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Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Juveniles: Fish Collection and Tagging, 2023

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Executive Summary

During summer 2023, we collected and tagged fish as part of a multiyear research project to assess migrational characteristics and estimate parr-to-smolt survival for wild Snake River spring/summer Chinook salmon smolts in the Snake River Basin. During each study year since 1991, we have collected wild Chinook parr in natal tributaries, implanted them with passive integrated transponder (PIT) tags, and released them near their respective collection sites.

In this report, we present data on fish collection and tagging efforts during July 2023. Detection data will be collected from these tagged fish as they begin migration during spring 2024. These data and the respective analyses will be presented in our 2024 *Survival and Timing* report.

- During July 2023, we collected a total of 6,498 wild Chinook salmon parr from 7 Idaho sample locations. Of the parr collected, 4,663 were PIT-tagged and released.
- For all fish collected, we observed an overall average length of 58.4 mm and average weight of 3.1 g.
- We observed a mortality rate of 1.1% (73) for collected fish over all sample reaches combined. The main cause of mortality was associated with collection of fish, and we recorded five mortalities associated with anesthetizing, tagging, and handling.

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Introduction

Snake River spring/summer-run Chinook salmon *Oncorhynchus tshawytscha* was listed as threatened under the U.S. Endangered Species Act (ESA) in 1992. Since that time, this evolutionarily significant unit (ESU) has been the focus of a recovery plan to restore its populations to self-sustaining levels. The plan serves as base of coordination for recovery efforts from federal, state, tribal, and municipal entities, as well as from private groups and individuals. Recovery efforts focus on both salmon populations and their habitats.

The most recent NMFS status review (NMFS 2016) indicated that the Snake River spring/summer Chinook salmon ESU remained at high overall risk, and that all but one population (Chamberlain Creek) remain at high risk. Natural-origin abundance for most populations in the ESU had increased over levels reported in the previous status review, although these increases were inconsistent across populations and not substantial enough to change viability ratings (NMFS 2016).

In an analysis of potential recovery strategies, Kareiva et al. (2000) found that "modest reductions in first-year mortality or estuarine mortality would reverse current population declines" for Snake River spring/summer-run Chinook salmon. Their finding supports prioritization of the juvenile stage as an efficient approach toward allocation of resources for recovery goals.

For Pacific salmon *Oncorhynchus* spp., tagging and recapture studies have been a central component of research to improve survival of juvenile downstream migrants. Tagging studies began in the mid-1950s, when researchers relied on data from methods that could only provide limited information on fish passage (i.e., freeze branding, index counts, etc.). In the late 1980s, the passive integrated transponder (PIT) tag was introduced to the fisheries community.

The PIT tag allows researchers to track and record the movements of individual fish. Because it is small and biologically inert, a PIT tag can be retained throughout the fish's life cycle. The "passive" capability of the tag, which does not require a battery means a single tag can potentially produce multiple detections of an individual fish throughout the life-span of that fish.

Since its introduction, use of the PIT tag has expanded from about 50,000 to more than 2 million fish tagged annually within the Federal Columbia River Power System (FCRPS). These tagging efforts, along with automated data collection methods, have

provided large data sets for a broad mixture of wild/natural and hatchery stocks, ages, and year classes. The Columbia Basin PIT Tag Information System (PTAGIS) was established as a shared repository for these data (PSMFC 1996).

Construction and installation of the spillway PIT detection system at Lower Granite Dam was completed in January 2020. The spillway system detects fish (including fish from this study) as they pass through spill bay 1 (PITAGIS interrogation site GRS). During 2022, the spillway system detected 195,666 fish, with a nearly 172% increase in total project detection. Prior to installation of the spillway system, a large number of PIT tagged fish passed Lower Granite without detection. The new system allows for more precise estimates of survival and timing for the wild Snake River spring/summer Chinook tagged as part of this project.

