Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Juveniles

Fish Collection and Tagging, 2021

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Executive Summary

During late summer 2021, we collected and tagged fish as part of a multiyear research project to monitor the migrational behavior and survival of wild juvenile spring/summer Chinook salmon in the Snake River Basin. Each study year, we collect wild Chinook parr in natal tributaries, implant them with passive integrated transponder (PIT) tags, and release them near their respective collection sites.

In this report, we present data on fish collection and tagging efforts during July and August 2021. Detection data will be collected from these tagged fish as they begin migration during spring 2022. These data and the respective analyses will be presented in our 2022 *Survival and Timing* report.

- During July-August 2021, we collected a total of 7,654 wild Chinook salmon parr from 11 Idaho sample locations. Of the parr collected, 6,232 were PIT-tagged and released.

- Of all fish collected, we observed an overall average length of 67.4 mm and average weight of 3.7 g.

- We observed a mortality rate of 1.1% (86) for collected fish over all sample reaches combined. The main cause of mortality was associated with collection of fish, and we recorded only one mortality associated with anesthetizing, tagging, and handling.

Contents

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.

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, and advances in technology since that time have continued to improve various tagging methods. However, until the late 1980s, resource managers relied on methods that could provide only limited information on fish passage, such as freeze-branding, index counts at traps and dams, and analyses of flow patterns.

In the late 1980s, the passive integrated transponder (PIT) tag was introduced to the fisheries community. Each PIT tag contains a unique code, which 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 tag allows multiple detections of an individual fish without physical recapture.

Since its introduction, use of the PIT tag has expanded from about 50,000 to more than 2 million fish tagged annually. 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).

Data from PIT tag detections have provided 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. Major gaps remain in understanding 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.

In addition to acquiring data for the Northwest Power and Conservation Council and several other fish and wildlife programs, our research addresses "Reasonable and Prudent Alternatives" in the 2000 NMFS Biological Opinion (NMFS 2000). For example, section 9.6.5.2 of action 180 advocates a regional monitoring effort on the population status of wild fish stocks and the environmental status of their natal streams and tributaries. Section 9.6.5.5, Action 199 and Appendix H, research action 1193 call for

> ...research to produce information on the migrational characteristics of Columbia and Snake River basin salmon and steelhead. The smolt monitoring program produces information on the migrational characteristics of various salmon and steelhead stocks...and provides management information for implementing flow and spill measures designed to improve passage conditions in the mainstem lower Snake and Columbia Rivers (NMFS 2000).

In response to the remanded biological opinion, the *Final Updated Proposed Action for the FCRPS Biological Remand* proposed that researchers should

> …implement and maintain the Columbia River Basin PIT Tag Information System. Expand the system to systematically plan PIT tag efforts in the pilot study basins such that production and survival can be estimated throughout the system for wild and hatchery fish. Also, continue development and implementation of new fish detection and tagging techniques (Action Agencies 2004).

Also, in an effort to improve the conservation value of tributary habitat,

> …the Action Agencies, in cooperation with numerous non-Federal partners, have implemented actions to address limiting factors in spawning and rearing areas. These include acquiring water to increase streamflow, installing or improving fish screens at irrigation facilities to prevent entrainment, removing passage barriers and improving access, improving channel complexity, and protecting and enhancing riparian areas to improve water quality and other habitat conditions (NMFS 2008).

Clearly, the migratory performance of wild fish (e.g., run-timing/survival) is important and should continue to be monitored. To this end, marking wild/natural parr with PIT tags in their natal streams during the summer of their first year of life provides

the opportunity to precisely track these stocks through instream PIT-tag detectors, traps, and detection systems in the hydroelectric complex during their parr/smolt migrations.

This report includes information on tagging of wild Chinook salmon parr from Idaho streams during 2021. We will monitor these fish during spring and early summer 2022 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 2022 *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, 1997-1998, 2000-2001a, 2001b, 2002-2012; Lamb et al. 2013-2019). 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 provides critical information for recovery planning and ultimately for the 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 2021, NOAA Fisheries personnel tagged fish in 11 Idaho streams or sample reaches (Figure 1). Fish collection followed the safe handling methods developed for this study and detailed by Matthews et al. (1990, 1997). Anesthetized fish were tagged, provided they met the 55-mm minimum fork length requirement.

