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WALLA WALLA RIVER SUBBASIN SALMONID MONITORING AND EVALUATION PROJECT

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Executive Summary

The primary goal of this project is to collect and analyze data to inform the status and trend of mid-Columbia Summer Steelhead in the Touchet River, including Coppei and Patit Creeks. The project uses adult weirs in accordance with regional monitoring guidance documents to estimate hatchery and natural-origin adult escapement.

The 2019 trapping season was complicated by significant late winter snowfall, followed by rapid stream discharge increases in late March and early April, compromising Coppei and Patit Creek weirs. Overall, trapping numbers improved over the 2018 season, but weir efficiency declined. Trap catches at Coppei Creek were nearly double the 2018 captures, with 34 unique, natural-origin steelhead captured. Trap operations on Patit Creek resulted in slightly over double the 2018 catch, with a total of 28 natural-origin adults captured, and an additional 38 hatchery-origin fish captured. Similarly, adult steelhead captures at the Dayton Adult trap increased relative to the 2018 trapping efforts, and resulted in 245 steelhead captured, of which 127 were natural-origin adults. This represents a 30% increase over 2018 captures.

The project made considerable progress developing a model to estimate juvenile abundance, survival, and adult conversion and abundance using PIT tags implanted in natural-origin steelhead at the Harvey Shaw rotary smolt trap. The model developed also uses PIT tags from Touchet endemic and Wallowa stock releases. Specifically, the model focused on the fall 2015 and spring 2016 smolt trap releases and the 2016 releases of hatchery-origin fish, covering the migratory year 2016 cohort. Based on the PIT model we estimate that 132 (95% CI 33-314) ocean age-2 adults returned as far the Harvey Shaw instream PIT array site. The combined minimum abundance at the two project weirs and the Dayton Adult Trap totaled 194 fish and includes all age classes.

Previously, this project was a combined effort between the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and the Washington Department of Fish and Wildlife (WDFW). However, beginning in late 2018, with the re-negotiation of BPA Accords, this project was separated into to its base components; CTUIR focusing efforts on monitoring fish response and success relative to habitat restoration and fish passage improvements in the Walla Walla basin, while WDFW continues to focus on the VSP status of steelhead in the Touchet Basin in particular. Both entities will continue to collaborate and work as co-managers going forward.

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Introduction

The Walla Walla subbasin contains extant populations of summer steelhead (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*), both of which are listed as threatened under the Endangered Species Act (ESA). The subbasin also previously supported a significant, native population of Spring/Summer-run Chinook salmon (*Oncorhynchus tshawytscha*); however, the National Marine Fisheries Service (NMFS) considers the native population to be functionally extinct; the last run of any reasonable numbers occurred in 1925. As such, recovery and reintroduction efforts are currently underway for all three species. All three species are still found in the subbasin and occur at all major life stages. Significant investments and efforts have been made to address the factors that lead to the population declines, specifically fish passage, instream flow and habitat improvements. Maintaining healthy aquatic and terrestrial ecosystems and balancing those needs with sustaining agriculture is a critical component of the economy within the subbasin (SRSRB 2011).

The current iteration of this project is focused specifically on collecting data to inform summer steelhead Viable Salmonid Population (VSP) metrics in the Touchet River basin upstream of the Dayton, WA, including two tributaries to the mainstem Touchet, Coppei and Patit Creeks. (Figure 1). Previous to this contract, this project was a collaborative effort with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), through an Accord with Bonneville Power Administration (BPA). This report is the first report to be developed after the accord agreement ended. Going forward this project will be focused on collecting VSP metrics on summer steelhead in the Touchet Basin, while also reporting spring Chinook Salmon and bull trout as secondary objectives. As such this project will continue to be closely coordinated with CTUIR, as well as other local stakeholders United States Army Corps of Engineers (USACE), United States Forest Service (USFS), the Walla Walla Subbasin Watershed Council, Snake River Salmon Recovery Board (SRSRB), Walla Walla and Columbia County Conservation Districts, and other public and private groups. Project data and previous reports (Mendel et al. 2014. Mahoney et al. 2009, 2011, 2012, 2013, and 2014) may be found at http://data.umatilla.nsn.us/, https://data.ctuir.org/cdms/index.html and http://wdfw.wa.gov/publications).

This project supports the following Northwest Power and Conservation Council Fish and Wildlife program monitoring strategies:

-Assess the status and trend of adult natural and hatchery-origin abundance of fish populations for various life stages

-Assess the status and trend of juvenile abundance and productivity of natural-origin fish populations

-Are hatchery improvement programs and actions achieving the expected biological performance objectives?

-What effects does artificial production have on natural populations of anadromous fish?

The Walla Walla Basin has two distinct populations of steelhead (Walla Walla and Touchet), six local populations of bull trout, and a reintroduced hatchery origin population of spring Chinook. Monitoring of the bull trout and spring Chinook populations is coincident with steelhead trapping and monitoring. Our approach in the Touchet Basin includes the use of adult migrant monitoring stations for the Dayton adult trap (DAT) at the acclimation pond intake dam and fish ladder on the mainstem Touchet River in Dayton, WA (part of the Lower Snake River Compensation Plan [LSRCP] hatchery program), and seasonal adult weirs on Coppei Creek and Patit Creek, as well as additional sites that are being considered or

tested. The Dayton Adult Trap provides a counting point for upstream returns and an index of adult abundance and run timing for the upper Touchet River. Our approach is consistent with recommendations in Crawford & Rumsey (2009) that identified adult abundance and productivity as highest priorities for monitoring, as well as smolt abundance and freshwater productivity to evaluate the freshwater phase of their life history.

Methods: Protocols, Study Designs, and Study Area

Monitoring methods for this project are still under development as part of the agency-wide method review and standardization processes(for more details see: https://www.monitoringresources.org/Document/Protocol/Details/3340. Weir operations most closely fit into the Asotin Creek (BPA# 2002-053-00) and Small Streams Projects (2010-028-00). In the next contract period, we will be updating the data analysis techniques and methods used to estimate adult abundance described below.

The WDFW's approach in the Touchet Basin includes the use of adult migrant monitoring stations for the Dayton Adult Trap (DAT) at the acclimation pond intake dam and fish ladder on the mainstem Touchet River in Dayton, WA (part of the LSRCP hatchery program), and seasonal adult traps on Coppei Creek, and Patit Creek. The Dayton Adult Trap provides a fixed, long term counting point for upstream returns and an index of adult abundance for the upper Touchet River. WDFW uses a combination of data from sampling steelhead at the DAT with redd counts upstream of that point to make estimates of adult abundance in the Touchet River Basin upstream of the DAT. This approach is consistent with recommendations in Crawford & Rumsey (2011) that identified adult abundance and productivity as highest priorities for monitoring, as well as smolt abundance and freshwater productivity to evaluate the freshwater phase of their life history.

Smolt production monitoring was conducted in the mainstem Touchet River, using a 1.5m rotary screw trap deployed near rkm 50. In 2015 WDFW retired the previous rotary screw trap location at Dayton and moved the trap downstream to the current location to improve operations over a range of flows and to get a better understanding of total steelhead smolt production in the Touchet Basin. This project provides funding as needed to assist with smolt monitoring, but the majority of the funding comes from the Washington Governor's Salmon Recovery Office (GSRO) Fish In-Fish Out monitoring program and LSRCP. Outmigrating naturally produced salmonids captured at the smolt trap are PIT tagged for evaluating juvenile run timing and survival to McNary Dam, as well as to evaluate adult return timing and survival. Further details of the smolt trapping operations and data analysis can be found in Gallinat and Ross (2018).

Study Area

The focus area of the adult trapping described in this report is the Upper Touchet River Basin, upstream of Dayton, WA and two small tributaries of the upper Touchet River, Coppei and Patit Creeks.

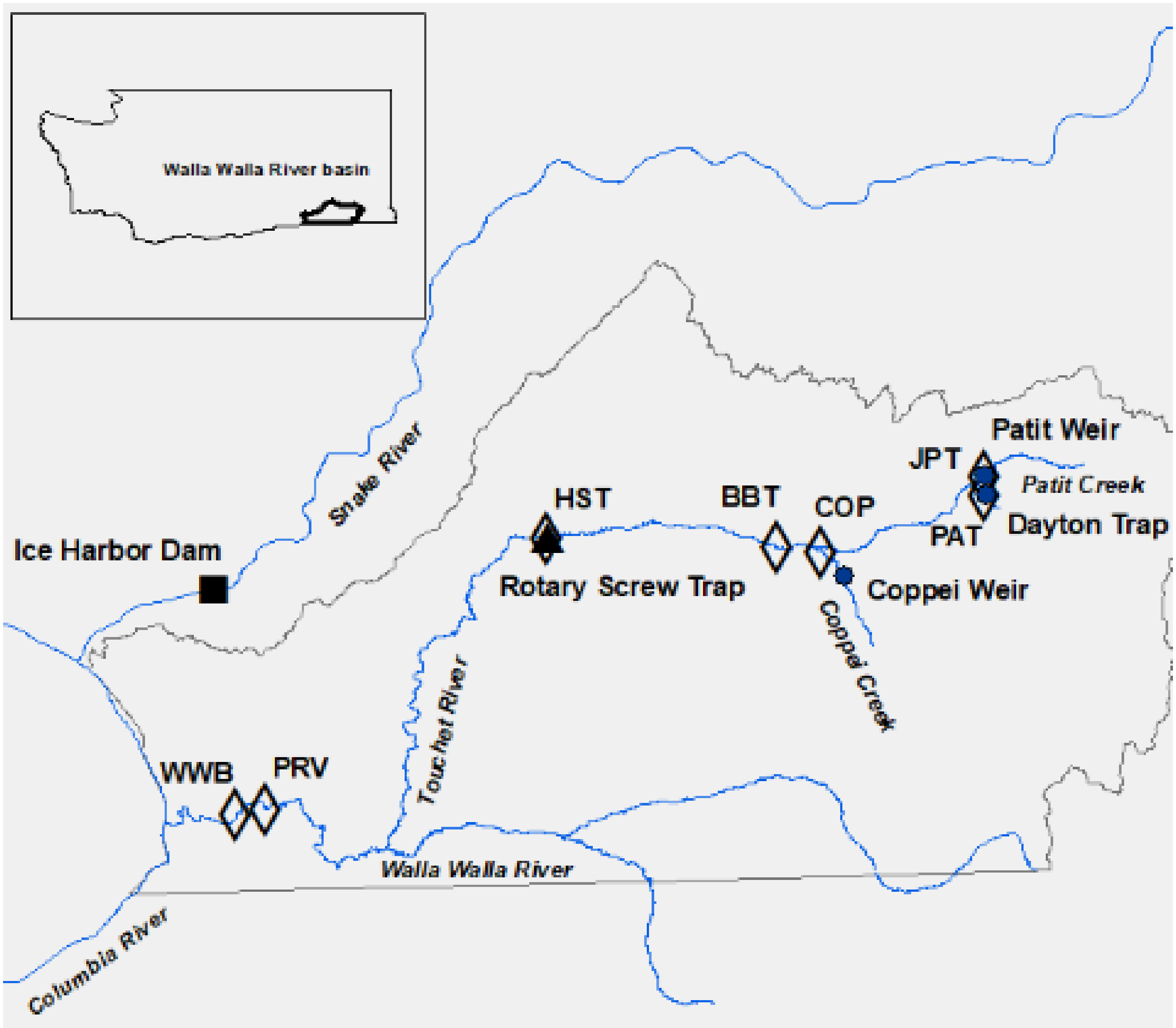

Figure 1. Sampling locations and major tributaries in the Walla Walla Subbasin. *Note: Open diamonds denote Instream array locations; blue stars denote adult trapping locations, closed square denote mainstem dams, closed triangles are juvenile traps.*

Coppei Creek is a third order tributary of the Touchet River, joining the mainstem Touchet near rkm 82. The Coppei Creek drainage encompasses approximately 9,400 hectares. The watershed is composed of several smaller north and west flowing tributaries, draining the northwestern foothills of the Blue Mountains. The watershed ranges in elevation from 1200' at its confluence with the mainstem Touchet River near Waitsburg, to 4250 feet above sea level at the watershed divide with Mill Creek. The basin averages 32.1 inches of precipitation annually with a mix of rain and snow occurring from mid fall through spring.

