UPPER-COLUMBIA RIVER STEELHEAD KELT RECONDITIONING PROJECT:

2019 ANNUAL REPORT
February 1, 2019 through January 31, 2020

Prepared by:
Matthew S. Abrahamse
Keely G. Murdoch

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

January 2020

Prepared for

Project # 2008-458-00
Contract #56662 REL 174
U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97283-3621

Yakama Nation Fisheries
Toppenish, WA

Table of Contents

List of Figures

List of Tables

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. Kelt reconditioning is defined as culturing post-spawn steelhead for 6-10 months in a captive environment where they reinitiate feeding, grow, and redevelop mature gonads. It is believed that kelt reconditioning may help counter the selective forces against iteroparity imposed by the hydroelectric power systems and provide benefits in addressing the population demographic and genetic issues in steelhead recovery (Hatch et al. 2002, 2003, and 2012).

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

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

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

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

This report will provide a summary of the steelhead kelt reconditioning efforts undertaken by this project in 2019. Topics address will include: kelt collection efforts, kelt reconditioning efforts, monitoring and evaluation efforts, and future project direction.

2 Kelt Collection

Identifying reliable places to collect natural origin (NOR) steelhead kelts has been critically important to the success of the UCKRP. Unlike kelt reconditioning projects in the Yakima River in Washington and Clearwater River in Idaho, the Methow River does not have an in-basin collection or trapping location for downstream migrating adult salmonids. 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.

Regionally, 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 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 include 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. All live-spawning has been conducted at WNFH since 2017, due to an agreement among co-managers and regulatory agencies comprising the Wells HCP Hatchery Committee to combine the broodstock for the two conservation hatchery programs.

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 prolific 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 would have spawned in the Methow, Okanogan, Entiat, and Wenatchee Rivers, or small tributaries to the Columbia River. Kelts have historically been encountered incidentally during Chelan County Public Utility District (CPUD) juvenile sampling at Rock Island. An arrangement was reached in 2014 with CPUD to allow kelts trapped during their normal spring sampling period to be included in the UCKRP.

This section will provide a summary of kelt collection activities in 2019.

2.1 Methods

2.1.1 Live-Spawning

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

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

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

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

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

2.1.2 Weir Trapping

Site Selection

Trapping locations were selected based on four criteria: manageable spring stream discharge, site morphology that includes pools or slow water, site access, and documented 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 with minimal stress. Only streams in which five or more redds had be observed within the last five years were considered for trapping so that resources were being spent in streams with a higher likelihood of encounter kelts.

Weirs were to be operated in Little Bridge Creek (Figure 2.1) and Beaver Creek (Figure 2.2) in 2019. The weir on Little Bridge Creek was located 0.15 river miles from the confluence with the Twisp River. At this point, reduced gradient creates a wide pool area where water velocity is diminished. The site was accessed from a small two-track road off of National Forest Development Road 4415. The weir on Beaver Creek was located 0.15 river miles from the confluence with the Methow River.

Figure 2.1 - Little Bridge Creek weir trap.

Figure 2.2 - Beaver Creek weir trap.

Weir Design

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

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

Weir Operation

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

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

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

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

2.1.3 Rock Island Dam

Kelts were encountered by CPUD during their operation of the Rock Island Dam juvenile bypass trap. Kelts suitable for reconditioning were retained in an aerated tank onsite to until UCKRP staff were able to transport the kelts 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. Kelts meeting the criteria were collected during normal sampling at Rock Island Dam. CPUD staff would hold the kelts in a large flow-through tank for no more than 24 hours. YN staff transport all Rock Island Dam collected kelts to the MSKF.

2.2 Results

2.2.1 Live Spawning

Spawning activities began at Winthrop NFH on April 10, 2019 and concluded May 22, 2019. A total of 60 NOR females were live-spawned in 2019. No HOR females were live-spawned. There were 5 post-spawn mortalities.

Table 1 – Females live-spawned at WNFH and MSH in 2018.

	NOR	HOR
WNFH	60	0
MORT	5	0
TOTAL	59	0

2.2.2 Weir Trapping

The Little Bridge Creek weir trap was installed in late-May and was operated until mid-June. Eight steelhead were trapped during the limited weir operation: one HOR males and seven NOR males. No females were encountered during limited trap operation.

The Beaver Creek weir was not operated in 2019 due to concerns related to high stream discharge.

2.2.3 Rock Island

Two NOR kelts were collected from the Rock Island Dam juvenile bypass facility in 2019.

Table 2 – Summary of NOR kelt collection numbers 2017.

Collection Location	# Collected
Winthrop NFH (Live-Spawn)	60
Little Bridge Creek Weir	0
Rock Island Dam Juvenile Bypass	2
Total	**62**

2.3 Discussion

In 2019, we collected a total of 62 NOR kelts through a combination of live-spawning, weir traps, and Rock Island Dam (Table 2). The NOR female broodstock live spawned at WNFH have continued to be an important part of the project. 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 ability to operate weir traps is limited by high stream discharge. However, we believe that there is value in using weirs to supplement live-spawning and Rock Island Dam collections traps when conditions allow. NOR females are scarce in the Methow and Twisp basins and 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.

Collections at Rock Island Dam vary annually. Annual variations in the number of kelts collected are linked to a combination of factors, including: timing of peak stream discharge, the magnitude of stream discharge, and the size of the NOR spawning population above Rock Island Dam. However, the cooperation and coordination with CPUD at Rock Island allows us to collect kelt opportunistically. The project's collection efforts are directly proportional to the number of kelts being captured at Rock Island Dam.

3 Kelt Reconditioning

The UCKRP implements long-term kelt reconditioning techniques in pursuit of its project objectives. Long-term recondition has been determined to be more effective at improving kelt survival than either short-term reconditioning or transporting unfed kelts (Hatch et al. 2012).

Long-term reconditioning is the process where steelhead kelts are collected through live-spawning or during their seaward migration, held and cultured in large tanks, and released in fall to coincide with the return of maiden spawners from the ocean. Prior to 2016, all kelts were released after approximately six months of reconditioning, regardless of their maturation status. Beginning in 2016, the UCKRP modified of its reconditioning practices to better address the different life history strategies observed in naturally occurring kelts, consecutive repeat spawners and skip repeat spawners.

Consecutive repeat spawners are those that return to spawn in the same calendar year as their outmigration. Skip repeat spawners are those that return the calendar year after their outmigration. It has been observed that steelhead populations that travel further upstream to spawn (i.e. Upper Columbia and Snake rivers and their tributaries) have a higher prevalence of skip repeat spawners (Keefer et al 2008).

The section describes the reconditioning efforts that the UCKRP conducted during 2019.

3.1 Methods

Methow Steelhead Kelt Facility

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

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

Treatment

Emamectin Benzoate

Kelts held for an extended period time in a captive environment are susceptible to severe infestation of parasitic copepods of the genus *Salmonicola*. These copepods attach to the gill lamellae and can inhibit oxygen uptake and gas exchange at the gill lamelle/water surface interface. All kelts coming into the reconditioning program received an injection of emamectin

benzoate for the treatment of parasites. The emamectin was administered at a dosage of 200 micrograms per kilogram of body weight which was injected into the body cavity.

