UPPER-COLUMBIA RIVER STEELHEAD KELT RECONDITIONING PROJECT:

2015 ANNUAL REPORT
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Prepared by:
Matthew S. Abrahamse
Keely G. Murdoch

Yakama Nation
Fisheries Resource Management
P.O. Box 151
Toppenish, Washington 98948

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P.O. Box 3621
Portland, Oregon 97283-3621

Yakama Nation Fisheries
Toppenish, WA

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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 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 2015. 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 2015.

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 2015.

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, 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 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 operated in Little Bridge Creek (Figure 2.1) and Beaver Creek (Figure 2.2) in 2015. 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. Prior to the

season we intended to place weirs in South Fork Gold Creek, Hancock Springs, and Libby Creek. A decision was made not to operate the weirs in South Fork Gold Creek and Hancock Spring due to personnel limitations. These weirs were had the fewest number of NOR steelhead encountered the previous trapping season. The Libby Creek weir site was deemed infeasible to install a weir on and will not be pursued in the future.

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. A detailed description of this study can be found in Appendix B.

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 March 25, 2015 and concluded May 13, 2015. A total of 30 NOR females were live-spawned in 2015. No HOR females were live-spawned in 2015. There was 1 post-spawn mortality.

Spawning activities began at MSH on April 1, 2015 and concluded May 12, 2015. A total of 14 NOR females were live-spawned in 2015. There was one post-spawn mortality.

Table 1 - Females live-spawned at WNFH and MSH in 2015.

	NOR	HOR
WNFH	30	0
MORT	1	0
TOTAL	29	0
MSH	14	0
MORT	1	0
TOTAL	13	0

2.2.2 Weir Trapping

The weir in Little Bridge Creek was installed on April 2, 2015. A total of 21 steelhead were trapped in this weir: 12 males and 9 females (Table 2.2). Of the females trapped, four were NOR. These four NOR female kelts were transported to the MSKF for reconditioning. The weir was removed on June 7, 2015.

The weir in Beaver Creek was installed on April 12, 2015. A total of 10 steelhead were trapped in this weir, 6 males and 4 females. One of the females was a NOR kelt that was brought to the MSKF for reconditioning. Three of the females were HOR and released downstream. The weir was removed on May 17, 2015 due to high water conditions.

Table 2 - Summary data for fish encountered at the tributary weir traps in 2015.

	MALE		FEMALE - KELT		
SITE	HOR	NOR	HOR	NOR	TOTAL
Little Bridge	9	3	5	4	21
Beaver	4	1	3	1	10
TOTAL	13	4	8	5	31

2.2.3 Rock Island

Nine NOR kelts were collected from the Rock Island Dam juvenile bypass facility in 2015.

Table 3 - Summary of NOR kelt collection numbers in 2015.

Collection Location	# Collected
Winthrop NFH (Live-Spawn)	30
Methow Salmon Hatchery (Twisp Stock Live Spawn)	14
Little Bridge Creek Weir	4
Beaver Creek	1
Rock Island Dam Juvenile Bypass	9
Total	**58**

2.3 Discussion

We began the reconditioning process with a total of 58 NOR kelts were collected through live-spawning, weirs, and main stem dams (Table 2.3). The NOR female broodstock live spawned at WNFH and MSH have continued 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 in 2016. Up to 48 NOR females could be available for reconditioning from this WNFH. 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.

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 UCKRP collected 17 fewer NOR kelts in 2015 than the previous year. This is largely due to a reduced number of kelts collected at Rock Island Dam. Expectations have been lowered for Rock Island to produce as a consistent source of kelts after the number collected dropped from 26 in 2014 to 9 in 2015. It is suspected that drought conditions in the UCR and corresponding below average stream flows may have contributed to the below average number of kelts observed at Rock Island. Regardless of the cause, the number of kelts collected at Rock Island Dam will likely vary year to year.

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 2015.

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 the shifted to include 50% krill and 50% pellets for another one to two weeks and then 25% krill and 75% 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.

Release and Tracking

Kelts surviving to 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 8th 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) researcher 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 2015 reconditioning activities in October. The project began the reconditioning process with a total of 58 NOR steelhead kelts and 30 of those fish survived until their release in mid-October (Table 3.1).

Examinations of reconditioned kelts revealed greatly improved physical condition in nearly all fish. Large increases in body weight and high body fat percentage are often indicators of re-maturation of gametes. A summary of the weight gain and fat meter data can be found in Table 3.2.