Patit Creek is a third order tributary of the Touchet River, flowing into the mainstem Touchet River at Dayton, WA near rkm 100. The drainage covers approximately 14,460 hectares. The Patit Creek drainage is composed of several mostly north flowing small ephemeral drainages, flowing off the north-east flank of the Blue Mountain foothills. The high point of the watershed is approximately 3,060' above sea level near Maloney Mountain, and ranges down to 1,620' at its confluence with the mainstem Touchet River. The basin averages 31.2 inches of precipitation annually (USGS StreamStats).

A resistance board floating weir made of aluminum and polyvinyl chloride (PVC), with a 1.8 m x 1.2 m x 1.1 m aluminum adult salmonid trap was deployed in Coppei Creek to capture adult pre-spawn steelhead near rkm 4.6, and in Patit Creek near rkm 1.6. In all previous years of the project, the Patit Creek weir had been located near rkm 6.6; however, in early 2018 the project lost access at the previous site, necessitating the relocation.

Results

Coppei Creek

The Coppei Creek floating weir was installed on 13 February 2019 and fished until 16 May (92 nights), when the trap was opened up to allow unimpeded upstream movement. The decision to open the trap was made based on the lack of captures and increasing stream water temperatures. During the period the trap was deployed, it fished for 73 nights (80%). The trapping season was tough due to prolonged low temperatures followed by significant high flow conditions that negatively affected trapping operations. Project staff had difficulty commuting to and maintaining the weir during the prolonged iced up period in late February-March. High flows were encountered in early April which compromised the weir and trap boxes and necessitated the re-installation of all components.

Project staff captured 34 unique natural-origin steelhead, and an additional five hatchery-origin steelhead. A slight majority (n=3) hatchery-origin steelhead were adipose fin clipped and removed from the population prior to spawning. Project staff recaptured five marked post spawn natural-origin adults and nine unmarked natural-origin adults at the weir. A total of three hatchery-origin kelts were captured at the weir, only one being previously marked prior to spawning.

Of the hatchery fish captured, only one coded wire tag (CWT) was recovered. The fish was an adipose fin clipped adult, with a CWT coded assigning it back to a Wallowa stock release from the Dayton Acclimation Pond. Staff encountered two additional hatchery-origin fish with CWT present. The fish were adipose intact and passed upstream as presumptive Touchet Endemic stock.

To estimate adult abundance, we modeled the escapement upstream of the weir using a hierarchical Bayesian model to account for missed trapping days and possible upstream escapement prior to weir installation as discussed in Jasper et al. (2018) and Sethi & Bradley (2016). We estimated 36 (95% CI 29-48) natural-origin adults spawned upstream of the weir site in 2019. We also used the same model for hatchery-origin fish, resulting in an estimate of 6(4-10) hatchery-origin spawners upstream of the trapping site.

The first natural-origin prespawn adult was captured on 18 March, considerably behind most previous years and the project average. Nevertheless, the run quickly caught up and overall return timing was in line with previous years return timing (Figure 2); 50% of the run passed by 28 March; 75% by 6 April and

90% by 16 April. Female spawners outnumbered male spawners in 2019 by 17%; making the sex ratio 58.8% female to 42.2% male. This sex ratio is more in line with the project average (Figure 3).

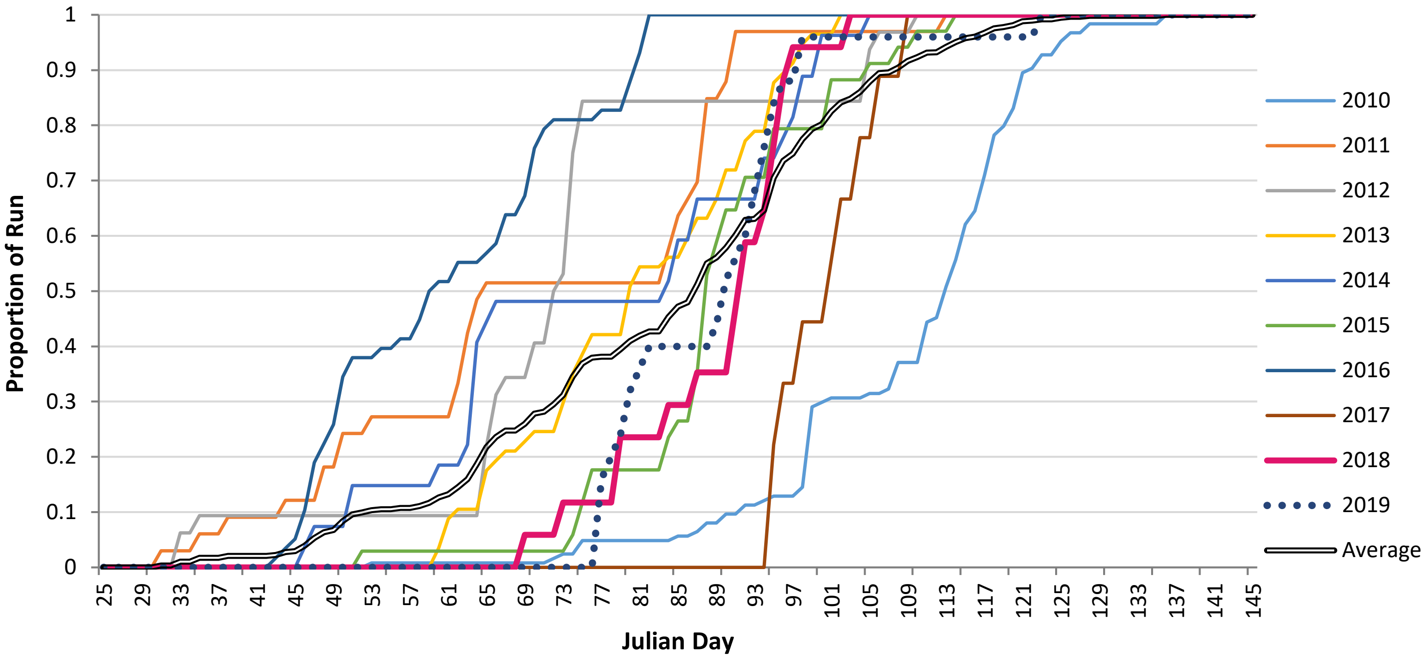

Figure 2. Prespawn run timing of natural-origin steelhead at Coppei Creek weir, 2010-2019.

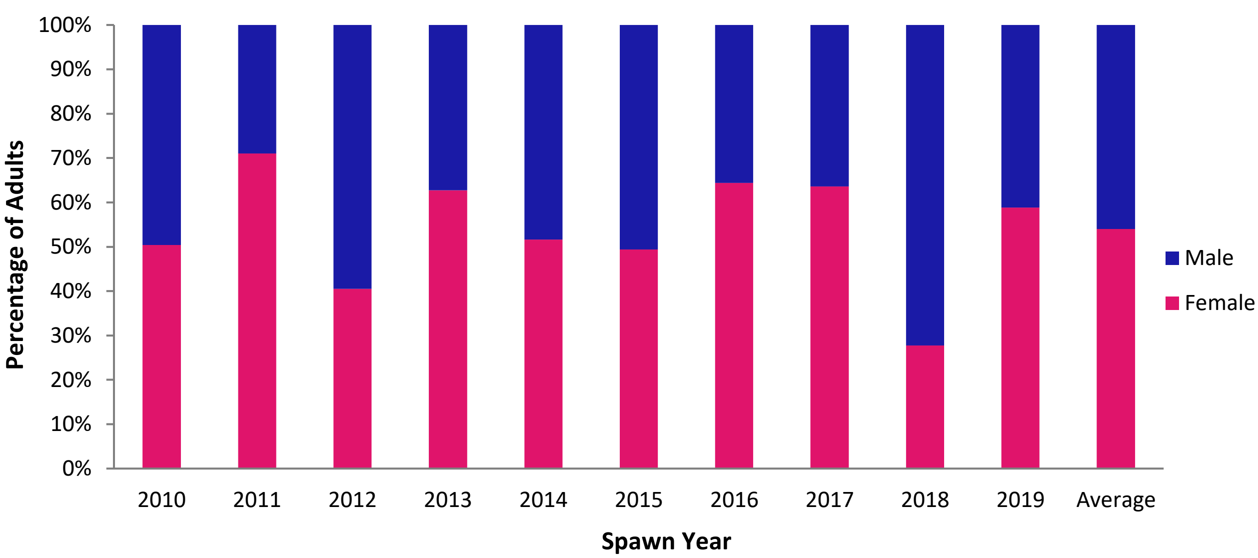

Figure 3. Sex ratio of natural-origin adult steelhead observed at Coppei Creek Weir 2010-2019 spawn years.

Average of adults captured did differ between sexes, with females averaging 608mm, while males averaged 587mm (Figure 4). The difference in average fork length is likely due to the larger number of ocean age-2 females in the sample, where only one ocean age-2 was identified in the scale samples(Table 1).