In 2021, all fish were tagged using individual single-use hypodermic needles pre-loaded with 9- or 12-mm PIT tags. All fish measuring 55-60 mm in streams without in-stream interrogation sites were tagged with 9-mm tags (per request of Idaho state permitting officials). All fish longer than 60 mm were tagged with standard 12-mm 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, 2003, 2004, 2010, 2011; Lamb et al. 2013-2020).

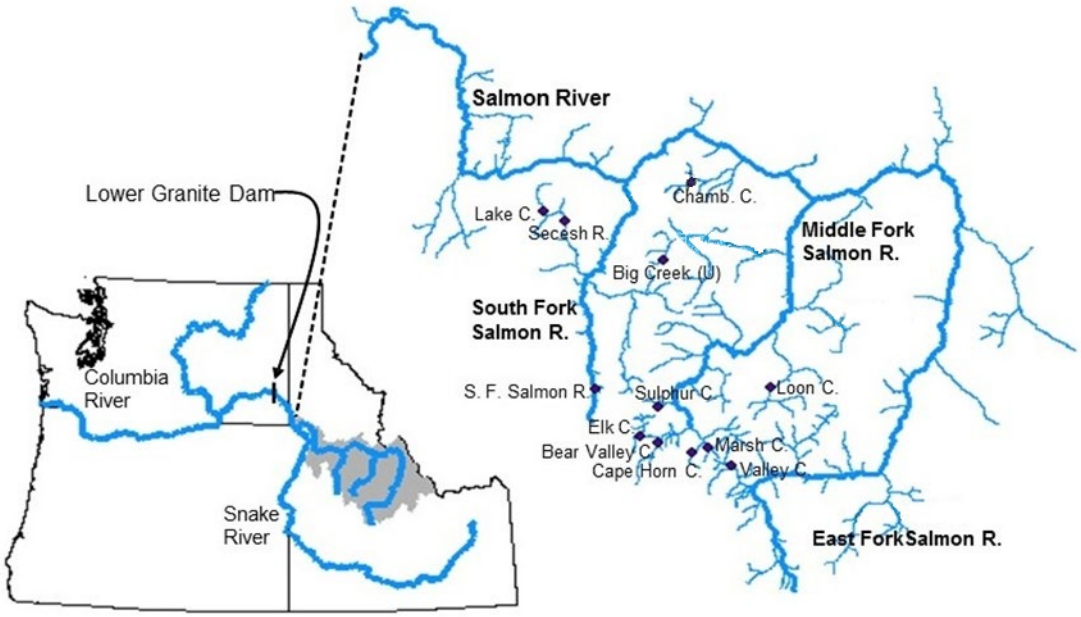

Figure 1. Map showing the streams and sample reaches where wild spring/summer Chinook salmon parr were PIT tagged during 2021.

Results

From 21 July to 16 August 2021, we collected 7,654 wild spring/summer Chinook salmon parr from 11 Idaho stream populations (Figure 1). Fish were collected over a distance of about 19.5 stream km and over an area of approximately 206,189 m^2 (Table 1; Appendix Table 1). Of the 7,654 fish collected, 6,232 were tagged with either 9-mm or standard 12-mm PIT tags.

All tagged fish were released back to their respective natal stream 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. Numbers of tagged fish released per stream or sample reach ranged from 173 in Elk Creek to 1,000 in Valley Creek and the South Fork Salmon River (Tables 1; Appendix Table 1).

In 2021, the mean fork length of all Chinook salmon parr collected was 67.4 mm and the mean weight was 3.7 g. For Chinook salmon parr that were tagged and released, mean fork length was 67.6 mm and mean weight was 3.7 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 2021 was very low (Table 3; Appendix Table 4). The collection and handling mortality rate was 1.1%, and there was only one single mortality following tagging and 24-h holding.