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

Formalin

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

Feeding

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

Mortalities

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

Prior to 2016, project survival rate was calculated for the period between the date of collection of the first kelt and the date of release. From 2016 onward, survival rate will be calculated from the previous reporting period's release date to the release date of the current reporting period. This will allow inclusion of skip-spawners retained at MSKF in annual survival rate calculations.

Pre-Release Sampling

All kelts surviving to October were sampled to assess reconditioning effectiveness and maturation status. Data collected included: fork and POH lengths, weight, body fat percentages, and blood samples.

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

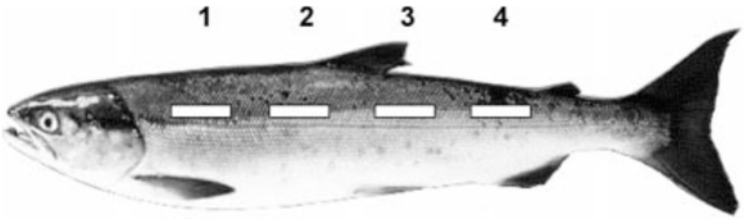

Figure 3.1 - Fatmeter reading locations. Readings are taken at locations 1 and 2

.

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

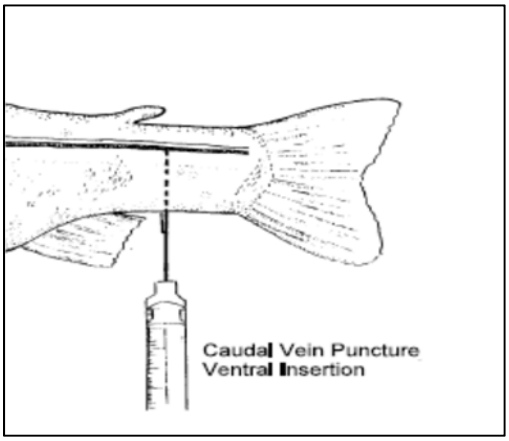

Figure 3.2 - Blood sampling location.

Length and weight data was used to calculate Fulton Condition Factor (K). K and body fat percentage were used as indices of available energy. One-way ANOVA was applied to compare K values and body fat percentage among sample years. If differences between groups were found with ANOVA, Tukey's test was used to identify where differences originated. All tests were done using an alpha level of 0.05. Mean fork length at collection was also calculated and used as an index of fish age.

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

Release and Tracking

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

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

3.2 Results

The UCKRP completed its 2019 reconditioning activities in October. The project began the reconditioning process with a total of 62 NOR steelhead kelts collected in 2019 and 24 skip-spawners retained from the 2018 collections (Table 3).

Table 3 – Number of kelts collected, released, and retained by the UCKRP in 2019.

Collection Location	Collected	Released	Retained
Winthrop NFH	60	15	14
Little Bridge Creek weir trap	0	0	0
Rock Island Dam Juv. Bypass	2	1	0
2018 Skip-Spawners	24	5	0
Total	**86**	**21**	**14**

A total of 35 kelts survived until release. Total survival rate for kelts in 2019 was 40.7%. The 2019 survival rate was below the seven-year project average (Table 4). Thirty of the 62 kelts collected in 2019 survived to release, a group survival rate of 48.4%. Five of the 24 skip-spawner kelts held over from 2018 survived to release, a group survival rate of 20.8%. Mean fork length at time of collection was 651 mm, greater than the project mean.

Blood plasma estradiol analysis revealed that 21 of the 35 surviving female kelts were maturing or borderline. Overall maturation rate for 2019 was 60.0%. Sixteen of the 30 surviving kelts collected in 2019 were maturing, a maturation rate of 53.3%. All 5 surviving skip-spawners from 2018 were determined to be maturing. All maturing kelts were released into the Methow River.

Table 4 – Summary of project survival and maturations for project years 2013-2018. Mean fork length at collection ($\bar{x}$ FL) was included as an index of fish age. Greater may $\bar{x}$ FL be correlated with survival rate.

Project Year	# Collected	$\bar{x}$ FL (mm)	# Surviving	Survival Rate	# Maturing	Maturation Rate
2013	9	-	6	66.7%	4	66.7%
2014	76	618	58	76.3%	31	53.4%
2015	58	669	30	51.7%	19	63.3%
2016	69	630	53	76.8%	32	60.4%
2017	88	705	46	52.3%	29	63.0%
2018	103	605	56	54.4%	32	57.1%
2019	86	651	35	40.7%	21	60.0%
Mean	**70**	**646**	**40**	**59.8%**	**24**	**60.6%**

One-way ANOVA analysis indicated that mean K and body fat percentage of kelts released in 2019 was not significantly different than kelts released in in previous years. A summary of the mean values and 95% confidence intervals can be found in Table 5.

Table 5 – Summary of condition factor (K) and body fat percentage from 2014 to 2019.

	K		Fat %	
Project Year	Mean	95% CI	Mean	95% CI
2014	1.17	(1.13, 1.20)	5.2	(4.7, 5.8)
2015	1.17	(1.13, 1.22)	5.8	(5.2, 6.3)
2016	1.19	(1.15, 1.23)	4.9	(4.5, 5.4)
2017	1.09	(1.05, 1.13)	5.0	(4.4, 5.5)
2018	1.12	(1.08, 1.16)	5.4	(4.9, 5.9)
2019	1.15	(1.11, 1.18)	5.2	(4.5, 5.9)

All maturing kelts were released into the Methow River on November 5, 2019. The kelts were released at river kilometer 1 (near Pateros, WA). Of the kelts released in, 16 were collected in 2019 and 5 were skip-spawners collected in 2018. No kelts were released into the Columbia River in 2019.

The remaining 14 kelts, 40.0% of those surviving to release, were determined not to be maturing. These fish were considered skip-spawners and were retained at the MSKF to undergo an additional year of reconditioning.

3.3 Discussion

Overall project survival in 2019 was the lowest observed since the project moved to full performance. Below average survival was seen in both the kelts collected in 2019 and skip-spawners collected in 2018. We have determined through data analysis that kelts that survive through reconditioning have significantly smaller mean fork length, POH length, and weight than kelts that do not survive. The surviving kelts are also significantly younger than those that do not survive. A full description of these analyses can be found in Appendix A.

The results of reconditioning skip-spawners from 2017 and 2018 was not as successful it was in 2016. However, survival rate for these fish would likely have been even lower if the kelts were not held for additional reconditioning. Only 18% of the skip-spawners released before 2016 were ever detected at PIT tag arrays following release. The majority of the detections that were made indicated that these fish were likely attempting to return to the ocean without having spawned (Appendix B).

4 Monitoring and Evaluation

Ongoing monitoring and evaluation (M&E) efforts are being conducted to evaluate the efficacy of long-term reconditioning to aide as a recovery tool for UCR steelhead. The focus of these M&E efforts in 2019 was addressing two 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?

The UCKRP continued answering these questions by examining post-release movement and survival of reconditioned kelts and reproductive success of reconditioned kelts. A study comparing maturation status and available energy between reconditioned kelts and maiden spawning steelhead was completed in 2018. A description of the study can be found in the 2018 annual report (Abrahamse and Murdoch 2019).

