Yankee Fork Chinook Salmon and Steelhead Projects: Ten Year Report 2008-2018

Prepared by:

Lytle P. Denny, Jonathan D. Ebel, Sammy Matsaw, and Joshua Jackson

Shoshone-Bannock Tribes
Fish and Wildlife Department
Fort Hall, Idaho
(208) 239-4560

Prepared for:
United States Fish and Wildlife Service
Lower Snake River Compensation Plan – Office
1387 S. Vinnell Way, Suite 343
Boise, Idaho 83709

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1.0. INTRODUCTION

Before we begin, we are acknowledging the ancestors, native plants and animals, waterways and lands of the Shoshone-Bannock Nation, hereafter referred to as Shoshone-Bannock Tribes or SBT. Herein is 10 years of interweaving two worldviews to bringing salmon back and to bring them back to a salmon-based culture dependent and defined by these fishes since time immemorial. The science is laid out by thoughtful use of Shoshone-Bannock Traditional Ecological Knowledge (SBTEK) and is building on many tools and methods of Western science. The Anadromous Fish Program has staff instilled with SBTEK, trained in Western science and working within the Tribes treaty rights, cultural ways of living and complex interactions across federal, state and non-governmental agencies' policies, science and management goals, objectives and actions. What is reported herein is a process of change, important to verb-thinking peoples like Shoshone-Bannocks, rather than the result of change, a Western thought expectation (Pierotti 2010). For instance, through SBTEK our perspective is to know salmon as a relative letting them teach us; what we've learned is salmon are imprinting in the Sawtooth Fish Hatchery then returning as adults to Sawtooth. They need to be in the Yankee Fork at an earlier life history stage to imprint cues before smolting. A larger part of this for us, is we do not have access to Western methods (rearing and hatchery facility) to implement how to release these salmon as they need for earlier rearing prior to imprinting and then home back to the Yankee Fork. To instances of learning how salmon learn about our weir traps and we've modified those to increase efficiency and redds above the weir (Tables 16 & 17) much like the traditional weir used for harvest (Lewis and Clark journals). These two knowledges are disconnected by power imbalances and a bias towards one-way of knowing thus the salmon knowledge and SBTEK values are disconnected making our abilities to be co-managers for bringing back salmon much more difficult.

Yankee Fork is the surrogate for Valley Creek a component of the Sawtooth Hatchery operations towards mitigation in three tributaries including Upper Salmon River above Sawtooth and East Fork Salmon River (Herrig 1990). The Tribes have been working in the Yankee Fork to bring salmon back through a multitude of actions within our scope such as we've dedicated a significant amount of our BPA Accords funding towards habitat restoration through 2008-to present (US Bureau of Reclamation reports https://www.usbr.gov/pn/fcrps/habitat/projects/uppersalmon/yankeeforkproject/). That habitat work has been restoring destroyed valley bottom from a dredge operation, overharvest of timber and occupation of a mining town and settlers impact on the watershed over the last century.

Our ancestors and elders here in the Shoshone-Bannock have informed us the Yankee Fork was a good fishery for salmon harvest. Our fathers fished the Yankee Fork and a peer in their generation, Cleo Tinno, was cited for spearing Chinook salmon in the Yankee Fork. More than a citation on Cleo, the Shoshone-Bannock Tribes were challenged on their treaty right-to-fish in State v. Tinno (1972). The state of Idaho did not want the case going into the 9th circuit federal court of appeals where tribes were in favor (US v. Oregon, and US v. Washington), so Tinno was settled in the Idaho Supreme Court preventing a US v. Idaho. In that case it was the testimony of Sven Liljeblad, a professor of anthropology and linguistics at Idaho State University, who testified that the interpretation of "to hunt" or Tygi/Hoawai, respectively, in the Shoshone and Bannock languages would have been "to gather wild foods" which would include the right-to-fish. Because of this the state of Idaho recognizes our treaty rights within the boundaries of Idaho, but our rights extend into our usual and accustomed areas outside of Idaho.

Within the Tribes' Fish and Wildlife department we have a collection of memories with our fathers where we caught our first salmon back in the 1980's. Sadly, at that time, we had seen some of the final days of salmon returning to that place. Since then many of us moved over the South Fork of the Salmon River fishery in the 1990's and hunted salmon through 2001 and 2002 returns of over 50,000 adults into Idaho. We were spearing so many salmon we had to fillet them along the river to get more fish into our coolers, and some of the transport home was storing our catch on willow beds (a traditional way of making beds out of fresh cut willows and stacking salmon on so they don't rot). Those returns had given us a taste of what type of fishery we want back into the Yankee Fork, it gave some semblance of what our fathers and grandfathers knew as a fishing right that our Tso-tso's forefathers/mothers secured for us through our 1868 Fort Bridger Treaty. A culmination of our efforts in higher education and trial by fire to figuring out: Western approaches to science methods and philosophy, policies from the federal and state governments, and how our treaty rights intersect. We remember when, applying Winans (1905, see Bell 2015), that treaty rights were "not a grant of rights to the Indians, but a grant of rights from them, a reservation of those not granted." to what we are working to protect, now today, and preserve for future generations.

This report summarizes hatchery-origin and natural-origin juvenile emigrant and adult return monitoring efforts from 2008-2018 in the Yankee Fork Salmon River conducted by the Shoshone-Bannock Tribes' Fish and Wildlife Department. The Yankee Fork Salmon River is a tributary of the upper Salmon River in Idaho. Once a major producer of Chinook salmon and Steelhead and important subsistence fishery for the Shoshone-Bannock peoples, the Yankee Fork stream habitats were heavily impacted by dredge mining and the anadromous salmonids were devastated by Columbia and Snake River hydrosystem development. These two co-occurring events resulted in very low natural origin anadromous salmonid abundance by the 1970’s. A reduced fishery quickly followed in concert with a suffering of the people here on the Fort Hall Indian Reservation.

In response to chronically low adult salmon and steelhead returns to the Yankee Fork and to enhance tribal harvest opportunities, the Shoshone-Bannock Tribes collaborated with the Lower Snake River Compensation Plan (LSRCP) and Idaho Department of Fish and Game (IDFG) to supplement Chinook salmon and steelhead populations in the Yankee Fork with hatchery fish.

This report covers: hatchery origin release totals, juvenile survival estimates, biological characteristics of natural origin fish, and smolt-to-adult return rates using a variety of techniques (Table 1.1); for both Chinook salmon (Shoshone language: *Agai*, *Oncorhynchus tshawytscha)* and steelhead (*Tsa baingwi*, *Oncorhynchus mykiss*); a long-term supplementation and monitoring effort providing high priority data germane to basin-wide regulatory requirements; and values of the Shoshone-Bannock Anadromous Fish Program embedded throughout this project (i.e. Legacy/Theory, Relationality/Relationships, Reciprocity/Honoring, Responsibility/Accountability).

Tribal fishery, study area, population status, genetic and supplementation history

The Yankee Fork Salmon River is a tribal fishery area that we are interested in because these places are imbued with memories from our ancestors, relatives and communities (Legacy/Theory). As young people we were brought to hunt salmon higher in watersheds like the upper Yankee Fork, in knee deep waters where we could spear salmon (Relationality/Relationships). Because we were raised there as a rite of passage and seen these places when we were going through our phase of imprinting, pubescent young Shoshone-

Bannocks, we've returned. Our return on an annual basis as tribal members, as families, as biologists, as teachers, as learners, as engineers, sacred people interacting on sacred lands is an important aspect not recorded in previous and non-tribal reports. However, we believe that in there lies the issue with understanding the stance of Indigenous peoples and how we see ourselves on the land. To imprint into these places and return year after year, generation after generation, millennia after millennia we've been informed on how to live in these places, to take care of them and they would take care of us. White settlers with a colonialism mindset are not a healthy way to view landscapes and a stance that has in so many ways proven as a detriment to the land, and now she is not taking care of us. The imbued memories and teachings are still with us today and we make spears as a relic of those teachings. Making spears to hunt salmon is an ethic we need right now.

Making spears is an important technology in our culture lifeways that brings families, relatives and community members close to one another. When we have a salmon spear in our camp, on our trucks, or carrying one in-hand along the stream it sends a signal. In these places we have and still do gather as families create memories, and re-create relationship with lands and waterways, learning and teaching the culture, songs, and celebrations to feed our families and feed the land. We connected and re-connected to land in many ways such as eating and gathering berries, and then leaving those berries as they pass though us with salmon nutrients, that is marine-derived nutrients directly assisting seed dispersal through our guts (Matsaw 2020). This is another promise to take of the plants that take care of us, and our agreement to help disperse their young. It is no coincidence there are berries in places where salmon hunting is optimal for spear hunting. This is what we mean when we say, "Mountain top to mountain top management." The spear is a gathering point for us, a technology filled with a caring for the land

and for one another. How we manage as the Indigenous peoples of these lands is through living by the spear.

The upper watershed in the Yankee Fork is ideal for living by the spear. It has been and always will be so as long as we can bring salmon back to there and get out of their way. The Yankee Fork Salmon River is located in central Idaho within Salmon-Challis National Forest (Figure 1). The river begins at 2500m above sea level and flows from north to south for 42 River kilometers (rkm) to an elevation of 1880m at its confluence with the Salmon River at rkm 590.6. Total watershed area is 314 km^2. The watershed once supported large populations of anadromous fish (Reiser and Ramey 1987). Gold was discovered in the Yankee Fork in the 1860's, which ushered in nearly 100 years of habitat destruction culminating with extensive dredge pile deposition from ca. 1930-1955 on the valley floor. Spring/summer Chinook salmon as well as anadromous and resident *O. mykiss* inhabit the Yankee Fork along with westslope cutthroat trout (Shoshone language: *Aingasayawena, O. clarkii lewisi),* mountain whitefish (*Muziwhiyu, Prosopium williamsoni*), shorthead sculpin (*Ahwe, Cottus confusus*), bull trout (*Salvelinus confluentus*), suckers (*Muugade'e, Catostomus spp*.), redside shiners (*Buhiwo, Richardsonius balteatus*) and dace (*Motonutse, Rhinichthys spp*.).

The Yankee Fork Chinook salmon population are considered spring-run as a result of their adult migration timing and is within the Snake River Spring/Summer-run Chinook Salmon Evolutionary Significant Unit that were listed as threatened under the Endangered Species Act in 1992 then reaffirmed as threated in 2005 and 2012. Within this ESU, the Yankee Fork population is one of nine populations within the Upper Salmon River Major Population Group (MPG). The Interior Columbia Technical Recovery Team (ICTRT 2003) identifies a Minimum Abundance Threshold of 500 spawners for the Yankee Fork population to remain viable with less than a 5% change of extinction over the next 100 years, but also acknowledges that the Yankee Fork population is currently comprised of non-native stock following periodic hatchery supplementation over the last 40 years.

The Yankee Fork steelhead population is a summer-run steelhead and falls within the Upper Salmon River component of the Salmon River MPG (ICTRT 2007), which is a group within the Snake River Basin steelhead designated population unit Designated Population Segment? (DPS). The Snake River Basin steelhead DPS was listed as threatened under the Endangered Species Act in 2006 then reaffirmed in 2014. The Salmon River MPG is a mixture of A-run (population consisting of predominantly adults that spend one year in the ocean) and B-run (population consisting of predominantly adults that spend two or more years in the ocean), although this classification system is increasingly criticized (Copeland et al. 2017). As a whole, the Upper Salmon River component is of intermediate size and considered A-run with out-of-MPG hatchery influence (ICTRT 2007).

Project History

The Legacy/History of Shoshone-Bannock peoples across the Snake River and its tributaries is ongoing since time immemorial. There are memory traces we maintain and uphold into the future that is the connection we have through space on our homelands, and time through our seasonal round that has shaped our unwritten laws—Deniwape. Part of unwritten laws are described through our oral tradition that has stories about salmon and how they gave their lives so that ours may go on. Because of the Deniwape we have a Reciprocal/Honoring of Relationality/Relationship to maintain with these powerful and sacred animals; today they are in need of our help and knowledge. We are using both SBTEK and Western tools of science to make the best decisions possible with a limited amount of resources, personnel, and funding.

Because of this the activities on-the-ground are complex, sporadic, difficult at times and disheartening. This is important to recognize because it has much to do with the state of salmon recovery and hegemonic structures of power that cause an imbalance for the Tribes to work amongst and within.

Reductions in Chinook salmon and steelhead populations in the Salmon River and upper Snake River basin corresponding to the construction of the Hells Canyon dam complex and four dams on the lower Snake River during the middle of the 20th century annihilated and greatly reduced subsistence opportunity for Shoshone-Bannock tribal members. As a result of an annihilated and reduced harvest opportunity, Idaho Department of Fish and Game released the first recorded Chinook hatchery origin juveniles into the Yankee Fork in 1978 (Brood year 1976) from Mackay Fish Hatchery near MacKay, ID. Further recorded releases did not occur until 1988-1990 and 1993 when both smolt and parr were released. After another gap, Chinook smolt releases began again in 2006, then 2010-2018 with the exception of 2011 (See Section 3). Only smolt releases occurring from 2006 forward are included in this report.

In 2006, the Tribes initiated the Yankee Fork Chinook Supplementation Strategy to increase the number of adults returning to the Yankee Fork for the tribal fishery. Chinook from the Sawtooth Fish Hatchery were selected for release because the Sawtooth stock is the closest remaining Chinook population to the Yankee Fork. Yet, smolt releases of 200,000 to 300,000 smolts from Sawtooth Fish Hatchery are insufficient to meet the Tribes harvest objectives in the Yankee Fork, thus the Tribes have pursued the construction of a separate hatchery near Springfield, Idaho (Crystal Springs Hatchery*) to consistently produce enough smolts to achieve their harvest objective and re-build a self-sustaining Chinook population in the Yankee Fork.

**Crystal Springs Hatchery has been shelved although the Tribes are still interested in a hatchery dedicated to achieve the goals outlined below.*

To achieve these dual goals, the Crystal Springs Hatchery program is progressing in three phases.

- Phase 1 is to develop a local broodstock by releasing up to 1500 surplus hatchery adults into the Yankee Fork and release a minimum of 200,000 smolts per year. Broodstock for Crystal Spring Hatchery after construction will begin with a mixture of adults captured in the Yankee Fork and Sawtooth Fish Hatchery.
- Phase 2 will consist of the complete conversion of the Crystal Springs Hatchery program to broodstock collected from the Yankee Fork that will occur after there is a five year running geometric mean return of 1000 Chinook salmon adults (hatchery origin plus natural origin fish) to the Yankee Fork.
- Phase 3 is a possible long-term outcome where the Tribes develop an integrated harvest program. However, this possibility hinders on substantially increased population productivity and abundance over time. Mostly, arising from improvements in Chinook passage and survival through the Federal Columbia River Power System (FCRPS) and habitat improvements in the upper Salmon River basin. This phase will be implemented if the 5-year running average natural origin escapement to the Yankee Fork exceeds 750 Chinook salmon adults. Termination of the hatchery program as a whole would occur if the 5-year running average run size exceeds 2000 Chinook salmon adults.

In part, the Chinook salmon portion of this report describes the implementation, monitoring, and evaluation of Phase I of the Crystal Springs Hatchery plan.

The current SBT steelhead supplementation program was initiated to increase the viability and production of steelhead in the Yankee Fork and provide increased harvest opportunity for Tribal members. The first recorded hatchery origin steelhead releases by Idaho Department of Fish and Game occurred through 1986-1989 with Pahsimeroi (PAH) and Sawtooth (SAW) stocks. Steelhead were not released again until 2000. From 2000-2012, steelhead released in Yankee Fork were raised at either Hagerman National Fish Hatchery or Magic Valley Fish Hatchery. In 2012, the Tribes, in collaboration with Idaho Department of Fish and Game, transitioned the Yankee Fork releases from SAW stock to B-run stocks as part of the Upper Salmon River B-run Program. The Upper Salmon River B-run steelhead program began with releases of smolts reared from adults returning to Dworshak Fish Hatchery in the 1970's as a means of increasing the diversity of the fishery in the Salmon River (IDFG 2011). Those consequent adults returning to the upper Salmon River served as a source of eggs to subsequent generations of the new Upper Salmon B-Run stock. This stock maintains its ancestral B-run traits, but over time has exhibited higher smolt to adult survival rates than continuing releases of Dworshak-sourced smolts. In an effort to fully transition B-run smolt releases to a locally adapted stock, the Shoshone-Bannock Tribes and Idaho Department of Fish and Game began releasing a portion of the B-run stock in the Yankee Fork in 2012. This was happening concurrently with plans to construct a permanent weir associated with the Crystal Springs Fish Hatchery. As a result, steelhead smolt releases into the Yankee Fork consisted of a mixture of Dworshak and Upper Salmon River B-Run smolts from 2012-2018. See Section 2 for detailed information on steelhead juvenile releases in the Yankee Fork from 2010-2018.