Table 4 - 2015 MSKF kelt collection and release numbers.

Collection Location	# Collected	# Released
Winthrop NFH (Live-Spawn)	30	16
Methow Salmon Hatchery (Twisp Stock Live Spawn)	14	9
Little Bridge Creek Weir	4	0
Beaver Creek	1	0
Rock Island Dam Juvenile Bypass	9	5
Total	**58**	**30**

Table 5 - Summary of weight gain and fat meter readings from 2015 pre-release workup.

Metric	Weight Gain (kg)	Weight Gain (%)	Fat %
Mean	1.87	78	5.8
Maximum	3.76	159	8.8
Minimum	0.68	27	2.8

Results of the blood analysis demonstrated that 63% of the reconditioned kelts appeared to be re-maturing. 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 6 - Re-maturation rate by kelt collection methods.

		Non Re-maturing		Re-maturing	
Collection Type	Total	#	%	#	%
Live-spawning	26	10	38	16	62
Mainstem Dam	4	1	25	3	75
Total	*30*	*11*	*37*	*19*	*63*

All 30 kelts on station were released. Kelts originating in the Methow basin were released at river km 6 of the Methow River on October 7th and 8th. Kelts originating from Rock Island Dam were released into the Columbia River at river km 742 on October 9th.

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 2015, 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, 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 of 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 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.

S_r calculations have been completed for the MY 2013 reference group (Table 4-1). 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 4-1). 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 not been completed for MY 2015 reference group (Table 4-1). None of the reference group kelts were detected returning in 2015. The S_r calculations will be completed in fall of 2016. Once completed, the S_r values for the MY 2015 reference group will be compared to 30 of the 58 kelts in the UCKRP that survived to release (51.7%).

Table 7 - 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	-	48	-	58	30	51.7

S_s calculation have been completed for the MY 2013 reference group (Table 4-2). 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 calculation have not been completed for the MY 2014 reference group (Table 4-2). One of the reference group kelts was detected returning in the spring of 2015. S_s calculation for the MY 2014 reference group will completed in the spring of 2016. In comparison, 28 of the 58 kelts released by the UCKRP were detected in the UCR in spring of 2015.

S_s calculation have not been completed for the MY 2015 reference group (Table 4-2) and will be completed in 2017.

Table 8 - 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 (C_s)	Detected (Q_s + P_s)	Survival % (S_s)
2013	0	0	40	0	5	1	20.0
2014	1	-	103	-	58	28	48.3
2015	-	-	48	-	30	-	-

To date, 46% 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).

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 had the potential to return to the Twisp River in 2015.

Six reconditioned kelts released in 2014 were captured at the Twisp River weir 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 the six reconditioned fish and any first-time spawners sampled at Twisp Weir.

Nine kelts collected through live spawning at MSH were successfully reconditioned and released in 2015. The number returning to the Twisp River will be evaluated in the spring of 2016.

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. During this period WDFW conducts their annual steelhead run composition monitoring efforts at Wells Dam. Sampling occurs between August 1st and October 31st. During that time approximately 5% of the steelhead run over Wells Dam is sampled.

Trapping by WDFW occurred 3 days a week and sampling occurs the day after trapping. All fish from the first trapping day of the week were sampled and length, sex, scale samples, and tag presence data were collected. Following the second and third weekly trapping events only wild and/or unmarked fish were sampled.

The UCKRP had a goal to collect additional samples from up to 25 HOR and 25 NOR steelhead females per year. Additional sampling consisted of the collection of blood samples, fat meter readings, and weight data.

Data Collection

Blood sampling occurred immediately following the WDFW's sampling while the fish were anesthetized. The fish were held on a board with their head in the water. A syringe was inserted along the ventral midline between the anal fin and the tail (Figure 4.1) 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. The blood samples were then be processed by YN FRM personnel and shipped to a CRTIFC Fish Physiologist for analysis.

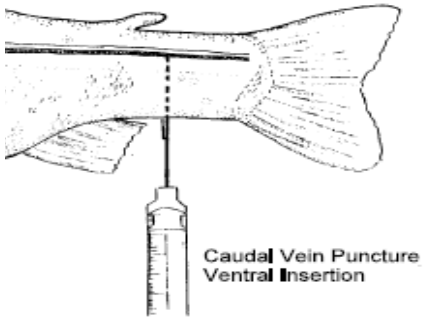

Figure 4.1 - Blood sampling location.