4.1 Movement and Survival

The demonstration of improved survival of iteroparous steelhead in the Upper Columbia is important to understanding the contribution of kelt reconditioning 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 PIT tag data. The PTAGIS database was used to identify known UCR steelhead demonstrating downstream migration consistent with iteroparous life history. Two criteria were used in choosing steelhead for the reference group: (1) tagged or recapture as adults in the Upper Columbia and (2) demonstrated downstream movement in the Columbia River following spawning.

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

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

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

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

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

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

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

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

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

4.1.2 Results

The number of fish in the reference group and reconditioned kelt group for each MY can be found in Table 7.

S_r calculations have been completed for the MY 2013 reference group (Table 6). 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 6). Three of the reference group kelts were detected returning in 2014 and no kelts were detected in 2015 (S_r = 2.9). In comparison, 58 of the 76 kelts in the UCKRP survived to release (76.3%).

S_r calculations have been completed for MY 2015 reference group (Table 6). None of the reference group kelts were detected returning in 2015 or 2016. In comparison, 30 of the 58 kelts in the UCKRP survived to release (51.7%).

S_r calculations have been completed for MY 2016 reference group (Table 6). None of the reference group kelts were detected returning in 2016 or 2017. In comparison, 50 of 69 kelts in the UCKRP survived to release (72.5%).

S_r calculations have been completed for MY 2017 reference group (Table 6). None of the reference group kelts were detected returning in 2017 or 2018. In comparison, 19 of the 67 kelts in the UCKRP survived to release (28.4%).

S_r calculations have been completed for MY 2018 reference group (Table 6). None of the reference group kelts were detected returning in 2018 or 2019. In comparison, 29 of the 84 kelts in the UCKRP survived to release (34.9%).

S_r calculations have not been completed for MY 2019 reference group (Table 6). S_r calculations will be completed in the fall of 2020. Once complete, the S_r values for MY 2019 will be compared to the 16 kelts surviving to release in 2019 and the number of surviving skip spawners to be released in 2020.

Table 6 – 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. The number of 2018 skip-spawners released (marked with *) will be updated in the 2019 annual report if mortalities are observed.

	In-River Reference Group				Project Group			
Maiden Year	Q_r	P_r	C_r	S_r	Collected (C_r)	Released (Q_r)	Skips Released (P_r)	Survival % (S_r)
2013	0	0	40	0.0	9	6	NA	66.7
2014	3	0	103	2.9	76	58	NA	76.3
2015	0	0	48	0.0	58	30	NA	51.7
2016	0	0	53	0.0	69	32	18	72.5
2017	0	0	47	0.0	67	11	8	28.4
2018	0	0	56	0.0	83	24	5	34.9
2019	0	-	263		62	16	14*	32.3

S_s calculations have been completed for the MY 2013 reference group (Table 7). None of the reference group kelts were detected returning in the spring of 2014 or 2015 (S_r = 0.0). In comparison, 1 of the 5 (20.0%) kelts released by the UCKRP were detected in the UCR in spring of 2014.

S_s calculations have been completed for the MY 2014 reference group (Table 7). One of the reference group kelts was detected returning in the spring of 2015. No reference group kelts were detected returning in spring of 2016 (S_r = 0.9). In comparison, 31 of the 58 kelts released by the UCKRP were detected in the UCR in spring of 2015 (54.4%).

S_s calculations have been completed for the MY 2015 reference group (Table 7). No reference group kelts were detected returning in spring 2016 or 2017. In comparison, 13 of the 30 kelts released by the UCKRP were detected in the UCR in spring of 2016 (43.3%).

S_s calculations have been completed for the MY 2016 reference group (Table 7). No reference group kelts were detected returning the spring 2018 or 2019. To date, 50 kelts collected in 2016 have been released, 32 were released in 2016 and 18 were released as skip-spawners in 2017. Thirty-two of the 50 kelts released by the UCKRP were detected in the UCR in spring of 2017 and 2018 for a survival rate of 57.8%.

S_s calculations have been completed for the MY 2017 reference group (Table 7). Nineteen kelts collected in 2017 have been released. Six of the kelts released by the UCKRP were detected in the UCR in the spring of 2018 and 2019 for a survival rate of 31.6%.

Table 7 – 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. The number of 2018 skip-spawners released (marked with *) will be updated in the 2019 annual report if mortalities are observed.

	In-River Reference Group				Project Group			
Maiden Year	Q_s	P_s	C_s	S_s	Released (C_s)	Detected (Q_s)	Skips Detected (P_s)	Survival % (S_s)
2013	0	0	40	0.0	5	1	0	20.0
2014	1	0	103	0.9	58	31	2	56.9
2015	0	0	48	0.0	30	13	0	43.3
2016	0	0	53	0.0	50	23	10	64.0
2017	0	0	47	0.0	19	4	2	31.6
2018	0	-	56	-	29	20	-	-
2019	-	-	263	-	16*	-	-	-

S_s calculations for the MY 2018 reference group will be completed in 2020 (Table 7). No reference group kelts were detected returning in spring 2019. Twenty 29 reconditioned kelts collected in 2018 have been released. Twenty of the 24 MY18 kelts released by the UCKRP were detected in the UCR in the spring of 2019. The skip spawners collected in MY 18 and released in 2019 will be included in the analysis once detections are made in the spring of 2020.

To date, 53.9% 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 B).

4.1.3 Discussion

Ongoing monitoring data continues to suggest that long-term reconditioning efforts improve indices of survival to return and survival to spawn. Repeat spawning of non-reconditioned kelts in the natural environment appears to be uncommon. We recognize that PIT tag detections alone are not sufficient to make definitive claims on the ability of steelhead kelt reconditioning to contribute to steelhead recovery in the UCR. However, when these data are view alongside other metrics, such as reproductive success, we may be able to infer the contribution of the UCKRP to steelhead populations compared to a no-action alternative.

4.2 Reproductive Success

The documentation of the reproductive success of reconditioning kelts has been a key goal of the project since its inception, as is demonstrated by the project's Objective 3. YN acknowledges that tracking the kelts to the spawning ground may indicate a spawning event, but will not confirm that the success of the spawning event. Documentation of living offspring from reconditioned kelts spawning in the wild is an important step in the assessment of long term reconditioning as a contributor to steelhead recovery in the UCR.

WDFW is currently operating a multi-generational relative reproductive success (RRS) study 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) (Goodman et al 2018). The Twisp RRS study documents living offspring. It uses genetic testing to assign parents to juvenile steelhead collected in the Twisp.

The UCKRP has prioritized the collection, reconditioning, and release of Twisp River origin steelhead kelts to coincide with this ongoing study. The reconditioning and release of Twisp River-origin kelts will allow their inclusion in the Twisp RRS study when they return to the Twisp to spawn, thus providing a direct means to document the reproductive viability of reconditioned kelts. The steelhead RRS study in the Twisp River is the only such study in the UCR Basin which plans to include reconditioned kelts in the analysis of relative reproductive success of steelhead in the natural environment.

4.2.1 Methods

A description of the protocols used by WDFW for the Twisp RRS can be found in at https://www.monitoringresources.org/Document/Protocol/Details/121.

Descriptions of reconditioning and release methodologies can be found in Section 3 of this report.

4.2.2 Results

Between 2014 and 2019, nearly 30 successfully reconditioned (Table 8), Twisp River origin kelts have been released. Most of these fish were lived spawned broodstock from the Douglas County PUD Twisp River Steelhead Program. Twisp River origin fish collected at the Little Bridge Creek weir and Rocks Island Dam have also been released.