Table 1. Summary of collection, PIT tagging, and release of wild Chinook salmon parr with average fork lengths and weights (collection totals include recaptured tagged fish), approximate distances, and estimated areas sampled in Idaho streams from July through August 2021.

	Number of fish		Average length (mm)		Average weight (g)		Collection area to stream mouth (km)	Estimated stream area sampled (m^2)
Tagging location	Collected	Tagged & released	Collected	Tagged	Collected	Tagged		
Loon Creek	314	250	64.5	65.4	2.7	2.9	28-29	9,368
Valley Creek	1,215	1,000	70.1	70.3	3.7	3.7	3.5-5.0	16,406
Marsh Creek	1,275	1,000	63.8	65.4	3.3	3.4	11-12.8	16,995
Cape Horn Creek	1,227	715	63.5	64.7	3.3	3.3	0.5-1.5	16,746
Bear Valley Creek	628	594	70.7	70.3	4.4	4.3	8-9.75 & 12.3-13.5	35,661
Elk Creek	183	173	72	71.7	4.4	4.3	0.2-1.5	12,742
Big Creek (upper)	552	500	65.3	65.3	3.4	3.3	56.5-59	21,547
S Fork Salmon R	816	750	71.3	70.0	4.4	3.9	117-120	35,067
Secesh River	540	500	68.9	68.4	4.2	4.0	24.2-25.5	14,370
Lake Creek	627	500	64.7	64.6	3.5	3.3	2-3.2	20,481
Chamberlain Creek	277	250	67.2	67.2	3.8	3.8	24-25	6,806
Totals/averages	**7,654**	**6,232**	**67.4**	**67.6**	**3.7**	**3.7**	**19.5**	**206,189**

Table 2. Summary of species other than Chinook salmon observed during collection operations in Idaho from July through August 2021.

Sample site	Steelhead	Unidentified fry	Brook trout	Bull trout	Sculpin	Dace	Sucker	Whitefish	Pacific lamprey (ammocete)
Loon Creek	64	313	0	0	158	0	0	0	0
Valley Creek	41	222	27	0	460	109	31	75	0
Marsh Creek	28	302	27	0	391	1	0	0	0
Cape Horn Creek	25	96	39	1	804	0	0	0	0
Bear Valley Creek	98	497	304	2	270	88	1,658	12	0
Elk Creek	32	221	168	0	165	55	126	9	0
Big Creek (upper)	20	189	193	3	1,508	0	0	0	0
S Fork Salmon River	122	379	49	1	518	348	0	1	0
Secesh River	41	58	6	0	150	27	0	0	270
Lake Creek	15	95	97	22	2,086	23	0	0	130
Chamberlain Creek	21	4	0	0	243	0	0	2	0
Totals	**507**	**2,376**	**910**	**29**	**6,753**	**651**	**1,815**	**99**	**400**

Table 3. Mortality percentages for wild Chinook salmon parr collected and PIT-tagged in Idaho from July through August 2021.

	Mortality (%)		
Tagging location	Collection	Tagging/24 h	Overall
Loon Creek	0.3	0.0	0.3
Valley Creek	0.2	0.0	0.2
Marsh Creek	0.9	0.0	0.9
Cape Horn Creek	0.9	0.0	0.9
Bear Valley Creek	3.7	0.2	3.8
Elk Creek	4.4	0.0	4.4
Upper Big Creek	1.3	0.0	1.3
S. Fork Salmon	1.1	0.0	1.1
Secesh River	0.9	0.0	0.9
Lake Creek	1.0	0.0	1.0
Chamberlain Creek	0.7	0.0	0.7
Lower Big Creek			
Averages	1.1	0.0	1.1

Discussion

During July and August 2021, the number of wild Chinook salmon parr tagged was much lower than the annual average number tagged over the past 10 years (6,232 vs. 12,032). Pre-season analysis of redd counts (provided by IDFG) from 2020 led us to believe that parr densities would be low at most locations; however, we were surprised to find relative densities higher than predicted. Collection and tagging goals (max tagging numbers set by Idaho permit) were easily met at all locations with the exception of Bear Valley and Elk Creek. Conditions during collection periods were good all season, with low-to-average flows and high water clarity.