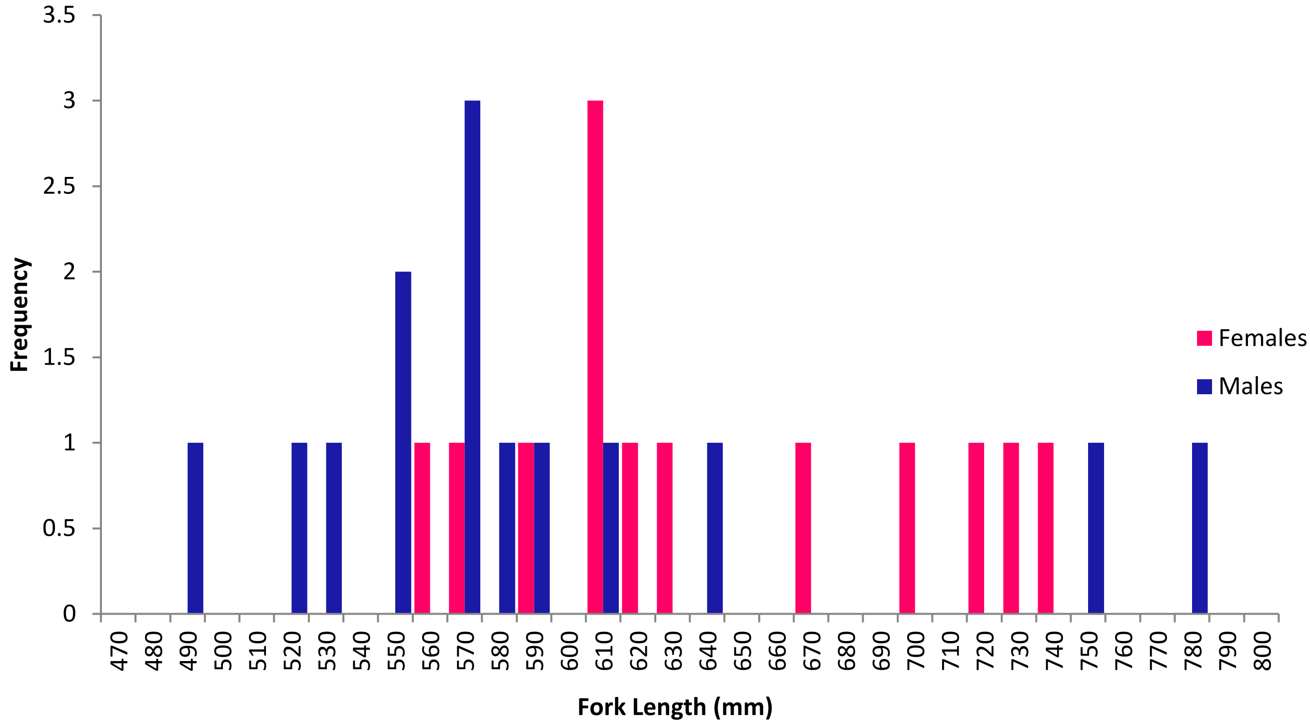

Figure 4. Length frequency of natural-origin adult steelhead captured at Coppei Creek weir, 2019.

Scale samples were collected from 100% of the natural-origin adults captured (n=34). A majority (70.59%) of the scales sampled were readable in both freshwater and saltwater growth regions (Table **1**).

Returning adults aged 2.1 dominated the samples for both sexes, making up 58.3% of the total readable samples. Overall, the age composition is similar to the project average, although we did not encounter any spawners aged 1.1, which typically account for 7% of fish sampled, but has ranged as a high as 31% (Figure 5).

Table 1. Summary of scale samples and ages of natural-origin steelhead captured by sex at Coppei Creek weir, 2019.

Age	Female		Male		Total	
(fresh.ocean)	*n*	%	*n*	%	*n*	%
1.1	0	0.00%	0	0.00%	0	0.00%
1.2	1	5.88%	1	14.29%	2	8.33%
2.1	10	58.82%	4	57.14%	14	58.33%
2.2	6	35.29%	0	0.00%	6	25.00%
3.1	0	0.00%	2	28.57%	2	8.33%
3.2	0	0.00%	0	0.00%	0	0.00%
Total Readable	17	85.00%	7	50.00%	24	70.59%
r	0	0.00%	1	16.67%	1	10.00%
r.1	2	25.00%	6	75.00%	8	80.00%
r.2	1	100.00%	0	0.00%	1	10.00%
Regenerated	3	15.00%	7	50.00%	10	29.41%
Total n	20		14		34	

As discussed briefly above, in terms of ocean age, the majority of fish returned after spending one year in the salt (Table 2), accounting for 60% of the females and 92% of the males. Length at ocean age also varied between the sexes, with males consistently being 3-10% longer than females of the same age. It is worth noting that the ocean age 2 component of males was limited to a single fish.

Table 2. Mean fork length of maiden natural-origin adult steelhead, by ocean age captured at Coppei Creek weir, 2019.

Ocean Age	Statistic	Females	Males
	n	12	12
1	Fork Length(mm)	555	567
	SD	36.41	38.25
	n	8	1
2	Fork Length(mm)	687	710
	SD	23.17	0

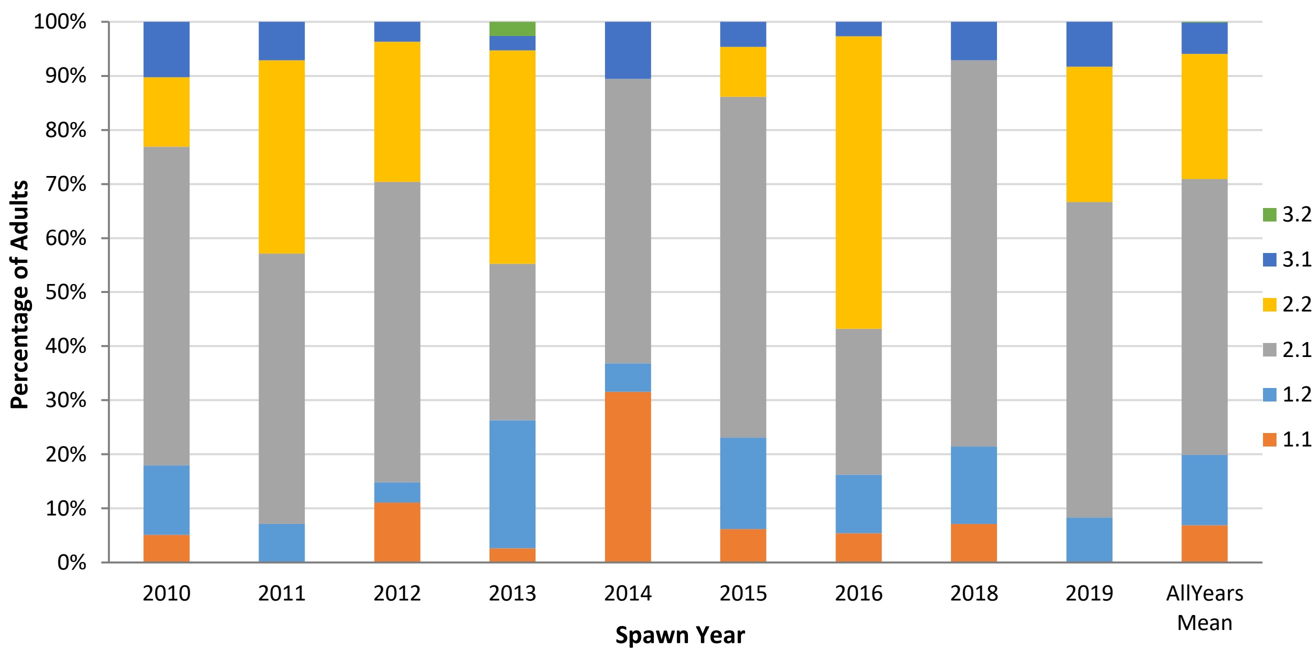

Figure 5. Summary of age composition of natural-origin steelhead captured at Coppei Creek weir, 2010-2019.

Patit Creek

The Patit Creek adult weir was installed and operational beginning 7 March and fished until 17 May (72 trap nights). Normally we would have operated the weir through May, but due to rising water temperatures and a lack of captures we ended early in 2019. Weir operations at the new site were difficult because of near record flows encountered in 2019. Despite difficult conditions the weir fished effectively for a total of 63 trap nights, or 87.5% of the time it was deployed. The longest outage was coincident with a record flow event, beginning 9 April and lasting until 16 April. In most previous years, the run is between 80-90% complete in this timeframe. This is consistent with Coppei Creek, which has

twice the number of trapping seasons. In 2019, only one additional upstream natural-origin fish was captured after this event.

During trapping operations, we handled 28 unique natural-origin adults and 38 hatchery-origin adults. A slight majority (n=20; 52.6%) of hatchery-origin spawners were captured as post-spawn kelts, which likely escaped above the weir during the outage described above. The remaining 47.4%(n=18) were captured prior to spawning. A total of 11 fish were adipose fin-clipped fish and presumed to be out-of-basin strays. As such, project staff removed the fish from the population prior to spawning.

From the 38 hatchery-origin fish captured two CWTs were recovered, both of which assigned back to releases from the Dayton Acclimation Pond. We also encountered eight previously implanted PIT tags in returning hatchery-origin fish. All the fish had intact adipose fins and snubbed dorsal fins, which indicates that they were probable Touchet Endemic stock. Indeed, six of the PIT tags observed were implanted in combination with CWTs in fish as juveniles and released at the Dayton Acclimation Pond and the other two PIT tags were applied to adults captured at the Dayton Adult Trap. We did not sample CWT's from these fish, as they were endemic stock and had previously implanted PIT tags. We speculate that the high number of hatchery-origin fish encountered at the Patit Creek weir were fish previously released downstream at the Dayton Adult Trap (Table 5), and those two PIT tags support that conclusion. This is somewhat unusual compared to previous years, when Snake River Lab staff transported adipose fin clipped fish further downstream to allow for an additional opportunity for anglers to harvest fish that are part of harvest augmentation programs.

Using the same method to estimate escapement as described for Coppei Creek, we estimate that 31 (95% CI 26-38) natural-origin and 13 (95% CI 9-19) hatchery-origin steelhead migrated above the trapping site.

Return timing to Patit Creek was later than previous years' run timing despite the weir being relocated downstream five kilometers (Figure 6). This is similar to what was observed in Coppei Creek and is most likely due to the record breaking cold and snowfall received in Southeast Washington throughout February 2019. As we pointed out in last year's annual report, in most previous years' weir operations have been incomplete due to the flashy nature of Patit Creek and the associated high-water events compromising the weir and traps. As a result, interpreting the run timing of steelhead in Patit Creek should be done with caution.