Muscle lipid levels were measured following blood sample collection using a Distell Fish Fatmeter model 692. Two readings were taken (locations 1 and 2; Figure 4.2) and the results averaged. Fish weight was measured to the nearest gram.

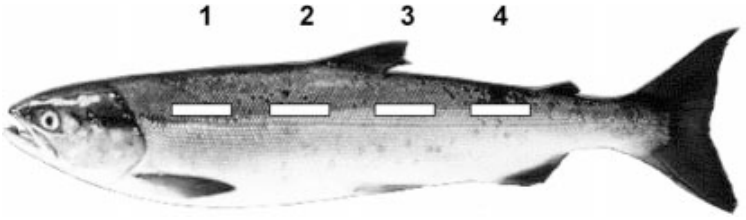

Figure 4.2 - Fatmeter reading locations. Readings are taken at locations 1 and 2.

Sampling will continue for up to 4 years.

Data Analysis

Blood samples were analyzed for concentrations of the maturation hormone estradiol in the blood plasma. Hormone concentration will be applied as an index for maturation timing. Length and weight data were used to calculate Fulton Condition Factor (K) and somatic lipid levels (%) were measured through Fatmeter readings. These metrics were used as indices of available energy stores. One-way ANOVA was be used to determine if there was a statistical difference in the three indices between reconditioned kelts at the time of release and first time HOR and NOR spawners.

4.3.2 Results

Sampling was conducted between September 28 and October 8, 2015. A total of 13 first time spawners were sampled at Wells Dam; 12 HOR and 1 NOR. Low water conditions during the sampling period resulted in fewer fish than expected available for sampling.

ANOVA calculations for estradiol concentration, K, and somatic lipid levels were made between the 30 reconditioned kelts released in 2015 and the 12 HOR first time spawners sampled at Wells Dam. Sample size for NOR first time spawners was too small for significant analysis.

No significant difference was found in the concentration of estradiol in the blood samples from reconditioned kelts and HOR first time spawners (p-value of 0.31). Both K and somatic lipid levels were found to be significantly greater in reconditioned kelts with p-values of <0.001 and 0.023 respectively. Mean K values were 1.17 for reconditioned kelts and 0.94 for first time HOR spawners. Mean somatic lipid levels were 5.7% for reconditioned kelts and 4.5% for first time HOR spawners.

4.3.3 Discussion

The project acknowledges that it is too early to make any assertions regarding differences between reconditioned kelts and first time spawners. Several years of data will need to be gathered and sample sizes must be increased, particularly for first time NOR spawners. However, preliminary data analysis suggests that reconditioned kelts may be maturing in similar timeframe to first time spawners and may have greater available energy stores to utilize during the overwinter, pre-spawning, and spawning periods.

The UCKRP will continue to data collection and analyses for the next several years. Progress in this matter will be included in future reports.

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 has begun to apply 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 will be conducted as part of the WDFW's Twisp RRS study. While the study is ongoing to date they have put their analysis on hold at the request of BPA in order to reduce current costs. When the analysis is complete we will be able to include this information in Section 4.2 of our reports.

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 4.4. 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 and create bias in any comparisons to maiden spawners.

Thus far, 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. Further research is needed to determine if the release of non-maturing kelts is a viable management option. The UCKRP is also exploring the possibility of retaining non-maturing kelts through a second reconditioning cycle and examining their maturation status the following year.

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 sense. It is unlikely that homing and straying rates can be quantified in any significant way. However, any unusual detection date suggesting that a kelt may be straying outside its natal basin will be noted in this report.

The WDFW has also begun implementing a two year steelhead radio telemetry study 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. It is hoped that this will provide insight into kelt movement during the post-release/pre-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. Studies are being developed to determine the best possible time and place to release reconditioned kelts. However, recent wildfire activity in the Methow Basin limited the number of suitable release sites in 2014 and 2015 making implementation of release site evaluations impossible. The wildfires in the Methow Basin have resulted in flooding and mudslides that have the potential to impact fish survival in downstream habitats, limiting the projects opportunities to conduct any meaningful studies on the effect of release location or timing on fish survival. Pursuit of release site evaluations will continue at a time when the UCKRP believes significant stochastic events are unlikely to bias results.

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. In 2014, the number of spawning pairs increased from 12 to 33. In 2015, 30 NOR females were spawned at WNFH. The WNFH steelhead program has plans to increase the number of spawning pairs in 2016. 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 2015 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.