Our overall collection effort in 2021 included 11 possible sample reaches with a combined sample area of 206,189 m^2. Over the entirety of the sample area, we estimated an annual density of 3.7 parr/100 m^2. Parr densities varied among sampling sites, with the highest observed in Marsh Creek (7.50 parr/100 m^2) and the lowest in Elk Creek (1.44 parr/100 m^2). Past data has indicated an inverse relationship between parr density and parr-to-smolt survival (Figure 2).

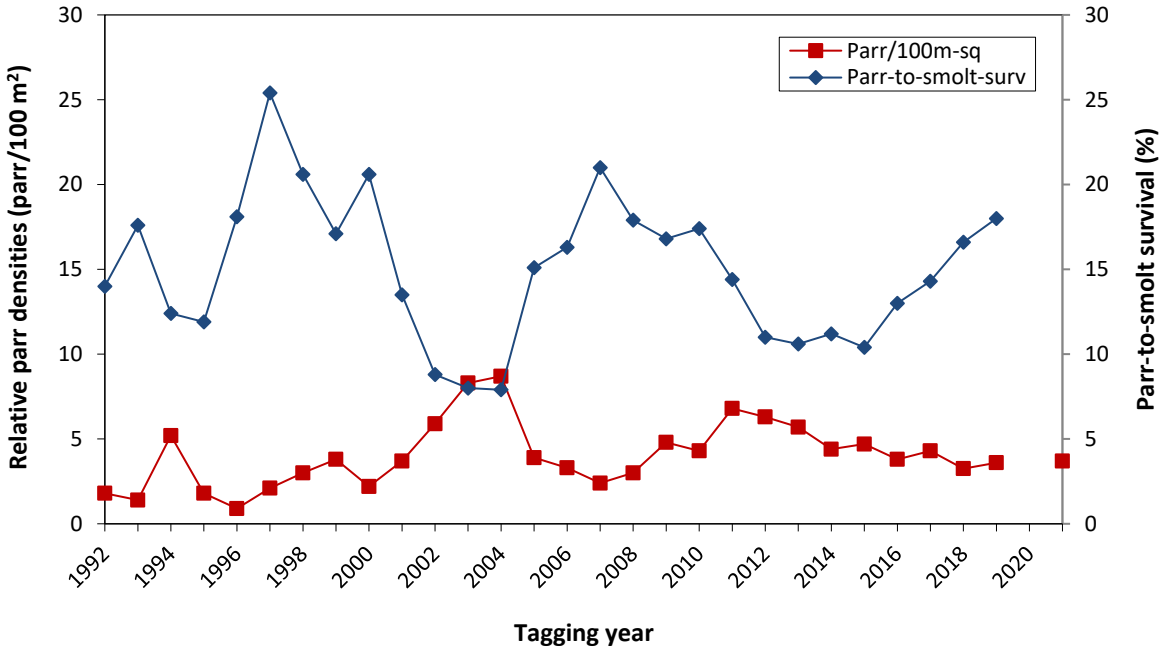

Figure 2. Annual average density of Chinook salmon parr (parr/100 m^2) in Idaho streams vs. annual estimated survival of smolts from these streams to Lower Granite Dam the following year, 1992 to 2021.

During 2022, we will collect downstream migration data from the wild spring/summer Chinook parr collected and tagged during field operations in July and August 2021. 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 are included in our annual reports, along with environmental data collected from each tagging location and growth data on migrants recaptured at Lower Granite Dam.

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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, 2021. Some length-weight data includes recaptured tagged fish and precocious Chinook.