Data from PIT tag detections continue to provide insight for decisions on programs to enhance juvenile passage at dams, such as spill and transportation. However, there is an ongoing need for recent data upon which to base decisions for these and other restoration and recovery efforts. Gaps remain in our understanding of life history patterns and survival at different points in the life cycle of Columbia Basin stocks. Our research directly addresses these data gaps for wild Snake River spring/summer Chinook salmon at the parr-to-smolt stage.

The 2020 Columbia River System Biological Opinion (NMFS 2020) calls for investigations to understand the factors contributing to the expressions of life-history diversity, such as yearling vs. subyearling life-history strategies for spring/summer Chinook salmon. We need to examine factors influencing the adoption of alternative life-history patterns, and how such changes might contribute to the abundance and productivity of affected populations. These factors include how and where potential density-dependence limitations are affecting productivity in freshwater habitats and their influence on the overwintering life stage. Investigation of factors that contribute to the subyearling life-history pattern is also needed, along with the limiting factors that determine adult returns.

Section 1.3.2.5.5 of the 2020 BiOp states that

The Action Agencies will continue to: monitor habitat status and trends (including stream temperature and flow); conduct compliance and implementation monitoring (to ensure that habitat improvement actions are implemented as planned); monitor effectiveness of their habitat mitigation efforts at a range of scales; fund fish and habitat monitoring; and, support research projects with regional partners as funding and priorities allow.

Clearly, the migratory performance of wild fish (e.g., run-timing/survival) is important and should continue to be monitored. To this end, we continue marking wild/natural spring/summer Chinook parr with PIT tags in their natal streams during the summer of their first year of life. Marking efforts provide the opportunity to precisely track these stocks during their parr/smolt migrations through natal rearing streams, unimpounded sections of the Salmon and Snake Rivers, and the hydroelectric complex.

This report includes information on tagging of wild Chinook salmon parr from Idaho streams during 2023. We will monitor these fish during spring and early summer 2024 as they migrate downstream towards the Pacific Ocean. Estimates of downstream survival and timing of study fish to Lower Granite Dam, as well as interrogation data from other downstream sites throughout the Snake and Columbia River Basin, will be provided in the 2024 *Survival and Timing* component of this report.

This research continues studies that began in 1991 with funding from the Bonneville Power Administration (BPA). Results from previous study years have been reported annually (Achord et al. 1994, 1995a, 1995b, 1996a, 1996b, 1997, 1998, 2000, 2001a, 2001b, 2002-2006, 2007a, 2007b-2012; Lamb et al. 2013-2018a, 2018b, 2018c, 2019a, 2019b, 2020, 2021, 2022). The goals of this ongoing study are to:

1. Characterize migration timing and growth and estimate parr-to-smolt survival to Lower Granite Dam of different populations of wild Snake River spring/summer Chinook salmon.
2. Determine whether consistent patterns in migration/survival are apparent.
3. Determine which environmental factors may influence patterns in migration/survival.
4. Characterize the migrational behavior and estimated survival of different wild juvenile fish populations as they move downstream from natal rearing areas.

This study continues to provide critical information for recovery planning and restoration of these wild fish populations, all of which remain listed as threatened under the U.S. Endangered Species Act (NMFS 2008).

Methods

During summer 2023, we tagged fish in sample reaches of 7 Idaho streams (Figure 1). Fish collection followed the safe handling methods developed for this study and detailed by Matthews et al. (1990, 1997). We adapted our electrofishing methods to those described by Meyer et al. (2021) as the “100-Watt method.” This technique results in fewer delayed effects for collected fish while increasing catch per unit effort. Anesthetized fish were tagged provided they met the 55-mm minimum fork length requirement and had no observable pre-existing injuries.

In 2023, all fish were tagged using individual single-use hypodermic needles pre-loaded with 12-mm PIT tags. This method ensured that each fish was tagged with a sterile, sharp needle, thus minimizing stress and injury during the tagging process. All other tagging methodology remained the same as in previous years of this study (Achord et al. 1994, 1995a, 1995b, 1996a, 1996b, 1997, 1998, 2000, 2001a, 2001b, 2002-2006, 2007a, 2007b-2012; Lamb et al. 2013-2018a, 2018b, 2018c, 2019a, 2019b, 2020, 2021, 2022).