The Yankee Fork Chinook salmon and steelhead programs in the Yankee Fork are designed to monitor and evaluate hatchery releases of smolts and alternative hatchery supplementation techniques (i.e., live adult outplants). The goal is to obtain baseline information on the feasibility of hatchery releases in the Yankee Fork and monitor their potential effects on natural-origin populations. As such, this report includes both hatchery and natural origin monitoring of juvenile emigrants and adult spawners from a single river since the program's inception in 2008 to 2018.

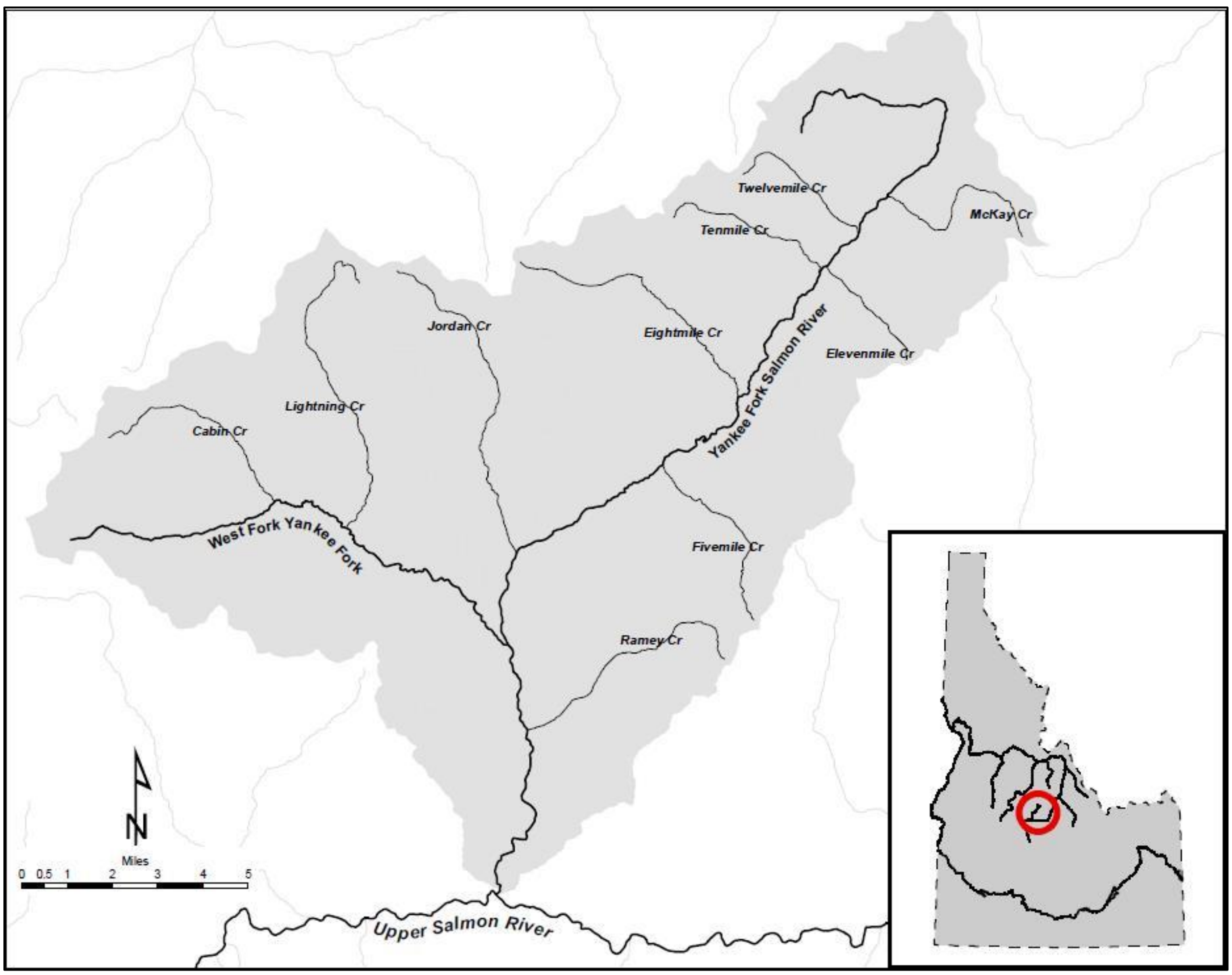

Figure 1. Map of the Yankee Fork Salmon River, Idaho.

Table 1. Summary of implementation and monitoring activities undertaken in the Yankee Fork 2008 – 2018. C denotes that the target species was Chinook salmon, whereas S denotes that the target species was steelhead.

	Juvenile monitoring			Adult monitoring					
Year	Smolt Releases	Rotary Screw Trap	Electrofishing	Mainstem Weir	Side Channel Weirs	PIT Array	Adult Outplants	Spawning Ground Survey	Harvest Monitoring
2008	C, S	--		C			C	C	C
2009	C, S	C, S		C			C	C	C, S
2010	C, S	C, S		C				C	C, S
2011	S	C, S		C				C	C
2012	C, S	C, S		C		C, S	C	C	C
2013	C, S	C, S	C, S	C		C, S	C	C	C
2014	C, S	C, S	C, S	C		C, S	C	C	C
2015	C, S	C, S	C, S	C		C, S		C	C
2016	C, S	C, S	C, S [1]	C	S	C, S	C	C	C
2017	C, S	C, S	C, S [1]	C	S	C, S		C	C
2018	C, S	C, S		C	S	C, S		C	C, S

[1]Electrofishing in 2016 and 2017 was focused on a mark-recapture study to determine the efficiency of snorkeling surveys in the Yankee Fork.

2.0 HATCHERY-ORIGIN JUVENILE RELEASES

The SBT released Chinook salmon and steelhead smolts annually into the Yankee Fork at three general locations — semi-acclimated releases occurred at Dredge Pond 1 and direct stream releases occurred at either the Third Bridge (3rd Bridge) or the confluence with Jordan Creek (Jordan Creek). Details for release sites, study design, and further results can be found in IDFG reports (see Warren et al. 2015). Chinook salmon smolts were generally released in the third week of April but released occurred earlier in 2010 and 2015 (Table 2) in an effort to improve fidelity to Yankee Fork. Steelhead smolt releases occurred after Chinook and extended from the last week of April through the first week of May (Table 3).

The number of Chinook salmon smolts released into the Yankee Fork has varied over the years and has been a subject of discussion within the*United States vs. Oregon* process. The initial release of Brood Year (BY) 2004 smolts in 2006 included approximately 135,934 individuals (Table 2). Due to limited broodstock in 2005, 2006, and 2007, IDFG and the SBT could not reach consensus on the Yankee Fork smolt release allocation and as a result no fish were released into Yankee Fork in 2007, 2008, or 2009. The second and third releases in 2010 and 2011 consisted of ~400,000 smolts. In 2010, the SBT and IDFG reached consensus and adopted a sliding-scale production allocation for releases into Yankee Fork. Essentially, when Sawtooth is at full production, approximately 300,000 smolts are produced for release into Yankee Fork. Due to limited adult returns in 2011, no fish were released into Yankee Fork in 2013.

Steelhead smolt releases also varied since 2006. Sawtooth stock smolts (SawA) were released from 2006-2013 when releases shifted to Dworshak B-run stock (DworB) and upper Salmon River B-run stock (USRB). SawA stock releases were reared at Magic Valley Fish Hatchery and Hagerman National Fish Hatchery and ranged from ca. 122,000 to 455,000 individuals from 2006-2013. DworB and USRB stock releases were reared exclusively at Magc Valley Fish Hatchery. With the onset of DworB and USRB releases in the Yankee Fork the production goal increased to 496,000 individuals in 2014 and 2015 (IDFG et al 2014, 2015) and to 622,000 in 2017 and 2018. Actual releases ranged from 314,000 to 634,000 individuals (Table 3).

Methods

Downstream migration through the FCRPS

We estimated survival and travel time of hatchery Chinook and steelhead smolts through the FCRPS using PIT tags and the program PitPro 4. We used the PTAGIS platform to determine all PIT tagged hatchery Chinook and steelhead that were released into Yankee Fork. PitPro 4 uses a Cormack-Jolly-Seber mark recapture model in its estimate of survival and calculates a mean travel time to designated points using downstream detections at designated points. Here, we analyzed survival and travel time by including the following sites in PitPro 4 — the Yankee Fork PIT array (included only for years after 2012), Lower Granite Dam, Little Goose Dam, Lower Monumental Dam, Ice Harbor Dam, McNary Dam, John Day Dam, and Bonneville Dam Complex. We quantified 50% and 80% passage dates at Lower Granite Dam for each release group by extracting detections of hatchery released juveniles from the Interrogation at Mainstem Sites report in PTAGIS and producing empirical cumulative distribution functions for each year. Finally, we assessed whether arrival at Lower Granite Dam occurred during periods of spill at Lower Granite Dam by extracted spill data for Lower Granite Dam from the Fish Passage Center (http://www.fpc.org/river/flowspill/FlowSpill.asp).

Results

Downstream migration to the FCRPS

Hatchery Chinook salmon smolts survival from release to Lower Granite Dam ranged from 0.30 to 0.64 for release years 2012 and 2006, respectively (Table 4). Median survival across years was 0.43. Travel time varied among years and ranged from 20 to 36 days from release to detection at Lower Granite Dam (Table 4).

Hatchery steelhead smolt survival from release to Lower Granite Dam ranged from 0.58 to 0.82 in 2012 and 2008 respectively (Table 5). Survival of DworB stock was similar to USRB stock in two of three years when both DworB and USRB stocks were released (2015, 2016, 2018). We did not compare survival of SawA stock to DworB stocks because releases only overlapped in 2013 and some of the DworB releases were entrained shortly after release. Travel time for hatchery origin steelhead smolt groups through the FCRPS varied from 12 days in 2016 to 31 days in 2009 (Table 6).

We estimated cumulative passage at Lower Granite Dam from PIT tagged individuals of both species across years and release groups Dam (Figures 2 & 3). Passage of all individuals from a release group generally stretched over a 30 to 40-day period. Hatchery steelhead smolts arrived at Lower Granite Dam later than Chinook salmon (Table 6), which could be a consequence of the later release dates for steelhead in the Yankee Fork (Table 2, Table 3). For all hatchery releases of both species, 50% and 80% passage dates at Lower Granite Dam occur during the period of spill. Spill at Lower Granite Dam ranged from 20 kcfs to 120 kcfs at 50% and 80% passage dates, respectively (Figure 4).

Table 2. Summary of Brood Year 2004 – 2016 Chinook salmon smolt releases into the Yankee Fork Salmon River.

Brood Year	Release Date	Hatchery	Stock	Release Site	Total Individuals Released	Adipose Fin Clip		No Clip		PIT Tags
						CWT	No CWT	CWT	No CWT	
2004	April 19, 2006	Sawtooth	USRSeg	Jordan Creek	135934	0	135934	0	0	695
2005	—	—	—	—	0	0	0	0	0	0
2006	—	—	—	—	0	0	0	0	0	0
2007	—	—	—	—	0	0	0	0	0	0
2008	April 20, 2010	Sawtooth	USRSeg	3rd Bridge	196730	0	0	190829	5901	4354
	April 20, 2010	Sawtooth	USRSeg	Dredge Pond 1	201714	0	201714	0	0	0
2009	April 20, 2011	Sawtooth	USRSeg	3rd Bridge	198640	0	198640	0	0	2395
	April 19, 2011	Sawtooth	USRSeg	Dredge Pond 1	199237	0	0	191965	7272	0
2010	April 3, 2012	Sawtooth	USRSeg	Dredge Pond 1	197036	0	0	194730	0	3381
2011	—	—	—	—	0	0	0	0	0	0
2012	April 24, 2014	Sawtooth	USRSeg	Dredge Pond 1	192577	0	0	190008	2569	2385
2013	April 20, 2015	Sawtooth	USRSeg	Dredge Pond 1	183379	181545	1834	0	0	2496
2014	April 19, 2016	Sawtooth	USRSeg	3rd Bridge	189786	0	189786	0	0	2496
2015	April 1, 2017	Sawtooth	USRSeg	3rd Bridge	188280	0	188280	0	0	2490
2016	April 6, 2018	Sawtooth	USRSeg	Dredge Pond 1 / Jordan Creek	272798	118597	154201	0	0	2490

Table 3. Summary of Brood Year 2005 – 2017 steelhead smolt releases into the Yankee Fork Salmon River.

Brood Year	Release Date	Hatchery	Stock	Total Individuals Released	Adipose Fin Clip		No Clip		PIT Tags
					CWT	No CWT	CWT	No CWT	
2005	May 1, 2006	HNFH	SawA	238117	0	105513	0	142341	592
	May 1, 2006	MVFH	SawA	95600	30808	32717	0	32075	0
2006	May 3, 2007	HNFH	SawA	247854	0	105513	0	142341	598
	April 27, 2007	MVFH	SawA	91234	29956	30827	0	30695	0
2007	May 12, 2008	HNFH	SawA	235420	0	100879	0	134541	4069
	April 30, 2008	MVFH	SawA	921126	28674	32757	0	30695	0
2008	May 6, 2009	HNFH	SawA	294050	0	148863	0	145187	5000
	April 30, 2009	MVFH	SawA	93216	30433	30433	0	31222	0
2009	May 5, 2010	HNFH	SawA	427440	83154	126208	0	218078	7259
2010	May 6, 2011	HNFH	SawA	434338	83906	130013	0	218078	8212
2011	May 1, 2012	HNFH	SawA	455163	87989	140417	0	226757	8069
2012	April 26, 2013	HNFH	SawA	214860	88481	126379	0	0	0
	April 24, 2013	MVFH	DworB	465830	62666	188299	0	214865	11256
2013	April 28, 2014	MVFH	USRB	506762	0	278586	0	228176	11374
2014	April 27, 2015	MVFH	DworB	189423	0	123799	0	65624	5190
	April 23, 2015		USRB	288569	0	127641	0	160928	8070
2015	April 29, 2016	MVFH	DworB	242530	0	82030	0	160500	7378
	April 28, 2016		USRB	71500	0	15530	0	55970	3928
2016	April 27, 2017	MVFH	USRB	625690	0	405410	0	220280	13217
2017	April 23, 2018	MVFH	DworB	275210	0	275210	0	0	8458
	April 27, 2018		USRB	217340	0	0	213816	3524	6943

Table 4. Average survival and travel time to Lower Granite Dam for hatchery Chinook salmon smolts released into Yankee Fork Salmon River in 2006 – 2018.

Release Year	Survival (1SE)	Travel Time (1SE)
006	0.64 (0.03)	20 (5)
2007	—	—
2008	—	—
2009	—	—
2010	0.51 (0.04)	30 (5)
2011	0.34 (0.02)	25 (4)
2012	0.30 (0.01)	31 (9)
2013	—	—
2014	0.39 (0.03)	21 (5)
2015	0.43 (0.06)	20 (4)
2016	0.62 (0.02)	21 (4)
2017	0.62 (0.07)	36 (5)
2018	0.43 (0.03)	23 (7)

Table 5. Average survival and travel time to Lower Granite Dam for hatchery steelhead smolts released into Yankee Fork Salmon River in 2006 – 2018.

Release Year	Survival (1SE)	Travel Time (1SE)	Survival (1SE)	Travel Time (1SE)	Survival (1SE)	Travel Time (1SE)
2006	0.69 (0.03)	14 (7)	—	—	—	—
2007	0.74 (0.07)	15 (7)	—	—	—	—
2008	0.82 (0.03)	19 (10)	—	—	—	—
2009	0.74 (0.01)	31 (17)	—	—	—	—
2010	0.71 (0.02)	29 (10)	—	—	—	—
2011	0.75 (0.02)	18 (17)	—	—	—	—
2012	0.58 (0.02)	23 (32)	—	—	—	—
2013	84.1[a]	N/A	0.49 (0.02) [b]	17 (12)	—	—
2014	—	—	—	—	0.69 (0.01)	20 (8)
2015	—	—	0.63 (0.09)	24 (14)	0.71 (0.09)	19 (28)
2016	—	—	0.73 (0.02)	12 (6)	0.63 (0.02)	13 (6)
2017	—	—	—	—	0.74 (0.02)	18 (9)
2018	—	—	0.70 (0.01)	19 (8)	0.68 (0.01)	17 (8)

Notes:
[a] Survival obtained from Warren et al. (2015)
[b] A portion of this release were entrained at the release site due to low flows. See Warren et al. (2015)

Table 6. Passage dates (50% and 80%) at Lower Granite Dam for Chinook salmon and steelhead smolt release groups from 2006-2018.