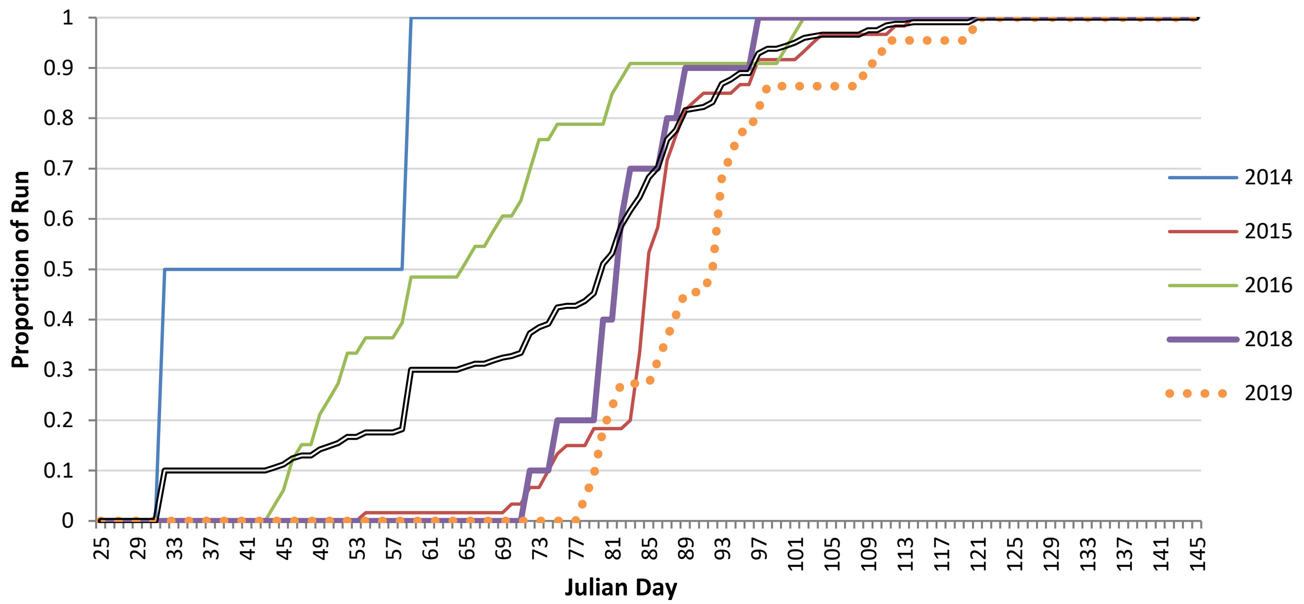

Figure 6. Prespawn run timing of natural-origin steelhead at Patit Creek weir, 2014-2016, 2018-2019.

Of the natural-origin adults captured, the sexes were nearly evenly split; 46.4% female; 53.6% male (Figure 7). Throughout the course of the project sex ratios have remained close to 50:50 despite years with poor sampling sizes, or no captures at all in 2017.

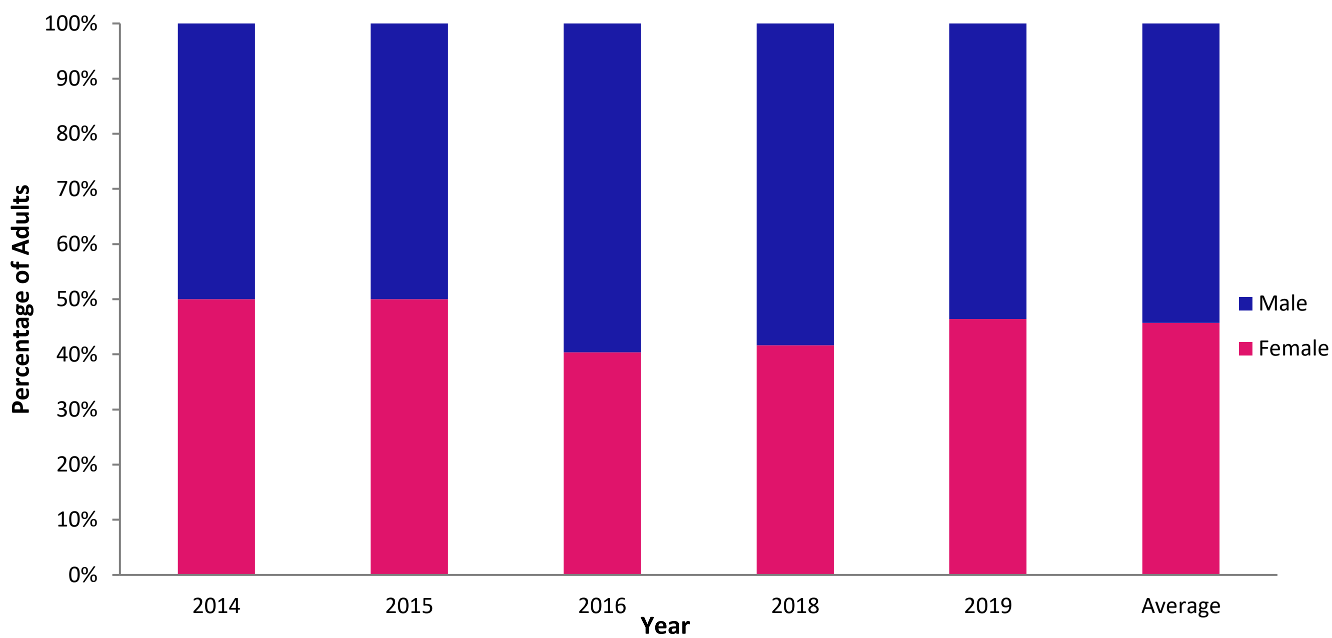

Figure 7. Sex ratios of natural-origin adults captured at Patit Creek weir, 2014-16, 2018-2019.

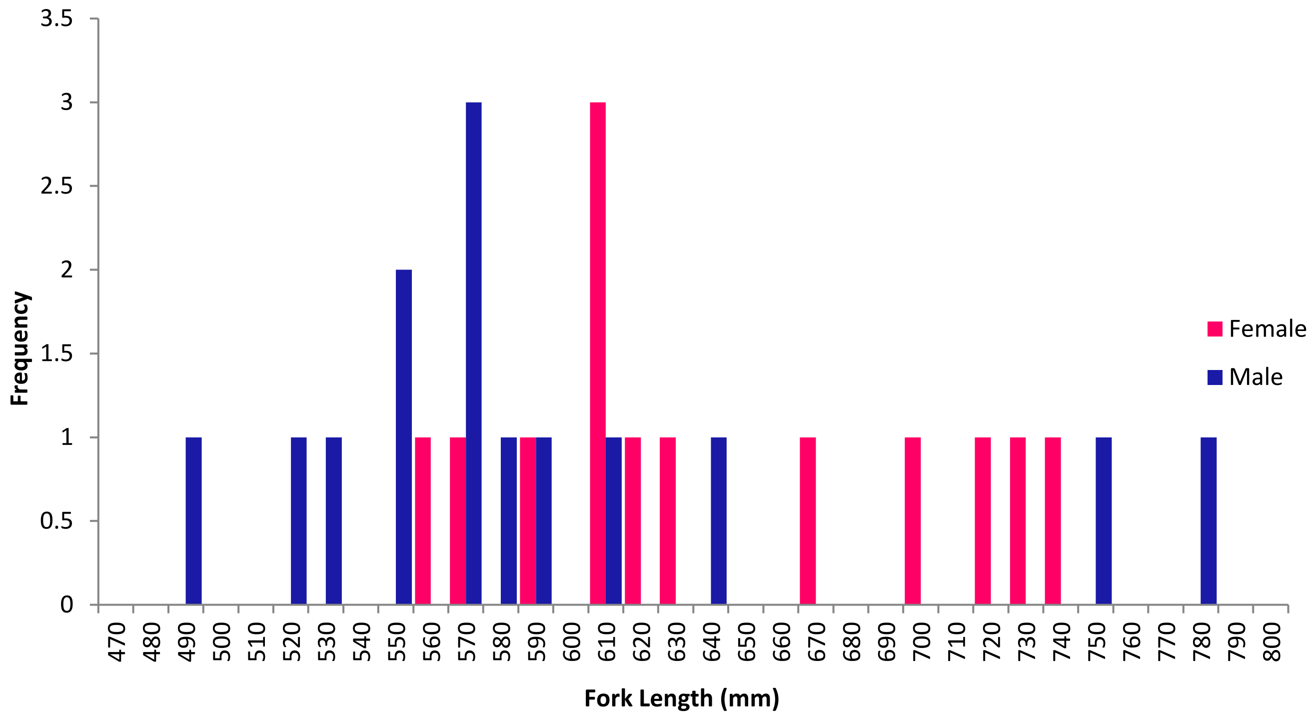

Figure 8. Length frequency by sex of maiden, natural-origin steelhead captured at Patit Creek weir, 2019.

We collected scale samples from 100% (n=28) of the natural-origin adults captured. The majority (75.00%, n=21) were readable in both the freshwater and saltwater growth periods. Scale age analysis indicates simple life history patterns for males; we only found evidence of males spending one year in the ocean after one (44.4%) or two (55.6%) years in freshwater. The female returns were dominated by adults aged 2.2 and had most age categories represented in the sample (Table 3).

Table 3. Summary of scale samples and ages of natural-origin steelhead captured by sex at Patit Creek weir, 2019.

Age	Female		Male		Total	
(fresh.ocean)	*n*	%	*n*	%	*n*	%
1.1	1	8.33%	4	44.44%	5	23.81%
1.2	1	8.33%	0	0.00%	1	4.76%
2.1	3	25.00%	5	55.56%	8	38.10%
2.2	6	50.00%	0	0.00%	6	28.57%
3.1	1	8.33%	0	0.00%	1	4.76%
3.2	0	0.00%	0	0.00%	0	0.00%
Total Readable	12	57.14%	9	42.86%	21	75.00%
r	0	0.00%	1	100.00%	1	14.29%
r.1	1	25.00%	3	75.00%	4	57.14%
r.2	0	0.00%	2	100.00%	2	28.57%
Regenerated	1	14.29%	6	85.71%	7	25.00%
Total n	13		15		28	

Table 4. Mean fork length of maiden natural-origin adult steelhead, by ocean age captured at Patit Creek weir, 2019.

Ocean Age	Statistic	Females	Males
	N	6	12
1	Fork Length(mm)	589	582
	SD	20.49	59.49
	N	7	2
2	Fork Length(mm)	682	792
	SD	43.03	15.50

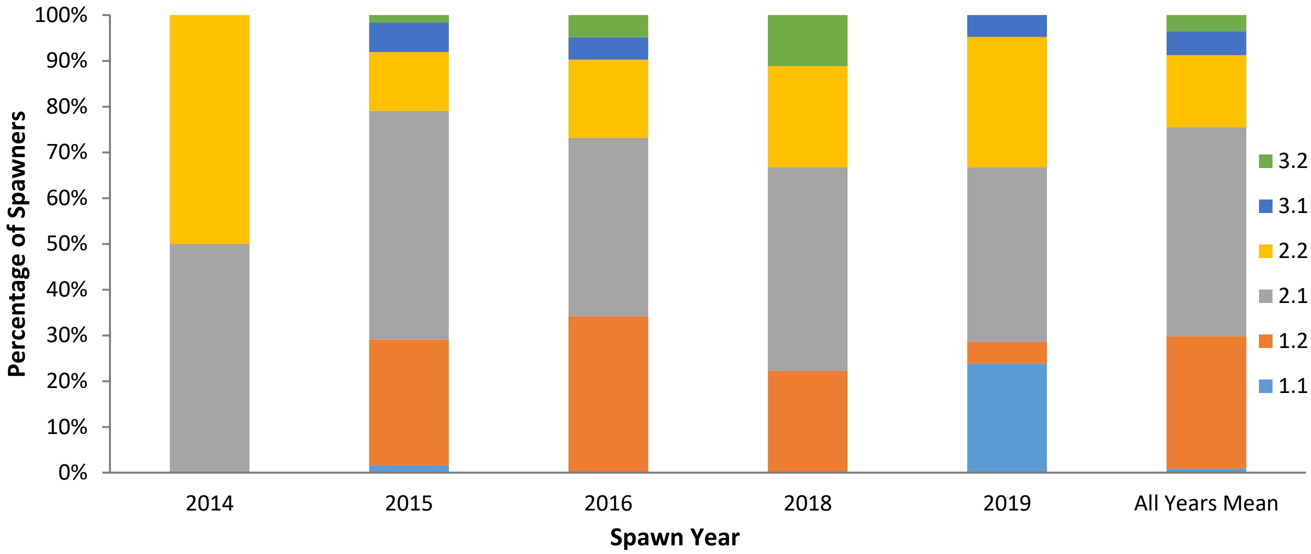

Figure 9. Summary of age composition of natural-origin steelhead captured at Patit Creek weir, 2014-2016 & 2018-2019.