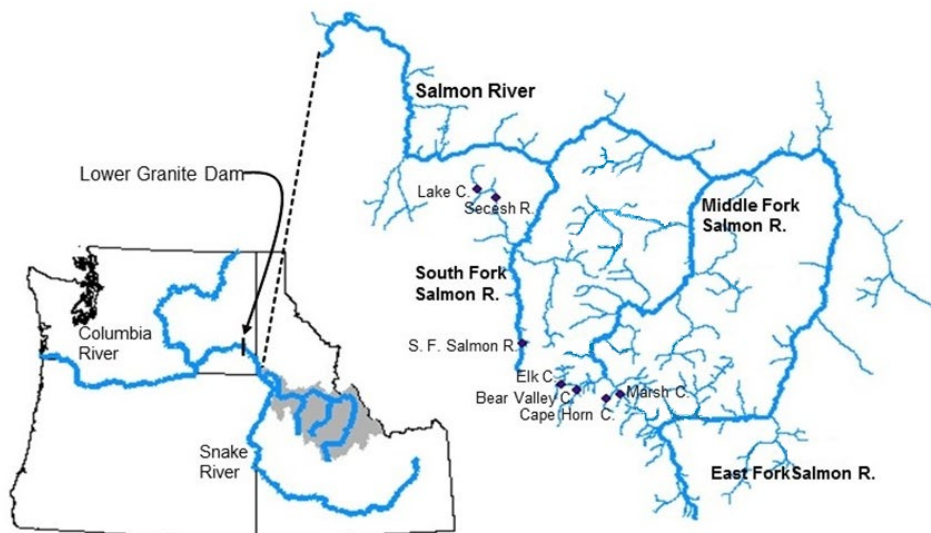


Figure 1. Map showing the streams and sample reaches where wild spring/summer Chinook salmon parr were PIT tagged during 2023.

Results

From 18 July to 1 August 2023, we collected 6,498 wild spring/summer Chinook salmon parr from 7 Idaho stream populations (Figure 1). Fish were collected over a distance of about 14.75 stream km and over an area of approximately 149,119 m² (Table 1; Appendix Table 1). Of the 6,498 fish collected, 4,663 were tagged with standard 12-mm PIT tags.

All tagged fish were released back to their respective natal streams along with any remaining untagged live fish. Collected fish were returned to the natal stream without tagging if they had been previously tagged, were too small, injured, had matured precociously, or if sufficient numbers of fish had already been tagged. Number of tagged fish released per stream or reach ranged from 0 in Cape Horn Creek (due to the small size of fish collected) to 1,446 in Bear Valley Creek (Table 1; Appendix Table 1).

In 2023, the mean fork length of all Chinook salmon parr collected was 58.4 mm and the mean weight was 3.1 g. For Chinook salmon parr that were tagged and released, mean fork length was 63.0 mm and mean weight was 3.3 g (Table 1; Appendix Table 1). Collection areas within each stream were delineated by recording the global positioning system (GPS) coordinates of each tagging site using the Universal Transverse Mercator (UTM) coordinate system (Appendix Table 3).

Other than Chinook salmon parr, sculpin (genus *Cottus*) was the most abundant fish observed during field collection operations (Table 2). However, records of non-target species did not represent their total abundances in collection areas, as only Chinook salmon were targeted for collection. Non-target species were counted as incidental take.

Mortality associated with collection and tagging procedures in 2023 was very low and consistent with what we have observed in previous years (Table 3; Appendix Table 4). The overall collection, handling, and tagging mortality rate was 1.1% across all sampling locations, which included a 24-h hold for a portion (10% or more) of the tagged fish to evaluate post-tagging mortality and tag retention.

Table 1. Summary of collection, PIT tagging, and release of wild Chinook salmon parr with average fork lengths and weights (includes recaptured tagged fish), approximate distances, and estimated areas sampled in Idaho streams during July and August 2023.