Table 8 – The number of Twisp River origin reconditioned kelts released and included in the Twisp Reproductive Success Study.

Release Year	N Released	N Twisp RRS
2014	10	6
2015	5	2
2016	4	3
2017	0	0
2018	5	5
2019	3	

Results from the Twisp RSS have been received for fish that spawned in 2015 and 2016. Eight reconditioned kelts released in 2014 (N=6) and 2015 (N=2) were sampled by WDFW and included in the Twisp RRS. The WDFW found evidence that all eight reconditioned kelts produced age-1 offspring. Reconditioned kelts produced an average of 13.5 age-1 offspring per spawner. The average age-1 offspring produced by reconditioned kelts was greater than the average of maiden spawning NOR females (11.48 age-1 offspring per spawner), HOR females (6.1 age-1 offspring per spawner), and one natural NOR female kelt (0 age-1 offspring) (Ben Goodman et al 2020). A summary of the 2015 and 2016 Twisp RRS study results can be found in Table 9.

Table 9 – Summary of the results for 2015 and 2016 of the Twisp RRS study. Includes sample size (N), mean number of offspring per spawner ($\bar{x}$), standard deviation (SD), and 95% confidence intervals.

Group	N	$\bar{x}$	SD	95% CI
HOR Maidens	37	6.11	8.65	(3.32, 8.65)
NOR Maidens	46	11.48	15.00	(7.15, 15.80)
Recond. Kelts	8	13.50	9.98	(6.58, 20.40)
Natural Kelts	1	0	-	-

Three reconditioned kelts released in 2016 were sampled by WDFW in 2017 and included in the Twisp RRS study. Results from these release groups are forthcoming.

No kelts released in 2017 were included in the Twisp RRS study.

Five reconditioned kelts released in 2018 were sampled by WDFW in 2019 and included in the Twisp RRS study. Any progeny of these kelts will be available to be sampled by WDFW as age 1s in 2020.

4.2.3 Discussion

Continued documentation of living offspring from reconditioned kelts in the UCR is valuable evidence that project fish may be contributing to productivity of the natural population. The mean number of age-1 offspring produced was higher for reconditioned kelts than both NOR and HOR maiden female spawners in 2015 and 2016.[1]

Analysis comparing the relative reproductive success of maiden spawners and reconditioned kelts is in the preliminary stages. Interpretation of the data may continue to change as additional year-classes are sampled and the sample size of reconditioned kelts increases.

A greater sample size of reconditioned kelts and their progeny are needed before the relative reproductive success of reconditioned kelts, and both NOR and HOR maiden spawners can be compared with a higher degree of certainty. However the documentation of reproductive success for a reconditioned kelt is significant and likely indicates that life-time reproductive success of repeat spawning reconditioned kelts is higher than steelhead which are only able to complete a single spawning event. Live-spawning of NOR females from the Methow/Twisp River Steelhead Programs will continue for the foreseeable future, however recent changes in hatchery program management will likely reduce the number of Twisp specific broodstock available for reconditioning.

It is important to note that, regardless of any similarities or differences in relative reproductive success quantified through ongoing monitoring, successful spawning by a reconditioned kelts adds juveniles to the population that would be otherwise absent. Most, if not all, of the reconditioned kelts released by this project would not have survived to repeat spawn. Comparison of indices of survival between reconditioned kelts and an in-river reference group can be found in Section 4.1 of this report. Reconditioning can increase the lifetime reproductive success of an individual fish beyond what would be allowable without intervention (Seamons and Quinn 2010).

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]This is contrary to what was reported in the 2018 annual report (Abrahamse and Murdoch 2019). Data documenting age-1 offspring of reconditioned kelts became available after the previous year's reporting had been concluded.

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

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

5.1 Qualification #1

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

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

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

5.2 Qualification #2

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

These analyses are being conducted as part of the WDFW's Twisp RRS study and will be included in Section 4.2 of our report when the analysis is complete. There are varying degrees of reproductive success information that may be collected through the Twisp RRS study. At a minimum the study has documented offspring produced by a multiple reconditioned kelts. Ideally the study may quantify the average number of offspring produced by reconditioned kelts and life-time reproductive success. If sufficient data is collected a comparison of relative reproductive success between reconditioned kelts and both NOR and HOR maiden spawners may be possible. 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 and concluded in 2018. A detailed description of this study can be found in the 2018 annual report for this project (Abrahamse and Murdoch 2019). Gamete viability will be indirectly assessed through the Twisp RRS study described in Section 4.2

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

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

Retaining non-maturing kelts has become standard practice in recondition programs in recent years (Hatch et al 2016). The UCKRP have been retaining non-maturing kelts for additional reconditioning. All of the surviving kelts held determined to be maturing and have been released. Survival of non-maturing kelts during the additional reconditioning period has been variable. This practice will continue to be evaluated by this project and other kelt reconditioning programs throughout the Columbia River basin for the next several years.

5.4 Qualification #4

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

All reconditioned kelts released from the project are marked with a PIT tag with a unique code. There is an intensive system of PIT tag detection arrays in Methow River and other basins in the Upper Columbia. Many of these antennas, particularly in the smaller tributaries, were installed

as one of the primary means of determining adult steelhead spawning distribution and abundance. PIT tag detections will be the primary means for tracking kelt movement. Information on where kelts originally spawned often completely unknown and, if known, only in a general location. It is unlikely that homing and straying rates can be quantified in any significant way. However, any unusual detection data suggesting that a kelt may be straying outside its natal basin will be noted in this report.

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

5.5 Qualification #5

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

Uncertainty over the best release locations and time period has primarily linked to attempts to avoid an active fall steelhead fishery in the UCR and Methow River. The majority of fall fishing pressure occurs in the first 50 rkm. Since 2014, reconditioned kelts have either been released near the mouth of Methow River at rkm 1 or near rkm 50.

We used PIT tag data to compare the potential effect of release location on overwinter survival. Kelt releases from 2014 to 2016 were categorized into two groups. One group contained reconditioned kelts released near the mouth of the Methow. The other group contained reconditioned kelts released near rkm 50. We queried the PTAGIS data base to determine if kelts in each group were detected between February 1st and June 30th. Kelts were then categorized as either detected or undetected. Chi-Square analysis was then used to determine if there was a significant difference in the frequency with which kelts were detected based on where they were released.

Chi-Square analysis demonstrated that kelts released near rkm 50 were more frequently detected than those released near the mouth, $p=0.03$. However, this is likely due to differences in detection efficiency between the PIT tag arrays at near the two release sites and not differences in survival.

The project has determined that it will release kelts near the mouth of the Methow River whenever possible. This will allow kelts to have greater volition in choosing their overwintering sites. Releases will be made near rkm 50 in years in which a fall steelhead fishery is active, to limit the fishes' exposure to angling.

6 Future Activities

6.1 Kelt Collection

6.1.1 Live-spawning

All NOR females used as broodstock by WNFH and DCPUD continue to be live-spawned in a combined effort by the YN and USFWS staff. WNFH is planning on spawning 50 NOR pairs of steelhead in 2020. In 2020, the Douglas County PUD Twisp River conservation hatchery program will conduct its steelhead spawning at WNFH. This program will include 12 pair of NOR steelhead. Up to 62 NOR females could be available for live spawning and reconditioning.