Species	Release Year	Stock	50% Passage Date	80% Passage Date
Chinook	2006	USRseg	May 10	May 16
Chinook	2010	USRseg	May 19	May 22
Chinook	2011	USRseg	May 13	May 16
Chinook	2012	USRseg	May 2	May 16
Chinook	2014	USRseg	May 16	May 19
Chinook	2015	USRseg	May 8	May 12
Chinook	2016	USRseg	May 9	May 11
Chinook	2017	USRseg	May 6	May 10
Chinook	2018	USRseg	May 7	May 10
Steelhead	2006	SawA	May 17	May 21
Steelhead	2007	SawA	May 14	May 19
Steelhead	2008	SawA	May 23	June 2
Steelhead	2009	SawA	June 4	June 8
Steelhead	2010	SawA	June 5	June 8
Steelhead	2011	SawA	May 25	June 11
Steelhead	2012	SawA	May 24	June 6
Steelhead	2013	DworB	May 13	May 17
Steelhead	2014	USRB	May 20	May 23
Steelhead	2015	DworB	May 15	May 28
		USRB	May 8	May 21
Steelhead	2016	DworB	May 13	May 18
		USRB	May 10	May 14
Steelhead	2017	USRB	May 10	May 19
Steelhead	2018	DworB	May 10	May 20
		USRB	May 15	May 23

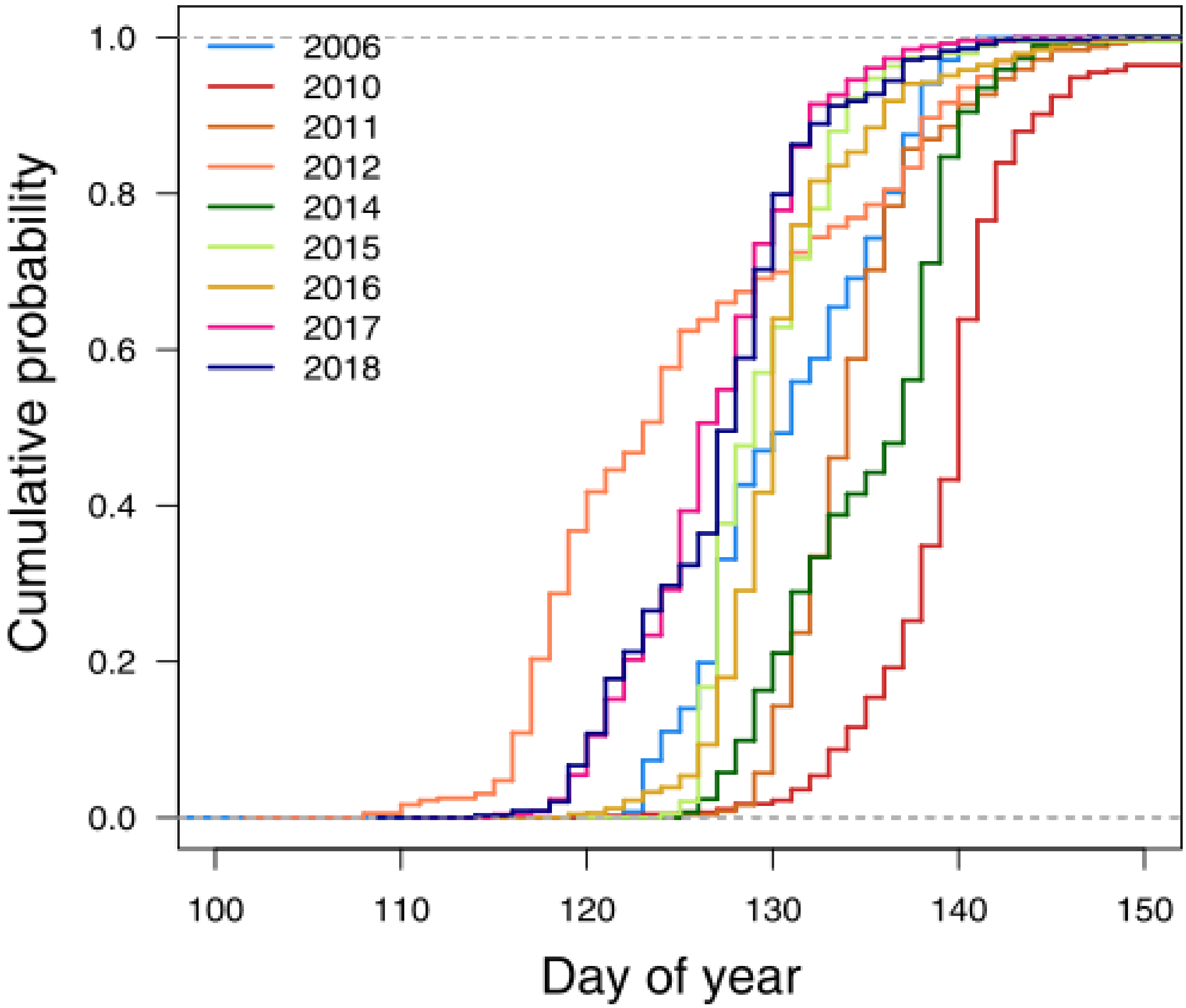

Figure 2. Cumulative passage of hatchery reared Chinook salmon smolts at Lower Granite Dam from 2006-2018.

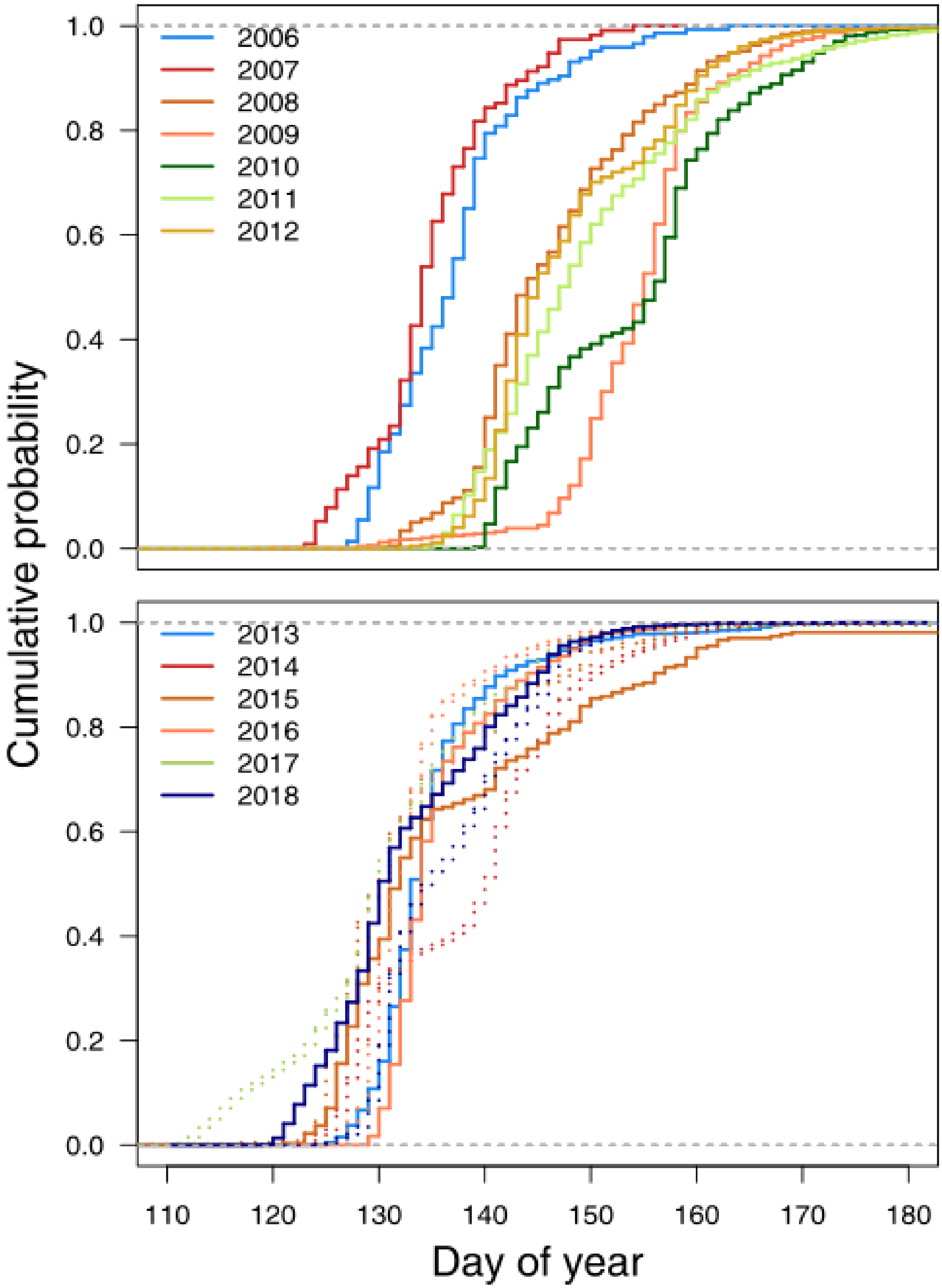

Figure 3. Cumulative passage of hatchery reared steelhead smolts at Lower Granite Dam from 2006 – 2018. Top panel shows releases of SawA stock and the bottom panel shows releases of DworB (solid lines) and USRB stocks (dotted lines).

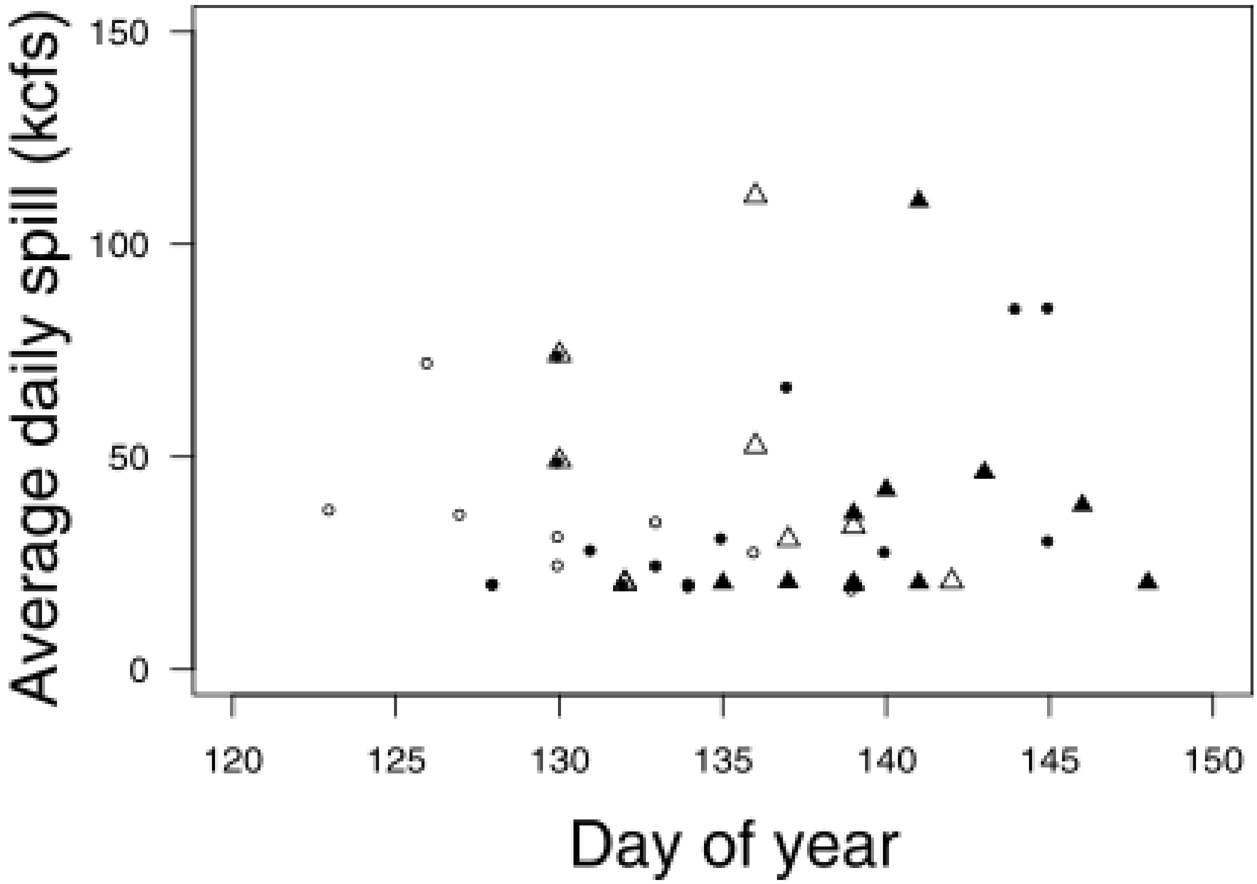

Figure 4. Average daily spill at Lower Granite Dam on 50% passage day of year (solid points) and 80% passage day of year (open points) for hatchery reared Chinook salmon (circles) and steelhead (triangles) released in the Yankee Fork Salmon River from 2006-2018. Points represent release groups.

3.0 NATURAL ORIGIN JUVENILE EMIGRANT MONITORING

We conducted hatchery effectiveness monitoring to determine the efficacy of hatchery origin adult outplanting as a supplementation technique (See Section 4.0). We began monitoring naturally produced juvenile emigrants in 2009 with a rotary screw trap deployed approximately 5 rkm upstream of its confluence with the mainstem Salmon River. A rotary screw trap consists of two floating pontoons and a rotating cone that funnels small fish into a live well. The rotary screw trap is typically installed in the last week of March and begins operation on April 1. The trap is removed for approximately a week after releases of hatchery smolts and when flows exceed 1200 cfs. The rotary screw trap is redeployed on the descending limb of the hydrograph (Table 7).

Methods

Estimating natural origin juvenile production

The primary purpose of the Yankee Fork rotary screw trap is to estimate natural origin juvenile emigrant abundance. We also measure biological characteristics of juvenile emigrants and collect tissue samples for genetic analysis as part of a reproductive success study. SBT staff check the livewell for captures on a daily basis while the trap is operating. Captured fish are moved in buckets of aerated river water to a tagging station located at nearby Pole Flat Campground where both Chinook salmon and steelhead are identified, measured, sampled, and tagged. Individuals < 70 mm fork length are stained with Bismark brown dye whereas individuals ≥70 mm are marked with a PIT tag. Newly marked individuals are released 0.6 km upstream of the trap while previously marked fish (i.e., recaptures) and non-target species (i.e., hatchery Chinook salmon, hatchery steelhead, bull trout, mountain whitefish, and westslope cutthroat trout) are released below the trap.

The mark-recapture design allowed us to estimate juvenile production using a mark recapture analysis program in GAUSS (Steinhorst et al. 2004). The program uses a Bailey adjusted Lincoln-Peterson estimator to provide an estimate of outmigrant abundance and confidence intervals are obtained with bootstrapping. The Bailey adjusted Lincoln-Peterson estimate is calculated as

$$\widehat{N} = \frac{c(m+1)}{r+1};$$

where $\widehat{N}$ is the estimate, *c* is the number of captures, *m* is the number of individuals marked, and *r* is the number of recaptures. Steinhorst et al. (2004) suggests stratifying estimates into periods of equal capture probability. For Chinook, we used life stage and fish size to stratify our rotary screw trap data. We delineated life stage by time of year with smolts being individuals ≥70 mm captured from March 1 – May 31, fry as individuals < 70 mm migrating captured from March 1 – May 31, parr as all individuals captured June 1 – August 31, and presmolt as all individuals captured September 1 until the end of trapping in November. While Steinhorst et al. (2004) suggests stratifying sample periods to estimate an overall abundance, we were unable to calculate this because most brood years had at least one life stage with too few recaptures (typically fry or smolt) to obtain an overall estimate. Therefore, we calculated the abundance and confidence intervals in two ways: (1) we removed captures associated with the life stage that precluded model convergence and ran the model with the reduced dataset and (2) we ran the model without stratification by summing all captures and recaptures associated with a specific brood year into a single stratum. Both techniques were analyzed with a Bailey-adjusted Lincoln Peterson model with 1000 bootstraps to estimate an overall brood year production.

Downstream migration through the FCRPS

We estimated survival and travel time of natural origin Chinook and steelhead smolts through the FCRPS using PIT tags and the program PitPro 4. We used the PTAGIS platform to extract all natural origin individuals that were PIT tagged at the rotary screw trap. PitPro then uses a Cormack-Jolly-Seber mark recapture model in its estimate of survival and calculates a mean travel time to designated points using downstream detections at designated points. We analyzed survival and travel time by including the following sites in PitPro — the Yankee Fork PIT array (included only for years after 2012), Lower Granite Dam, Little Goose Dam, Lower Monumental Dam, Ice Harbor Dam, McNary Dam, John Day Dam, and Bonneville Dam Complex.