Upper Touchet- Dayton Adult Trap

The Dayton Adult Trap (DAT) began operation for the 2019 trapping season on 1 February 2019 and ran until 30 June. The trap is run by WDFW's Snake River Lab staff as part of the Touchet Endemic Steelhead program for broodstock collection and management. It serves as a fixed counting station and allows us to provide an index of natural-origin steelhead spawning escapement in the upper Touchet River basin. Because of this, we report demographic data on natural-origin adults only, further information on the Touchet Endemic Steelhead program can be found in Miller et al (*in press*).

During trapping operations WDFW staff captured 245 unique, prespawn adult steelhead. Wild origin adults accounted for the largest proportion, accounting for slightly over half of the total (n=127; 51.8%). Wallowa stock hatchery-origin fish were the next largest component, accounting for 35.1% (n=86) of the total captured. The remaining fish were Touchet Endemic program adults, accounting for 13.1% (n=32; Table 5). Most natural-origin adults (n=92; 72.4%) and all endemic origin adults (n=32) captured were passed upstream to spawn naturally, while other hatchery-origin fish were predominantly removed from the system or released downstream to augment angling opportunities. The specific details of broodstock collection and management at the Dayton Adult Trap and the Touchet Endemic Steelhead program can be found in Miller et al (*in press*).

Table 5. Origin and fate of adult steelhead captured at the Dayton Adult Trap, 2019.

Origin	***Passed Upstream***	***Passed Downstream***	***Broodstock***	***Broodstock-Returned to Stream***	***Kids Pond***	***Surplus***	***Trap-KO***	***Total***
Wild	92	0	14	21	0	0	0	***127***
Endemic	32	0	0	0	0	0	0	***32***
Hatchery	0	59	0	0	1	20	6	***86***
Total	***124***	***59***	***14***	***21***	***1***	***20***	***6***	***245***

Of the natural-origin fish captured and sampled at the Dayton Adult Trap, females dominated the returns, accounting for 60.6% of the overall run.

Staff from the Snake River lab collected scales from the majority (97.6%, n=124) of natural-origin adults captured. Three natural-origin females were passed upstream without collecting scale samples.

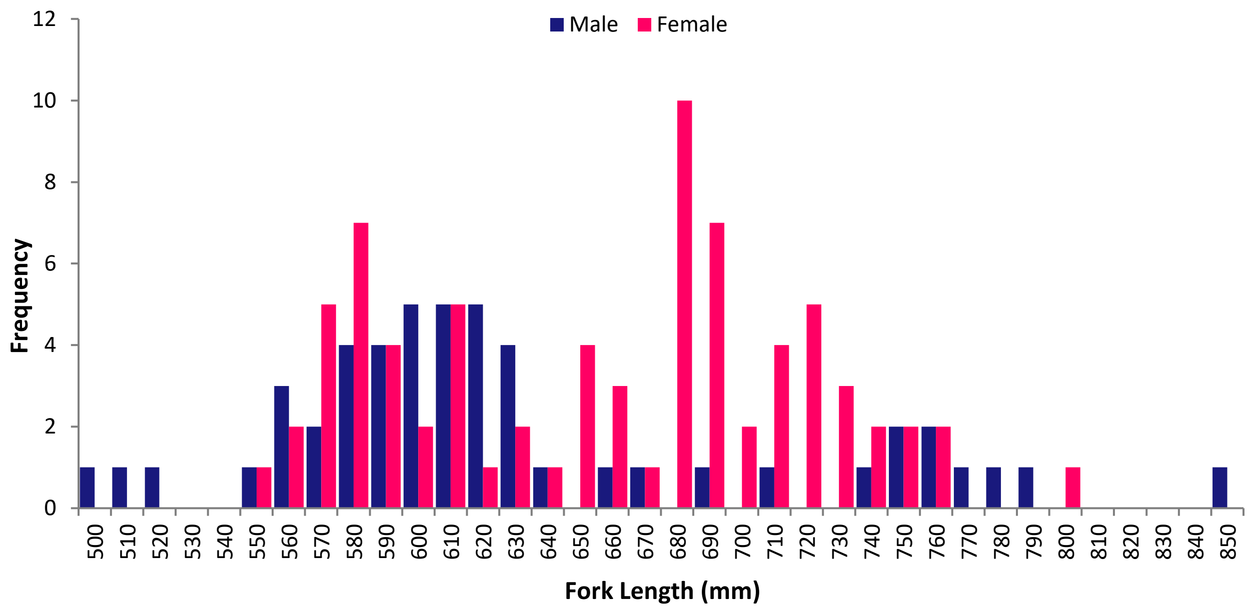

Figure 10. Length frequency by sex of maiden, natural-origin steelhead captured at Dayton Adult Trap, 2019.

Length at ocean-age did differ between sexes, specifically in ocean-age 2 returns. Ocean age 2 returning males averaged just over 50mm greater fork length than females spending the same amount of time in the salt. Similar to what was observed in 2018, fish aged 2.1 made up the greatest proportion of the natural-origin returns, making up 43.01% of the overall returns, and 59.46% of the male returns (Table 7). Natural-origin females were only slightly dominated by age 2.2 returns, accounting for 35.71% of the readable scales.

Table 6. Mean fork length of maiden natural-origin adult steelhead, by ocean age captured at Dayton Adult Trap, 2019.

Ocean Age	Statistic	Females	Males
	N	32	37
1	Fork Length(mm)	593	598
	SD	24.14	34.96
	n	38	11
2	Fork Length(mm)	699	756
	SD	31.9	45.18

*****does not include repeat spawners.*

Table 7. Summary of scale samples and ages of natural-origin steelhead captured by sex at Dayton Adult Trap, 2019.

Age	Female		Male		Total	
(fresh.ocean)	*n*	%	*n*	%	*n*	%
1.1	0	0.00%	2	5.41%	2	2.15%
1.2	3	5.36%	2	5.41%	5	5.38%
2.1	18	32.14%	22	59.46%	40	43.01%
2.1s	1	1.79%	0	0.00%	1	1.08%
2.2	20	35.71%	7	18.92%	27	29.03%
2.2s	1	1.79%	0	0.00%	1	1.08%
3.1	7	12.50%	2	5.41%	9	9.68%
3.2	4	7.14%	1	2.70%	5	5.38%
3.2s	1	1.79%	0	0.00%	1	1.08%
4	0	0.00%	1	2.70%	1	1.08%
4.1	1	1.79%	0	0.00%	1	1.08%
Total Readable	56	60.22%	37	39.78%	93	75.00%
r	1	5.88%	1	7.69%	2	4.00%
r.1	6	41.18%	11	84.62%	17	60.00%
r.2	11	52.94%	1	7.69%	12	36.00%
Regenerated	18	24.32%	13	26.00%	31	25.00%
Total n	74		50		124	

Compared to previous years' the adult age composition at the DAT was similar to previous years. Notably, proportion of adults aged 1.1 (BY 2016) and 2.2 (BY2014) were less than the average, though this was balanced out by returns of 2.1 (BY 2015) adults, which was 11% greater than the average of 2010-2019 returns (Figure 11). The decline in the 1.1 component is not much different from Coppei Creek, where the 1.1 age class was entirely absent. To the contrary, the age composition at Coppei Creek was dominated by the 2.2 age class. At Patit Creek, the proportion of 1.1 was 23% greater than the project average. While this may indicate some local anomalies related to steelhead spawning and

rearing in the Touchet River system, it should be noted that none of these trapping locations can be considered a census count; fish can pass DAT and avoid the trap under the right circumstances just as they can pass the tributary weirs prior to installation or during high flow events. Also, the data in Patit Creek is sparse in most years, and the time series is shorter than for Coppei Creek and the DAT datasets.

We do not provide run timing data for the Dayton Adult Trap here because fish can pass the trap and structure volitionally. Snake River Lab staff have tried numerous techniques to dissuade trap-bypass passage with mixed results. Until this issue is resolved, we cannot accurately characterize run timing at the DAT.

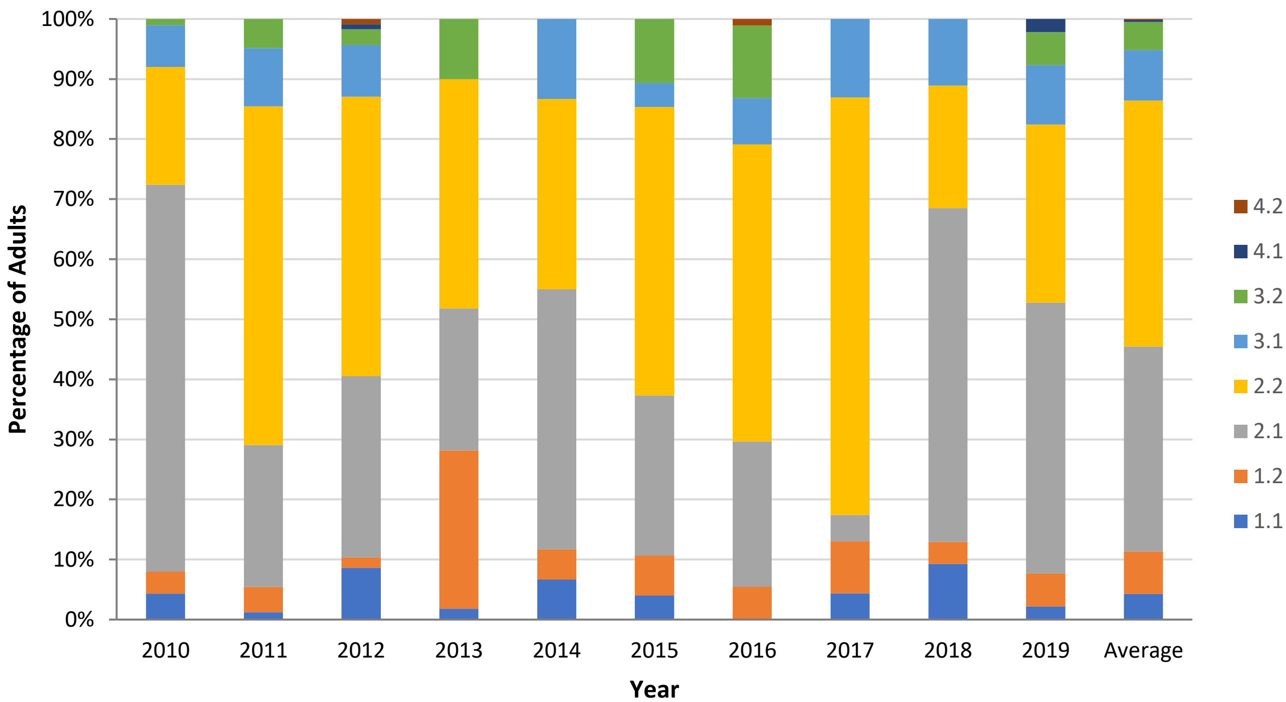

Figure 11. Summary of age composition of natural-origin steelhead captured at the Dayton Adult Trap (DAT), 2010-2019.