				Collection				Tagging and release			
		Fish (n)		Length (mm)		Weight (g)		Length (mm)		Weight (g)	
	Collected	Tagged	Released	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Loon Creek	314	250	250	49-87	64.5	1.0-7.0	2.7	54-87	65.4	1.6-7.1	2.9
Valley Creek	1,215	1,000	1,000	48-131	70.1	1.2-25.7	3.7	56-110	70.3	1.6-14.6	3.7
Marsh Creek	1,275	1,000	1,000	43-135	63.8	0.9-28.7	3.3	53-85	65.4	1.1-7.5	3.4
Cape Horn Creek	1,227	715	715	42-129	63.5	0.8-28.0	3.3	54-91	64.7	1.4-8.7	3.3
Bear Valley Creek	628	595	594	50-141	70.7	1.1-40.9	4.4	57-89	70.3	2.1-8.5	4.3
Elk Creek	183	173	173	61-126	72	2.4-24.0	4.4	61-85	71.7	2.4-7.6	4.3
Big Creek (upper)	552	500	500	49-124	65.3	1.5-23.0	3.4	55-83	65.3	1.7-6.7	3.3
S Fork Salmon River	816	750	750	51-127	71.3	1.3-25.9	4.4	56-106	70.0	1.6-16.5	3.9
Secesh River	540	500	500	57-118	68.9	1.9-18.4	4.2	57-86	68.4	1.9-8.0	4.0
Lake Creek	627	500	500	44-123	64.7	0.7-24.2	3.5	55-100	64.6	1.6-13.3	3.3
Chamberlain Creek	277	250	250	47-114	67.2	1.4-19.9	3.8	55-88	67.2	2.0-8.1	3.8
Total or mean	7,654	6,233	6,232	42-141	67.4	0.7-40.9	3.7	53-110	67.6	1.1-16.5	3.7

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 2021. Except where noted, all capture methods were electrofishing.

	Tagging			Release				
Group	Date (2021)	Time (PST)	Temp (°C)	Date (2021)	Time (PST)	Temp (°C)	Location (rkm)	n
Loon Creek								
GAA-2021-202-001	21 Jul	0600	1 0.5	21 Jul	0800	12.5	30	250
Valley Creek								
GAA-2021-203-001	22 Jul	0630	9.5	23 Jul	0530	10.0	5	102
GAA-2021-203-002	22 Jul	0830	11.5	22 Jul	1200	16.0	5	528
GAA-2021-203-003*	22 Jul	1045	15.0	22 Jul	1200	16.0	5	370
Marsh Creek								
GAA-2021-204-001	22 Jul	0540	6.0	24 Jul	0520	6.0	11	100
GAA-2021-204-002	22 Jul	0540	6.0	22 Jul	1210	10.0	12	900
Cape Horn Creek								
GAA-2021-205-001	24 Jul	0600	6.0	25 Jul	0512	6.5	1	104
GAA-2021-205-002	24 Jul	0700	6.0	24 Jul	1000	11.0	2	611
Bear Valley Cr								
GAA-2021-215-001	3 Aug	0700	12.5	4 Aug	0500	14.0	9	100
GAA-2021-215-002	3 Aug	0700	12.5	3 Aug	1100	16.0	9	198
GAA-2021-216-001	4 Aug	0600	14.0	4 Aug	1100	16.5	13	296
Elk Creek								
GAA-2021-217-001	5 Aug	0600	14.5	5 Aug	0945	16.0	1	174
Big Creek (upper)								
GAA-2021-218-001	6 Aug	0600	8.0	7 Aug	0500	6.5	59	53
GAA-2021-218-002	6 Aug	0600	8.0	7 Aug	0500	6.5	59	447
S Fork Salmon River								
GAA-2021-223-001	11 Aug	0600	13.5	12 Aug	0600	12.5	118	117
GAA-2021-223-001	11 Aug	0800	15.0	11 Aug	1300	17.5	117	279
GAA-2021-224-001	12 Aug	0600	12.5	12 Aug	1000	16.0	118	354
Secesh River								
GAA-2021-225-001	13 Aug	0600	11.0	13 Aug	1000	14.0	26	750
Lake Creek								
GAA-2021-226-001	14 Aug	0600	9.0	14 Aug	1100	11.0	3	500
Chamberlain Creek								
GAA-2021-228-001	16 Aug	0630	11.0	17 Aug	0545	11.0	25	250

***** Fish were captured using a beach or purse seine

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 2021.