6.1.2 Temporary tributary weirs

The project has decided to give lower priority to the use of weirs as a collection method due to the low number of kelts collected compared to other collection methods. Weirs will still be employed in areas of special interest, such as those with ongoing reproductive success studies or populations not represented through other means of collection. Weirs will be operated in Little Bridge Creek and Beaver Creek in 2019. Traps will be installed as early as possible in the spring relative to run timing for a specific year.

6.1.3 Rock Island Dam

The collaboration with CPUD is expected to continue in 2020. The number of kelts collected at Rock Island Dam has varied during the three years the project has used it as a collection site. The number of kelts collected at Rock Island Dam is likely linked various factors, including: timing of peak stream discharge, the magnitude of stream discharge, and the size of the NOR spawning population above Rock Island Dam. Regardless of the cause, the number of kelts collected at Rock Island Dam will likely vary year to year. However, the cooperation and coordination with CPUD at Rock Island allows us to collect kelt opportunistically. The project's collection efforts are directly proportional to the number of kelts being observed at Rock Island Dam, thus yearly variation is not a concern.

6.2 Kelt Reconditioning and Release

This activity will continue in 2020 as it had the past 7 years. It is expected that the UCKRP will begin reconditioning with 60 to 100 in 2019. Based on survival rates at the reconditioning facility seen to date, YN could expect to see 30 and 75 reconditioned kelts released.

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

6.3 Monitoring and Evaluation

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

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

7 Literature Cited

Abrahamse, M. and K. Murdoch. 2019. Upper-Columbia River Steelhead Kelt Reconditioning Project: 2018 Annual Report. Annual Report to the Bonneville Power Administration for Project No. 2008-458-00. Prepared by Yakama Nation Fisheries Resource Management.

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.

Goodman, B., C. Snow, A. Murdoch, and T. Seamons. 2020. Monitoring the reproductive success of naturally spawning hatchery and natural-origin steelhead in the Twisp River, 1/1/2019–12/31/2019. DRAFT Annual Report to the Bonneville Power Administration, Project 2010-033-00, Portland, Oregon.

Goodman, B., C. Snow, A. Murdoch, and T. Seamons. 2018. Monitoring the reproductive success of naturally spawning hatchery and natural-origin steelhead in the Twisp River, 1/1/2017–12/31/2017. Annual Report to the Bonneville Power Administration, Project 2010-033-00, Portland, Oregon.

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.

Hatch, D., Branstetter R., Stephenson J., Pierce A., Newell J., Bosch W., Graham N., Medeiros, L., Jenkins L., Hoffman B., Vrtelova-Holbert J., Cavileer T., Nagler, J., Frederickson C., Blodgett J., Fast D., Fiander M., Lessard R., Whiteaker J., Everett S., and Johnson R. Kelt Reconditioning and Reproductive Success Evaluation Research. 1/1/2017 - 12/31/2017 Bonneville Power Administration Annual Report, 2007-401-00.

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

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.

Pierce, A.L., J.W. Blodgett, T.D. Cavileer, L.R. Medeiros, J. Boyce, L.K. Caldwell, W.J. Bosch, R. Branstetter, D.E. Fast, D.R. Hatch, and J.J. Nagler. 2016. Reproductive development in captive reconditioned female steelhead kelts: evidence for consecutive and skip spawning life histories. Canadian Journal of Fisheries and Aquatic Sciences DOI:10.1139/cjfas-2016-0065.

Seamons T.R., *T*. P. Quinn. 2010. Sex-specific patterns of lifetime reproductive success in single 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

Inter-annual variations in the survival rate of kelts undergoing long-term reconditioning have been observed from the onset of the UCKRP. Mortalities within the program have generally been attributed to a poor feeding response and/or pre-existing physical injuries which resulted in fungal infections. Significant outbreaks of viral and bacterial infections have not been recorded and are not considered to be a major contributor to mortality in the UCKRP.

The survival rate for kelts in the UCKRP in 2019 was the lowest observed in the seven years of full project implementation. Low survival could not be linked to a specific fish health or water quality causes. A preliminary review of summary data suggested a correlation between mean fork length at time of collection and survival rate. A greater mean fork length may imply an older age fish. The project years in which mean fork length was above average tended to have lower survival rates. This prompted us to develop a statistical comparison to test whether metrics sampled during kelt collection could be linked to kelt survival during reconditioning.

Methods

Data from all kelts collected by the UCKRP from 2014 to 2019 were compiled and stratified into two groups, survivors and mortalities. Only kelts entering the reconditioning projects were selected. Skip spawners entering the project for a second year of reconditioning were excluded.

Size, condition, and age metrics collected at the start of reconditioning were compared between groups using main-effects analysis of variance (MANOVA) testing. If significant differences were found, post-hoc analysis was done using Tukey's test to identify which metrics were significantly different between the groups. Size and condition data were collected by UCKRP project staff on all fish entering the reconditioning project. Size metrics included fork length, POH length, and weight. Fulton's condition factor (K) was the condition metric used to compare groups.

Age data was collected from scales by USFWS staff as part of their broodstock data collection. Only the ages of kelts collected through live-spawning were compared. Total age was compared using paired t-tests to determine statistical significance and median age by group was used to illustrate biological significance, if present.

Results

Total sample size for size and condition analysis was 447 kelts (survivor N = 260; mortality N = 187). MANOVA analysis determined that there was a significant difference between groups. Tukey's test revealed that kelts in the mortality group were significantly larger than those in the survivor group in every category: fork length ($p<0.0001$), POH length ($p=0.0011$), and weight ($p<0.0001$). Mean fork length of the survivor and mortalities groups were 640 mm and 669 mm, respectively (Figure 1). Mean POH length of the survivor and mortalities groups were 527 mm and 544 mm, respectively (Figure 2). Mean weight of survivor and mortality groups were 2,183 g and 2,503 g, respectively (Figure 3).

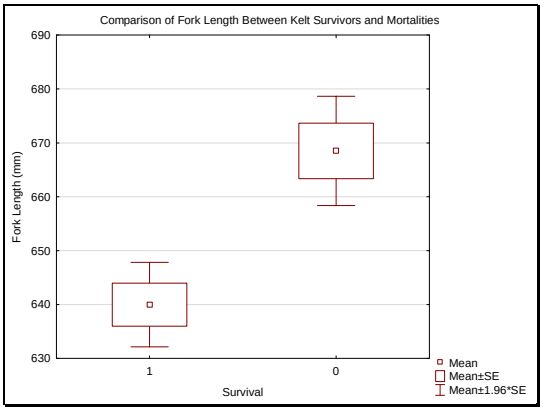

Figure 1 - Results of significance testing comparing fork length of kelts that survived reconditioning (1) and kelts that were mortalities in the UCKRP (0).

