in the spring relative to run timing for a specific year. The project expects to collect as many as 10 NOR females that are in spawning condition from the 5 weirs. If kelts from Rock Island or live-spawning provide adequate numbers to recondition, then UCKRP would consider not using the weirs.

5.1.3 Rock Island Dam

The collaboration with CPUD is expected to continue in 2015.

5.2 Kelt Reconditioning and Release

This activity will continue as it is currently, with increased numbers anticipated from new sources. A total of 76 were collected for 2014; 100 or more are expected in 2015. In 2014, based on survival rates at the reconditioning facility seen to date, YN could expect to see 35-44 reconditioned kelts released. In 2015, if YN obtains the predicted 100 kelts, between 45 and 60 reconditioned kelts would be released.

The UCKRP will explore the possibility of retaining non-rematuring kelts for additional reconditioning.

5.3 Monitoring and Evaluation

All reconditioned kelts are 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 install temporary PIT tag monitoring arrays will be installed at Little Bridge Creek and Libby Creek traps to determine if the traps are delaying fish migration.

5.4 Addressing ISRP Qualifications

The YN will begin addressing qualifications put for by the Independent Scientific Review Panel (ISRP) during the UCKRP 2014 check in. 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 will put forth significant effort to address each qualification within the scope of its project objectives.

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