We examined the time of emigration from the Yankee Fork by quantifying 50% and 80% passage at the rotary screw trap during the trapping season. We also quantified 50% and 80% passage date at Lower Granite Dam for migration year (i.e., year detected at Lower Granite Dam) by extracting detections of captured and tagged NOR juveniles from the Interrogation at Mainstem Sites report in PTAGIS and producing empirical cumulative distribution functions for each year. We analyzed migration year rather than year captured at the rotary screw trap or brood year because individuals, particularly steelhead, may spend more than one year above the dam before being detected and we were interested in placing Lower Granite Dam passage relative to spill rates. We also evaluated travel time from the rotary screw trap to Lower Granite Dam for detected individuals to demonstrate potential associations between travel time for steelhead or Chinook and size at emigration from the Yankee Fork. Finally, we assessed whether arrival at Lower Granite Dam occurred during periods of spill at Lower Granite Dam by extracted spill data for Lower Granite Dam from the Fish Passage Center (http://www.fpc.org/river/flowspill/FlowSpill.asp).

Results

The rotary screw trap in Yankee Fork was operated for between 127 and 193 days per year from 2009 – 2018 (Table 7). As expected, biological characteristics of Chinook salmon varied by life stage and year (Table 8) as did steelhead (Table 9). Capture efficiencies varied substantially among years and differed between life stages within year (Figure 5). Median capture efficiency of Chinook salmon from 2009 – 2018 was 0.10 but ranged across years from 0.04 to 0.25.

Capture efficiencies for steelhead were lower than those for Chinook salmon. Capture efficiency for steelhead ranged from 0.02 to 0.20 with a median of 0.06 when all data for a capture year was pooled (Table 10). In 2017, we did not recapture any steelhead released upstream from the trap.

Juvenile Chinook salmon emigrant abundance estimates also varied widely across the monitoring period with interannual variability being strongly tied to the number of natural and hatchery-outplant spawners (See Section 4). The three highest brood year emigration estimates were associated with years of high hatchery adult returns to the Salmon River basin and subsequent hatchery adult outplants (2008, 2009, 2012 in Figure 6; range 103,483 – 414,243 individuals in Figure 7). The range for all other years ranged from 3,148 in brood year 2017 to 67,273 emigrants from brood year 2013. Across all years, median emigrant abundance was 54,460 individuals; however, juvenile Chinook salmon emigrant abundance spanned two orders of magnitude from 2008 – 2017.

We report only steelhead emigrant abundance by capture year rather than tracing individuals to brood year using length-at age curves. Steelhead emigrant abundance by capture year ranged from 5,156 to 99,177 individuals with a median annual emigration of 21,496 (Figure

7). No estimate is available for capture year 2017 because the recapture rate was too low (Table 11).

Natural origin Chinook salmon survival to Lower Granite Dam ranged from 0.04 for brood year 2013 to 0.30 for brood year 2014 (Figure 8). Meanwhile, steelhead survival ranged from 0.05 to 0.22 between capture years 2012 and 2017 (Figure 9).

Table 7. Summary of rotary screw trap operations in the Yankee Fork Salmon River from 2009 – 2018.

Trap year	Operation Dates	No. Trapping Days
2009	July 2 – November 13	134
2010	April 27 – June 3 August 21 – November 16	157
2011	April 13 – May 5 July 13 – November 2	140
2012	April 11 – April 21 May 6 – November 13	132
2013	April 2 – May 9 May 22 – November 15	186
2014	April 5 – April 25 May 9 – May 17 June 2 – June 13 June 20 – November 4	183
2015	March 25 – April 22 May 6 – November 10	164
2016	March 30 – April 28 May 20 – November 7	193
2017	March 31 – April 14 June 27 – November 14	127
2018	April 1 – April 11 June 2 – November 14	171

Table 8. Brood year, life stage, sample size, weight, and fork length of juvenile emigrant Chinook salmon captured at the Yankee Fork rotary screw trap.

Brood Year	Smolt			Fry			Parr				Pre-Smolt			
	n	Weight (g ±1 SD)	Fork Length (mm ±1 SD)	*n*	Weight (g ±1 SD)	Fork Length (mm ±1 SD)	Size	*n*	Weight (g ±1 SD)	Fork Length (mm ±1 SD)	Size	*n*	Weight (g ±1 SD)	Fork Length (mm ±1 SD)
2010	11	8.4 ± 2.5	92 ± 8.3				>70				>70			
							<70				<70			
2011	51	8.4 ± 3.0	90 ± 11.0	0	—	—	>70	30	12.6 ± 5.9	98 ± 16.2	>70	664	8.9 ± 6.0	84 ± 11.9
							<70	23	3.6± 6.1	47 ± 12.1	<70	56	4.0 ± 1.3	63 ± 7.0
2012	87	5.5 ± 1.5	80 ± 6.1	1	3.5	67	>70	53	15.3 ± 12.4	100 ± 27.2	>70	383	5.8 ± 1.5	80 ± 6.1
							<70	169	1.5 ± 0.9	49 ± 8.0	<70	111	2.5 ± 0.9	60 ± 6.5
2013	52	6.7 ± 2.3	84 ± 8.8	8	2.9 ± 0.5	64.5 ± 3.2	>70	188	7.1 ± 6.3	83 ± 15.6	>70	528	5.7 ± 4.2	80 ± 10.0
							<70	248	2.1 ± 0.9	57 ± 8.4	<70	371	2.4 ± 0.7	60 ± 6.8
2014	224	5.9 ± 1.7	82 ± 7.1	1	2.2	60	>70	50	8.3 ± 8.5	84 ± 17.4	>70	181	6.4 ± 2.2	82 ± 7.3
							<70	175	1.9 ± 0.8	55 ± 8.4	<70	96	2.1 ± 0.8	58 ± 6.7
2015	9	8.3 ± 1.2	92 ± 4.8	18	1.3 ± 1.3	46.1 ± 15.1	>70	200	6.7 ± 3.1	82 ± 9.9	>70	582	7.4 ± 2.5	86 ± 8.1
							<70	70	2.0 ± 1.0	55 ± 9.3	<70	2	3.7 ± 0.6	67 ± 2.1
2016	78	7.3 ± 2.3	86.1 ± 8.4	1	Not measured	64 ± NA	>70	17	6.5 ± 7.8	77 ± 15.2	>70	866	6.1 ± 1.8	81 ± 6.8
							<70	54	2.1 ± 0.8	57 ± 7.3	<70	88	3.0 ± 0.7	64 ± 5.1
2017	2019 Trapping Season			2	3.5 ± 0.5	67 ± 2.8	>70	107	10.3 ± 4.6	92.2 ± 12.6	>70	396	8.9 + 4.5	89.5 ± 11.6
							<70	8	2.7 ± 1.3	60 ± 10.9	<70	2	3.0 ± 0.4	66.0 ± NA

Table 9. Capture year, sample size, weight, and fork length of steelhead emigrants (≥70mm) captured in the Yankee Fork rotary screw trap.

Capture Year	*n*	Weight (g ±1 SD)	Fork Length (mm ±1 SD)
2012	272	23.6 ± 26.5	110.4 ± 39.6
2013	944	33.5 ± 33.3	134.0 ± 46.9
2014	133	27.7 ± 24.0	128.0 ± 41.2
2015	55	51.9 ± 51.5	155.1 ± 53.4
2016	1125	21.9 ± 19.2	119.3 ± 32.8
2017	197	21.1 ± 25.3	115.2 ± 36.4
2018	425	36.7 ± 28.1	138.9 ± 41.7

Table 10. Number of juvenile Chinook salmon captured, marked, recaptured, and capture efficiency at the Yankee Fork rotary screw trap for brood years 2008-2017.

Brood Year	Captured	Marked	Recaptured	Capture Efficiency
2008	37137	12077	906	0.08
2009	35052	1250	309	0.25
2010	1566	598	46	0.08
2011	1570	630	67	0.11
2012	15988	2468	422	0.17
2013	5476	1983	175	0.09
2014	4073	3358	305	0.09
2015	1290	1144	116	0.10
2016	2017	1916	74	0.04
2017	525	444	76	0.17

Table 11. Number of juvenile steelhead captured, marked, recaptured, and capture efficiency at the Yankee Fork rotary screw trap for capture years 2009-2018.

Capture Year	Captured	Marked	Recaptured	Capture Efficiency
2009	4865	2588	126	0.05
2010	2307	253	50	0.2
2011	239	150	6	0.04
2012	591	272	18	0.07
2013	2049	879	58	0.07
2014	1294	417	22	0.05
2015	867	451	7	0.02
2016	1555	1409	101	0.07
2017	221	217	0	0
2018	464	421	27	0.06

Table 12. Passage dates (50% and 80%) at Lower Granite Dam for natural origin Chinook salmon and steelhead juveniles tagged at the Yankee Fork rotary screw trap 2010-2018.

	Chinook			Steelhead		
Year	50% Passage	80% Passage	No. Detections	50% Passage	80% Passage	No. Detections
2010	May 9	May 23	35	May 4	May 22	27
2011	May 12	May 27	71	May 13	May 15	23
2012	April 25	May 5	23	April 26	April 28	8
2013	May 10	May 14	32	May 13	May 15	16
2014	May 10	May 26	48	April 30	May 13	18
2015	May 14	May 18	10	NA	NA	0
2016	May 9	May 20	57	April 17	May 6	8
2017	April 27	May 8	51	May 10	May 26	35
2018	May 6	May 11	63	May 8	May 20	25

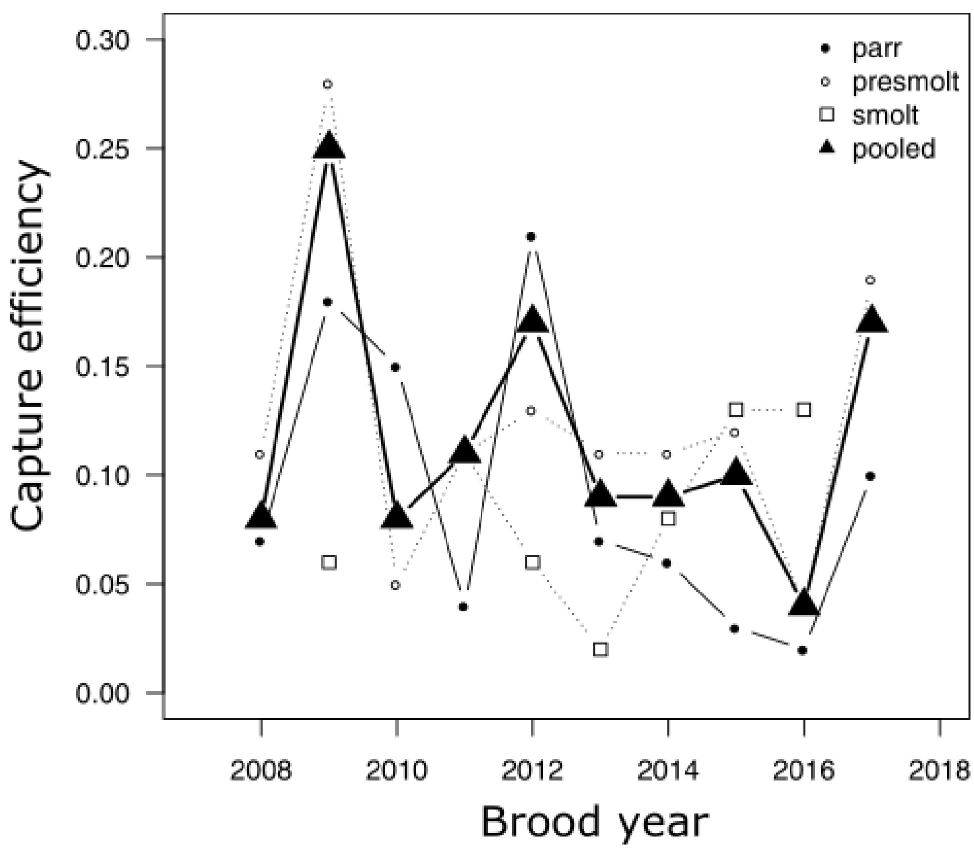

Figure 5. Capture efficiency of the Yankee Fork rotary screw trap for brood year 2008-2017 juvenile Chinook salmon.

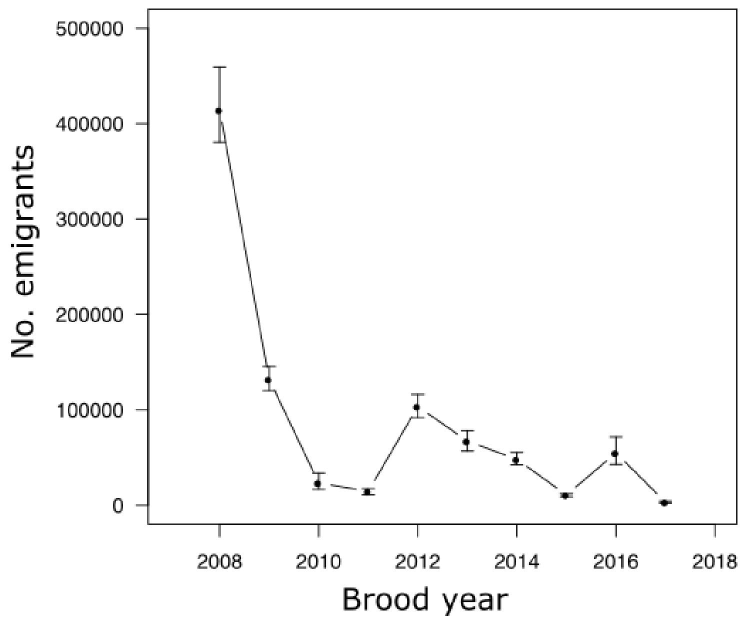

Figure 6. Estimated number of juvenile Chinook salmon emigrating from the Yankee Fork Salmon River from brood years 2008 – 2017.

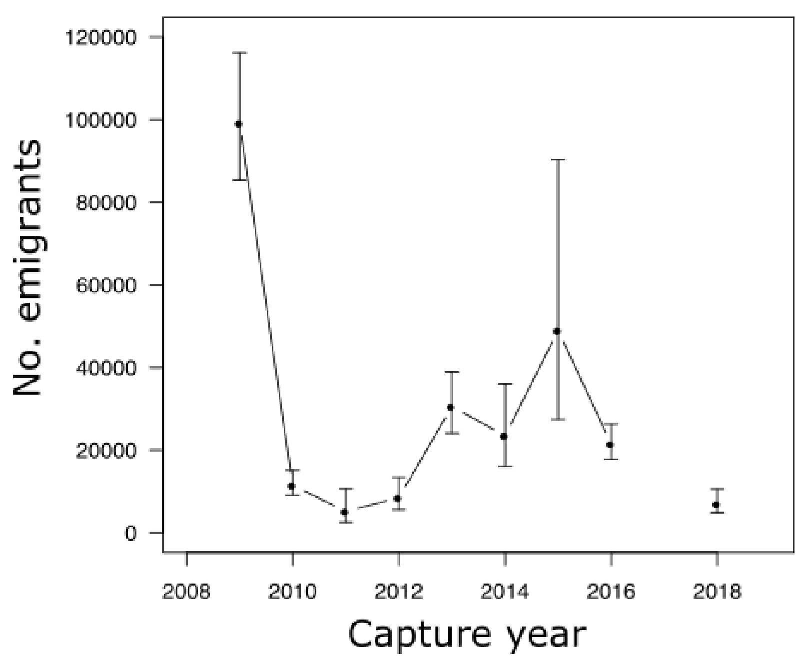

Figure 7. Estimated number of juvenile steelhead emigrating from the Yankee Fork Salmon River during capture years 2009 – 2018.