Streams & Dates	Section covered	UTM start		UTM end	
		Northing	Easting	Northing	Easting
Loon Creek					
7/21/2021	left bank	4942235	11T0675164	4941867	11T0674665
7/21/2021	right bank	4942247	11T0675164	4941873	11T0674656
Valley Creek					
7/22/2021	right bank	4899712	11T0661397	4899712	11T0660733
7/22/2021	left bank	4899456	11T0661378	4899712	11T0660733
7/22/2021	both banks	4898712	11T0660733	4899723	11T0660667
Marsh Creek					
7/23/2021	left bank	4917434	11T0645813	4916996	11T0646249
7/23/2021	right bank	4917431	11T0645800	4916991	11T0646243
Cape Horn Creek					
7/24/2021	left bank	4917384	11T0645765	4916761	11T0645367
7/24/2021	right bank	4917393	11T0645755	4916817	11T0645407
Bear Valley Creek					
8/3/2021	right bank	4920710	11T0633358	4920898	11T0632557
8/3/2021	left bank	4920710	11T0633358	4920779	11T0632332
8/4/2021	right bank	4919145	11T0630293	4918514	11T0629800
8/4/2021	left bank	4919159	11T0630334	4918587	11T0629753
Elk Creek					
8/5/2021	left bank	4919159	11T0630334	4918587	11T0629753
8/5/2021	right bank	4918808	11T0629510	4918688	11T0628811
Big Creek (upper)					
8/6/2021	left bank	4996815	11T0631716	4995440	11T0631340
8/6/2021	right bank	4996818	11T0631719	4995495	11T0631296
South Fork Salmon River					
8/11/2021	left bank	4946562	11T0602943	4945327	11T0602941
8/11/2021	right bank	4946585	11T0602928	4945502	11T0602071
8/12/2021	left bank	4945327	11T0602941		
8/12/2021	right bank	4945331	11T0602911	4945112	11T0602789
Secesh River					
8/13/2021	left bank	5006444	11T0593219	5006777	11T0593225
8/13/2021	right bank	5006435	11T0593240	5007206	11T0593523
Lake Creek					
8/14/2021	left bank	5012339	11T0586129	5012769	11T0585884
8/14/2021	right bank	5002340	11T0586129	5013062	11T0585702
Chamberlain Creek					
8/16/2021	left bank	5026462	11T0642325	5026206	11T0642191
8/16/2021	right bank	5026462	11T0642334	5026204	11T0642157

Appendix Table 4. Summary of observed total mortality for PIT-tagged wild Chinook salmon parr collected from Idaho streams from July through August 2021. 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.

			Fish rejected for tagging		Observed mortality			
					Collection and	Tagging and	Total	
Stream	Fish collected (n)	Fish tagged (n)	(n)	(%)	handling	delayed	(n)	(%)
Loon Creek	314	250	64	20.4	1	0	1	0.3
Valley Creek	1,215	1,000	215 (1)	17.7	3	0	3	0.2
Marsh Creek	1,275	1,000	275 (4)	21.6	11	0	11	0.9
Cape Horn Creek	1,227	715	512 (13)	41.7	11	0	11	0.9
Bear Valley Creek	628	594	34 (4)	5.4	23	1	24	3.8
Elk Creek	183	173	10 (1)	5.5	8	0	8	4.4
Big Creek (upper)	552	500	52 (3)	9.4	7	0	7	1.3
S Fork Salmon R	816	750	66 (24)	8.1	9	0	9	1.1
Secesh River	540	500	40 (5)	7.4	5	0	5	0.9
Lake Creek	627	500	127 (14)	20.3	6	0	6	1.0
Chamberlain Cr	277	250	27 (1)	9.7	2	0	2	0.7
Totals/averages	**7,654**	**6,232**	**1,422 (70)**	**18.6**	**86**	**1**	**87**	**1.1**