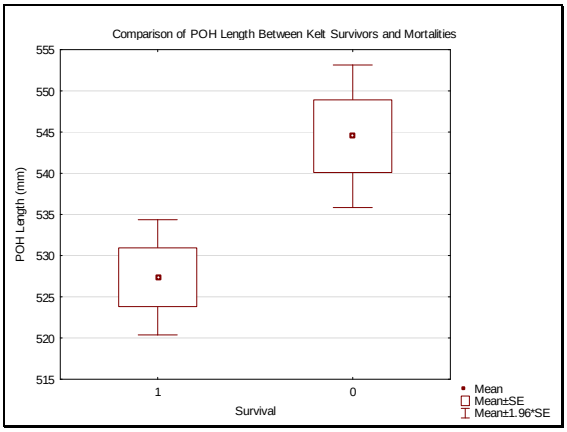

Figure 2 - Results of significance testing comparing POH length of kelts that survived reconditioning (1) and kelts that were mortalities in the UCKRP (0).

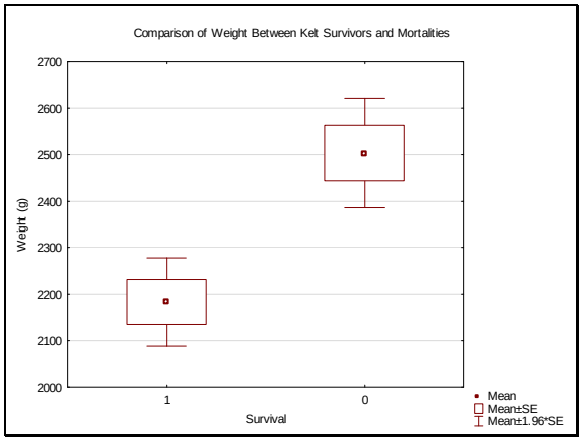

Figure 3 - Results of significance testing comparing weight (g) of kelts that survived reconditioning (1) and kelts that were mortalities in the UCKRP (0).

There was not a significant difference in K values between groups, p=0.5947.

Total sample size for age comparison analysis was 222 kelts, (survivor N = 131; mortality N = 91). Paired t-test analysis showed that the mean total age of kelt mortalities was greater than kelt survivors, p=0.003 (Figure 4). Median total age of survivor kelts was 4 years and median total age of mortality kelts was 5 years.

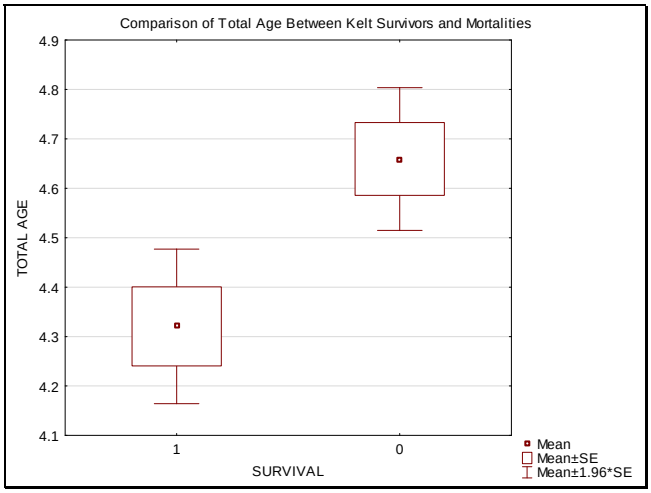

Figure 4 - Results of paired t-test comparing total age of kelts that survived reconditioning (1) and kelts that were mortalities in the UCKRP (0).

Discussion

Kelts that survived through the long-term kelt reconditioning were significantly smaller and younger than kelts that did not survive. A significant difference in condition factor (K) does not appear to be correlated with fish survival. This is an indication that survivors are not in significantly better condition at the start of recondition.

The strong correlation between fish size and total age makes it difficult to determine if one metric has more influence on survival. Additional analysis will need to be done to determine if it possible to differentiate the influence of kelt size and age on survival. Research questions for future analysis include:

- Are larger kelts less likely to survive than smaller kelts of the same age?
- Are older kelts less likely to survive than young kelts of similar size?

Answering these questions may help guide the selection of kelts for inclusion in long-term reconditioning projects in the future. In the short term, these analyses may be used to partially explain the variation annual survival rates for kelts in the UCKRP. Lower survival rates can be expected in years where the maiden steelhead run have a higher proportion of large and/or older fish, and vice versa.

Appendix B

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

Tag Code	Origin	Detection Site	Event Date	Maturing?
384.3B239AA629	WNFH	CRW - Chewuch River above Winthrop	04/11/14	YES
		CRW - Chewuch River above Winthrop	04/23/14	
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		Event Site Name	Event Date	Maturing
384.36F2B4A078	WNFH	RRJ - Rocky Reach Dam Juvenile	04/22/15	YES
384.3B23ADF01C	WNFH	RRJ - Rocky Reach Dam Juvenile	05/06/15	YES
3D9.1BF1AC6840	RI	LWE - Lower Wenatchee River	03/31/15	NO
3D9.1C2D732EDE	WNFH	MRW - Methow River at Winthrop	03/18/15	YES
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	
3D9.1C2D7344E2	RI	BCC - BON PH2 Corner Collector	04/30/15	NO
3D9.1C2D734B1F	WNFH	CRW - Chewuch River above Winthrop	03/22/15	YES
		CRW - Chewuch River above Winthrop	04/17/15	
3D9.1C2D7398AF	RI	BCC - BON PH2 Corner Collector	05/19/15	NO
3D9.1C2D739A01	WNFH	CRW - Chewuch River above Winthrop	03/12/15	YES
3D9.1C2D73B2DE	RI	BCC - BON PH2 Corner Collector	05/21/15	NO
3D9.1C2D73BAA9	RI	PES - Peshastin Creek	03/14/15	YES
		PES - Peshastin Creek	04/04/15	
3D9.1C2D73BE5A	WNFH	CRW - Chewuch River above Winthrop	03/11/15	YES
		CRW - Chewuch River above Winthrop	04/02/15	

2014 post-release detections continued

Tag Code		Event Site Name	Event Date	Maturing
3D9.1C2D73CAD9	RI	RRF - Rocky Reach Fishway	06/22/15	NO
		WEA - Wells Dam, DCPUD Adult Ladders	07/10/15	
		ENL - Lower Entiat River	03/23/16	
		ENL - Lower Entiat River	03/31/16	
		MAD - Mad River, Entiat River Basin	04/06/16	
3D9.1C2D73D51E	RI	PES - Peshastin Creek	03/07/15	YES
		PES - Peshastin Creek	04/06/15	
		BCC - BON PH2 Corner Collector	05/18/15	
3D9.1C2D73D746	HCS	RRJ - Rocky Reach Dam Juvenile	05/25/15	YES
3D9.1C2D73EB2A	WNFH	RRJ - Rocky Reach Dam Juvenile	04/29/15	YES
3D9.1C2D73EBB3	MSH	TWISPW - Twisp River Weir (WDFW)	03/02/15	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	03/20/15	
3D9.1C2D743279	WNFH	CRW - Chewuch River above Winthrop	03/23/15	YES
		CRW - Chewuch River above Winthrop	04/24/15	
3D9.1C2D74376F	WNFH	CRW - Chewuch River above Winthrop	04/08/15	YES
3D9.1C2D743D67	RI	JDJ - John Day Dam Juvenile	05/22/15	NO
3D9.1C2D744057	RI	TWR - Lwr Twisp Rvr near MSRF Ponds	03/28/15	YES
		RRJ - Rocky Reach Dam Juvenile	04/30/15	
3D9.1C2D7442F9	WNFH	CRW - Chewuch River above Winthrop	03/14/15	YES
		CRU - Upper Chewuch Instream Array	04/05/15	
		RRJ - Rocky Reach Dam Juvenile	04/11/15	
3D9.1C2DF5CDB3	MSH	TWISPW - Twisp River Weir (WDFW)	03/02/15	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	03/25/15	
		RRJ - Rocky Reach Dam Juvenile	05/30/15	