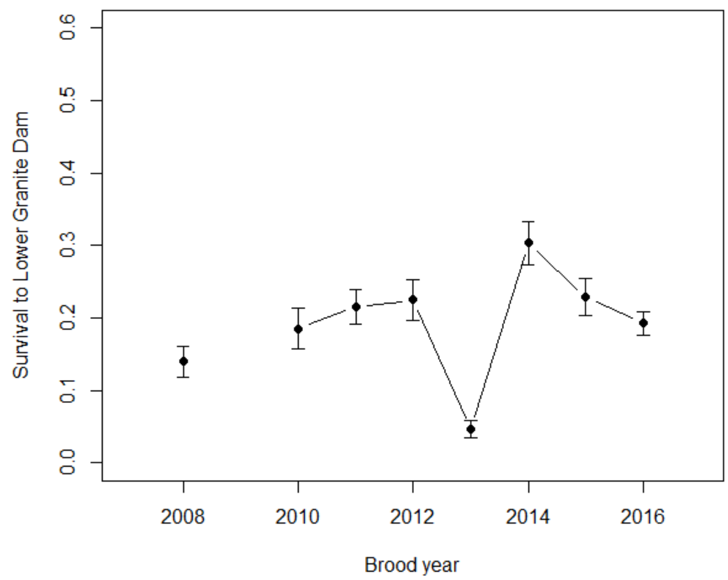

Figure 8. Natural origin juvenile Chinook salmon survival to Lower Granite Dam for brood years 2008 – 2016.

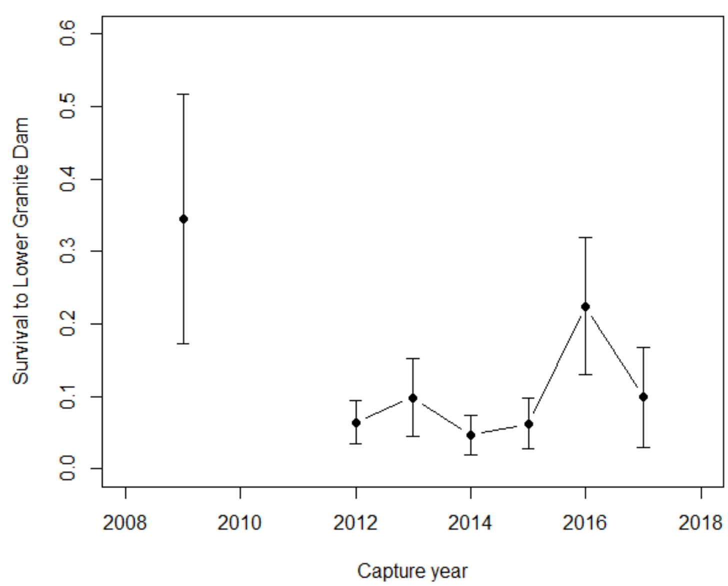

Figure 9. Natural origin juvenile steelhead survival to Lower Granite Dam for capture years 2009 – 2017.

4.0. CHINOOK SALMON AND STEELHEAD ADULT MONITORING

The SBT has two primary ways for enumerating anadromous adult returns depending on species; Pole Flat weir for Chinook salmon and the Yankee Fork PIT array (YFK) for steelhead. In addition to the weir and PIT array, the SBT uses auxiliary methods for monitoring adult anadromous fishes including spawning ground surveys for Chinook salmon and side channel weirs for steelhead. The goals of monitoring adult returns to the Yankee Fork are to collect localized broodstock, to evaluate the success of outplanting hatchery adults as a supplementation technique, and to monitor hatchery origin and natural origin fish interactions.

Chinook salmon monitoring

Methods

SBT installs a temporary picket weir near Pole Flat Campground on the Yankee Fork Salmon River to enumerate adult Chinook salmon returns when flows reach approximately 500 cfs on the descending limb of the hydrograph (Table 13). The weir is removed from the stream in the middle of September near the cessation of spawning above the weir site. Pole flat weir is located approximately 5.2 km upstream from the confluence of the Yankee Fork with the Salmon River. The weir consists of picket-panels arranged in a “V”-shape with an instream fish trap located at the point of the “V”.

Pole Flat weir is checked daily between 0800-1200 hours. We record sex, length, and weight for all newly trapped fish and check for existing tags (PIT tags, coded wire tags, adipose clips) to determine whether an individual is natural origin or hatchery origin. Each fish receives a right operculum punch using a paper punch, which in conjunction with spawning ground surveys facilitates a mark-recapture evaluation of escapement above the weir. The operculum punch also serves as a genetic sample for our study aimed at identifying the relative reproductive success of hatchery adult outplants. The number of outplanted fish are provided in this report and included in brood year analyses; however, this report does not contain the genetic results.

To estimate weir efficiency and continue long term population status monitoring of Chinook salmon, we conduct spawning ground surveys during August and early September of every year. The spawning ground surveys also form the basis of population abundance estimates for population status assessments (NMFS 2015). The stream and its major tributaries are divided into 11 sections ranging in length from ~ 1-9 km (Table 14); however, the number of segments has varied among years (see Tardy and Denny 2009, Tardy and Denny 2010, Tardy and Denny 2011, Tardy 2012, Denny et al. 2013, Denny et al. 2014). Each section was surveyed weekly for six weeks beginning the first full week of August and ending the second week of September. Week 5 of surveys in the Yankee Fork is submitted to Idaho Department of Fish and Game to continue their long-term trend index site dataset.

During spawning ground surveys, redd locations are flagged streamside and the location is marked with a handheld global positioning system (GPS) unit. If a live Chinook salmon adult was recorded nearby, the redd was deemed active. All carcasses encountered during surveys were inspected to determine sex and pre-spawn mortality, measured for fork length and a tissue sample was collected. We also determined the presence or absence of the adipose fin, coded wire tag, and PIT tag as well as whether the carcass had other external marks such as a left or right operculum punch. A female was determined to be a pre-spawn mortality if > 1000 eggs were found in the body cavity. Additionally, we collected dorsal fin rays from carcasses, which were subsequently sent to IDFG's ageing laboratory to determine age-at-maturity.

Carcasses found during spawning ground surveys form the recapture portion of the capture-mark-recapture based estimate of total returns to the Yankee Fork. We used the

Chapman modification of the Peterson method (Johnson et al. 2007) to estimate total adult escapement above Pole Flat weir. Adult escapement is estimated from the total number of Chinook salmon marked at Pole Flat weir with an operculum punch (*M*), the total number of fish recovered above the weir (*C*) during spawning ground surveys, and the total number of marked fish recovered (*R*) as carcasses during surveys as

$$Escapement = \left[\frac{(M+1)(C+1)}{(R+1)}\right] - 1$$

To calculate variance in the escapement estimate, we used the method of Seber (1970), as cited in Johnson et al. (2007):

$$Escapement\ variance = \left[\frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R\ +2)}\right]$$

Carcass recovery is an important component of determining an escapement estimate using the Chapman modified Lincoln-Petersen mark-recapture model. Carcass data from the Yankee Fork is complex because of three possible groups can be recovered; natural origin fish, hatchery origin returns, and hatchery adults captured at Sawtooth Fish Hatchery outplanted in the Yankee Fork. Hatchery-origin carcasses are determined by the presence/absence of the adipose fin and presence/absence of a coded wire tag. To be classified hatchery origin in the carcass recovery dataset, the adipose fin must be absent *or* have a coded wire tag. To be classified as natural origin, the adipose fin must be present *and* there can be no coded wire tag. Some carcasses in the time series had present adipose fins, but the presence of a coded wire tag was either not determined or not recorded. These carcasses were not used in mark-recapture model for natural origin fish because the Yankee Fork received unclipped smolt released with coded wire tags multiple times in the past 10 years and, therefore, the presence of the adipose fin alone does not necessarily mean that the fish was natural origin. Adults outplanted from Sawtooth Fish

Hatchery were marked with a left operculum punch whereas fish captured at the weir were marked with a right operculum punch. Carcasses with a left operculum punch were not included in the mark-recapture estimate of escapement because these fish did not pass the weir on their own volition. Similarly, only hatchery fish with a right operculum punch or no punch were used to estimate the hatchery origin adult escapement.

We estimated total adult recruitment to the Yankee Fork, including fish spawning below Pole Flat Weir by estimating the number of fish per redd above the weir and applying it to the number of redds observed below the weir in a given year.

To determine brood year returns, we constructed a length-age key and applied that key to unaged fish captured at Pole Flat Weir. Ages were determined from fin-rays collected from carcasses during spawning ground surveys and submitted to the IDFG Ageing Lab. From 2008 – 2018, we collected 128 individual ages with associated carcass lengths. Because the number of known ages within some years was low or zero, we created an age-length key with the whole dataset by placing known age fish into 20mm increment length categories based on carcass fork length and calculated the proportion of fish of each age within a length category. We applied this length-age key to known age fish captured at the weir using the 'alkIndivAge' function in the 'FSA' package in R (Ogle 2016), which relies on the methods described in Isermann and Knight (2005). We then multiplied the proportional representation of a given age class by spawn year escapement above the weir to estimate the number of fish of each age. Fish age was traced back to brood year and the sum of age 3, age 4, and age 5 represents brood year production. We then estimated juvenile to adult survival from the Yankee Fork back to the Yankee Fork for brood years 2008 – 2014 (i.e., years for which we have full juvenile outmigration data).

Results

A total of 1,425 Chinook salmon were captured at Pole Flat Weir from 2008 – 2018. Of these fish, 381 were of known hatchery origin and 1,044 were of natural origin. Weir efficiency increased over the 10 years covered in this report with iterative improvements to weir design, placement, and installation time (Table 15; Table 16). Natural-origin adult returns to the Yankee Fork varied more than 10-fold from its minimum in 2017 to its peak in 2013. The highest natural origin abundances occurred between 2012 – 2014. In contrast, hatchery origin adult abundance above Pole Flat Weir varied from zero returns in 2010 and 2017 to a high of 254 in 2008. Rather than having a peak in the middle of the time series, hatchery returns were highest in 2008 and then declined under the end of the time series (Table 16). Natural-origin returns exceeded hatchery-origin returns in all years except 2008. Brood year abundance followed a similar pattern with natural brood year production peaking during the middle of the time series (Figure 10). Meanwhile, hatchery brood year returns declined over the time series. It is important to note that there were no direct releases of brood year 2005, 2006, 2007 and 2011 hatchery-origin Chinook salmon and returns associated with those brood years are near zero. We presume that hatchery adults returning in those brood years were either misclassified to an age class or were strays.

Outplants of live adults from Sawtooth Fish Hatchery dominated the spawning population in the years when the outplants occurred as demonstrated by the difference between the proportion of hatchery spawners and the proportion of hatchery escapement above Pole Flat Weir in 2008, 2009, 2012 – 2014, and 2016 (Table 17). In years with high numbers of outplanted adults, hatchery spawners comprised 79-98% of the spawning population in the Yankee Fork above Pole Flat Weir. In years without outplants from Sawtooth Fish Hatchery, hatchery spawners comprised 0-50% of the spawning population (Table 17).

The number of fish spawning below Pole Flat Weir decreased over the ten years (Table 17), which may be associated with changes to weir operation over time. The proportion of fish naturally returning to the Yankee Fork (i.e., not including outplants) that spawned below the weir was highest in 2009 at 0.74 (Table 17); however, the median of all other years was 0.14. It is possible that adults outplanted above the weir were able to fall back below the weir and spawn in lower sections of Yankee Fork, but carcass recoveries suggested this was not the case. This could have inflated the estimated return to the Yankee Fork for 2009 as evidenced by estimated return abundance above the weir of 51 fish using Pole Flat Weir mark recapture analysis (Table 15), but an estimate of 145 fish below the weir based on redd expansion.

Generally, both hatchery-origin and natural-origin returns were dominated by age-4 fish (Table 18). However, hatchery-origin returns were comprised of a higher proportion of age-3 fish than other age classes in 2015 and 2016 (Table 19). Returns of age-5 fish as a proportion of the total run was always higher for natural-origin fish than hatchery-origin fish (Table 19).

The highest hatchery smolt to adult return rate was highest for the first smolt release (BY 2004) of 0.125%. Yet, subsequent releases had returns to the Yankee Fork one or two orders of magnitude lower than the first release and ranged from 0.003-0.025%. Meanwhile, natural-origin juvenile to adult return rate estimates were higher than hatchery smolt releases for all brood years where data is available (Table 20) and ranged from 0.03 for brood year 2013 to 1.037% for brood year 2010. Because juvenile trapping only encompasses a portion of the year and it is difficult to obtain estimates of smolt migrants in the spring (see Section 3), juvenile abundance estimates are probably biased low and, consequently, juvenile to adult survival is biased high.

Steelhead monitoring

Methods

To estimate hatchery origin adult returns to Lower Granite Dam and the Yankee Fork, we filtered the complete tag histories of all PIT tagged hatchery steelhead smolts released in the Yankee Fork from 2010 – 2016 for only tags detected at the Lower Granite Adult ladder, which indicates that the individual returned as an adult. Estimated returns from a release year to Lower Granite Dam are calculated as

$$N_{t,LGN} = n_{t+1,LGN}T_t + n_{t+2,LGN}T_t$$

where $N_{t,\,LGN}$ is the estimated total number of steelhead returning to Lower Granite Dam, n_{t+k} is the number of hatchery released tags detected at Lower Granite Adult Ladder in a given year, T_t is the tagging rate of a given smolt release group, and t is release year. The two sections of the equation provide an estimate of the one-ocean and two-ocean components of the steelhead adult return to Lower Granite.

We estimate adult steelhead returns to the Yankee Fork using a dual panel PIT array. The Yankee Fork array (YFK) was installed in early 2012 and located 3.1 rkm upstream from the confluence of Yankee Fork with the Salmon River. When PIT-tagged fish cross over the array, it records the PIT tag and uploads the record to the Columbia Basin PIT Tag Information System (PTAGIS) repository. We calculated hatchery returns to the Yankee Fork for each release year

$$N_{t,YF} = d\left(n_{t+2,YF}T_t + n_{t+3,YF}T_t\right)$$

where d is the detection efficiency of the Yankee Fork array and the other parameters are described above for Yankee Fork rather than Lower Granite Dam. We used captures of PIT tagged individuals above YFK in 2012, 2016, and 2017 to calculate detection efficiency (d) of YFK (See APPENDIX A). All PIT-tagged fish captured above the weir were detected by the array, therefore we set *d* equal to 1. The years for the calculation of one-ocean and two-ocean returns (i.e., $t+k$) differ between the calculation of returns to Lower Granite Dam and returns to Yankee Fork because steelhead cross Lower Granite Dam in the fall prior to reaching their spawning tributaries in the spring of the following year.

IDFG applies expansion rates to PIT tag-based adult abundance estimates. These expansion rates are based on parentage-based genetic analyses (PBT) of fish samples at the Lower Granite Dam adult trap (Camacho et al. 2016). We did not apply expansion rates to our estimates for this report, therefore our estimates are a minimum estimate of hatchery returns to the Yankee Fork. Indeed, our estimates of returns could represent only 60-80% of actual returns (Camacho et al. 2016, C. Warren *personal communication*).

We also estimated natural origin adult returns to the Yankee Fork using PIT tag-based methods. A portion of natural and hatchery origin adult steelhead are trapped and PIT tagged at Lower Granite Dam. Trapping rates, as a portion of total fish crossing Lower Granite Dam, vary daily. Trapping, total enumeration, and fish sampling methods at Lower Granite Dam are described elsewhere (See Camacho et al. 2016). We filtered all steelhead PIT detections at YFK for PIT tags inserted into adults at the Lower Granite adult trap for each year from 2012 – 2017. Using the date the fish was tagged, we merged the Yankee Fork array detections with the daily trapping rates extracted from the Columbia River Data Access in Real-Time trapping metadata repository to associate each fish with the trapping rate on the day it was captured. We confirmed that a Lower Granite applied tag was actually a natural origin fish by checking all PIT-tagged and genetic sampled fish against IDFG's PBT baseline. Those fish that had no external or internal hatchery related mark and did not trace back to the hatchery PBT baseline were considered natural origin adults (C. Camacho, *personal communication*). It is important to note that of 184 total PIT tags designated as natural origin in the PTAGIS repository, only 37 were truly natural origin when compared against the hatchery PBT baseline. We estimated total natural origin adult returns to Yankee Fork ($N_{NOR,\,t}$) as the number of fish tagged at Lower Granite Dam on a given day (n_d) multiplied by the trapping rate on that day (T_d). Then this daily crossing was summed for all days when fish eventually detected at YFK crossed Lower Granite Dam during the summer migration period (July – November), which is expressed as

$$N_{NOR,t} = \sum n_d \, T_d.$$

In 2017 and 2018, we operated two side channel steelhead weirs at different sites to collect broodstock for the "B-run" hatchery program and obtain biological information from steelhead returning to the Yankee Fork. Weirs consisted of a trap box and one or two picket panels to block the entire side channel and were installed on April 5, 2017 and March 27, 2018. Fish captured in the weirs were determined to be hatchery or natural origin based on external and internal marks (i.e., coded wire tags, adipose clips, dorsal fin erosion), determined to be male or female based on morphology, and measured for weight and length. Individuals were either collected for broodstock or released upstream of the weirs to spawn. We also obtained tissue samples from captured fish to further identify their origin because adipose-intact, non- coded wire tagged individuals may be true natural origin fish or produced by stream-side incubators occasionally used in tributaries of the Yankee Fork.