Smolt Trapping and Model Development

This project previously supported smolt trapping on the Touchet River. However, recent reductions in funding from BPA have limited our ability to operate the smolt trap. The majority of the financial support comes from the Washington State Governor's Salmon Recovery Office (GSRO) through the statewide Fish-In/Fish-Out contract. Nevertheless, this project continues to support the smolt trapping effort primarily through purchases of PIT tags being implanted at the trap. We describe relevant data below, in the context of the fall 2018 and spring 2019 trapping operations. Additional data and analysis, beyond what is presented here can be found in Gallinat and Kiefel (2019).

Staff from the WDFW Snake River Lab deployed the smolt trap on 15 October 2018 and removed the trap on 1 July 2019, due to declining captures and stream discharge. During the time the trap was deployed, trapping operations were compromised for a total of 57 days due to high debris loads and stream discharge. The magnitude of stream discharge is significantly greater on the mainstem Touchet

than in its tributaries, resulting in longer periods of outages and much higher debris loads. The outage extended from 20 March until 2 May 2019. While the trap was in operation, staff captured 1,058 juvenile steelhead parr with fork lengths between 80 and 124mm (sub-smolts in Gallinat et al. 2019) and 3,384 smolts (>=125mm). Gallinat et al. (2019) used the methods outlined by Steinhorst et al (2004) to estimate a total of 4,027 (95% C.I. 3,362-4,917) emigrating sub smolts and 20,534 (95% C.I. 17,882-24,010) smolts during the period prior to the trap outage described above, and an additional 4,795 (95% C.I. 3,366-7,651) smolts following the trap outage 3 May-1 July. No estimate of sub-smolts is available for the period following the trap outage due to low captures of the smaller size class. This illustrates a weakness in using the Steinhorst method when trapping data is sparse or interrupted by long outages. The method is adequate for estimating outmigrant abundance with complete, uninterrupted trapping periods and sufficient recaptures. We provide a summary of the estimates and numbers of PIT tags applied at the Harvey Shaw smolt trap from fall 2014 to present in Table 8 below.

Table 8. Summary of steelhead captures, estimates and PIT tagged at the Harvey Shaw smolt trap site, 2014-2019.

Year	*Outmigrant Estimate*	*95% CI*	*n Captured*	*n PITs*	*% PIT Tagged*	*Trapping Dates*
2014-2015[a]	988	617-1,681	211	116	55%	1/8/2015-6/5/2015
2014-2015[b]	13,428	10,154-17,745	1,101	966	88%	
2015-2016[a]	9,042	7,942-10,296	2,530	1,746	69%	10/13/2015-6/30/2016
2015-2016[b]	22,778	18,561-28,581	3,044	1,794	59%	
2016-2017[a]	5,804	4,082-9,345	882	402	46%	10/30/2016-6/30/2017
2016-2017[b]	5,077	3,909-6,882	1,086	525	48%	
2016-2017[c]	8,457	5,429-13,547	577	560	97%	
2017-2018[a]	10,806	9,691-12,230	4,948	2,980	60%	10/16/2017-6/29/2018
2017-2018[b]	14,168	12,274-16,715	4,567	2,853	62%	
2017-2018[c]	10,518	7,536-14,857	984	750	76%	
2018-2019[a,c]	4,027	3,362-4,917	1,058	899	85%	10/15/2018-7/1/2019
2018-2019[b,c]	20,534	17,882-24,010	3,664	3,384	92%	
2018-2019[b,c]	4,795	3,366-7,651				

Note: [a] refers to estimates of fish considered to be "sub-smolts" 80-124mm fork length; [b] refers to estimates of fish considered to be smolts >=125mm fork length; [c] refers to estimates from partial or truncated trapping season.

Because of the trapping difficulties encountered on a nearly annual basis, we are developing a hierarchical Bayesian model (HBM) to estimate abundance during the gaps in trap operations and produce a more precise estimate of the complete juvenile steelhead emigration.

The model is composed of two distinct parts - a juvenile component to estimate weekly abundance by size class and the proportion of fish PIT tagged during each weeks and an adult component to estimate detection probability and abundance at mainstem and tributary PIT tag detection sites. The first part of the model uses the Bayesian Time Stratified Population Analysis (BTSPAS) package developed by Bonner and Schwarz (2011) to estimate juvenile steelhead abundance at the smolt trap by size class, sub-smolts (80-124mm fork length) and smolts (>124mm fork length), and migration period, early (trap installation-

31 January) and late (after 31 January). We use this model to generate the proportion of fish tagged relative to the number moving past to the trap, essentially providing a weekly PIT tag expansion factor that accounts for uncertainty. The second component of the model is informed by this PIT tag expansion factor using a Cormack Jolly Seber (CJS) survival estimate through the hydrosystem. Because we have a more precise expansion factor with uncertainty, we can use this data to estimate total adult abundance at each detection site for each year of adult returns, with a higher degree of accuracy and precision than simple PIT tag expansion factors provide.

For the proof of concept for this approach we used fall 2015 through spring 2016 (MY 2016) trapping data, the first full season of trapping operations at the Harvey Shaw site. As described in Gallinat and Ross (2016), during the 2015-16 trapping season the trap was operational for 81.6% percent of the period the trap was deployed which is higher than the average (70.8%; range: 53.3-86.5%) for all the years the trap has been operating at the Harvey Shaw site. This makes the MY 2016 data a good fit for assessing new methods of estimating trap efficiency and juvenile emigrant abundance.

The BTSPAS model estimated 9,215 (95% CI 8,118 -10,580) sub-smolts and 31,755 (95% CI 23,309-45,177) smolts emigrated past the trap site during MY 2016 (Figure 12). The sub-smolt estimate is only 1.9% greater than the estimates provided by Gallinat and Ross (2016) (Table 8) and the bounds are slightly wider. This is due to the generally stable trap efficiency of the smaller size class of fish. The stable trap efficiency is due to the overall low abundance of smaller size class. The smaller size class also had a frequency curve closer to a unimodal distribution, with the peak emigration occurring in the early winter portion of the trapping season. The difference was much larger when comparing estimates of smolts; the hierarchical Bayesian estimate was outside the confidence bounds provided by Gallinat and Ross (2016) and 37.75% greater. This difference can best be explained by the wider variability in trap efficiency of the larger size class and the bimodal distribution in emigration timing. The larger fish were more likely to emigrate in both the late fall and spring periods, and as a result they are more likely to be missed during trap outages during the peaks in emigration (Figure 12). The main difference between these two analytical methods of estimating juvenile abundance is that the BTSPAS model estimate includes fish passing when the trap is non-operational, whereas the Steinhorst estimate is limited to periods when the trap is fishing.

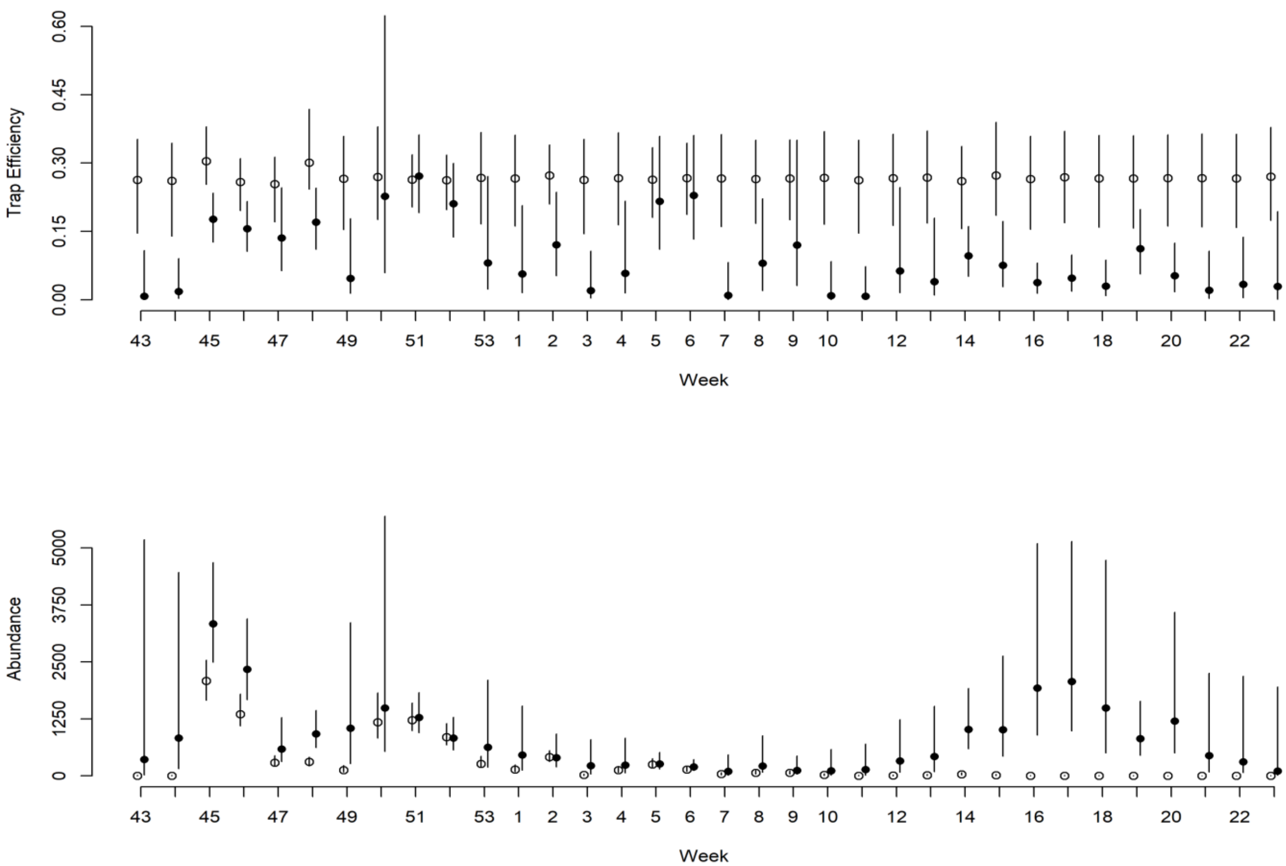

Figure 12. Estimates of trap efficiency (top panel) and juvenile emigrant abundance (bottom panel) by trapping week, 2016 migratory year. (*Note: open circles = sub smolts (80-124mm); closed circles = smolts (>124mm).*

The greatest strength of the HBM model lies in our ability to estimate the proportion of emigrants PIT tagged on a weekly basis, which in turn yields a weekly mark rate comparing PIT tagged fish to total emigrants. The weekly mark rate and abundance estimates enable unbiased expansions of PIT tagged fish detections into estimates of total adult abundance at various detection sites throughout the Columbia Basin. This novel approach may represent a substantial improvement over traditional methods, especially considering the challenges of estimating adult abundance using weirs and traps in target areas, as well as the portions of the Touchet Basin that are not monitored using weirs and traps (e.g. mainstem Touchet downstream of Dayton).