2014 post-release detections continued

Tag Code		Event Site Name	Event Date	Maturing
3D9.1C2DF62C18	MSH	TWISPW - Twisp River Weir (WDFW)	03/02/15	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	03/14/15	
		TWISPW - Twisp River Weir (WDFW)	03/17/15	
3D9.1C2DF64BDE	WNFH	RRJ - Rocky Reach Dam Juvenile	04/21/15	NO
		RRJ - Rocky Reach Dam Juvenile	04/22/15	
3D9.1C2DF75115	WNFH	BCC - BON PH2 Corner Collector	05/04/15	NO
3D9.1C2DF7C1E9	WNFH	CRW - Chewuch River above Winthrop	02/21/15	YES
3D9.1C2DF7D9E3	SFG	GLC - Gold Creek, Methow River	03/24/15	YES
		GLC - Gold Creek, Methow River	03/26/15	
3D9.1C2E0A38F1	WNFH	CRW - Chewuch River above Winthrop	03/08/15	YES
		BCC - BON PH2 Corner Collector	06/07/15	
3DD.003BC49A4D	MSH	TWISPW - Twisp River Weir (WDFW)	03/02/15	YES
		TWISPR - Twisp River	03/14/15	
		TWISPR - Twisp River	03/15/15	
		TWR - Lwr Twisp Rvr near MSRF Ponds	03/28/15	
		BCC - BON PH2 Corner Collector	06/02/15	
		TWX - Estuary Towed Array (Exp.)	06/04/15	
3DD.003BC49A5C	MSH	TWISPW - Twisp River Weir (WDFW)	03/02/15	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	04/19/15	
		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	

2014 post-release detections continued

Tag Code	Origin	Event Site Name	Event Date	Maturing
3DD.003BC49E6A	WNFH	WELLD2 - WEL - Release West Adult Fish Ladder	08/04/15	NO
		PRA - Priest Rapids Adult	09/05/15	
		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	
3DD.003BC49E73	WNFH	BCC - BON PH2 Corner Collector	05/18/15	NO
3DD.003BC49E7B	WNFH	RRJ - Rocky Reach Dam Juvenile	04/03/15	NO
		BCC - BON PH2 Corner Collector	04/29/15	
		BO3 - Bonneville WA Shore Ladder/AFF	07/28/15	
		BO4 - Bonneville WA Ladder Slots	07/28/15	
3DD.003BC4A0E8		TWISPW - Twisp River Weir (WDFW)	03/07/16	
		MRC - Methow River at Carlton	03/20/16	
		TWR - Lwr Twisp Rvr near MSRF Ponds	04/01/16	
		MSKF - Methow Steelhead Kelt Facility	11/02/16	
		MRC - Methow River at Carlton	12/21/16	
3DD.003BC4A0F4	MSH	TWISPW - Twisp River Weir (WDFW)	03/02/15	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	03/28/15	
		MWF - Whitefish SC in Methow River	05/11/15	
		RRJ - Rocky Reach Dam Juvenile	05/15/15	
3D9.1C2E0A88EA	WNFH	Not Detected		YES
384.36F2B4A35A	RI	Not Detected		NO
3D9.1BF1AC542B	RI	Not Detected		NO
3D9.1C2D733B2F	RI	Not Detected		NO
3D9.1C2D73B098	RI	Not Detected		NO

2014 post-release detections continued

Tag Code	Origin	Event Site Name	Event Date	Maturing
3D9.1C2D73B098	RI	Not Detected	NO	
3D9.1C2D73D1C8	WNFH	Not Detected	YES	
3D9.1C2D73D2C0	RI	Not Detected	NO	
3D9.1C2D73D569	RI	Not Detected	NO	
3D9.1C2D73D807	WNFH	Not Detected	NO	
3D9.1C2D73E484	RI	Not Detected	NO	
3D9.1C2D73EB54	WNFH	Not Detected	NO	
3D9.1C2D73EE8A	WNFH	Not Detected	NO	
3D9.1C2D743711	WNFH	Not Detected	NO	
3D9.1C2D744268	RI	Not Detected	NO	
3D9.1C2DF6D35E	WNFH	Not Detected	YES	
3DD.003BC49A31	MSH	Not Detected	NO	
3DD.003BC49A54	WNFH	Not Detected	NO	
3DD.003BC49E35	WNFH	Not Detected	YES	
3DD.003BC4A0DC	RI	Not Detected	NO	
3DD.003BC4A105	MSH	Not Detected	NO	
3DD.003BC4A127	MSH	Not Detected	NO	

Summary of post-release PIT tag detections for reconditioned kelts released in the fall of 2015.

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

2015 post-release detections continued

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

Summary of post-release PIT tag detections for reconditioned kelts released in the fall of 2016.

Tag Code	Origin	Event Site Name	Event Date	Maturing
3D9.1C2D733CCD	RI	ENL - Lower Entiat River	04/13/17	YES
		RRJ - Rocky Reach Dam Juvenile	05/29/17	
3D9.1C2D733F00	RI	OKL - Lower Okanogan Instream Array	11/25/17	YES
3D9.1C2D73AE3C	RI	CRW - Chewuch River above Winthrop	04/13/17	YES
		RRJ - Rocky Reach Dam Juvenile	05/02/17	
		RIS - Rock Island Dam	05/03/17	
3D9.1C2D73D37B	RI	MRC - Methow River at Carlton	03/15/17	YES
		RRJ - Rocky Reach Dam Juvenile	05/12/17	
3D9.1C2D73E73D	RI	MRC - Methow River at Carlton	02/19/17	YES
3D9.1C2D73E9BA	RI	ENL - Lower Entiat River	03/12/17	YES
		ENA - Upper Entiat River at rkm 17.1	03/18/17	
		ENM - Middle Entiat River	03/20/17	
		ENM - Middle Entiat River	03/26/17	
		ENS - Upper Entiat River at rkm 35.7	04/05/17	
		ENS - Upper Entiat River at rkm 35.7	04/10/17	
		ENS - Upper Entiat River at rkm 35.7	04/12/17	
		ENL - Lower Entiat River	05/01/17	
3D9.1C2D73EDF6	RI	MRC - Methow River at Carlton	03/20/17	YES
		CRW - Chewuch River above Winthrop	04/01/17	
		CRW - Chewuch River above Winthrop	04/29/17	
3D9.1C2D7430C1	RI	MRC - Methow River at Carlton	03/15/17	YES
		JDJ - John Day Dam Juvenile	05/05/17	
3D9.1C2D74392B	RI	MCL - Lower Mission Creek Instream	04/20/17	YES
		MCL - Lower Mission Creek Instream	04/21/17	
		PES - Peshastin Creek	05/08/17	
		PES - Peshastin Creek	05/14/17	
		PES - Peshastin Creek	05/16/17	
		PES - Peshastin Creek	05/20/17	
		PES - Peshastin Creek	05/21/17	
		PES - Peshastin Creek	05/27/17	
3DA.1A19B041AE	WNFH	MRC - Methow River at Carlton	03/14/17	YES
		CRW - Chewuch River above Winthrop	04/02/17	
3DA.1A19B04701	WNFH	CRW - Chewuch River above Winthrop	04/21/17	YES
		MRC - Methow River at Carlton	04/23/17	
3DA.1A19B04790	WNFH	LMR - Lower Methow River at Pateros	02/23/17	YES
		LMR - Lower Methow River at Pateros	03/17/17	
3DA.1A19B10E17	WNFH	MRC - Methow River at Carlton	03/14/17	YES