Results

Hatchery adult steelhead returning to the Yankee Fork decline from 2012 to 2018, corresponding in part to the change in the characteristics of the hatchery stocks being released. Estimated escapement to Lower Granite Dam of brood year 2009 and 2010 SawA stock exceeded 3000 and 2000 fish (Table 21). Approximately 70% of returns from these two brood years were 1-ocean steelhead and 30% returned after two years in the ocean. Approximately 2000 adults returned from the brood year 2013 USRB release and 80% of these returns were two-ocean fish (Table 21). After BY 2013, returns back to Lower Granite Dam declined substantially such that it is difficult to make estimates using PIT tags. It is interesting to note that only one PIT tag from each USRB and DworB returned to Lower Granite Dam from the BY 2014 release, suggesting a near complete loss of these groups.

Estimates of returns to the Yankee Fork are much lower than estimates to Lower Granite Dam. Across years where we were able to produce estimates from PIT tags, escapement to the Yankee Fork ranged from around 1000 adults from brood year 2009 and 2010 SawA releases to 450 for the brood year 2013 USRB release (Table 21). Overall SAR to Lower Granite Dam was similar between SawA releases from brood year 2009 – 2012 and USRB and DworB of BY 2012 and 2013. However, SAR to Yankee Fork was an order of magnitude lower for the later releases of USRB and DworB (See Discussion in Section 6). Natural origin steelhead returns to the Yankee Fork were low throughout the timeseries ranging from 20 to 150 (Table 22).

Table 13. Number of fish trapped at Pole Flat Weir during 2008 – 2018.

Year	Dates of Operation	Natural	Hatchery	Bull Trout
2008	July 9 – September 25	44	184	12
2009	June 30 – September 15	30	20	18
2010	July 9 – September 9	17	0	2
2011	July 14 – September 13	63	58	38
2012	June 26 – September 20	168	29	23
2013	June 13 – September 24	253	41	207
2014	June 19 – September 19	206	26	136
2015	June 9 – September 20	89	12	19
2016	June 15 – September 11	108	9	105
2017	July 12 – September 9	29	0	2
2018	June 14 – September 15	42	4	1

Table 14. Delineation of spawning ground survey segments in the Yankee Fork Salmon River.

Section	Start	End	Start Coordinates	End Coordinates	Length (km)
1	Pole Flat Weir	Yankee Fork Mouth	N 44.303037° W -114.720434°	N 44.269743° W -114.734579°	5.23
2	West Fork Confluence	Pole Flat Weir	N 44.349041° W -114.726489°	N 44.303037° W -114.720434°	5.83
3	Custer Pullout	West Fork Confluence	N 44.385455° W -114.701455°	N 44.349041° W -114.726489°	5.6
4	Five-mile Creek Confluence	Custer Pullout	N 44.404930° W -114.655340°	N 44.385455° W -114.701455°	4.73
5	Eight-mile Creek Confluence	Five-mile Creek Confluence	N 44.426280° W -114.620670°	N 44.404930° W -114.655340°	5.1
6	Ten-mile Bridge	Eight-mile Creek Confluence	N 44.457979° W -114.590099°	N 44.426280° W -114.620670°	5.53
7	Twelve-mile Bridge	Ten-mile Bridge	N 44.483370° W -114.561270°	N 44.457979° W -114.590099°	4.01
8	Downstream of West Fork Canyon	West Fork Mouth	N 44.370960° W -114.754210°	N 44.349041° W -114.726489°	3.83
9	Cabin Creek Confluence	Downstream of West Fork Canyon	N 44.396930° W -114.828260°	N 44.370960° W -114.754210°	9.2
10	1.18 km upstream in Jordan Creek	Jordan Creek Confluence	N 44.378251° W -114.721001°	N 44.387238° W -114.726120°	1.18
11	1.52 km upstream in Eight-mile Creek	Eight-mile Creek Confluence	N 44.426312° W -114.620585°	N 44.430417° W -114.621316°	1.52

Table 15. Natural origin Chinook salmon adult returns above Pole Flat Weir for trap years 2008 – 2018.

Year	Rack return	Adults passed upstream	Unmarked carcasses	Marked Carcasses	Weir Efficiency	Estimated abundance (+/- 95% CI)
2008	44	43	15	21	29%	137 (64-209)
2009	30	27	1	11	91%	31 (27-34)
2010	17	17	13	19	32%	50 (27-72)
2011	63	63	4	36	89%	71 (65-76)
2012	168	168	16	62	74%	225 (197-252)
2013	253	253	6	33	82%	307 (262-351)
2014	206	205	2	47	96%	214 (202-225)
2015	89	88	2	28	93%	95 (87-102)
2016	108	108	1	25	96%	112 (104-119)
2017	29	29	0	4	100%	29 (29-29)
2018	42	37	2	17	88%	46 (40-51)

Table 16. Hatchery origin Chinook salmon adult returns above Pole Flat Weir for trap years 2008-2018

Year	Rack return	Adults passed upstream	Unmarked carcasses	Marked Carcasses	Weir Efficiency	Estimated abundance (+/- 95% CI)
2008	185	173	52	130	71%	254 (243-264)
2009	20	20	0	0	—	20 (20-20)
2010	0	0	0	0	—	—
2011	58	5	2	1	33%	64 (56-71)
2012	29	29	4	10	71%	39 (29-48)
2013	41	41	1	9	90%	45 (37-52)
2014	26	26	0	1	100%	26 (26-26)
2015	12	12	1	2	67%	16 (8-23)
2016	9	9	3	5	63%	14 (9-18)
2017	0	0	0	1	100%	—
2018	4	3	1	1	50%	6 (3-8)

Table 17. Summary of the number of redds, in-stream harvest, estimation of total return to the Yankee Fork and the proportion of hatchery-origin returns and spawners.

Year	Redds above weir	Redds below weir	Harvest	Fish per redd above weir	No. of fish spawning below weir	Total return to Yankee Fork	Prop. HOR returns	Prop. HOR spawners	Prop. Return spawning below weir
2008	611	49	1	3.0	147	538	0.65	0.93	0.27
2009	379	35	1	4.1	145	196	0.39	0.98	0.74
2010	22	5	1	2.2	11	62	0.00	0.00	0.18
2011	16	8	0	8.4	68	203	0.47	0.47	0.33
2012	229	16	242	4.7	75	340	0.15	0.79	0.22
2013	99	11	7	6.3	70	422	0.13	0.52	0.16
2014	89	4	6	5.1	20	261	0.11	0.54	0.08
2015	16	1	0	6.9	7	118	0.14	0.14	0.06
2016	255	4	3	3.8	15	142	0.11	0.89	0.11
2017	13	1	0	2.2	2	32	0.00	0.00	0.07
2018	13	1	3	3.8	4	56	0.12	0.12	0.07

Table 18. Number of adult Chinook salmon captured at Pole Flat weir assigned to three age groups.

		Hatchery origin			Natural origin				
Spawn Year	Fin rays	Age 3	Age 4	Age 5	Age 3	Age 4	Age 5	HOR Total	NOR Total
2008	5	1	130	54	1	19	22	185	42
2009	5	1	7	12	7	12	10	20	29
2010	0	0	0	0	0	13	4	0	17
2011	11	54	2	0	23	29	11	56	63
2012	0	5	22	2	11	133	24	29	168
2013	21	17	20	4	72	127	53	41	252
2014	11	1	18	6	14	131	61	25	206
2015	27	8	4	0	16	59	14	12	89
2016	27	7	1	1	8	69	30	9	107
2017	0	0	0	0	7	8	14	0	29
2018	21	0	4	0	4	35	3	4	42

Table 19. Age distribution of Chinook salmon adult returns to Pole Flat Weir from 2008-2018.

	Natural-origin			Hatchery-origin		
Year	Age 3	Age 4	Age 5	Age 3	Age 4	Age 5
2008	0.02	0.40	0.57	0.01	0.64	0.35
2009	0.21	0.48	0.31	0.05	0.25	0.70
2010	0.00	0.71	0.29	—	—	—
2011	0.33	0.51	0.16	1.00	0.00	0.00
2012	0.06	0.81	0.13	0.14	0.86	0.00
2013	0.29	0.49	0.22	0.37	0.61	0.02
2014	0.06	0.66	0.28	0.08	0.76	0.16
2015	0.19	0.67	0.13	0.67	0.25	0.08
2016	0.09	0.65	0.25	0.78	0.11	0.11
2017	0.31	0.24	0.45	—	—	—
2018	0.05	0.88	0.07	0.00	1.00	0.00

Table 20. Brood year production and juvenile-to-adult return rates of hatchery and natural origin fish from brood year 2004 – 2014.

	Hatchery-origin			Natural-origin		
Brood Year	Smolts released	Return to weir	Smolt to adult return (%)	Juvenile emigrants	Return to weir	Juvenile to adult return (%)
2004	135,934	170	0.125	—	66	—
2005	0	8	—	—	33	—
2006	0	1	—	—	53	—
2007	0	0	—	—	66	—
2008	398,444	99	0.025	414,243	273	0.066
2009	397,877	37	0.009	131,928	225	0.171
2010	197,036	38	0.019	23,439	243	1.037
2011	0	8	—	14,615	105	0.718
2012	192,577	12	0.006	103,483	105	0.101
2013	183,379	11	0.006	67,273	21	0.031
2014	189,786	6	0.003	48,069	50	0.104

Table 21. Hatchery steelhead adult returns to Lower Granite Dam and Yankee Fork based on PIT tagging.

Brood Year	Release Year	Stock	Spawn Year	PIT tagged adults detected at LGN	PIT tagged adults detected at YFK	Estimated Escapement to LGN	Estimated Escapement to YFK	SAR to LGN	SAR to YFK
2009	2010	SawA	2012	43	8	2532	471	0.009	0.0023
			2013	19	9	1119	530		
2010	2011	SawA	2013	29	17	1534	899	0.005	0.0027
			2014	12	5	635	264		
2011	2012	SawA	2014	23	9	1297	508	0.004	0.0016
			2015	8	4	451	226		
2012	2013	SawA	2015	29	10	1562	539	0.010	0.0030
			2016	11	2	593	108		
		DworB	2015	7	1	290	Too Low	0.001	0.0001
			2016	9	0	372	Too low		
2013	2014	USRB	2016	8	2	356	89	0.004	0.0009
			2017	36	8	1604	356		
2014	2015	DworB	2017	0	0	Too Low	Too Low	Very Low	-
			2018	1	-	Too Low	Too Low		
		USRB	2017	0	0	Too Low	Too Low	Very Low	-
			2018	1	-	Too Low	Too Low		
2015	2016	DworB	2018	6	-	188	-	Incomplete Run	-
			2019	-	-	-	-		
		USRB	2018	4	-	215	-	Incomplete Run	-
			2019	-	-	-	-		

Table 22. Estimated escapement of natural origin steelhead to the Yankee Fork Salmon River 2012 – 2017.

Spawn Year	No. Lower Granite PIT tags	Mean daily tagging rate	Estimated Return
2012	15	0.101	148
2013	3	0.152	20
2014	4	0.180	23
2015	9	0.082	125
2016	3	0.120	25
2017	4	0.190	21
2018	2	—	—

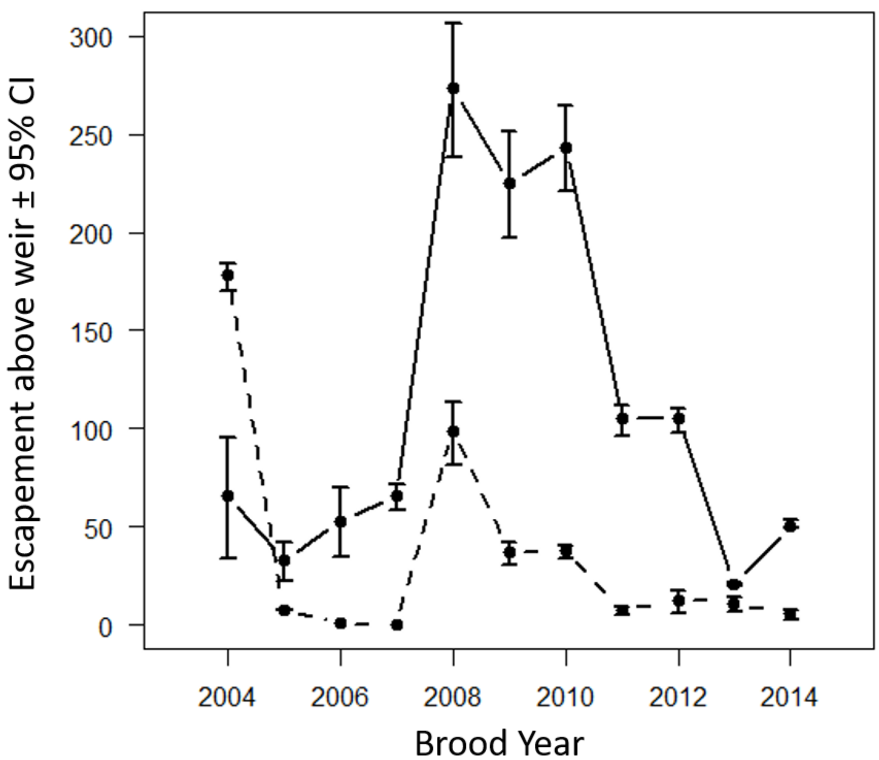

Figure 10. Hatchery (dotted line) and natural (solid line) adult Chinook salmon escapement above Pole Flat weir for brood years 2004-2014.

5.0 DISCUSSION

This report covers hatchery-origin and natural-origin monitoring in the Yankee Fork Salmon River over ten years. Many changes occurred over the 10-year period for both the Chinook salmon and steelhead programs, as implementation in the Yankee Fork was refined through both SBTEK and Western science methods, and as co-manager agreements developed. This report is unique in that all years of the program are presented allowing for a long-term view of implementation of hatchery releases alongside the responses of natural origin fish.

Chinook salmon

In general, hatchery Chinook salmon smolt releases into the Yankee Fork yield very few adult returns to the release site. SAR of hatchery smolt releases in the Yankee Fork are often one or two orders of magnitude lower than the SAR of the same stock group released directly at Sawtooth Fish Hatchery. For example, SAR to Sawtooth Fish Hatchery for brood year 2009 release was 0.114% (Sullivan et al. 2018) whereas observed SAR to the Yankee Fork was 0.009% (Table 20). There are two potential reasons for the low return rates of hatchery origin adults to Pole Flat weir — (1) lower survival of Chinook salmon smolts released in the Yankee Fork relative to direct releases from Sawtooth and (2) low release site fidelity of adults upon returning from the ocean. There is evidence for both potential causes. Generally, Chinook salmon smolts released into the Yankee Fork have lower survival rates to Lower Granite Dam than their counterparts released at Sawtooth Fish Hatchery. For example, Chinook smolts released in 2014 into the Yankee Fork had a 39% survival while those release directly at Sawtooth Fish Hatchery had 65% survival (Sullivan et al. 2016). In 2011, Chinook salmon released into the Yankee Fork had a 34% survival rate while direct releases at Sawtooth Fish Hatchery had 53% survival (Cassinelli et al. 2012). Differences in survival to Lower Granite

Dam may be associated with transport stress of fish released in the Yankee Fork. Homing back to the Yankee Fork also appears to be an issue. An *ad hoc* examination of the fate of smolts released into the Yankee Fork using coded wire tags (Table 23) and PIT tags (Table 24) show that the vast majority of tag recoveries of these release groups occur at Sawtooth Fish Hatchery.

Given the heavy bias towards tag recoveries at Sawtooth Fish Hatchery, we believe homing to the Yankee Fork to be the most significant challenge to ensuring hatchery adults return to the Yankee Fork for broodstock collection and to support the tribal fishery. Fish imprint on the chemical signatures of their natal waters and use those olfactory cues to return to those waters as adults. Imprinting can occur throughout a salmonids juvenile residence (Keefer and Caudill 2014) and particularly during period of parr-smolt transformation (Yamamoto et al. 2010) much like the pubescent rites of passage and ceremonies for tribal youth (SBTEK value Relationality/Relationships). The release of fish from Sawtooth Fish Hatchery into the Yankee Fork occurs in late April and these fish are in the process of smoltification or have already become smolt. Thus, they have imprinted on Sawtooth Fish Hatchery rather than the Yankee Fork. Long-term acclimation of hatchery juveniles in the Yankee Fork (i.e., 3-4 months encompassing the parr-smolt transformation period) may be one option to increase homing to the release site.