Tagging location	Number of fish		Average length (mm)		Average weight (g)		Collection area to stream mouth (km)	Est. stream area sampled (m ²)
	Collected	Tagged & released	Collected	Tagged	Collected	Tagged		
Marsh Creek	1,581	1,374	62.6	63.9	3.6	3.7	11-14.5	28,420
Cape Horn Creek	159	0	49.8	--	2.7	--	0.5-1.0	3,225
Bear Valley Creek	1,495	1,446	65.7	65.9	3.9	3.9	8-9.75	15,903
Elk Creek	673	631	66.3	65.6	4.2	3.6	0.2-2.2	14,960
Secesh River	132	33	52.5	60.1	2.4	3.1	24.5-26.5	15,040
Lake Creek	641	178	54.1	61.4	2.8	2.9	2-3.5	31,846
S Fork Salmon River	1,817	1,001	57.6	61.3	2.3	2.6	115-116.5 & 118-120	39,725
Totals/averages	6,498	4,663	58.4	63.0	3.1	3.3	14.75	149,119

Table 2. Summary of species other than Chinook salmon observed during collection operations in Idaho July 2022.

Sample Site	Steelhead	Unidentified Fry	Brook Trout	Bull trout	Sculpin	Dace	Sucker	Whitefish	Redsided Shiner	Pacific Lamprey
Marsh Creek	20	116	170	0	580	0	0	0	0	0
Cape Horn Creek	0	7	23	0	210	0	0	7	0	0
Bear Valley Creek	33	113	389	0	23	71	167	137	0	0
Elk Creek	48	30	602	1	170	76	283	179	0	0
Secesh River	49	24	49	0	180	52	0	0	0	212
Lake Creek	7	57	133	4	1,135	24	0	0	0	467
S Fork Salmon River	54	282	1 61	0	23	118	0	3	28	0
Totals	211	629	1,527	5	2,321	341	450	326	28	679

Table 3. Mortality percentages for wild Chinook salmon parr collected and PIT-tagged in Idaho during July-August 2023.

Tagging Location	Mortality (%)		
	Collection	Tagging/24 h	Overall
Marsh Creek	0.8	0.0	0.8
Cape Horn Creek	2.5	0.0	2.5
Bear Valley Creek	0.1	0.0	0.1
Elk Creek	0.6	0.0	0.6
Secesh River	2.3	0.0	2.3
Lake Creek	0.9	0.0	0.9
S Fork Salmon River	2.0	0.5	2.3
Averages	1.3	0.1	1.4

Discussion

During 2023, the number of wild Chinook salmon parr tagged was far lower than the annual average number tagged over the past 10 years (4,663 vs. 10,488). This low number was mostly due to the fact that we sampled at only 7 locations in 2023, while up to 16 locations have been sampled in previous years. Pre-season analysis of redd counts provided by Idaho Department of Fish and Game (IDFG 2017) showed that parr densities would be low at some locations in 2023, and that many (including 9 of our annual sampling locations) would fall below the IDFG “critical abundance threshold.” At streams with parr densities below this threshold, sampling in Idaho was again prohibited during 2023. Nevertheless, stream conditions during collection periods were good all season, with low-to-average flows and high water clarity.

Fish collection in Cape Horn Creek was cut short quickly after it had begun (3,225 m²; Table 1) when NOAA Fisheries personnel observed that fish were too small for tagging (average of 49.8 mm). Recent work from Kiffney et al. (In press) suggests that Cape Horn fish are smaller than their cohorts in similar streams (Marsh Creek) due to the fact that colder-than-average water temperatures limit food availability, with direct effects on growth.