6.1.2 Temporary tributary weirs

In 2015, traps were installed in Little Bridge Creek and Beaver Creek. The project plans to continue operating these weirs in 2016 and weirs will also be operated in South Fork Gold Creek and Hancock Springs. These weirs were not in operation in 2015 due to personnel limitations.

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 4 weirs. If kelts from Rock Island or live-spawning provide adequate numbers to recondition, then UCKRP would consider not using the weirs.

6.1.3 Rock Island Dam

The collaboration with CPUD is expected to continue in 2016. Expectations have been lowered for Rock Island to produce as a consistent source of kelts after the number collected dropped from 26 in 2014 to 9 in 2015. It is suspected that drought conditions in the UCR and corresponding below average stream flows may have contributed to the below average number of kelts observed at Rock Island. More years of data are need to establish if there is a relationship between peak discharge or some of variable and kelt numbers observed at Rock Island Dam. 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 2016 as it had the past 2 years. Increased numbers are anticipated in 2016 due to expansion of the WNFH steelhead program and a return to average stream flows potentially increasing the number of kelts at Rock Island Dam. It is hoped that the UCKRP will begin reconditioning with 100 or more are expected in 2016. Based on survival rates at the reconditioning facility seen to date, YN could expect to see 45 and 60 reconditioned kelts released.

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

6.3 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.

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

7 Literate Cited

Abrahamse, M. and K. Murdoch. 2012. Upper-Columbia River Steelhead Kelt Reconditioning Project: 2011 Annual Report. Annual Report to the Bonneville Power Administration for Project No. 2008-458-00. Prepared by Yakama Nation Fisheries Resource Management.

Behnke, R. J. 1992. Native trout of Western North America. American Fisheries Society, Monograph 6, Bethesda, Maryland.

Connolly, P. J., I. G. Jezorek, K. D. Martens, and E. F. Prentice. 2008. Measuring the performance of two stationary interrogation systems for detecting downstream and upstream movement of PIT-tagged salmonids. North American Journal of Fisheries Management 28:402-417.

Glover KA, O.B. Samuelsen, O.T. Skilbrei, K. Boxaspen, and B.T. Lunestad. 2010. Pharmacokinetics of emamectin benzoate administered to Atlantic salmon, Salmo salar L., by intra-peritoneal injection. Journal of Fish Disease 33:183-186.

Hatch, D.R., P.J. Anders, A.F. Evans, J. Blodgett, B. Bosch, D. Fast., and T. Newsome. 2002. Kelt reconditioning: A research project to enhance iteroparity in Columbia Basin steelhead (Oncorhynchus mykiss). 2001 Annual Report to U.S. Dept. of Energy, Bonneville Power Administration, Project No. 2000-017. Prepared by the Columbia River Inter-Tribal Fish Commission, Portland, OR.

Hatch, D.R., R. Branstetter, J. Blodgett, B. Bosch, D. Fast, and T. Newsome. 2003. Kelt reconditioning: A research project to enhance iteroparity in Columbia Basin steelhead (Oncorhynchus mykiss). Annual Report to the Bonneville Power Administration for Contract No. 00004185. Prepared by the Columbia River Inter-Tribal Fish Commission, Portland OR.

Hatch, D.R., R. Branstetter, J. Stephenson, A. Pierce, J. Whitekaer, and B. Bosch. 2012. Steelhead Kelt Reconditioning and Reproductive Success 2011 Annual Report. Annual Report to the Bonneville Power Administration for Contract No. 00004185. Prepared by the Columbia River Inter-Tribal Fish Commission, Portland OR.

Hatch, D., R. Branstetter, J. Stephenson, A. Pierce, A. Matala, R. Lessard, W. Bosch, S. Everett, N. Graham, L. Madeiros, L. Jenkins, M. Elliott, L. Caldwell, T. Cavileer, J. Nagler, M. Fiander, C. Frederickson, J. Blodgett, D. Fast, J. Newell, J. Whiteaker, R. Johnson. 2015. Kelt Reconditioning and Reproductive Success Evaluation Research 1/1/2014 - 12/31/2014 Annual Report to the U.S. Dept. of Energy, Bonneville Power Administration. Project No. 2007-401-00. Portland, OR: Prepared by the Columbia River Inter-Tribal Fish Commission.