Adult outplants of Chinook salmon appear to have increased juvenile emigrant abundance. The highest estimates of juvenile abundance occurred for brood years that had high numbers of adult outplants. It also appears that adult outplants contributed to increased adult returns for brood years 2008 and 2009 (Figure 10), but we cannot confirm this until all genetic samples have been analyzed. Indeed, brood year 2010 — a year with no adult outplants — had adult returns approximately equal to the preceding brood years with outplants. This may be caused by unusually high smolt to adult survival rates or potentially misclassification of ages.

Steelhead

The largest change to the steelhead program in the Yankee Fork was the shift from Sawtooth A run steelhead to Upper Salmon B-run steelhead in release year 2013. With the shift in stock, the proportion of one-ocean to two-ocean adults changed from 30% two-ocean in the SawA stock to 80% two-ocean with the USRB and DworB stocks, thereby achieving the goal of returning larger steelhead to the Yankee Fork. Unfortunately, a downturn in at-sea survival of steelhead resulted in hatchery returns too low to estimate with PIT array methods in subsequent years. There is a large difference between the number of steelhead returning to Lower Granite Dam and the number that subsequently enter the Yankee Fork, which can largely be attributed to harvest in the Salmon River (Warren et al. 2018). Warren et al. (2018) estimated that 168 and 175 steelhead from the DworB and USRB releases, respectively, were harvested in the Salmon River in 2016. Tribal harvest in the Yankee Fork is low and therefore not included in this report.

SBT relies on the Yankee Fork PIT array to estimate all steelhead escapement into the Yankee Fork and it appears that in years with low returns, current tagging rates of hatchery smolts is inadequate to produce an estimate of returning hatchery adults. Natural-origin adults have similarly low returns with only between 2 and 15 PIT tags detected at the array each year in the time series. Such low numbers of tags make estimates of returning adults difficult. With the need to obtain precise estimates of the proportion of hatchery steelhead spawning in Salmon River tributaries, it may be prudent to increase tagging rates of these hatchery steelhead groups.

Obtaining localized broodstock was one objective for releasing B-run stocks into the Yankee Fork; however, broodstock collection has proven difficult without significant infrastructure. The SBT has operated side channel weirs since 2016 to capture B-run steelhead. In 2017, these weirs were successful in capturing 35 hatchery steelhead adults and 17 natural adults. In 2018, with the onset of very low adult returns, the SBT only trapped three adults. Efforts to capture fishing by angling yielded zero fish over approximately 80 hours of effort. In addition to challenges capturing fish in the Yankee Fork, the timing of migration into the Yankee Fork is late relative to the spawning of hatchery fish at Sawtooth and Pahsimeroi hatcheries and is largely flow dependent (Appendix B). The majority of steelhead do not enter the Yankee Fork until flows exceed 200 cfs. Overall, obtaining adequate numbers of adults for broodstock and controlling hatchery-origin adult spawning in the Yankee Fork can only be obtained if a permanent adult weir and holding facility is constructed.

Shoshone-Bannock Traditional Ecological Knowledge

The interweaving of two knowledges is a difficult lift and one the SBT does not take lightly as we report back to our tribal membership; they are not satisfied. We are not able to bring salmon back because of hegemonic structures of power imbalances and a usurping of facilities, production, transportation, etc. The life of salmon through our traditional storytelling was that the salmon stepped up, gave their lives so that ours may go on. The time is now for us to repay our debt to our brother salmon. The knowledge base we have access to has neither been fully accessed nor funded in a meaningful way to bring salmon or steelhead back. More importantly, we are ready to bring forth our knowledge through a Shoshone-Bannock methodology and Western methods of science, it is methodologies that cause harm, not methods (Walters and Anderson 2011).

Our abilities are expansive yet reduced from problematic issues with our ideas and ways of knowing being dead on arrival in professional and academic settings (Matsaw et al 2020). We are understanding to the idea that most of our counterparts such as the LSRCP, and others, are not savvy to our cultural knowing and thought, and most of what is known about us is stereotypes, stigmas and misnomers. The intersectionality of these issues facing tribes, and in some manner more so for the SBT, happen on the ground at microlevels to higher up at funding agencies and legislative processes at a macrolevel across the Columbia River basin. Overall, we are submitting this 10-year report being reflexive of how we want to move forward into future years in expanding our ideas, thoughts and cultural underpinnings shaping our management and science schemas. Our hope is to keep you updated on those changes and keep moving progressively into the next 10-years. We close with acknowledging our ancestors, the future of our plants and animals, waterways and lands of the Shoshone-Bannock.

Table 23. Coded wire tag recoveries by brood year for Chinook smolts released in the Yankee Fork. Data extracted from the Regional Mark Information System. Note that low numbers of CWT were recovered above Sawtooth Weir and in the Columbia River gillnet fishery. Additionally, low numbers of recovered CWT from spawning ground surveys for brood years 2009-2013 were submitted to IDFG for analysis, but may not have been read. Additionally, these are absolute values of CWT and are not corrected for subsampling rates.

Brood Tear	Coded Wire Tags.released	Recoveries at Sawtooth	Recoveries at Yankee Fork	Recoveries in Mainstem above East Fork
2008	190,829	643	48	28
2009	191,965	16	0	5
2010	194,730	44	0	24
2011	No Release	—	—	—
2012	190,008	4	0	6
2013	181,545	2	0	1
TOTAL	949077	709	48	64

Table 24. PIT tag detections of hatchery smolt reared at Sawtooth Fish Hatchery and released in the Yankee Fork. PIT detections only depict those of returning adults. Low number of adult detections in most years can be attributed by low tagging rates of hatchery smolts.

Brood Year	Recaptures and detections			
	Bonneville	Lower Granite Ladder	Sawtooth Hatchery	Yankee Fork
2008	17	14	10	0
2009	1	1	0	0
2010	4	2	2	0
2011	No Release	—	—	—
2012	3	3	2	0
2013	0	1	0	0
2014	1	1	1	0
TOTAL	26	21	15	0

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APPENDIX A. DETECTION PROBABILITY FOR ADULT STEELHEAD CROSSING THE YANKEE FORK PIT ARRAY

We used known recaptured individuals in three years to estimate the detection probability of the Yankee Fork PIT Array. PIT tagged individuals were recaptured in the Yankee Fork during tribal harvest monitoring, tangle nets, and side channel weirs in 2012, 2016, and 2017, respectively. Detection probability was calculated as $\frac{N_{recap,detected}}{N_{recap}}$; where N_{recap} is the number of PIT tagged individuals recaptured during sampling events and $N_{recap,\ detected}$ is the number of PIT tagged individuals recaptured during sampling events that were also detected at the Yankee Fork PIT array.

All PIT tags recaptured during sampling events in 2012, 2016, and 2017 were also detected at the Yankee Fork PIT array. Therefore, we applied a detection probability of 1.0 to all adult escapement estimates

Table A1. Summary of adult steelhead captures above the Yankee Fork PIT array used to determine detection probability of adult steelhead at the array.

Year	Sampling method	No. indiv. recaptured	No. recaptured PIT tags	No. Recaptured PIT tags detected at YF array	Detection probability
2012	Harvest	116	8	8	1
2016	Tangle Nets	23	5	5	1
2017	Side-channel weirs	53	8	8	1

APPENDIX B: TIMING OF ADULT CHINOOK SALMON AND STEELHEAD MIGRATIONS INTO THE YANKEE FORK SALMON RIVER

Methods

To assess the migration timing of Chinook salmon and steelhead in the Yankee Fork Salmon River, we used data from Passive Integrated Transponder (PIT) tags. We compiled data on Chinook salmon tagging, release, and detection data associated with the Yankee Fork PIT array from the Columbia Basin PIT Tag Information System (PTAGIS). A PIT array is a stream wide, continuously operating antenna that detects PIT tagged fish as they cross over a given section of stream bed. The Yankee Fork PIT array is located 3.1 km upstream from the confluence with the mainstem Salmon River.

Data Filtering

For this analysis, we used detections of Chinook salmon and steelhead tagged as juveniles at various rotary screw traps in the Snake River basin and at Lower Granite Dam that returned to the Yankee Fork as adults. We also included Chinook salmon and steelhead tagged as adults below Bonneville Dam, at Bonneville Dam and at Lower Granite Dam. It is important to note that these data were obtained from PTAGIS outputs. Because some steelhead releases were adipose intact, some hatchery fish may have been misclassified as natural origin fish at Lower Granite Dam. Therefor, hatchery steelhead

Yankee Fork mean daily discharge was extracted from USGS gage # 13296000 using the *dataRetrieval* package in R.

Statistical Analysis

To quantitatively examine the association of Chinook salmon and steelhead adult migration into the Yankee Fork with discharge and date, I calculated empirical cumulative distribution functions (ECDFs) for detections within years and pooled among years. In this context, ECDFs describe the proportion of total number of individuals migrating across the PIT array below a value of interest (i.e., day of year or discharge). ECDFs have an underlying cumulative frequency distribution that is used to predict the proportion of individuals crossing the array at any given value of interest. We used R version 3.4.0 (R Core Team 2017) for these analyses. For this appendix, We did not statistically test for differences in ECDFs among years.

Results

Chinook

- 168 adult Chinook salmon were detected at the Yankee Fork Salmon River PIT array from 2012-2017. Of the 168 individuals, two individuals were confirmed hatchery origin fish and 13 individuals were of unknown origin (tagged at or below Bonneville Dam).
- Chinook salmon arrive at the Yankee Fork Salmon River PIT array in the middle of June (Fig. B1, Fig. B3) and individuals continue to enter the Yankee Fork into the beginning

of September. The earliest detection of an adult Chinook salmon occurred on 09-June-2015 (Day 160; Fig. B3). The latest upstream migrating adult Chinook salmon occurred on 14-September-2013 (day 258; Fig. 3). Over 90% of individuals in each spawning year were detected before 27-August (day 238).

- The lowest discharge when a tagged adult was detected at the PIT array was 55 cfs (Fig. B1, Fig. B4). The highest discharge at which adults were detected was 593 cfs (Fig. B4). 99% of individuals were detected at flows below 500 cfs.

Steelhead

- A total of 368 adult steelhead tagged at Lower Granite dam during their upstream migration were detected at the Yankee Fork PIT array from 2012-2017 with an almost equal representation of natural origin (NOR; Table B2) and hatchery origin fish (HOR; Table B2). Mean fork length was higher in 2017 than in previous years (Table B2), suggesting returns of B-run steelhead from both streamside incubators and smolt releases.
- Steelhead arrive at the Yankee Fork PIT array in the middle of March (Fig. B5, Fig. B6). The earliest detection of an adult steelhead from the analyzed tag grouping occurred on 16-March-2015 (Day 75; Fig. B6). The latest upstream migrating steelhead occurred on 11-May-2016 (day 132; Fig. B6). Over 90% of individuals in each spawning year were detected before 01-May (Table B3).
- The lowest discharge when a tagged adult was detected at the PIT array was 73 cfs (Fig. B7, Fig. B8), which occurred in 2014. The highest discharge at which adults were detected was 1390 cfs in 2012 (Fig. B8). All detected individuals crossed the PIT array below 1000 cfs in all years except 2012, and below 750cfs in all years except 2012 and 2016 (Table B4).
- Please see notes on Table B3 and Table B4 for a brief description of why 2012 was anomalous.

Table B1: Date of first detection relative to the installation date of the temporary picket weir in Yankee Fork from 2012-2017.

Year	Date of first detection	Weir install date	Weir install discharge (cfs)	% of Run missed based on discharge of weir install
2012	26-Jun	26-Jun	548	3.9%
2013	13-Jun	13-Jun	352	0%
2014	20-Jun	19-Jun	447	8.3%
2015	09-Jun	09-Jun	444	0%
2016	18-Jun	14-Jun	486	0%
2017	10-Jul	11-Jul	450	9.1%

Table B2. Summary of the number of steelhead detections of each rear type and mean fork length of individuals tagged and measured at Lower Granite Dam.

	Hatchery origin		Natural origin	
Spawn Year	No. of tagged individuals detected	Mean fork length (mm ± 1SD)	No. of tagged individuals detected	Mean fork length (mm ± 1SD)
2012	89	Not measured	27	Not measured
2013	0	NA	109	623 ± 72
2014	47	581 ± 42	9	601 ± 78
2015	26	669 ± 36	10	630 ± 73
2016	1	630 ± NA	14	615 ± 29
2017	20	720 ± 32	16	712 ± 54
Pooled	183	635 ± 69	185	630 ± 73

Table B3. Percent of the total number of tagged adult steelhead detected at the Yankee Fork Salmon PIT array before a given date from 2012-2017. Percentage derived from empirical cumulative distribution functions.

Spawn Year	April 1	April 15	May 1
2012	0.0	18.1	97.4
2013	14.7	71.6	99.1
2014	1.8	58.9	98.2
2015	77.8	88.9	97.2
2016	6.7	53.3	93.3
2017	30.6	86.1	100.0
Pooled†	15.5	55.2	98.1

Notes:
†Pooled estimate includes only data from 2013-2017 because the PIT array did not function throughout the migration period in 2012. Also during 2012, an apparent rain-on-snow event on 25 April triggered a rapid influx of fish to Yankee Fork.

Table B4. Estimated percent of the total number of tagged adult steelhead detected at the Yankee Fork Salmon PIT array below a given discharge threshold from 2012-2017. Percentage derived from empirical cumulative distribution functions.

Spawn Year	250 cfs	500 cfs	750 cfs	1000 cfs
2012	10.3	51.7	54.3	56.9
2013	65.1	99.1	100.0	100.0
2014	17.9	82.1	100.0	100.0
2015	38.9	97.2	100.0	100.0
2016	26.7	60.0	80.0	100.0
2017	0.0	91.7	100.0	100.0
Pooled†	39.3	91.7	98.8	100.0

Notes:
†Pooled estimate includes only data from 2013-2017 because the PIT array did not function throughout the migration period in 2012. Also during 2012, an apparent rain-on-snow event on 25 April triggered a rapid influx of fish to Yankee Fork or an array malfunction.

Table B5. Percent of days in the steelhead migration period (15Feb-15May) when flows are above a given discharge (cfs) from 1986-1991 and 2001-2017.

Year	500 cfs	750 cfs	1000 cfs	1310 cfs
1986	14	1	0	0
1987	1	0	0	0
1988	0	0	0	0
1989	11	6	1	0
1990	0	0	0	0
1991	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	20	7	1	0
2007	11	4	0	0
2008	4	0	0	0
2009	1	0	0	0
2010	0	0	0	0
2011	6	2	1	0
2012	27	18	9	3
2013	8	3	2	0
2014	14	2	0	0
2015	1	0	0	0
2016	34	18	4	0
2017	23	14	13	12
Pooled	8	3	1	1

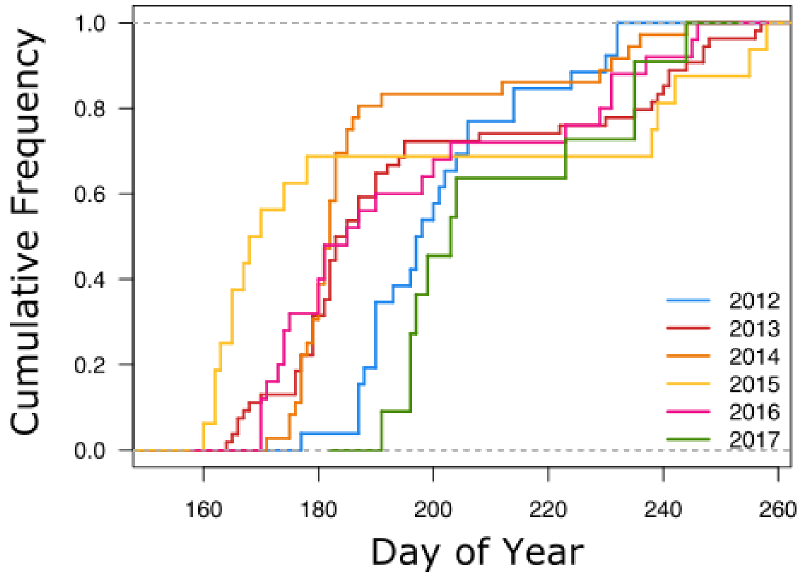

Figure B1. Empirical cumulative frequency distribution of adult Chinook detections on the Yankee Fork Salmon River PIT array by day of year on first date an individual was detected for each year 2012-2017.