Our overall collection effort in 2023 included 7 sample reaches with a combined sample area of 149,119 m². Over the entirety of the sample area, we estimated an annual density of 4.36 parr/100 m², which is slightly higher than the five-year average of 4.11 parr/100 m² from 2018 to 2023 (excluding 2020, when no fish were collected). Parr densities vary among sampling sites and can be biased high when using seine nets in deeper pools where parr tend to congregate. This was the case in Bear Valley Creek, which had the highest observed density (9.40 parr/100 m²). Past data has indicated an inverse relationship between parr density and parr-to-smolt survival (Figure 2).

During 2024, we will collect downstream migration data from the wild spring/summer Chinook parr collected and tagged during field operations in 2023. Analyses from these data will include estimates of parr-to-smolt survival, arrival and migration timing to Lower Granite Dam from streams with instream detection capabilities, and smolt passage timing at Lower Granite. These analyses will be included in our annual report, along with environmental data collected from each tagging location and growth data on migrants recaptured at Lower Granite Dam.

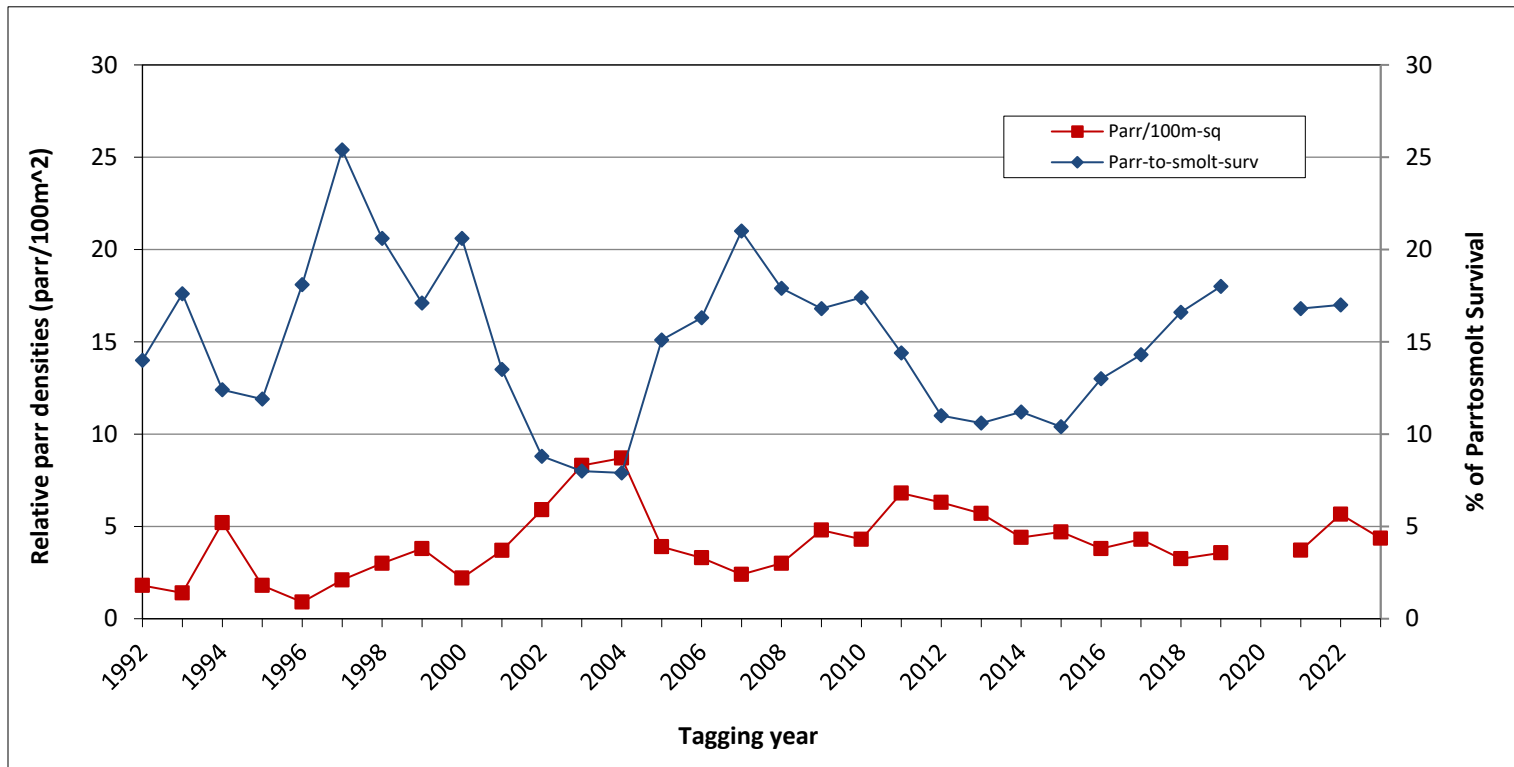


Figure 2. Annual average density of Chinook salmon parr (parr/100 m²) in Idaho streams vs. annual estimated survival of smolts from these streams to Lower Granite Dam the following year, 1992 to 2023 (excluding 2020, when no fish were collected).

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Appendix: Data Tables

Appendix Table 1. Summary of numbers collected, tagged, released (with tags), and minimum, maximum, and mean lengths and weights of wild Chinook salmon parr, collected and PIT tagged in various Idaho streams, 2023. Some length-weight data includes recaptured tagged fish and precocious Chinook.

	Fish (n)			Collection				Tagging and release			
	Collected	Tagged	Released	Length (mm)		Weight (g)		Length (mm)		Weight (g)	