Orr, W., J. B. Shrable, D.J. Abeyta, J. McFall, and D. Noble. 1999. Hydraulic Spawning of Rainbow Trout. Developments in Fish Culture. U.S. Fish and Wildlife Service, Ennis, MT.

Seamons T.R., *T*. P. Quinn. 2010. Sex-specific patterns of lifetime reproductive success insingle and repeat breeding steelhead trout (Oncorhynchus mykiss). 2010. Behavioral Ecology and Sociobiology 64:505–513.

Shrable, ,J. B., D. J. Abeyta, J. E. McFall, D. G. Noble, and W. H. Orr. 1999. Comparison of eye-up of rainbow trout eggs spawned by injecting oxygen at four, eight, twelve, and sixteen pounds of pressure versus spawning with hand pressure. Developments in Fish Culture. U.S. Fish and Wildlife Service, Ennis, MT.

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 CRW - Chewuch River above Winthrop	03/22/15 04/17/15	YES
3D9.1C2D73BE5A	WNFH	CRW - Chewuch River above Winthrop CRW - Chewuch River above Winthrop	03/11/15 04/02/15	YES
3D9.1C2D743279	WNFH	CRW - Chewuch River above Winthrop CRW - Chewuch River above Winthrop	03/23/15 04/24/15	YES
3D9.1C2D7442F9	WNFH	CRW - Chewuch River above Winthrop CRU - Upper Chewuch Instream Array RRJ - Rocky Reach Dam Juvenile	03/14/15 04/05/15 04/11/15	YES
3D9.1C2E0A38F1	WNFH	CRW - Chewuch River above Winthrop BCC - BON PH2 Corner Collector	03/08/15 06/07/15	YES
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 BCC - BON PH2 Corner Collector	04/03/15 04/29/15	NO
3D9.1C2DF64BDE	WNFH	RRJ - Rocky Reach Dam Juvenile RRJ - Rocky Reach Dam Juvenile	04/21/15 04/22/15	NO
3D9.1C2DF75115	WNFH	BCC - BON PH2 Corner Collector	05/04/15	NO
3DD.003BC49E73	WNFH	BCC - BON PH2 Corner Collector	05/18/15	NO

Tag Code	Origin	Detection Site	Event Date	Remature
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	
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

Tag Code	Origin	Detection Site	Event Date	Remature
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
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

Appendix B

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. Monitoring of steelhead travel time through the LBT weir continued in 2015.

Methods

The goal of this project was to determine whether or not the YN's operation of a temporary weir in Little Bridge Creek delayed the migration of adult steelhead to their spawning grounds. To accomplish this, the project used PIT tag records for the Twisp River and Little Bridge Creek to assess upstream travel time between two sites, the Twisp River weir and the temporary PIT array in Little Bridge Creek. PIT antenna arrays have been in operation above the Little Bridge Creek weir site two years in which the LBT weir was not in operation, 2011 and 2012, and two years in which the weir was in operation, 2014 and 2015. An ongoing Douglas Public Utility District and Washington Department of Fish and Wildlife project operates a channel spanning weir in the Twisp River downstream of the confluence with Little Bridge Creek. As a result nearly all adult steelhead in the upper Twisp River have PIT tags. It should be noted that the Little Bridge Creek weir was briefly operational in 2012 but the after the majority of upstream migration had already taken place.

Travel time was estimated between the Twisp River weir, where tagging or recapture data was recorded, and the site upstream of the Little Bridge Creek weir, where temporary PIT arrays were operational in 2011, 2012, 2014, and 2015. The PTAGIS database was used to query the time and date adult steelhead were detected upstream of the Little Bridge Creek weir site. A complete tag history of steelhead known to be present in Little Bridge Creek in a given year was then queried to identify the date and time the fish were tagged or recaptured at the Twisp River weir.

Travel time for an individual fish from the Twisp River weir to upstream of the Little Bridge Creek weir was estimated by calculating the difference in days between the last known mark/recapture event at the Twisp River weir and the first detection at the upstream array.

The project understood that the efficiency of the PIT tag detection arrays is always less than 100%. 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 at the Little Bridge Creek could result in fish not being recorded during their upstream migration. If the fish was tagged migrating downstream after spawning it would result in a large travel time estimate. However, the project expects that array efficiency would be relatively similar among the years studied and inflated travel times would likely occur at a similar rate.

Travel time estimates were compared among years using one-way ANOVA with an alpha level of 0.05. If differences between years were found with ANOVA, Tukey's test was applied to identify similarities and differences in travel time among years sampled.