2016 post-release detections continued

Tag Code	Origin	Event Site Name	Event Date	Maturing
3DA.1A19B1387A	WNFH	MRC - Methow River at Carlton	03/22/17	YES
		MRC - Methow River at Carlton	03/25/17	
		CRW - Chewuch River above Winthrop	04/07/17	
		CRU - Upper Chewuch Instream Array	04/14/17	
		CRU - Upper Chewuch Instream Array	05/02/17	
		CRW - Chewuch River above Winthrop	05/02/17	
3DD.003BC44E13	MSH	MRC - Methow River at Carlton	04/01/17	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	04/07/17	
		TWISPW - Twisp River Weir (WDFW)	04/17/17	
3DD.003BD8EFAA	MSH	MRC - Methow River at Carlton	04/03/17	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	04/06/17	
		TWISPW - Twisp River Weir (WDFW)	04/23/17	
3DD.003BD8EFB1	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	04/02/17	YES
		WFC - Wolf Creek, Methow River	04/18/17	
		WFC - Wolf Creek, Methow River	05/03/17	
3DD.003BD8EFF9	MSH	TWR - Lwr Twisp Rvr near MSRF Ponds	04/01/17	YES
		TWISPW - Twisp River Weir (WDFW)	04/10/17	
3DD.0077526747	WNFH	CRW - Chewuch River above Winthrop	03/27/17	YES
		CRW - Chewuch River above Winthrop	04/12/17	
3DD.0077535E01	WNFH	MRC - Methow River at Carlton	03/16/17	YES
		CRU - Upper Chewuch Instream Array	04/19/17	
		CRW - Chewuch River above Winthrop	04/23/17	
3DD.0077553B4F	WNFH	MRC - Methow River at Carlton	03/17/17	YES
		RRJ - Rocky Reach Dam Juvenile	05/23/17	
3DD.007790A376	RI	LMR - Lower Methow River at Pateros	03/16/17	YES
		MRC - Methow River at Carlton	03/24/17	
3DD.007791609F	WNFH	MRW - Methow River at Winthrop	04/12/17	YES
		EWC - Early Winters Creek rkm 0.36	04/18/17	
3DA.1A19B04A64	WNFH	Not Detected		YES
3D9.1C2D733B66	RI	Not Detected		YES
3D9.1C2D73B543	RI	Not Detected		YES
3DA.1A19B063F0	WNFH	Not Detected		YES
3DA.1A19B0649D	WNFH	Not Detected		YES
3DA.1A19B135B4	WNFH	Not Detected		YES
3DA.1A19B1537A	WNFH	Not Detected		YES
3DD.003BC4A0E8	MSH	Not Detected		YES
3DD.003BD8F038	WNFH	Not Detected		YES

Summary of post-release PIT tag detections for reconditioned kelts released in the fall of 2017.

Tag Code	Origin	Event Site Name	Event Date	Maturing
3D9.1C2D192A26	WNFH	MRC - Methow River at Carlton	2/8/2018	YES
		CRW - Chewuch River above Winthrop	4/16/2018	YES
3D9.1C2D286859	WNFH	LMR - Lower Methow River at Pateros	3/29/2018	YES
3D9.1C2D739FBA	RI	LMR - Lower Methow River at Pateros	2/4/2018	YES
		MRC - Methow River at Carlton	3/1/2018	YES
		CRW - Chewuch River above Winthrop	3/14/2018	YES
		CRW - Chewuch River above Winthrop	3/28/2018	YES
3D9.1C2D73C825	RI	LMR - Lower Methow River at Pateros	3/29/2018	YES
3D9.1C2D73D0CA	RI	SA1 - Salmon Creek Instream Array	3/15/2018	YES
		SA0 - Salmon Creek below OID Div.	3/19/2018	YES
3D9.1C2D73E3AB	RI	ENL - Lower Entiat River	3/1/2018	YES
		ENL - Lower Entiat River	3/5/2018	YES
3D9.1C2D743180	RI	PES - Peshastin Creek	2/9/2018	YES
		PES - Peshastin Creek	3/25/2018	YES
		PES - Peshastin Creek	4/10/2018	YES
3D9.1C2D743E88	RI	OMK - Omak Creek Instream Array	5/4/2018	YES
3D9.1C2DD85FC4	WNFH	TWR - Lwr Twisp Rvr near MSRF Ponds	3/18/2018	YES
		TWR - Lwr Twisp Rvr near MSRF Ponds	3/31/2018	YES
3DA.1A19B0420B	WNFH	MRC - Methow River at Carlton	2/5/2018	YES
		MRC - Methow River at Carlton	3/13/2018	YES
		CRW - Chewuch River above Winthrop	3/28/2018	YES
3DA.1A19B064DA	WNFH	MRC - Methow River at Carlton	2/8/2018	YES
		MRW - Methow River at Winthrop	3/12/2018	YES
3DA.1A19B06651	WNFH	MRC - Methow River at Carlton	3/12/2018	YES
		CRW - Chewuch River above Winthrop	3/30/2018	YES
3DA.1A19B14848	WNFH	MRC - Methow River at Carlton	2/8/2018	YES
		CRW - Chewuch River above Winthrop	3/22/2018	YES
		CRW - Chewuch River above Winthrop	4/14/2018	YES
3DD.0077537A09	WNFH	MRC - Methow River at Carlton	2/3/2018	YES
		CRW - Chewuch River above Winthrop	3/28/2018	YES
		MRC - Methow River at Carlton	3/30/2018	YES
3DD.00775E7525	WNFH	MRC - Methow River at Carlton	3/14/2018	YES
3D9.1C2D73970F	RI	MRW - Methow River at Winthrop	3/24/2018	YES
3D9.1C2D73BC5F	RI	Not Detected		YES
3D9.1C2D73D6E1	RI	Not Detected		YES
3D9.1C2DEC3E50	WNFH	Not Detected		YES
3DA.1A19B063FA	WNFH	Not Detected		YES
3DA.1A19B0649F	WNFH	Not Detected		YES
3DA.1A19B14A70	WNFH	Not Detected		YES
3DD.003BDCD761	RI	Not Detected		YES
3DD.0077531B0D	WNFH	Not Detected		YES
3DD.0077535321	WNFH	Not Detected		YES
3DD.00779181B3	RI	Not Detected		YES
3DD.007791B435	WNFH	Not Detected		YES
3DD.007791DCFD	WNFH	Not Detected		YES
3DD.0077923C57	RI	Not Detected		YES
3DD.0077924A98	WNFH	Not Detected		YES