				Range	Mean	Range	Mean	Range	Mean	Range	Mean
Marsh Creek	1,581	1,374	1,374	42-126	62.6	0.8-29	3.6	54-84	63.9	1.4-8.9	3.7
Cape Horn Creek	159	0	0	37-128	49.8	0.3-29	2.7	--	--	--	--
Bear Valley Creek	1,495	1,446	1,446	45-135	65.7	1-36.1	3.9	54-87	65.9	1.9-10	3.9
Elk Creek	673	631	631	49-135	66.3	1.5-36.4	4.2	54-83	65.6	1.5-9.5	3.6
Secesh River	132	33	33	39-101	52.5	0.6-15.6	2.4	55-70	60.1	1.4-5.7	3.1
Lake Creek	641	178	178	32-135	54.1	0.5-29.2	2.8	54-90	61.4	1.3-9.6	2.9
S Fork Salmon River	1,817	1,006	1,001	37-132	57.6	0.3-31.5	2.3	48-85	61.3	1-10.4	2.6
Total or mean	6,498	4,669	4,663	33-135	68.4	0.3-36.4	3.1	53-95	63.0	1.0-10.4	3.3

Appendix Table 2. Summary of tagging dates, times, and temperatures at capture and release with capture method, distance (rkm) from stream mouth to release point, and number of tagged fish released in 2023. Except where noted, all capture methods were electrofishing.

Group	Tagging			Release				n
	Date (2023)	Time (PST)	Temp (°C)	Date (2023)	Time (PST)	Temp (°C)	Location (rkm)	
Marsh Creek								
GAA-2023-199-001	18 Jul	0730	6.5	19 Jul	0600	6.5	14	599
GAA-2023-200-001	19 Jul	0730	6.5	19 Jul	1330	10.5	13	774
Cape Horn Creek								
GAA-2023-200-002	19 Jul	1100	11.0	19 Jul	1345	11.0	2	---
Bear Valley Cr								
GAA-2023-201-001	20 Jul	0900	12.0	21 Jul	1000	11.5	9	194
GAA-2023-201-002	20 Jul	1100	12.0	21 Jul	1000	11.5	9	96
GAA-2023-201-003*	20 Jul	1200	12.0	21 Jul	1000	11.5	9	642
GAA-2023-202-001*	21 Jul	0630	12.0	21 Jul	1000	11.5	9	513
Elk Creek								
GAA-2023-202-002	21 Jul	800	11.0	21 Jul	1320	17.0	1	125
GAA-2023-202-003*	21 Jul	1000	11.0	21 Jul	1320	17.0	1	527
Secesh River								
GAA-2023-209-001	28 Jul	0800	11.0	28 Jul	1320	15.5	26	33
Lake Creek								
GAA-2023-210-001	29 Jul	0800	9.0	30 Jul	1045	11.5	3	77
GAA-2023-211-001	30 Jul	0700	9.0	30 Jul	1045	11.5	3	102
S Fork Salmon River								
GAA-2023-212-001	31 Jul	0800	11.0	1 Aug	1310	17.0	116	476
GAA-2023-212-001	1 Aug	0800	11.0	1 Aug	1310	17.0	118	528