Results and Discussion

Travel time calculations were made for 25 steelhead in 2011, 29 steelhead in 2012, 12 steelhead in 2014, and 22 steelhead in 2015. The mean travel time from Twisp River weir to the Little Bridge Creek PIT array ranged from 8.48 to 10.83 days (Table 1). Summaries of travel time calculations for each year can be found in Appendix C. ANOVA calculations revealed no statistical difference in travel time among the years with a p-value of 0.625.

Table 1 – Summary statistics for travel time estimations.

Year	Mean	SD	CI
2011	8.48	10.82	(4.24, 12.72)
2012	8.66	7.99	(5.75, 11.57)
2014	10.83	8.65	(5.94, 15.72)
2015	9.88	11.24	(5.94, 15.72)

This analysis could not find a significant difference in travel time before the Little Bridge Creek weir was operational (2011 and 2012) and during the weir's operation. It does not appear that the temporary picket weir for the collection of downstream migrating kelts is causing a measurable change in travel time for pre-spawn steelhead ascending Little Bridge Creek.

The YN would like to continue to operate the Little Bridge Creek weir and are requesting a 5-year Special Use Permit. The project plans to continue monitoring of travel times to insure that kelt collection efforts do not negatively impact steelhead migration. If continued monitoring efforts find evidence of migrations delays associated with weir operation, operations can be modified, or suspended.

Appendix C

Summary of travel time estimates for 2011. Little Bridge Creek detections are entered into PTAGIS as METHR with a conditional comment stating that the observation was made in Little Bridge Creek.

Tag Code	Event Type Name	Event Site Name	Event Date	Days
3D9.1C2D626BBA	Mark/Release	TWISPW	3/28/2011	35
	Recap	METHR	5/02/2011	
3D9.1C2D3DB679	Mark/Release	TWISPW	3/29/2011	1
	Recap	METHR	3/30/2011	
3D9.1C2D61F715	Mark/Release	TWISPW	3/29/2011	38
	Recap	METHR	5/06/2011	
3D9.1C2D627048	Mark/Release	TWISPW	3/31/2011	2
	Recap	METHR	4/02/2011	
3D9.1C2D625F43	Mark/Release	TWISPW	4/01/2011	4
	Recap	METHR	4/05/2011	
3D9.1C2D61DC07	Mark/Release	TWISPW	4/02/2011	3
	Recap	METHR	4/05/2011	
3D9.1C2D61ECC1	Mark/Release	TWISPW	4/05/2011	3
	Recap	METHR	4/08/2011	
3D9.1C2D625EF2	Mark/Release	TWISPW	4/07/2011	35
	Recap	METHR	5/12/2011	
3D9.1C2D61EBE4	Mark/Release	TWISPW	4/09/2011	2
	Recap	METHR	4/11/2011	
3D9.1C2D61EF9F	Mark/Release	TWISPW	4/09/2011	6
	Recap	METHR	4/15/2011	
3D9.1C2D6204EA	Mark/Release	TWISPW	4/17/2011	8
	Recap	METHR	4/25/2011	
3D9.1C2D62761F	Mark/Release	TWISPW	4/17/2011	9
	Recap	METHR	4/26/2011	
3D9.1C2D620521	Mark/Release	TWISPW	4/18/2011	1
	Recap	METHR	4/19/2011	
3D9.1C2D626C2D	Mark/Release	TWISPW	4/20/2011	12
	Recap	METHR	5/2/2011	
3D9.1C2D62064C	Mark/Release	TWISPW	4/22/2011	2
	Recap	METHR	4/24/2011	
3D9.1C2D6328D6	Mark/Release	TWISPW	4/23/2011	2
	Recap	METHR	4/25/2011	
3D9.1C2D61DCF5	Mark/Release	TWISPW	4/23/2011	2
	Recap	METHR	4/25/2011	
3D9.1C2D620F5F	Mark/Release	TWISPW	4/25/2011	0
	Recap	METHR	4/25/2011	

Tag Code	Event Type Name	Event Site Name	Event Date	Days
3D9.1C2D8E26FB	Recap	TWISPW	4/25/2011	1
	Recap	METHR	4/26/2011	
3D9.1C2D615369	Mark/Release	TWISPW	4/27/2011	13
	Recap	METHR	5/10/2011	
3D9.1C2D620F4B	Mark/Release	TWISPW	4/30/2011	11
	Recap	METHR	5/11/2011	
3D9.1C2D61E12A	Mark/Release	TWISPW	5/01/2011	8
	Recap	METHR	5/09/2011	
3D9.1C2D62852B	Mark/Release	TWISPW	5/04/2011	9
	Recap	METHR	5/13/2011	
3D9.1C2D62059A	Mark/Release	TWISPW	5/05/2011	2
	Recap	METHR	5/07/2011	
3D9.1C2D61EBED	Mark/Release	TWISPW	5/05/2011	3
	Recap	METHR	5/08/2011	

Summary of travel time estimates for 2012.