We also incorporated PIT tagged Touchet endemic and Wallowa stock hatchery-origin fish to boost the numbers of detections at each interrogation site and improve the estimates of detection (capture) probability in the model. This allows us to compare abundance and upstream survival for three groups of adults: natural-origin, Touchet endemic and Wallowa stock. As mentioned above, the large majority of Touchet adults return after spending one or two years in the salt. Therefore, we also estimate the adult abundance at each site for ocean age-1 and ocean age-2. For this model we used adult detections of each group at Bonneville (BON), The Dalles (TDA), and McNary (MCN) dam adult fish ladders, as well as instream detection sites in the lower Walla Walla (PRV: Pierce's RV Park[through 2019] + WWB: Walla Walla Floating Barge) and the lower Touchet River at the Harvey Shaw (HST).

Adult survival estimates are provided below in context with Touchet endemic and Wallowa stock returns, in Figure 13 and Figure 14. Natural-origin adult survival through the hydrosystem was quite high in the first year of returns (SY 2018) but dropped for the second year of adult returns in SY 2019. The drop is likely due to the smaller component of age 2 saltwater adults common in most return years in the Touchet River. Combined survival of natural origin adults from Bonneville Dam (BON) to McNary Dam (MCN) was 91.69%, in 2018 (Figure 13) and declined to 78.23% in 2019. Again, this is partly due to a smaller sample size in the second year of returns (Figure 14).

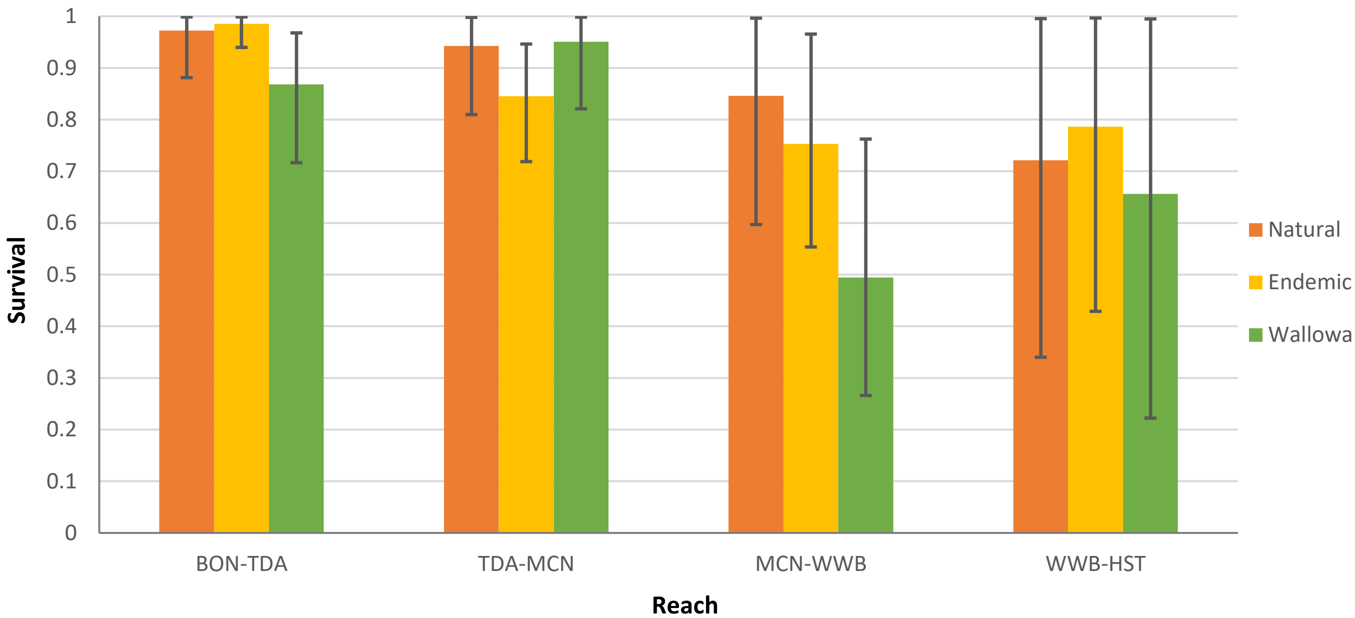

Figure 13. Reach survival of ocean age 1 adults from MY 2016 through the hydrosystem in 2017-2018 (SY2018). *Note: Error bars extend to upper and lower 95% confidence intervals.*

The decline in survival upstream of MCN, through the lower Walla Walla (WWB/PRV) and Touchet Rivers (HST) was lower than mainstem survival in both years. However, detection probabilities a the mainstem sites in the hydrosystem is generally much higher than at instream detection sites, depending on flow conditions and the operational status of each site. Natural origin adult survival from MCN to HST was 61.02% for adults returning to spawning 2018, and 72.93% in 2019. This is higher than both endemic and Wallowa stock hatchery origin fish. The reduced survival of Wallowa stock fish makes sense, as they are released with adipose fins clipped and meant for harvest augmentation. The lower survival of Touchet endemic stock fish could be related to straying, but likely not due to angler harvest, as they are released with intact adipose fins and not meant for harvest.

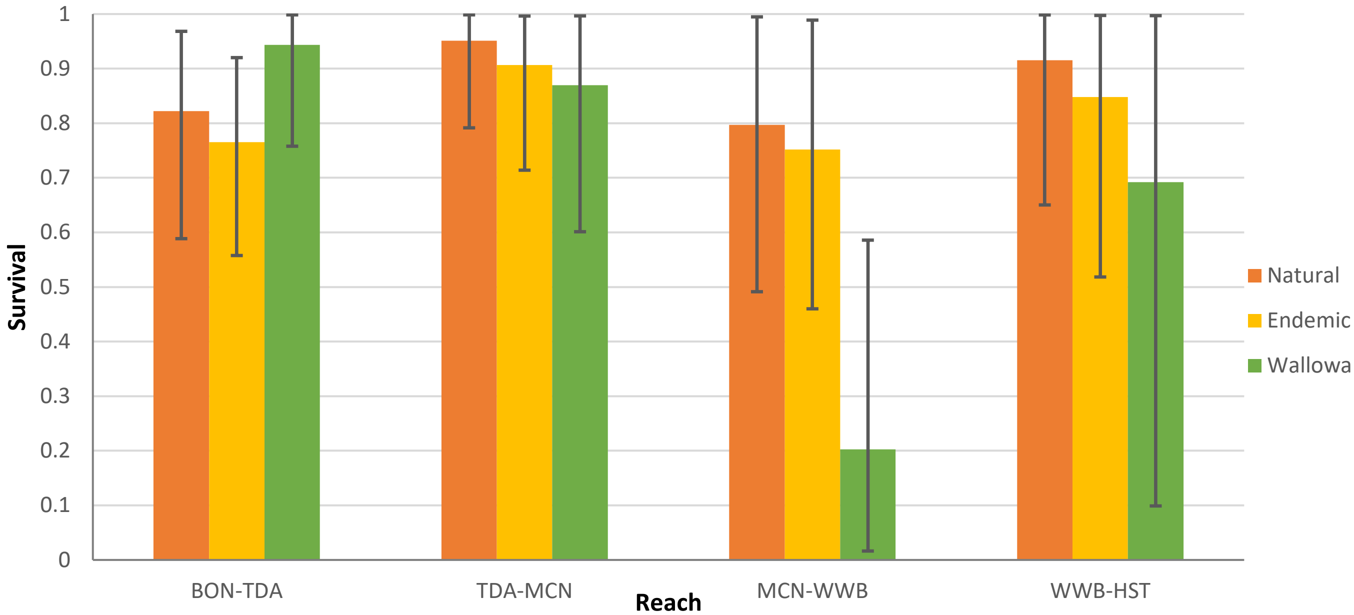

Figure 14. Reach survival of ocean age 2 adults from MY 2016 through the hydrosystem in 2018-2019 (SY2019). *Note: Error bars extend to upper and lower 95% confidence intervals.*

Estimates of adult abundance are presented below for both the 2018 and 2019 spawn years (Figure 15) and by stock and year in Figure 16. Wallowa stock had the highest abundance at all sites in 2018 and at most sites in 2019. This is unsurprising given that it was largest release group used in the model (88,100 smolts). However, estimates of natural-origin adult abundance at each site exceeded those of Touchet Endemic stock, despite the endemic release group of 47,175 smolts compared to only 40,970 combined natural-origin parr and smolt in MY 2016.

These estimates should be used with caution as they are considered preliminary at this time. Specifically, estimates of adult abundance at each of the instream sites (PRV and HST) are affected by the detection probability at each of those sites, which can vary widely depending on flow conditions and hardware functionality at each site. Despite these caveats, the data generated by the model is useful in assessing factors effecting adult survival through the hydrosystem. Abundance and survival estimates will likely be improved by incorporating additional detection sites in the Columbia and Snake Rivers. Adding detection sites to the model would allow us to better assign a fate to fish that did not survive back to the Touchet River (i.e., straying, harvest, overshoot, etc.). Until we can assess detections of fish outside the typical migratory path, we are unable to make conclusions from the discrepancies in adult survival. This model is our first attempt at using juvenile PIT tags to estimate adult abundance. With additional years of data in the model we hope to delve further into this in the next reporting period.