* Fish were captured using a seine net

Appendix Table 3. Universal Transverse Mercator grid coordinates of Global Positioning System that identifies sampling areas at the beginning and end of daily collections in streams for each collection crew in 2023.

Streams & Dates	Section covered	UTM start		UTM end	
		Northing	Easting	Northing	Easting
Marsh Creek					
7/18/2023	left bank	4917413	11T0645831	4916806	11T0646474
7/18/2023	right bank	4917405	11T0645827	4916921	11T0646293
7/19/2023	left bank	4916806	11T0646474	4916525	11T0646710
7/19/2023	right bank	4916864	11T0646382	4916525	11T0646710
Cape Horn Creek					
7/19/2023	left bank	4917372	11T0645737	4917226	11T0645709
7/19/2023	right bank	4917372	11T0645737	4917205	11T0645656
Bear Valley Creek					
7/20/2023	left bank	4920710	11T0633354	4920624	11T0633069
7/20/2023	right bank	4920734	11T0633386	4920976	11T0632813
7/20/2023	seine	4920729	11T0632897	4920747	11T0632800
Elk Creek					
7/21/2023	seine	4918800	11T0629526	4918814	11T0629474
7/21/2023	left bank	4918809	11T0629470	4918657	11T0628846
7/21/2023	right bank	4918809	11T0629515	4918996	11T0628814
Secesh River					
7/28/2023	left bank	5006441	11T0593269	5007268	11T0600208
7/28/2023	right bank	5006441	11T0593269	5007208	11T0593524
Lake Creek					
7/29/2023	left bank	5012339	11T0586126	5013006	11T0585200
7/29/2023	right bank	5012351	11T0586114	5013006	11T0585200
7/30/2023	left bank	5013025	11T0585803	5013131	11T0585560
7/30/2023	right bank	5013105	11T0585811	5013232	11T0585572
South Fork Salmon River					
7/31/2023	left bank	4946792	11T0602879	4946342	11T0603090
7/31/2023	right bank	4946792	11T0602879	4946419	11T0603063
8/1/2023	left bank	4945773	11T0602830	4945091	11T0602781
8/1/2023	right bank	4945823	11T0602844	4945527	11T0602860

Appendix Table 4. Summary of observed total mortality for PIT-tagged wild Chinook salmon parr collected from Idaho streams in July-August 2023. Number rejected includes; fish too small to tag, precocious males, injured fish, fish collected for genetic evaluation, previously tagged fish, and in some cases extra collected fish. Numbers of precocious males rejected for tagging are shown in parentheses.

Stream	Fish collected (n)	Fish tagged (n)	Fish rejected for tagging		Observed mortality			
			(n)	(%)	Collection and handling	Tagging and delayed	Total	
							(n)	(%)
Marsh Creek	1,581	1,374	207 (5)	13.1	13	0	13	0.8
Cape Horn Creek	159	0	159 (4)	100.0	4	0	4	2.5
Bear Valley Creek	1,495	1,446	49 (4)	3.3	1	0	1	0.1
Elk Creek	673	631	42 (15)	6.2	4	0	4	0.6
Secesh River	132	33	99 (6)	75.0	3	0	3	2.3
Lake Creek	641	178	463 (31)	72.2	6	0	6	0.9
S Fork Salmon R	1,817	1,001	816 (13)	44.9	37	5	42	2.3
Totals/averages	6,498	4,663	1,835 (78)	45.0	68	5	73	1.1



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