Tag Code	Event Type Name	Event Site Name	Event Date	Days
3D9.1C2D61F420	Mark/Release Recap	TWISPW LBRIC	4/10/2012 4/12/2012	2
3D9.1C2D6200A5	Mark/Release Recap	TWISPW LBRIC	4/10/2012 4/12/2012	2
3D9.1C2D60C772	Mark/Release Recap	TWISPW LBRIC	4/10/2012 4/12/2012	2
3D9.1C2D616C06	Mark/Release Recap	TWISPW LBRIC	4/12/2012 4/14/2012	2
3D9.1C2D4608BD	Mark/Release Recap	TWISPW LBRIC	4/12/2012 4/14/2012	2
3D9.1C2D41BDDE	Recap Recap	TWISPW LBRIC	4/12/2012 4/14/2012	2
3D9.1C2D61E377	Mark/Release Recap	TWISPW LBRIC	4/14/2012 4/20/2012	6
3D9.1C2D461C8F	Mark/Release Recap	TWISPW LBRIC	4/16/2012 4/21/2012	5
3D9.1C2D872304	Mark/Release Recap	TWISPW LBRIC	4/17/2012 4/29/2012	12
3D9.1C2D3F6D03	Recap Recap	TWISPW LBRIC	4/19/2012 4/20/2012	1
3D9.1C2D7C2A72	Mark/Release Recap	TWISPW LBRIC	4/20/2012 5/13/2012	23
3D9.1C2D66C317	Mark/Release Recap	TWISPW LBRIC	4/21/2012 4/22/2012	1
3D9.1C2D7AE138	Mark/Release Recap	TWISPW LBRIC	4/21/2012 4/22/2012	1
3D9.1C2D8877B7	Mark/Release Recap	TWISPW LBRIC	4/21/2012 4/22/2012	1
3D9.1C2D84AAFD	Mark/Release Recap	TWISPW LBRIC	4/21/2012 4/27/2012	6
3D9.1C2D8A3D2E	Mark/Release Recap	TWISPW LBRIC	4/21/2012 5/18/2012	27
3D9.1C2D3F8801	Recap Recap	TWISPW LBRIC	4/22/2012 5/13/2012	21
3D9.1C2D45FECC	Mark/Release Recap	TWISPW LBRIC	4/22/2012 5/15/2012	23
3D9.1C2D61677B	Recap Recap	TWISPW LBRIC	4/23/2012 4/28/2012	5

Tag Code	Event Type Name	Event Site Name	Event Date	Days
3D9.1C2D60BC0B	Mark/Release	TWISPW	4/23/2012	18
	Recap	LBRIC	5/11/2012	
3D9.1C2D8D0AD5	Recap	TWISPW	4/23/2012	19
	Recap	LBRIC	5/12/2012	
3D9.1C2D460282	Mark/Release	TWISPW	4/24/2012	14
	Recap	LBRIC	5/08/2012	
3D9.1C2D6150D8	Recap	TWISPW	4/25/2012	18
	Recap	LBRIC	5/13/2012	
3D9.1C2D8F86F0	Recap	TWISPW	5/03/2012	10
	Recap	LBRIC	5/13/2012	
3D9.1C2CBE7CF0	Mark/Release	TWISPW	5/09/2012	6
	Recap	LBRIC	5/15/2012	
3D9.1C2D8EA363	Recap	TWISPW	5/10/2012	3
	Recap	LBRIC	5/13/2012	
3D9.1C2D8C64EB	Recap	TWISPW	5/13/2012	7
	Recap	LBRIC	5/20/2012	
3D9.1C2D46241B	Recap	TWISPW	5/14/2012	2
	Recap	LBRIC	5/16/2012	

Summary of travel time estimates for 2014.