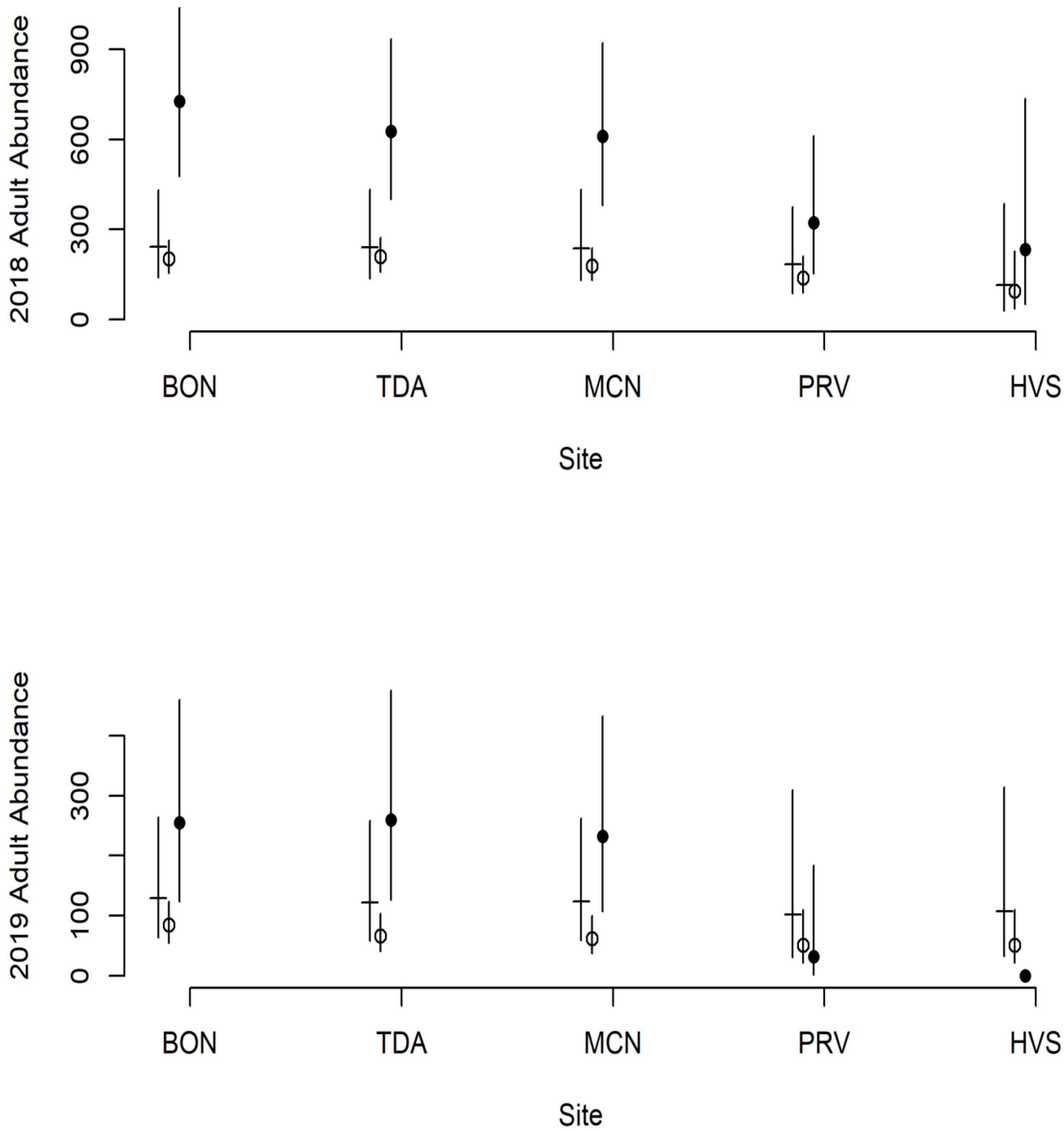

Figure 15. Adult abundance of MY 2016 ocean age-1 (top panel) and ocean age -2 (bottom panel) at adult fish ladders and instream detection sites. (*Note:* Natural-origin adults = *horizontal lines*; Endemic stock=*open circles*; Wallowa stock=*closed circles.* Vertical bars represent 95% confidence intervals.)

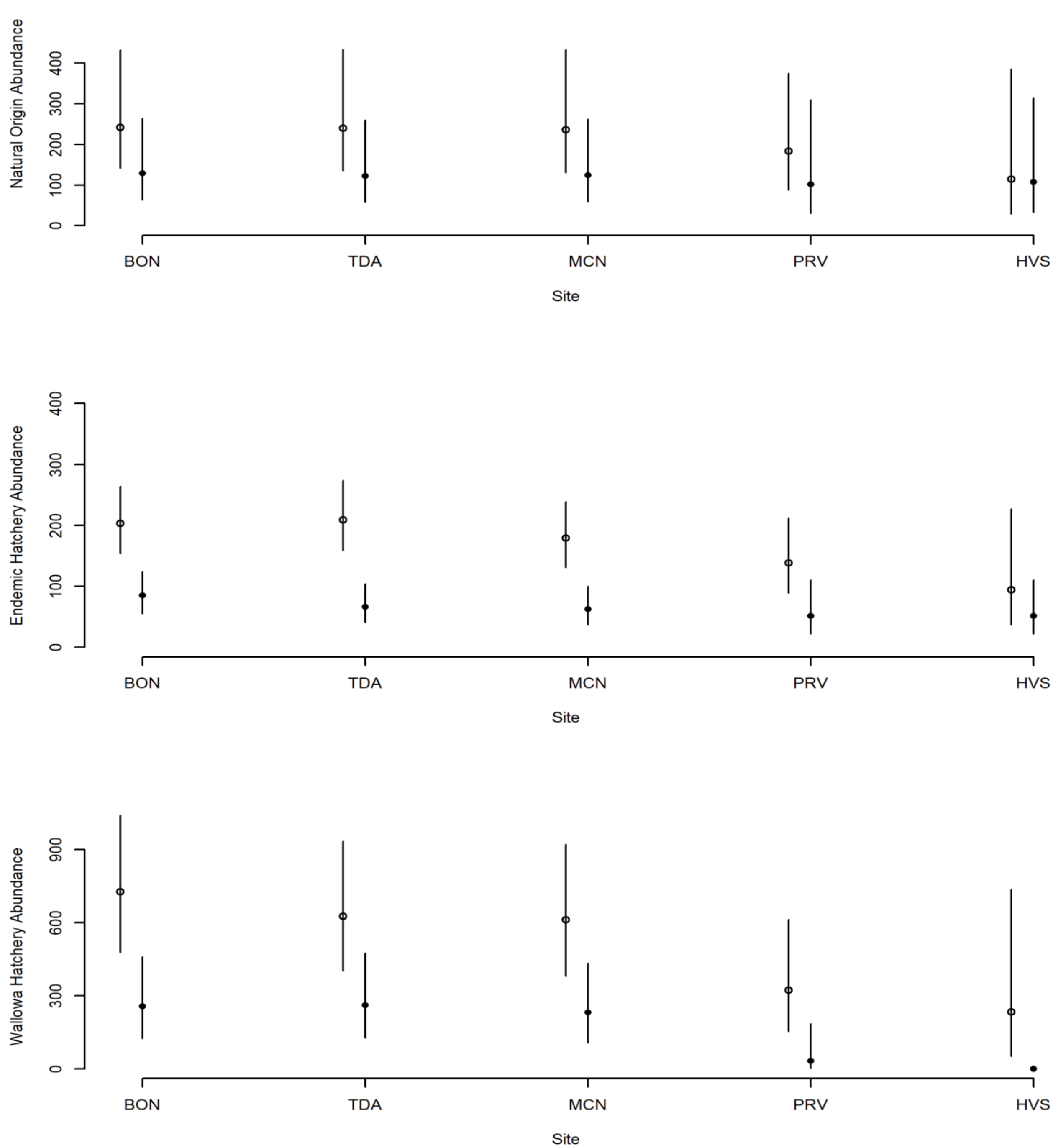

Figure 16. Estimates of PIT tag based adult abundance for Natural-origin (top panel), Touchet Endemic (middle panel) and Wallowa stock (bottom panel) by ocean age. (*Note:* Open circles=ocean age-1 adults (2018 spawners); closed circles = ocean age-2 adults (2019 spawners); vertical bars represent 95% confidence intervals.)

Discussion

As we presented in the 2018 annual report, overlapping high flow conditions and spring run timing has made it difficult to estimate adult escapement and juvenile emigrant abundance. For adults, the weir infrastructure upgrades made through this project have improved the resolution of the adult escapement data over what would have been achieved with older weirs. However, funding reductions and challenging field conditions have made it difficult to improve and maintain the juvenile trapping infrastructure in the Touchet basin. As described above, the flashy flow regime can wreak havoc on trapping equipment, limiting our ability to maintain trap operations through the entire trapping season due to damaged or otherwise inoperable equipment. The conservative approach to trap operations is dictated by the funding situation and limiting the risk to the trap. WDFW has engaged with the Snake River Salmon Recovery Board and the GSRO to find funding solutions that allow for optimized operations and a safety net to support trap maintenance and repair.

Project staff made significant improvements to weir infrastructure and fish capture at the Patit Creek and Coppei Creek adult trapping sites. This was a successful effort despite tough trapping conditions in the spring of 2019. The weirs were subjected to some of the largest flows (2,530-3730 cubic feet per second on the Touchet River at Bolles Bridge; WA Dept. of Ecology Site ID: 32B100) encountered over the course of the project. They were compromised for short (9 and 19 days, respectively), but significant periods of time due to the high likelihood that adult steelhead were moving past the sites. Project staff were able to reinstall the weirs as soon as water levels allowed for safe access. In previous years of the project, flow events like those encountered in 2019 would have been season ending events, like what occurred on Patit Creek in 2017. Aluminum has proven to be a much more durable and resilient material when compared to the wood and PVC weirs used by the project previously. In 2019, improved weirs accounted for decreased downtime, and as a result, more accurate and precise estimates of adult escapement in Coppei and Patit Creeks. The switch to aluminum components has also decreased preparation time prior to installation and shortened the time it takes to complete installation.

Despite improvements to the trapping infrastructure, adult returns to the Touchet River were down for the second year in a row. While this is somewhat concerning, adult steelhead abundance was down across the interior Columbia Basin. Estimates of adult abundance using PIT tags did trend similarly to weir estimates and adult counts at the Dayton Adult Trap, and account for most fish estimated to return upstream of the Harvey Shaw instream detection site. It is reasonable to assume that the remaining fish, unaccounted for upstream of HST are spawning elsewhere downstream of (and in between) the sites described within this report.

In the next reporting period, we intend to apply the same methodology used to estimate adult spawning escapement upstream of the project weirs using the same methods used in 2019 for all other years of the project. We are in the process of consolidating all previous data into an Access database. This should help improve the abundance estimates as the longer timeseries of data can inform priors to enhance the model.

Initial attempts at calculating adult abundance and escapement using juvenile PIT tags from the Touchet River smolt trap proved useful and encouraging. However, like the adult trapping apparatus, operations at the smolt trap are negatively affected by high flows. More research is needed to determine whether the PIT tagged fish used in the analysis are a representative sample of the population. Some of the

problems with smolt trap operations are due to our conservative approach to operating the trap, which is necessitated by limited funding. Reduced operations during periods of high flow mean that we miss key steelhead outmigration timing. Missing fish at the trap limits the number of PIT tags deployed, when they are deployed, may violate some of the mark-recapture assumptions, and these factors could bias the trap efficiency estimates. WDFW is pursuing additional funding opportunities to expand operations and hire additional personnel to operate the trap. Additional funding would also help to repair or replace the trap should significant damage occur in the course of normal operations. Going forward it may be possible to extend this model to include a multi-state component that may help understand the extent of straying upstream of the mouth of the Walla Walla River and into the Snake River.

The success of using juveniles implanted with PIT tags to estimate adult abundance can be limited by the detection probability of detection sites. Some of the same issues affecting our trapping operations can also influence the operations of instream detection sites. High streamflow and debris loads can impact IPTDS operations over a significantly longer time scale than the smolt trap or weirs. When arrays are damaged by high flows it can take weeks or months to bring the site back online or 100% operational functionality. Furthermore, when array systems fail it can mean complete rebuild of individual antennas and cables. It is imperative that the action agencies and co-managers prepare for this by providing additional resources to support instream sites located in a high-risk systems (Touchet & Walla Walla) and consider some redundancy between sites located in focal watersheds. Flexibility in fund allocation may also allow for quicker response and re-installation should instream sites be damaged.

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