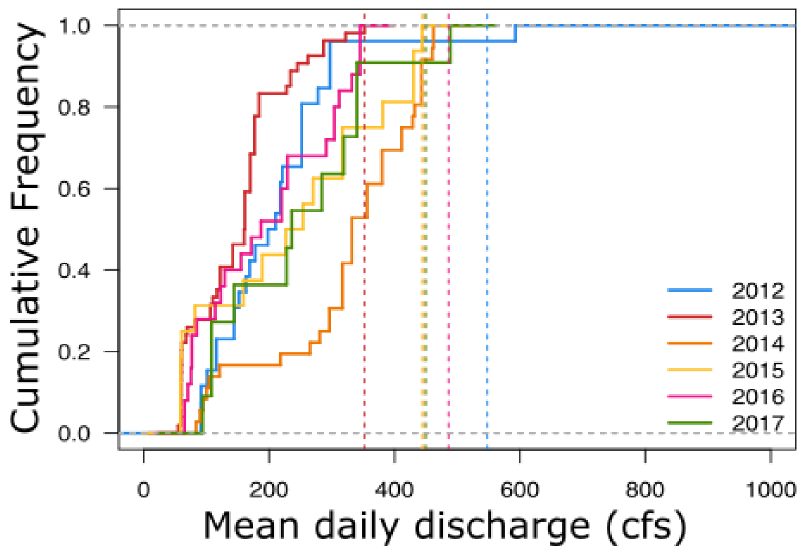

Figure B2. Empirical cumulative frequency distribution of adult Chinook detections on the Yankee Fork Salmon River PIT array by mean daily discharge on first date an individual was detected for each year 2012-2017. Dashed vertical line indicates the discharge at which the temporary picket weir was installed in a given year (also see Table 1).

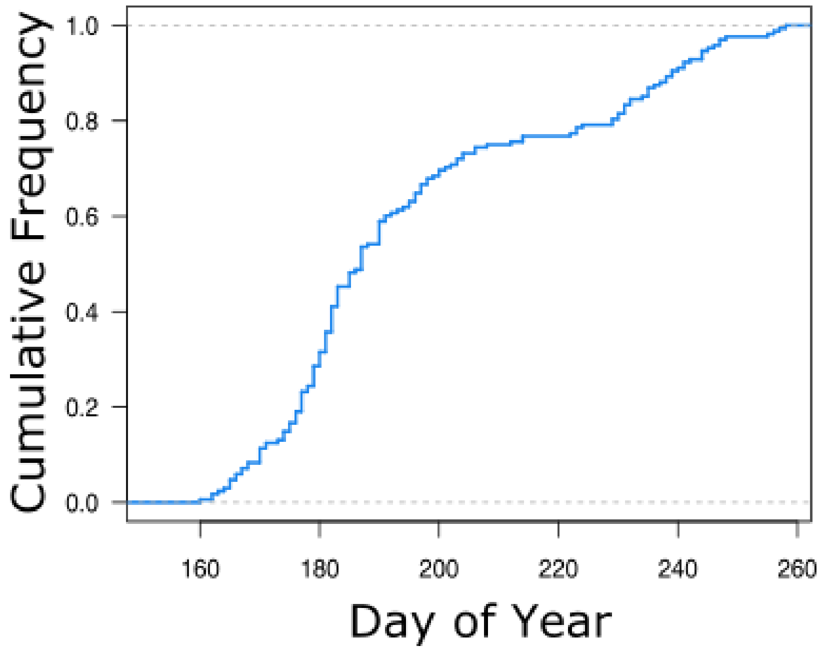

Figure B3. Empirical cumulative frequency distribution of adult Chinook detections on the Yankee Fork Salmon River PIT array by day of year on first date an individual was detected for each year 2012-2017. Detections from all years were pooled (n=168).

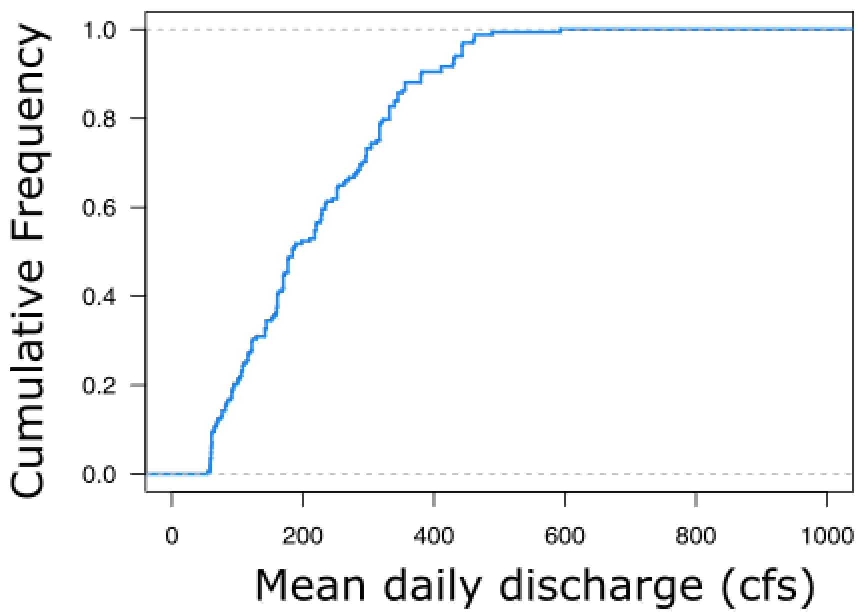

Figure B4. Empirical cumulative frequency distribution of adult Chinook detections on the Yankee Fork Salmon River PIT array by mean daily discharge on first date an individual was detected for each year 2012-2017. Detections from all years were pooled (n=168).

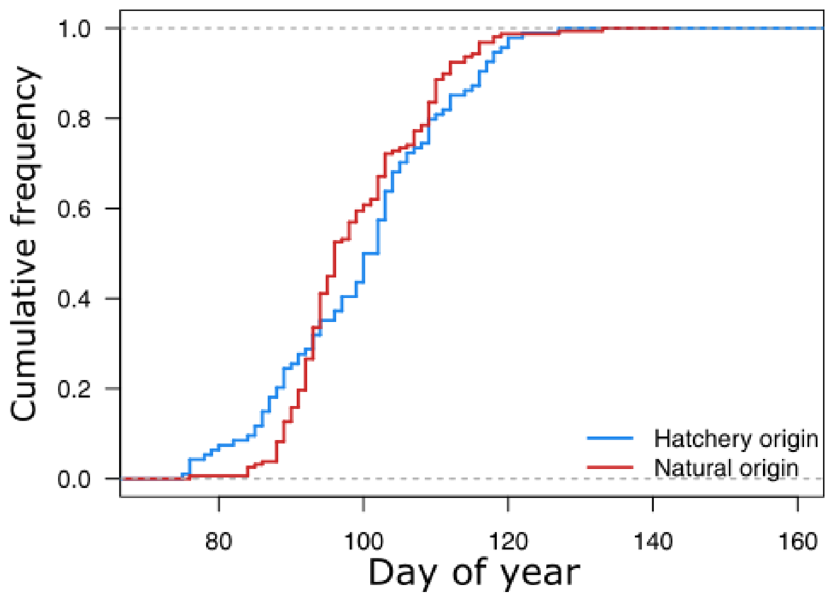

Figure B5. Empirical cumulative distribution function of hatchery origin (blue line) and natural origin (red line) adult steelhead detections on the Yankee Fork Salmon PIT array by the day of year an individual was detected. Data in this figure was pooled across spawn years 2013-2017.

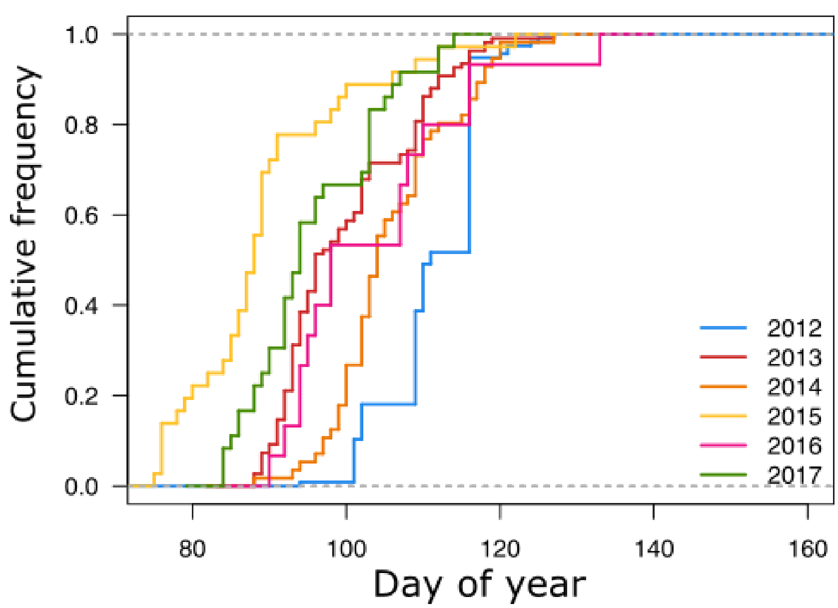

Figure B6. Empirical cumulative distribution function of adult steelhead detections on the Yankee Fork Salmon PIT array by day of year, 2012-2017.

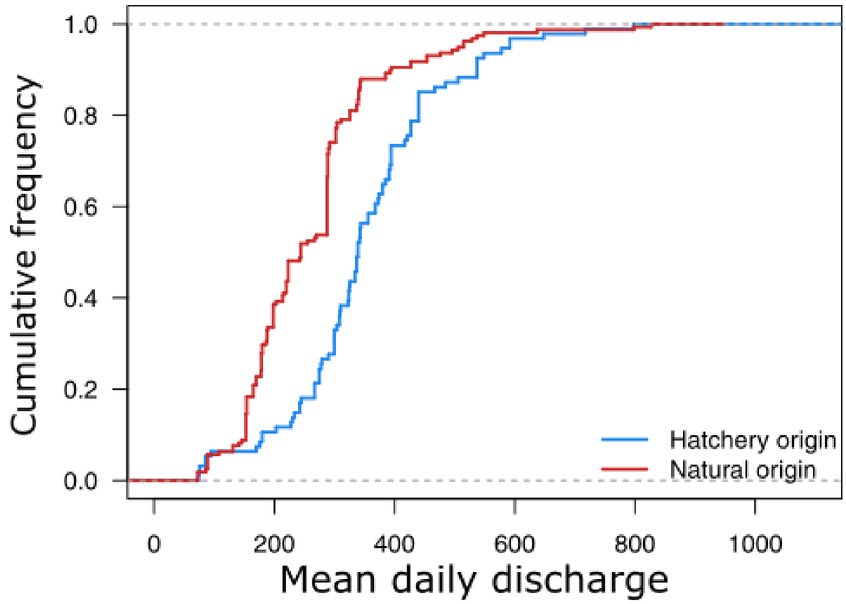

Figure B7. Empirical cumulative frequency distribution of hatchery origin (blue line) and natural origin (red line) adult steelhead detections on the Yankee Fork Salmon PIT array by the mean daily discharge on the day an individual was detected. Data in this figure was pooled across years 2013-2017.

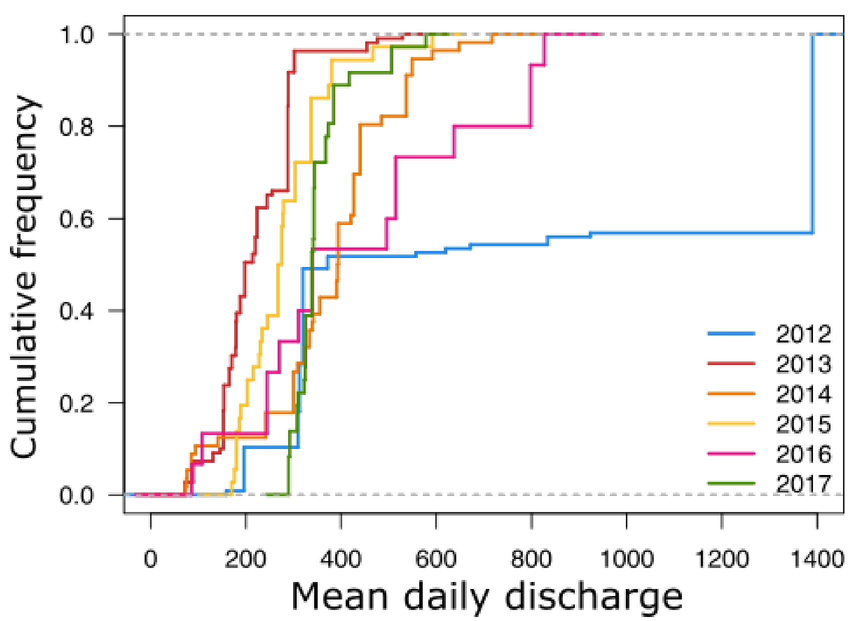

Figure B8. Empirical cumulative frequency distribution of adult steelhead detections on the Yankee Fork Salmon PIT array by mean daily discharge on the date an individual was detected for each year 2012-2017.

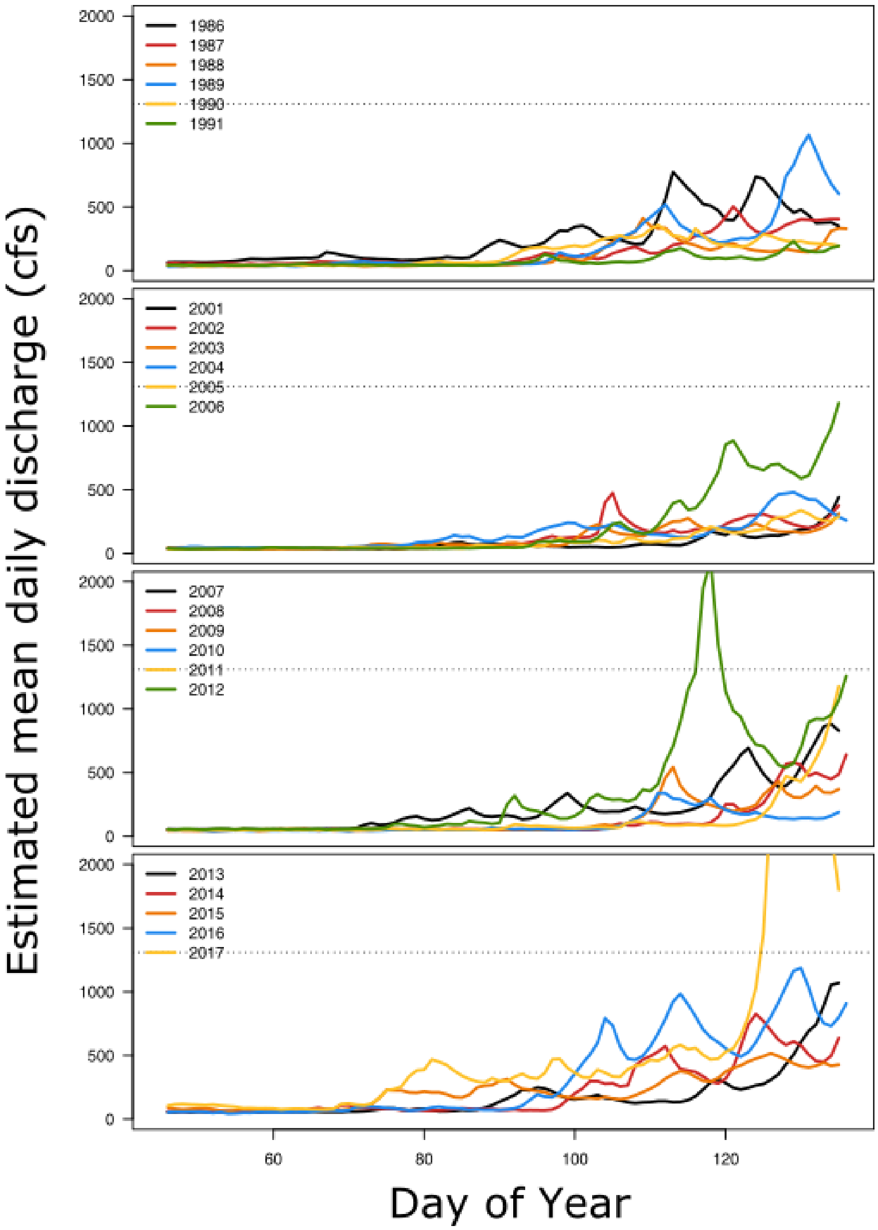

Figure B9. Estimated mean daily discharge at Yankee Fork Salmon River for 1986. We estimated discharge by regressing natural log transformed Yankee Fork discharge (USGS gage 13296000) against natural log transformed Salmon River below Yankee Fork discharge (USGS gage 13296500) for 2012-2017 (ln(YFK)= -4.24+1.36ln(SAL); R2 = 0.96). We then used the equation and historical Salmon River discharge to estimate Yankee Fork discharge for 1986-1991 and 2001-2017. The horizontal dashed line marks the 5% exceedance threshold identified by McMillen, Jacobs, and Associates Technical Memorandum 005-13 July 2016.