Tag Code	Event Type Name	Event Site Name	Event Date	Days
3DD.003BC4A100	Mark/Release	TWISPW	4/14/2014	10
	Obs	LBT	4/24/2014	
3DD.003BC4A0FF	Mark/Release	TWISPW	4/16/2014	6
	Obs	LBT	4/22/2014	
3DD.003BC4A103	Mark/Release	TWISPW	4/16/2014	14
	Obs	LBT	4/30/2014	
3DD.003BC4A0F9	Mark/Release	TWISPW	4/17/2014	6
	Obs	LBT	4/23/2014	
3DD.003BC4A11D	Mark/Release	TWISPW	4/18/2014	6
	Obs	LBT	4/24/2014	
3DD.003BC4A117	Recap	TWISPW	4/27/2014	1
	Obs	LBT	4/28/2014	
3D9.1C2DF64D2D	Recap	TWISPW	4/27/2014	17
	Obs	LBT	5/14/2014	
3DD.003BC4A114	Recap	TWISPW	4/27/2014	27
	Obs	LBT	5/24/2014	
3DD.003BC4A12E	Mark/Release	TWISPW	4/28/2014	1
	Obs	LBT	4/29/2014	
384.36F2B4A387	Recap	TWISPW	5/01/2014	1
	Obs	LBT	5/02/2014	
3DD.003BC49A54	Mark/Release	TWISPW	5/02/2014	16
	Obs	LBT	5/18/2014	
3DD.003BC49A33	Mark/Release	TWISPW	5/02/2014	25
	Obs	LBT	5/027/2014	

Summary of travel time estimates for 2015.

Tag Code	Event Type	Event Site	Event Date	Days
3DD.003BC452C4	Mark/Release	TWISPW	3/02/2015	83.00
	Obs	LBT	5/24/2015	
3DD.003BC452DA	Mark/Release	TWISPW	3/22/2015	31.00
	Obs	LBT	4/22/2015	
3DD.0077529ECD	Recap	TWISPW	3/27/2015	32.00
	Obs	LBT	4/28/2015	
3DD.003BC452B4	Mark/Release	TWISPW	3/28/2015	12.00
	Obs	LBT	4/09/2015	
3DD.003BC452F5	Mark/Release	TWISPW	3/28/2015	12.00
	Obs	LBT	4/09/2015	
3DD.003BC452E0	Mark/Release	TWISPW	3/28/2015	17.00
	Obs	LBT	4/14/2015	
384.36F2B48819	Recap	TWISPW	4/17/2015	26.00
	Obs	LBT	5/13/2015	
3DD.003BC452CB	Mark/Release	TWISPW	4/19/2015	11.00
	Obs	LBT	4/30/2015	
3DD.0077538A04	Recap	TWISPW	4/19/2015	14.00
	Obs	LBT	5/03/2015	
3DD.007754E851	Recap	TWISPW	4/20/2015	2.00
	Obs	LBT	4/22/2015	
3DD.0077556117	Recap	TWISPW	4/20/2015	23.00
	Obs	LBT	5/13/2015	
3DD.003BC452EE	Mark/Release	TWISPW	4/21/2015	1.00
	Obs	LBT	4/22/2015	
3DD.003BC45303	Mark/Release	TWISPW	4/21/2015	1.00
	Obs	LBT	4/22/2015	
3DD.003BC45308	Mark/Release	TWISPW	4/22/2015	0.00
	Obs	LBT	4/22/2015	
3DD.003BC453CC	Mark/Release	TWISPW	4/28/2015	0.00
	Obs	LBT	4/28/2015	
3DD.007754F935	Recap	TWISPW	4/28/2015	1.00
	Obs	LBT	4/29/2015	
3DD.003BC453C9	Mark/Release	TWISPW	4/28/2015	2.00
	Obs	LBT	4/30/2015	
3DD.003BC452DD	Recap	TWISPW	4/28/2015	3.00
	Obs	LBT	5/01/2015	
3DD.003BC45382	Mark/Release	TWISPW	4/30/2015	0.00
	Obs	LBT	4/30/2015	
3DD.003BC45387	Mark/Release	TWISPW	4/30/2015	1.00
	Obs	LBT	5/01/2015	
3DD.00773AA8DE	Recap	TWISPW	5/09/2015	6.00
	Obs	LBT	5/15/2015	
3DD.0077554588	Recap	TWISPW	5/12/2015	1.00
	Obs	LBT	5/13/2015	